Distal Radius Fracture: Relationships Between Psychological Factors and Recovery.

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Declaration

This thesis has been composed by myself and is entirely my own work. Contributions from others have been clearly stated in Acknowledgements or cited in References. The work has not been submitted for any other degree or professional qualification.

Stuart Goudie

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Abstract

Distal radius fracture is a common injury. The majority of people recover well but a proportion have ongoing pain, stiffness, deformity and functional limitation. Associations between these outcomes, injury characteristics and treatment methods are inconsistent, for example a deformed wrist is not always painful, stiff and functionally limiting. The psychological response to fracture and the role that psychological factors play in recovery are complex and poorly understood. Identification and treatment of those psychological factors that might influence disability and symptom intensity could improve outcomes in this large group of patients. The aim of this thesis is to explore the influence of psychological factors on outcome following fracture of the distal radius.

To investigate these relationships further a literature review was carried out looking at the association between psychological factors and outcomes in distal radius fracture patients. Prospective studies were then performed in order to identify associations between demographic factors, injury severity, treatment and psychosocial factors and symptom intensity and disability after fracture and to identify predictors of psychological response to injury. A prospective randomised controlled trail (RCT) was then carried out to compare the impact of an additional psychological workbook intervention versus an information workbook in the otherwise routine management of distal radius fracture.

The literature review identified evidence to support the association between psychological factors and outcome after acute injury in general but limited evidence specifically pertaining to distal radius fracture. The first prospective study of 216 patients found psychosocial factors to be more strongly associated with disability (Disability of Arm Shoulder and Hand score, DASH) and pain intensity after distal radius fracture than any injury or treatment factor. The second prospective study of 153 patients found that psychological traits are relatively stable in this cohort and that no demographic, injury or treatment factors were associated with the small changes in psychological scores up to 10 weeks following injury. The RCT demonstrated that use of a psychological workbook did not significantly improve disability six weeks after injury compared to an information workbook in a cohort of patients with distal radius fracture (DASH 38 vs 35, p = 0.949).

The importance of psychosocial factors in recovery from distal radius fracture has been demonstrated. Following this injury, psychological factors remain stable over time or

fluctuate to a small degree with distinct trends. In cohorts with stable psychological responses to fracture, the individual psychological response cannot be reliably predicted by demographic, injury or treatment factors. Use of a psychological workbook intervention does not improve outcomes in patients with a good initial psychological response to injury. Future work should investigate less psychologically stable and well adapted cohorts, establish how best to identify patients at risk of poor outcome and whether, indeed, these specific groups are amenable to treatment and if so what form this intervention should take. It should address limitations identified in this work, primarily, reduce questionnaire fatigue with more focused psychological questionnaires. Ultimately, it should work towards creating a structure where patients can be screened with a recognised psychological scoring system at initial presentation to fracture clinic and allow a sub-group of psychologically mal-adpted patients to be referred on to a dedicated psychology service, that would work to optimise the psychological conditions for recovery.

Lay Summary

Wrist fracture is a common injury from which most people recover well. However, some patients develop long term pain and disability despite having similar injuries to those who recover well. The variation in pain and disability among patients with similar medical conditions is due to the patients' psychological make up and social circumstances. The role of psychology and social circumstances in recovery from wrist fracture is not well understood. The identification of psychological traits that result in poor recovery would help surgeons make treatment decisions and counsel patients; it might also aid the development of psychological therapies to supplement routine surgical care. The aim of this thesis was to explore the influence that psychology has on recovery from wrist fracture.

This was done by reviewing the current literature regarding the association between psychology and recovery. Two prospective studies of patients with wrist fracture were then carried out. The first aimed to identify psychological factors that could be measured at the time of injury and were associated with long term pain and disability. The second aimed to investigate whether the psychological response to injury was associated with patient characteristics or a specific type of wrist fracture. Finally, a randomised controlled trial was carried out to compare disability 6 weeks after injury in a group of patients that were given a psychological workbook with another who were given an information-only workbook.

The literature review identified evidence to support the association between psychological factors and outcome after acute injury but very little evidence referring specifically to distal radius fracture. The first prospective study found that identifiable psychological traits and social circumstances were more strongly associated with the level of pain and disability experienced by patients after injury than the specific characteristics of the injury or treatment given. The second prospective study found that no specific patient, injury or treatment characteristics were associated with psychological response to injury. The RCT demonstrated that use of a psychological workbook did not reduce disability six weeks after injury compared to an information workbook in patients with wrist fracture.

The thesis demonstrated the importance of psychology in recovery from wrist fracture. It showed a patient's psychological response to injury cannot be predicted by their demographic details, injury or treatment characteristics. It found that the use of an additional psychological workbook during recovery does not reduce disability. Further work is needed

to develop a process that can identify patients at risk of high disability and pain after wrist fracture and then psychological treatments should be tested in these patients.

1 Introduction and literature review

1.1 Distal radius fracture

1.1.1 Definition

Distal radius fracture is a disruption of cortical bone in the metaphyseal region of the distal radius.

1.1.2 Epidemiology

There are around 120,000 distal radius fractures in the United Kingdom each year. They account for 17.5% of all adult fractures (1). The incidence of adult distal radius fractures in Scotland was 297 per 100,000 per year in 2010-11 (2), with a 2 to 3 times higher incidence in females than males (2, 3). This injury has a Type A age and gender fracture distribution curve (as described by Court-Brown et al. (1)) with an increased incidence among young males and a peak in elderly females (4). The average age is 44 among males and 64 among females (4).

The majority (90%) of distal radius fractures are a result of low energy injury, most often a fall from a standing height (1, 3, 5, 6). The injury is most often caused by an axial compression force to the outstretched hand. When the hand is dorsiflexed at impact compression of the dorsal cortex and tension on the volar cortex results in the typical pattern of dorsal displacement and angulation with dorsal comminution and radial shortening. Orthodoxy suggests that axial compression with the wrist flexed causes displacement and angulation in the volar direction (7). Around 60% of fractures are extra articular (AO-OTA fracture classification Type A (8)), 10% partial articular (AO-OTA fracture classification Type B) and 30% complete articular (AO-OTA fracture classification Type C). Metaphyseal fractures can be stable or unstable (which displace with time) (4). Only a very small proportion are complex intra articular fractures. They may be associated with fractures of the ulnar styloid/neck, injury to the triangular fibro cartilage complex (TFCC), disruption of the distal radio ulnar joint (DRUJ) or disruption of the interosseous carpal ligaments, carpal fractures and dislocation.

As a result of the increasing size of the active elderly population in developed countries the societal and economic cost of distal radius fracture is considerable and rising. The estimated cost of surgically treating a distal radius fracture in an NHS hospital in England is between £3440 and £4154 and the cost from a societal perspective, where time off work etc. is included, is between £3832 to £4413 depending on surgical technique (9). Time off work varies following fracture with the average being 9.4 weeks (10).

1.1.3 Treatment

Treatment varies according to patient, treating institution, fracture pattern and surgeon. The aim is to facilitate the return of satisfactory function and alleviate pain. This is done by providing stability for fracture healing and restoring anatomy in fit and active patients. There is a role for a variety of operative and non-operative management techniques. In situations where the treating surgeon feels a number of techniques could successfully be used there is no consensus as to which is superior (11, 12).

Non-operative management options include a period of immobilisation in a cast or wrist splint (with or without prior fracture reduction under anaesthetic) for a period of 4-6 weeks. Surgical treatment options include open reduction and internal fixation with a volar locked plate, manipulation under anaesthetic with Kirshner Wire fixation and external fixation.

1.1.4 Objective outcomes

A metaphyseal fracture of the distal radius can be expected to unite 4 to 8 weeks following injury. Patients can expect a small to moderate residual impairment in terms of range of motion (13-16). Systematic review of studies looking at outcomes after distal radius fracture in patients with a mean age of 60 or greater, including all treatment methods, found the mean flexion extension arc to be 115 degrees and the mean rotation arc to be 155 degrees at 1 year. Potential adverse events include mal-union resulting in reduced forearm rotation and weakened grip strength, extensor pollicus longus rupture, carpal tunnel syndrome and iatrogenic complications of surgery such as infection.

A study of 36,618 patients in the Swedish National Patient Registry found the reoperation rate following open reduction internal fixation of distal radius fracture to be 7%. The most common reason was removal of metal work, followed by reoperation with in 28 days for loss of reduction, carpal tunnel release, tendon repair and corrective osteotomy for mal-union (17). When the aim of additional surgical intervention is to relieve pain, or improve function in cases where fixation appears satisfactory and in cases of elective metalwork removal there may be a discord between pathology and symptoms, which suggests that both patient and surgeon psychological factors may influence the decision-making process. Decision making conflict is a state of uncertainty about the course of action that should be taken. It can occur when the best treatment is unclear or when the patient is ill informed or has poorly defined preferences (18). Specific surgeon – patient interaction during consultations and self-efficacy are both associated with decision making conflict (19). The association between decision making conflict and outcome has not been studied.

Complex regional pain syndrome (CRPS) is characterised by disproportionate pain, loss of function, vasomotor and sudomotor symptoms and signs and regional osteoporosis. It is seen in around 7% of patients with upper limb fracture (20). Its aetiology remains poorly understood and it is diagnosed on the basis of officially endorsed standardised criteria, the International Association for the Study of Pain (IASP) Modified Criteria for Complex Regional Pain Syndrome (21), which make it an objectively measurable outcome. Diagnostic criteria are seen in Section 2.3.5.3. CRPS is categorised as Type 2 if it is associated with injury to a major nerve and Type 1 if not. In its acute phase pain, swelling, increased temperature and skin colour changes are classically seen. The majority of these cases resolve spontaneously within 12 months of onset (22). A small number develop chronic CRPS, characterised by contractures, cold, sweaty skin and trophic skin and nail changes in the affected area. Although poorly defined, consensus of current opinion considers the aetiology of CRPS to be a multifactorial process. The mechanism may vary between patients and driving factors change with time for an individual patient. Nerve injury, oxidative stress, altered sympathetic nervous system function, inflammatory mediators and genetic predisposition have all been implicated (20). Following distal radius fracture there is evidence that there is no association between age, gender, type of fracture or subsequent orthopaedic management and development of CRPS (23) although increased cast tightness has been associated with development of CRPS (24). The disparity between physiological stimulus, pain experience and loss of function raise the question of what role, if any, do psychological factors play in the development of CRPS. The evidence for this is conflicting. Banu et al found that following upper extremity fracture higher levels of anxiety around the time of injury were associated with CRPS at 2-4 months (25), whereas Beerthuizen et al found no association between psychological factors and CRPS in a prospective trial of 748 patients (26). Beerthuizen et al did not include anxiety as one of their psychological factors. In a systematic review of 20 studies assessing the associations between psychological factors and CRPS, fifteen reported the presence of depression, anxiety and stress in patients with CRPS (27). This review is limited by the poor quality of literature on this subject, the majority of which is retrospective and cross sectional and a causal link between these psychological factors and CRPS cannot be made. Fear avoidance behaviours lead to disuse as described in Section 1.3.1. Artificially induced periods of disuse using cast immobilisation in animal models (28) can produce signs and symptoms of CRPS. No studies have considered the role of specific constructs from the Fear Avoidance Model in the development of CRPS. It seems very likely that psychological factors play a role in the aetiology of CRPS and if not they are certainly associated with the pain experience and disability that it creates. To date this has not been well defined.

1.1.5 Pain, disability and patient reported outcomes

It is recommended that radiocarpal alignment and radial length be restored, and an articular gap of less than 2mm be achieved, to optimise outcomes after distal radius fracture (29). Fracture classification has been consistently shown to have no association with functional outcome (30, 31). Articular congruity is associated with development of secondary arthritic change is the radio carpal joint but does not correlate with functional limitation (32). Radial shortening is considered one of the radiographic features most closely linked to functional outcome (33, 34). Radiocarpal malalignment is associated with reduced grip strength and worse functional outcome (16, 33) while dorsal tilt is associated with increased functional limitation (35).

However, the associations between these objective measures (radiographic parameters) and patient reported outcomes (symptom intensity and disability) are inconsistent (4, 29, 36-38). Forward et al followed up 108 patients for a mean of 38 years after conservatively managed distal radius fracture and found that although 65% were mal-united none reported any functional limitation as a result of the deformity (39). Randomised controlled trials comparing treatment modalities demonstrate that some techniques are more effective in terms of restoring and maintaining fracture reduction but this does not equate to improved functional outcome (28, 40). Radiographic measures have a role as predictors of functional outcome but this may be limited to the identification of patients with marked deformity that have an increased risk of poor functional outcome.

Patient reported outcome measures (PROMS) represent a patient's own interpretation of their injury illness or health. They are not an objective measure of outcome such as implant failure or radiographic alignment. As such PROMS are influenced by the personal and environmental context in which the patient experiences their illness and their personal interpretation of symptoms and pathological features. That is to say, psychosocial factors have a bearing on PROMS (37, 41-43).

Pain and function are closely linked. Pain is the dominant symptom following fracture (44, 45) and is therefore integral to PROMs in this context. Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage (46). The relationship between intensity of nociceptive stimulus and pain experience is not consistent, varies from person to person and is dependent on situation (47, 48). For example, an athlete may injury them-self during competition but only experience pain after the contest is over.

The World Health Organisation (WHO) defines disability as 'an umbrella term, covering impairments, activity limitations, and participation restrictions. An impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations' (49).

One year after distal radius fracture the majority of people have made a full recovery (11, 37, 50) but there remains a group, between 1% and 37%, who report disproportionate pain and disability (23, 51). The persistence of pain, stiffness and functional impairment is not closely associated with biological factors studied to date, such as, injury characteristics or treatment method (4, 29, 36-38). In many medical conditions, it is recognised that factors outwith disease pathophysiology (biomedical factors) may determine the course and outcome of illness or recovery from injury. These are described in the biopsychosocial model of health. This model suggests that biomedical factors, psychological factors and social factors all influence health. Factors in each of these three areas may account for the unexplained variance in outcome after distal radius fracture. The psychological response to distal radius fracture and the role that psychological factors play in recovery is not well understood and requires further investigation. An understanding of what factors influence poor outcomes would allow at risk patients to be identified and poor outcome to be avoided.

1.2 Illness models and outcome following injury

Illness models describe how different factors interact to create a state of ill health. The biomedical model considers illness to be a direct result of disruption of the normal function of an organ system caused by cellular dysfunction, infection, biochemical imbalance or biomechanical abnormality. This model has successfully driven understanding of the biomedical basis of illness and innovation of biomedical treatment. However, it fails to recognise the significant impact of psychological, social and environmental factors in the translation of a biomedical process to disability, symptom intensity and ultimately the impact on health, Figure 1-1 highlights the limitations of the biomedical model (52-56). The World Health Organisation (WHO) has identified the importance of these factors (57). The International Classification of Functioning Disability and Health (ICF) describes the associations between impairment, disability and health in an integrated 'bio-psycho-social' model (58-61). The biopsychosocial model, Figure 1-2, aims not to diminish the importance of biomedical factors but to encourage consideration of psychosocial factors in a holistic approach to health care.

1. A biochemical, anatomical or biomechanical alteration does not translate directly into an illness. The appearance of illness results from the interaction of diverse causal factors, including those at the molecular, individual, and social levels. And the converse, psychological alterations may, under certain circumstances, manifest as illnesses or forms of suffering that constitute health problems, including, at times, biochemical correlates
2. The presence of a biological derangement does not shed light on the meaning of the symptoms to the patient, nor does it necessarily infer the attitudes and skills that the clinician must have to gather information and process it well
3. Psychosocial variables are more important determinants of susceptibility, severity, and course of illness than had been previously appreciated by those who maintain a biomedical view of illness
4. Adopting a sick role is not necessarily associated with the presence of a biological derangement
5. The success of the most biological of treatments is influenced by psychosocial factors, for example, the so-called placebo effect
6. The patient-clinician relationship influences medical outcomes, even if only because of its influence on adherence to a chosen treatment
7. Unlike inanimate subjects of scientific scrutiny, patients are profoundly influenced by the way in which they are studied, and the scientists engaged in the study are influenced by their subjects

***Figure 1-1: Limitations of the Biomedical Model.** (55, 56).*

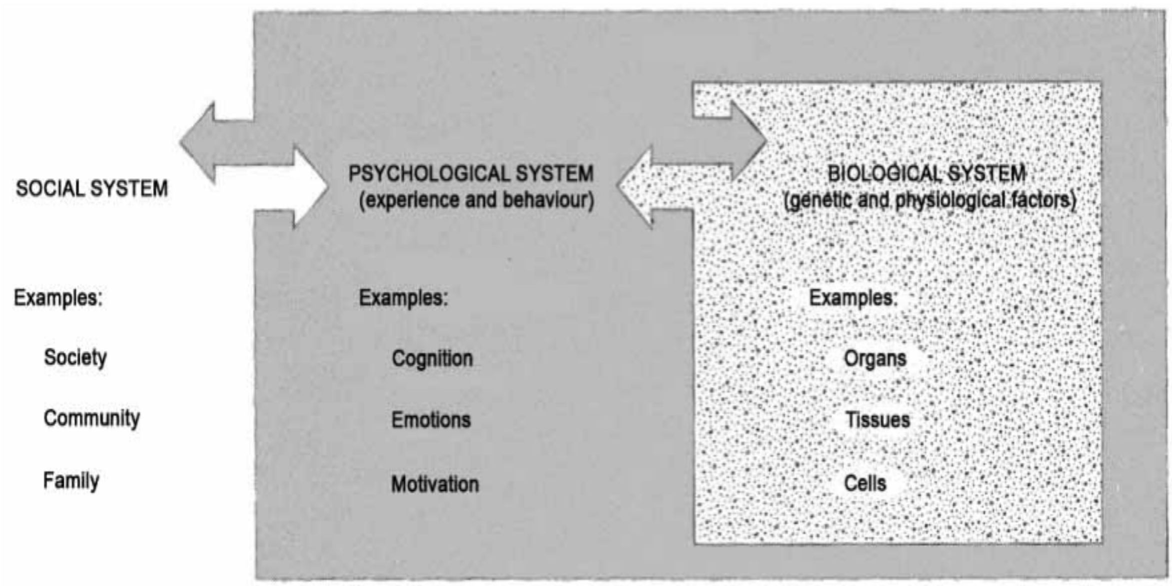

Figure 1-2: Relations between biological, psychological and social aspects in biopsychosocial model of health and disease (62).

1.2.1 The biopsychosocial model in orthopaedics

Consideration of the biopsychosocial model is important in the management of distal radius fracture. Patients in whom symptoms and disability are driven by psychosocial issues rather than an underlying biomedical problem may be better served by interventions focusing on reducing distress and teaching effective coping strategies rather than surgical intervention to correct deformity. An understanding of the psychological factors that are risk factors for adverse outcome after fracture would help surgeons identify these patients and target surgical intervention effectively. Treatment programmes to provide support and develop coping skills could supplement routine trauma care, improve patient reported outcomes (PROMS) and maximise health. Examples of the relevance of the biopsychosocial model in clinical orthopaedic practice include: the discordance between radiographic signs of arthritis, pain and disability; the variation in pain and functional ability among patients after total knee arthroplasty; the decision of one patient with degenerate rotator cuff tendinopathy to present to orthopaedic services seeking treatment and another's decision not to.

PROMs data are becoming increasingly important in modern day orthopaedics. They are widely used in research, registries, audit of surgeon performance and to guide resource management. It is therefore important to consider every way in which these can be improved.

Several psychological models have been described which provide insight into the role of psychological factors in the recovery from injury. These provide a basis for quantitative research looking at the relationships between psychological and outcomes.

1.3 Psychological models in musculoskeletal injury

Psychological models are frameworks used to describe the interaction of psychological factors and explain their impact on health.

1.3.1 The Fear Avoidance Model

The Fear Avoidance Model (FAM) describes how a nociceptive stimulus leads to disability, Figure 1-3, (63-65). Following injury and the development of acute pain, an individual either confronts the pain, adapts and recovers or they fail to confront the pain and enter a vicious cycle of mis- and over-interpretation of symptoms. Patients who respond badly develop an exaggerated response to the nociceptive stimulus. They ruminate, feel helpless and over interpret its harmful significance (catastrophic thinking) (66). These patients then develop a fear of pain and anxiety in anticipation of pain, movement or re-injury (kinesiophobia) which continues even when the painful stimulus has ceased. Fear and anxiety precipitate negative coping strategies (avoidance and escape behaviour) such as disuse and over protection which increase disability. Disuse and disability are associated with depressive symptoms which feedback to increase the pain experience. Constructs in the FAM are linked to psychological distress, which is caused by feelings of helplessness, fear and horror after injury. Post-traumatic stress disorder (PTSD) represents one extreme on a spectrum of symptoms of psychological distress that can affect patients following injury (59). Symptoms can be broadly grouped as: re-experience; avoidance and emotional numbing; and hyperarousal. These must be present for more than one month and start within 6 months of the traumatic event to meet the diagnostic criteria for PTSD (59) but less severe, shorter periods of psychological distress are also important.

In the context of distal radius fracture the Fear Avoidance Model represents a normal adaptive short term response which protects an acute injury (67). Problems arise when this normal response is exaggerated or persistent and becomes counterproductive (68), like a smoke alarm that continues to sound once the fire has been extinguished.

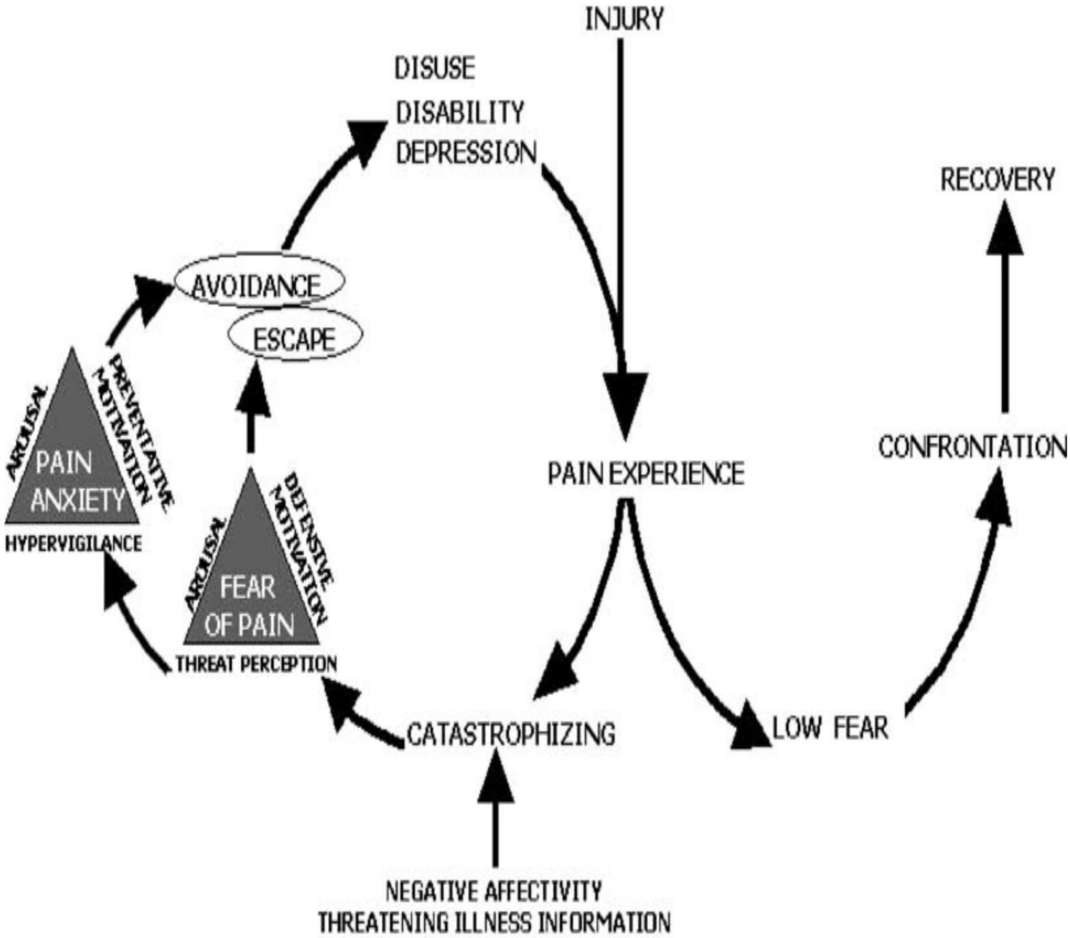

Figure 1-3: The Fear Avoidance Model (68). (Reproduced with the permission of Springer Publications).

1.3.2 Self-efficacy Theory

Self-efficacy Theory states that behaviour change (the ability to adapt and cope with adverse situations) will not occur without sufficient self-efficacy (69). Self-efficacy Theory is a core concept of Social Cognitive Theory, the theory that learning (including interpretation and reaction to illness) is a product of physical, psychological, spiritual and social factors. Perceived self-efficacy refers to a belief in one's own capabilities to organise and execute the appropriate actions to produce a given outcome (70). It is a product of efficacy expectations and outcome expectations, Figure 1-4. Efficacy expectations (EE) are the conviction that one can successfully perform a behaviour and outcome expectations (OE) are the conviction that performing a certain behaviour will result in a specific outcome (69, 71).

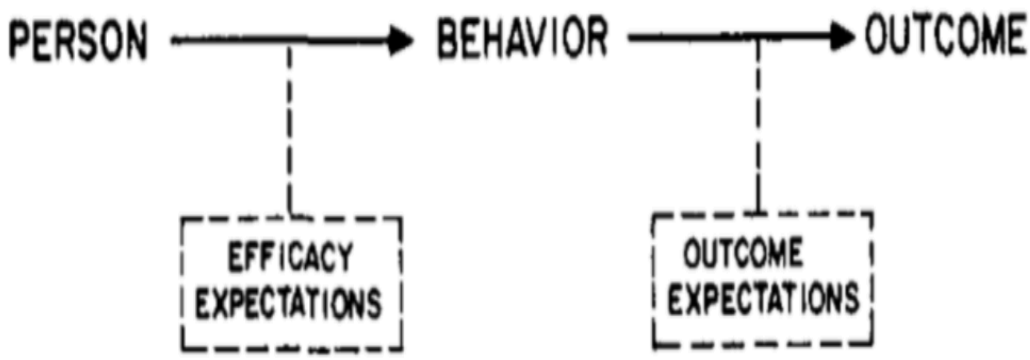

Figure 1-4: Self-efficacy Theory: diagrammatic representation of the difference between efficacy expectations and outcome expectation (69). (Reproduced with the permission of Elsevier).

In the context of rehabilitation from distal radius fracture if a patient (PERSON) moves their wrist despite pain (BEHAVIOR) this will result in an earlier return of activities of daily living (OUTCOME). The patient's efficacy expectations refer to their belief that they can move their wrist despite pain. The patient's outcome expectations refer to their belief that moving their wrist despite pain will result in a quicker return to activities of daily living. The level of a patient's EE and OE affect participation and persistence with the behaviour and ultimately outcome (72, 73). If perceived self-efficacy is lacking people tend to act ineffectually even if they have been told what they should do. If a patient believes that wrist movement despite pain improves recovery (high OE) but has strong beliefs that they are unable to move their wrist when it is sore (low EE), or vice versa, they will not perform the behaviour and so not achieve the outcome.

There are four sources of information that can result in a change in self efficacy. Personal experience (performance accomplishment), vicarious experience, verbal persuasion and emotional arousal. Performance accomplishment, a personal experience that one can perform a behaviour and that by performing this behaviour a desired outcome is achieved, is the most influential. Success breeds success and builds up over time. Occasional failures which are then overcome have a further strengthening effect. The effect of performance accomplishment is to a degree generalisable to other unrelated tasks but the strongest impact is task specific.

Vicarious experience, seeing others perform a behaviour and achieve a specific result, can improve perceived self-efficacy but is less dependable than performance accomplishment.

Verbal persuasion, when people are told they can perform or are led through persuasion to believe they can perform a behaviour and achieve a result is readily accessible and commonly used by surgeons in an outpatient setting but is weaker than development by personal achievement. Telling patients they will benefit from a treatment does not mean they necessarily will, particularly if it contradicts their personal experience. The efficacy of verbal persuasion is affected by confidence in the source of information and understanding of the advice.

Emotional arousal (emotional response to a situation) is the final pathway. People rely on information fed back from their psychological state to help make judgements about their capability to perform in a certain situation. Emotions such as stress and anxiety are usually associated with difficulty and poor performance so when these are experienced the expectation is of failure, and perceived self-efficacy will fall (69). The aim of rehabilitation should be to increase perceived self-efficacy by these methods and improve the ability to cope and adapt.

1.3.3 The Common Sense Model of Illness Representation

The Common Sense Model of Illness Representation emphasises the role of the individual's beliefs, social factors and environmental factors in health. The Self-Regulatory Framework integrates these factors and describes how patients represent and respond to health stressors (74-76). Individual patients are described as problem solvers dealing with two closely related phenomena that determine beliefs and subsequent actions. Firstly, the perceived reality of the health threat and secondly the emotional reaction to this threat. Perceptions of reality revolve around five distinct illness/injury dimensions: identity, timeline, cause, controllability and consequence. Table 1-1 explains these domains. Patients assimilate information from internal and external sources and interpret it in the context of prior experience and their social and environmental circumstances. Perceptions in each area are developed based on this information and in the context of emotional reaction (worry, anxiety, anger, fear). Beliefs and actions evolve over time as patients continually re-appraise their perceptions in the context of their changing situation. A rugby player who sustains a metacarpal fracture during a match may continue to play without loss of function but his perceptions of this injury may however change 2 days after the match once the diagnosis and prognosis are clear. His level of pain and disability will have likely increased by this time.

Illness cognition dimensions	**Description**
Identity	The location, extent and feel of symptoms that patients attribute to injury
Timeline	Expected timeline for recovery: acute, chronic, cyclical
Causal	Perceived cause of injury
Controllability	Responsiveness of injury to own action / treatment
Consequence	Personal, emotional and economic implications of injury

Table 1-1: Illness/injury perception dimensions in Common Sense Model Self-Regulatory Framework.

An understanding of how psychological factors affect recovery from distal radius fracture should be important to clinicians. It can help explain the discordance between pathophysiology and symptom intensity / magnitude of disability. It could allow the development of more accurate outcome measures, the more accurate prediction of outcome and create opportunities for improved recovery. This is a new area of research interest where there is a great potential of novel work that will directly impact clinical care.

The aim of the remainder of this chapter is to review current knowledge regarding the relationship between outcomes following distal radius fracture and the three psychological models described in Section 1.3. It will also consider the current evidence that interventions targeting psychological factors can impact outcomes, seek to identify gaps in current understanding and highlight important areas for future investigation. The focus will be on evidence specific to distal radius fracture but where this is limited the broader orthopaedic literature will be included. The literature reviewed was identified with an extensive online search of literature and follow up of references, it was not a formal systematic review.

1.4 Relationship between psychological models and outcome

1.4.1 Fear Avoidance Model constructs and outcome

The FAM is comprised of a number of individual constructs: pain experience, catastrophic thinking, negative affect, anxiety and fear and psychological distress.

1.4.1.1 Pain experience

Pain experience is traditionally considered an outcome measure but some outcome studies in musculoskeletal disease and distal radius fracture include it as a predictor of longer-term outcome. Baseline pain intensity is associated with long-term pain intensity and to a lesser extent disability after musculoskeletal trauma (38, 77-80). Mehta et al found that following distal radius fracture patients with a baseline score of >34/50 in the pain component of the Patient-Rated Wrist Evaluation (PRWE) score had an 8 times greater risk of developing chronic hand and wrist pain than those without (81). These associations are stronger than those between the level of nociceptive stimulus and outcome. Pain intensity for a given level of nociception is determined by psychosocial factors, and it is therefore these psychosocial factors that determine both pain experience and long-term outcome.

1.4.1.2 Catastrophic thinking (pain catastrophising)

Catastrophic thinking is a widely studied ineffective coping strategy that is strongly associated with pain intensity, magnitude of limitations, and ongoing use of opioids after injury. The influence of catastrophic thinking on patient reported outcomes is often greater than the influence of physical impairment (82-84). Ring et al found that in a mixed cohort of surgically managed orthopaedic trauma patients catastrophic thinking measured shortly after injury was the sole predictor of both pain and disability at 5 to 8 months (85). Among people recovering from a distal radius fracture, greater catastrophic thinking is associated with reduced grip strength, reduced motion, increased disability and pain intensity, reduced muscle function, and slower recovery (86, 87). Roh et al measured catastrophic thinking pre-operatively in 121 patients undergoing surgical management of their distal radius fracture and found that higher scores were independently associated with worse grip strength, range of motion and functional outcome score (86). Catastrophic thinking and depression are correlated but are considered independent constructs that have a synergistic effect on outcomes (66, 88, 89).

However, despite finding an association between catastrophic thinking and pain, a number of studies of patients recovering from hand fractures, acute musculoskeletal injury, lower extremity injury, and elective orthopaedic hand surgery failed to find similar associations between catastrophic thinking and disability (90-93). Contradictory conclusions may be due to differences in study cohorts, the questionnaires used, and covariates included in regression analyses. Studies of populations with higher baseline levels of catastrophic thinking are more likely to find associations with long-term outcomes than those with low mean baseline scores; there is thought to be a 'dose dependent' effect of catastrophic thinking (94).

1.4.1.3 Negative affect (depressive symptoms)

Depressive symptoms are common among orthopaedic trauma patients with a prevalence between 22-45% (95-99). Symptoms may pre-date the traumatic injury or develop as a result of it and its impact on a patient's life (82). They are often persistent, under-treated, and associated with poorer quality of life and increased disability (95-99). Gong et al found that 48% of patients in their cohort met criteria for depressive disorder two weeks following distal radius fracture but that treatment modality and duration of immobilisation were not predictors of depression (100).

Baseline levels of depressive symptoms are associated with symptom intensity and disability up to 1 year following wrist fracture and high levels of depressive symptoms have been associated with disproportionate pain and disability (101). In a prospective study of 228 patients over age 55 with distal radius fracture from a Level 1 Trauma Centre, Lefaivre et al found that 25% of patients were depressed at enrolment and that these patients had significantly worse DASH score at 1 year. Depression was also the strongest predictor of disability 1 year following injury (102). Similar findings are seen following minor hand surgery, and in mixed trauma and mixed minor injury cohorts in which increased symptoms of depression are consistently correlated with higher pain intensity, greater disability, delayed return to work, and reduced grip strength (54, 82, 85, 93, 103, 104). Even in comparatively minor injuries such as proximal interphalangeal joint sprain / dislocation Bot et al found depression to be associated with both pain and stiffness (105).

1.4.1.4 Anxiety and fear (avoidance behaviour)

In acute and chronic pain cohorts, back pain and sports injuries, anxiety and fear constructs are associated with disability and pain (65, 106-108). In a cohort of 187 patients with anterior cruciate ligament injury, fear of re-injury was one of the factors most strongly associated with return of function and return to sport (109). In fracture cohorts, the findings are less consistent (54, 85, 86, 92, 101). In a cross sectional study of patients with hand fractures Keogh et al found that pain related anxiety is associated with task related pain and anxiety sensitivity is associated with disability (91). Bot et al found that pain anxiety accounted for 9% of the variation of grip strength in patients recovering from distal radius fracture. However, in a cohort of patients with severe lower extremity fracture in a Level 1 Trauma Centre Archer et al found no such association between fear of movement and functional outcome. These differences may exist because pain-anxiety and fear avoidance have a more subtle influence that is more difficult to measure than some of the other psychological constructs such as depression. However, conclusions are limited by the small number of studies focusing on acute injury and variety of different anxiety/fear constructs and outcome measures used. Table 1-2 describes a number of commonly used constructs.

Anxiety / fear construct	**Description**
Trait anxiety	A person's background baseline level of anxiety. (110)
State anxiety	Current level of anxiety in response to a situation. (110)
Pain anxiety	Anxiety caused by anticipation of pain. (111)
Anxiety sensitivity	Fear of anxiety related situations. (112)
Kinesiophobia	Avoidance of movement due to fear of pain or re-injury. (113)
Fear-avoidance	Avoidance behaviour in response to fear. (114)

Table 1-2: Commonly used anxiety / fear related constructs.

1.4.1.5 Psychological distress

PTSD is common following orthopaedic trauma. High levels of PTSD symptoms are seen in as many as 20% of road traffic accident victims and 33% of children with orthopaedic injuries (115-117). It has a negative impact on physical and mental health (118, 119). Psychological distress in response to high-energy injury is correlated with functional outcome at 6 months and 5 years. Level of distress following injury is independent of preinjury level and only weakly related to injury severity (120, 121). The limited number of studies looking at isolated low energy fracture such as distal radius demonstrate that symptoms of distress correlate with disability at 5 to 8 months and mediate the relationship between pain and disability (82, 101).

1.4.2 Self-Efficacy Theory

There is a growing body of evidence supporting the association between self-efficacy and outcome after acute injury but this has not been adequately studied after distal radius fracture. High levels of self-efficacy are associated with increased physical function, reduced pain, reduced stiffness, earlier return to work and better patient reported measures of health (90, 105, 122-124). These findings echo work done looking at hip fracture, ACL rupture and chronic pain (125-132).

1.4.3 Common Sense Model of Illness Representation

Following acute injury, illness perceptions can change with time (133). There are no studies looking at the relationship between illness perceptions and outcome after distal radius fracture. In a mixed cohort of orthopaedic trauma patients Chaboyer et al found that perceptions of long recovery time and high injury identity (association of many symptoms with injury) are associated with worse patient reported outcomes at six months, independent of demographics or injury characteristics (134). In numerous other medical conditions such as acute myocardial infarction, there are moderate to strong associations between dimensions of illness perception, coping strategies and outcomes. Belief that an illness is controllable is an effective coping strategy whereas perceptions of high illness identity is maladaptive and associated with avoidance and helplessness. Better outcomes are associated with lower perceptions of consequence (the significance / impact of the injury), emotion and illness identity, higher perceptions of control and expectations of a short recovery time (135, 136).

1.5 Psychological interventions

Injury related morbidity is associated with psychological factors. These include the psychological responses, perceptions and attitudes which are drivers of the models described in Sections 1.3 and 1.4. Some are potentially modifiable and it is therefore possible that interventions targeting these factors will improve outcomes when used in conjunction with routine orthopaedic care. Several intervention studies targeting different psychological factors in patients with a variety of conditions (injuries) have been reported. These are reviewed in relation to the psychological model which the intervention is derived from.

1.5.1 Interventions based on The Fear Avoidance Model

Interventions such as cognitive behaviour therapy and self-regulatory treatments are designed to reduce negative / counterproductive responses to injury as conceptualised in the FAM and thus improve outcome.

Preliminary findings of a RCT of a psychological intervention in acute trauma patients, in which a therapist delivered six sessions of cognitive behaviour therapy (CBT) and relaxation techniques to target negative thoughts, catastrophic thinking and pain anxiety, demonstrated a large effect size and improved disability, coping strategies and mood (137). A pilot RCT looking at multidisciplinary intervention following acute non-life threatening orthopaedic trauma suggests a positive role for psychological intervention when used as part of a wider intervention strategy in this group of patients (138). The intervention provided care from a rehabilitation doctor, a physiotherapist and an occupational therapist during two 4 hour appointments. It aimed to address a wide range of issues from pain management to mobility aids. The psychological component involved prescription of antidepressants where needed, goal setting exercises, and psycho-education regarding PTSD and CBT for depression. Patients in the treatment group reported significantly improved relief of pain as a result of the intervention and few patients in this group developed new diagnoses of PTSD and depression during recovery. This evidence regarding patients with fractures is far from conclusive. A multitude of psychological based therapies have been used in rehabilitation from sports injuries and many have been shown to improve recovery to some extent, however, the heterogeneity of intervention strategy used and outcomes measures being assessed has resulted in no consensus as to best treatment being reached (139, 140). In acute back pain a RCT of a psychological intervention to address fear avoidance beliefs demonstrated an improvement in these beliefs and lower disability among a group of patients with high baseline levels of fear avoidance (141). This intervention was delivered by physiotherapists and via an information book to address fear avoidance beliefs by encouraging patients to take an active role in their recovery and educating patients to the view that their back pain is not a serious condition. A workbook led intervention which uses thought recording, reappraisal and cognitive restructuring aimed at improving catastrophic thinking and kinesiophobia improved time to return to work in patients with whiplash associated disorder (142). These studies in acute injury mirror the more extensive work done in chronic pain (143-145), where cognitive behaviour therapy and self-regulatory treatments are particularly effective (146) and accepted mainstream treatments.

1.5.2 Interventions based on the Self-Efficacy Theory

Much like the work looking at the FAM the majority of studies look at chronic musculoskeletal/pain conditions rather than acute orthopaedic trauma. The bias of current literature towards chronic rather than acute conditions stems from an appreciation of the influence that psychological factors play in chronic pain conditions that predates that in acute injury. In chronic cohorts both education-based interventions and internet-based self-management programmes increase self-efficacy and patient reported measures of health status (147, 148). Goal setting and modelling type interventions improve self-efficacy following acute sports injury and in early post-operative rehabilitation (149, 150). However, the evidence that self-efficacy can be improved in elderly hip fracture patients is mixed (151, 152). The psychological intervention used in the RCT in Chapter 5 is a workbook style intervention based on the LEARN approach to improve self-efficacy. Details of intervention and its rationale are in Section 5.1.

1.5.3 Interventions based on the Common Sense Model of Illness Representations

The efficacy of psychological interventions at altering illness perceptions and improving functional recovery following acute illness have been demonstrated in myocardial infarction (153, 154). In these studies, trained nurses delivered a psychological intervention to inpatients following acute myocardial infarction. Patients who received the intervention demonstrated a change in illness perceptions, returned to work sooner and reported fewer subsequent angina symptoms than controls. Work in acute trauma and fracture rehabilitation is scarce. A non-randomised trial comparing a nurse delivered psychological intervention that used nurse led education to target illness perceptions in patients with acute injuries (with International Severity Score >8) presenting to a Taiwanese medical centre demonstrated that perception of identity and controllability were significantly altered but this study did not assess the effect on pain and function (155).

1.6 Gaps in knowledge

Table 1-3 summarises all studies that explore the relationship specifically between psychological factors and outcomes after distal radius fracture.

Authors	**Year**	**Study design**	**Key findings**
Moseley et al (80)	2014	Prospective cohort study	Catastrophic thinking measured within 1 week of fracture associated with development of CRPS at 4 months but not part of significant regression model.
Gong et al (100)	2011	Prospective case control study	No difference in Centre of Epidemiological Studies Depression Scale (CED-S) between patients treated in cast or with volar plate following distal radius fracture, up to 24 weeks. However, depression scores improved in both groups over this time. Cross sectional analysis found depression score to be independently associated with disability and pain score at each measured time point up to 24 weeks.
Roh et al (86)	2014	Prospective cohort study	Increase in catastrophic thinking and pain anxiety score over time associated with reduced range of motion, grip strength and functional score after fracture.
Yeoh et al (102)	2016	Prospective cohort study	Baseline depression associated with SF-36 and DASH score at 1 year. Smaller improvement in DASH over first year seen in patients with depression.

Table 1-3: Summary of literature referring specifically to distal radius fracture and psychological factors.

The psychological constructs in the FAM, Self-efficacy Theory and illness perception as described in the Common Sense Model of Illness Representation have been shown to be associated with symptom intensity and level of disability following acute injury. However, the exact relationships are not fully understood. The existing literature fails to demonstrate consistency of associations, does not demonstrate causality and does not provide clear guidance as to how this information can be used clinically. The majority of work comes from mixed trauma cohorts and cross-sectional studies and very few focus on distal radius fracture. Conclusions are limited by the use of multiple different scoring systems and methodologies stemming from a lack of consensus as to the best way to assess the key psychosocial constructs. Clinically applicable psychological scoring systems that predict poor long-term outcome would be more relevant to orthopaedic surgeons than the underlying psychological theory. Future work should focus on identifying these scoring systems, what cut-off scores predict outcome, when during recovery they should be used and focus on distal radius fracture.

The theoretical basis for the use of psychological interventions is good. They have been well studied in chronic pain conditions and findings give cause for optimism but conclusions are limited by methodological weaknesses and heterogeneity of interventions tested (143, 156-161). The evidence following acute injury is inconclusive and distal radius fracture has not been studied. Randomised trials of recognised intervention techniques in this population are needed.

1.7 Summary

Distal radius fracture is a common injury. Speed and eventual level of recovery is variable (4, 13-16). At one extreme people are comfortable and quickly return to their normal routine. At the other extreme, the hand becomes hypersensitive, stiff, and swollen and is not used. The biopsychosocial model for health (162) suggests that the reasons for this are multifactorial and outcome may be driven by psychosocial as well as the more commonly studied biomedical causes (29, 36, 37). The psychological factors that influence recovery from distal radius fracture and their association with symptom intensity and disability is important and currently not understood. Research in this area would create an opportunity to enhance recovery from this common injury.

1.8 Aims of thesis

The aim of this thesis is to explore the role of psychological factors in recovery from distal radius fracture, their influence on outcome and potential as targets for intervention.

Aim 1: To identify early psychological predictors of long term disability and pain intensity after distal radius fracture (Chapter 3: The association between psychological factors and outcomes after distal radius fracture).

Aim 2: To identify associations between demographic, injury and treatment factors and psychological response to injury in a cohort of distal radius fracture patients (Chapter 4: Predictors of psychological response to distal radius fracture).

Aim 3: To test the effectiveness of a workbook style psychological intervention that aims to improve self-efficacy and therefore reduce disability in the otherwise routine management of distal radius fracture (Chapter 5: Prospective double blind randomised controlled trial of a psychological workbook versus an information workbook after distal radius fracture).

2 Patients, distal radius fracture treatment protocol and patient assessment techniques.

This chapter contains information that is relevant to the three succeeding clinical trial chapters.

2.1 Patients

All patients were recruited from a single orthopaedic trauma department. This department is the sole provider of orthopaedic trauma care to patients over 15 years of age in Edinburgh, Midlothian and East Lothian. Patients from the area diagnosed and initially managed out-with the area who then returned for follow up were included if they met inclusion criteria. This set up creates a situation where study cohorts are representative of the local population. According to 2011 census data the population over 15 years of age in Edinburgh, Midlothian and East Lothian is 559,841 (163).

2.2 Distal radius fracture management protocol

The distal radius fracture management protocol was the same for all patients enrolled in this thesis. Routine departmental management pathways were followed for all patients involved in the studies. Participation in studies did not affect treatment decisions. In the case of the RCT interventions were provided in addition to routine treatment, Figure 2-1.

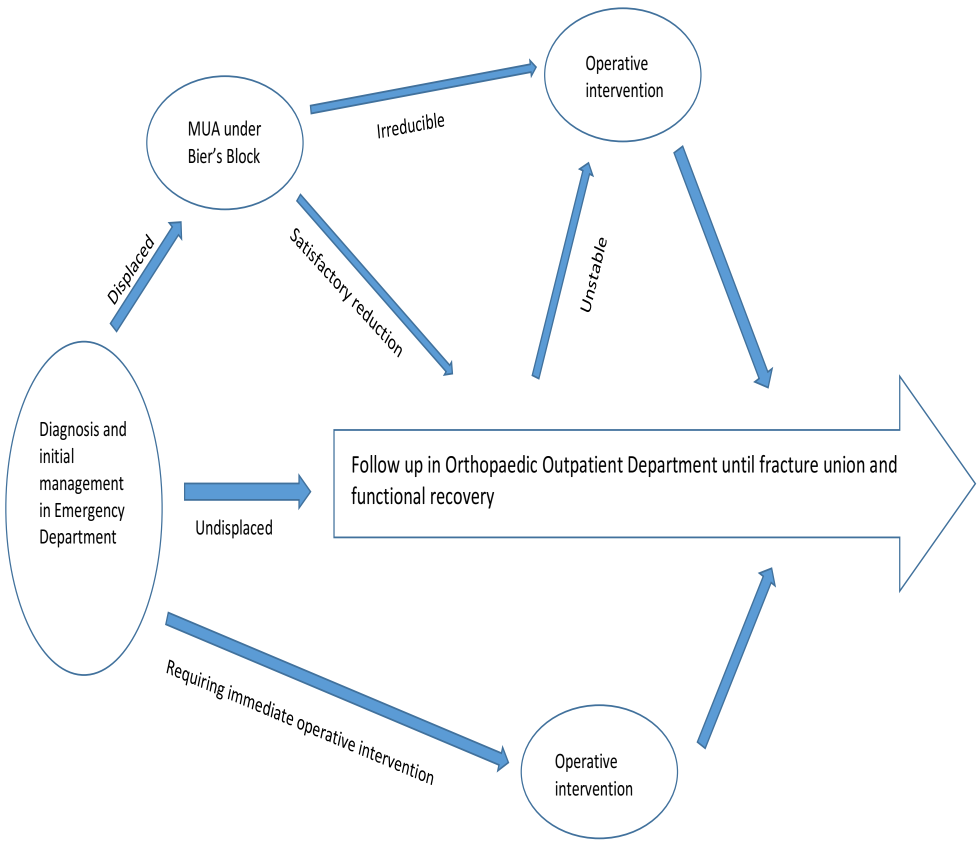

Figure 2-1: Flow diagram of routine distal radius fracture management.

2.2.1 Undisplaced fractures

Initial stabilisation was achieved with a plaster of Paris (POP) backslab before conversion to a light weight fibreglass cast two weeks following injury. A Spencer wrist support was used on occasions where the fracture was thought to be completely stable. Immobilisation was maintained for a total of 6 weeks.

2.2.2 Displaced fracture

Patients medically fit and of a sufficient level of function to warrant intervention had their fractures manipulated under Bier's block anaesthetic (MUA) and immobilised in a POP back slab. Irreducible fractures underwent operative intervention. Patients not suitable for intervention were treated as undisplaced fractures.

2.2.3 Operative intervention

Operative intervention was in the form of open reduction internal fixation with a volar locked plate, manipulation and Kirshner-wire (k-wire) fixation, non-bridging external fixation or bridging external fixator +/- supplementary k-wires. Decisions regarding operative technique were made by the operating surgeon. Indications for operative intervention were open injuries, ongoing neurovascular compromise despite emergency manipulation; partial articular volar displaced fractures (AO-OTA 2.3B3) and irreducible or unstable fractures with radiocarpal malalignment in patients with sufficient function and health to warrant surgery (this decision was at the discretion of the treating surgeon but in general terms would require independently living, active and cognitively well patients). Fractures were considered unstable if they displaced and developed radiocarpal malalignment during the first 2 weeks following injury/post reduction. The radiograph follow up schedule is described in radiographs in described in Section 2.2.4. Fractures can displace after this two week time point but within the Trauma Department at Edinburgh Royal Infirmary review at two week follow up is used as routine, to allow time for operative intervention prior to fracture union.

2.2.4 Outpatient follow up

Patients were followed up in orthopaedic clinic with postero anterior (PA) and lateral radiographs of the wrist at 1, 2 and 6 weeks following injury. These timings were chosen to fit in with follow up schedules used in routine treatment. Fractures were immobilised until there was radiographic and clinic evidence of union, usually for a period of 6 weeks, before patients began mobilisation and simple stretching exercises at home. Routine physiotherapy has been shown to confer no additional benefit in terms of functional outcome over stretching exercises (164) and so referral to physiotherapy was only made in cases of extreme stiffness.

2.3 Patient Assessment

A number of objective measures, psychological profiling questionnaires and scoring systems and patient reported outcome measures were used in the assessment of patients in this thesis.

2.3.1 Deprivation

The Scottish Index of Multiple Deprivation (SIMD) is a marker of socioeconomic deprivation (165). It uses indicators from seven domains: income, employment, health, education, skills and training, housing, geographic access and crime to create an overall deprivation index for a local area. This index allows each area to be ranked. Based on this rank, each area in Scotland is categorised into a quintile from 1 (most deprived) to 5 (least deprived). An individual patient's quintile is identified by searching the The Scottish Government SIMD Postcode to Datazone Lookup Table (166).

2.3.2 Radiographic assessment

Postero anterior (PA) and lateral radiographs of the wrist were taken in the standard manner. All radiographic assessment was carried out by a single Trauma nd Orthopaedic Specialty Trainee Registrar using a picture archiving and communication system (PACS), Carestream, Version 11.40.1253. Diagnosis of distal radius fracture was confirmed, AO-OTA fracture classification (8) applied and displacement, represented by radiocarpal alignment, ulnar variance (radial shortening), and palmar / dorsal tilt, was measured in all cases. Professor Margaret McQueen, thesis supervisor, blindly reviewed 50 randomly selected radiographs to allow assessment of interrater reliability. Cohen's Kappa was used to assess interrater reliability of AO-OTA classification (A, B or C), $\kappa = 0.576$ (95% CI, 0.364 to 0.788), $p < 0.005$, and maintenance of radiocarpal alignment, $\kappa = 0.539$ (95% CI, 0.275 to 0.803), $p<0.005$. These values represent moderate agreement (167). Interclass correlation (ICC) estimates were calculated using SPSS statistical package version 22 (SPSS Inc. Chicago, IL) based on two-way mixed effect and absolute agreement. Radial shortening demonstrated good reliability (168), ICC=0.887 (95% CI, 0.722 to 0.948), $p<0.005$. Dorsal tilt demonstrated excellent reliability (168), ICC=0.929 (95% CI, 0.819 to 0.968), $p<0.005$.

2.3.2.1 Definition of distal radius fracture

Disruption of the cortex of the metaphyseal region of the distal radius seen on anteroposterior or lateral radiograph.

2.3.2.2 AO-OTA fracture classification

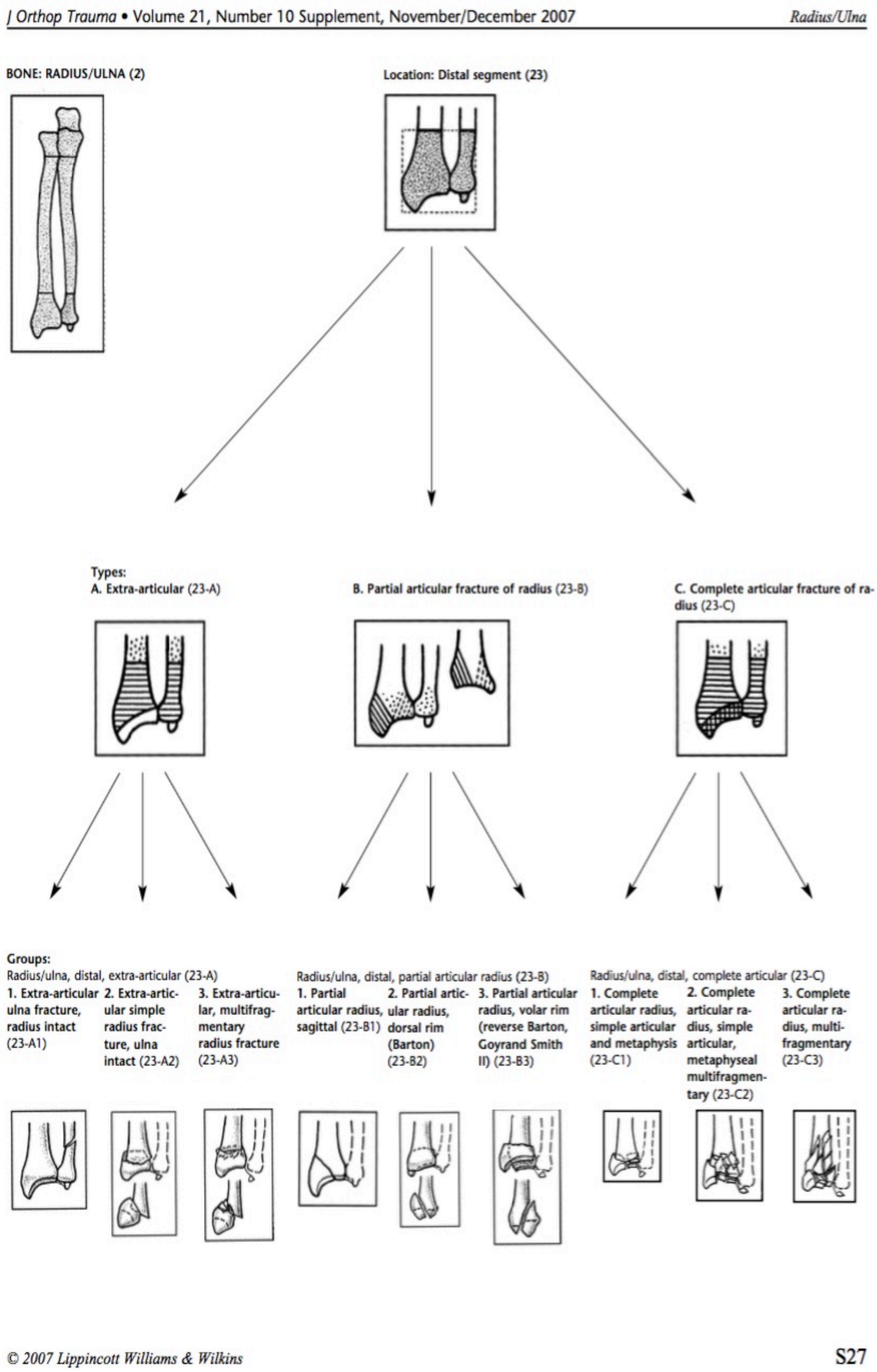

Figure 2-2: AO-OTA Classification for Distal Radius Fracture (8). (Reproduced with the permission of Wolters Kluwer Health Inc.).

2.3.2.3 Radiocarpal alignment

Assessed on the lateral view by drawing a line along the long axis of the capitate and another along the long axis of the radius. If the lines intersected with in the carpus then radiocarpal alignment was maintained, Figure 2-3, (16).

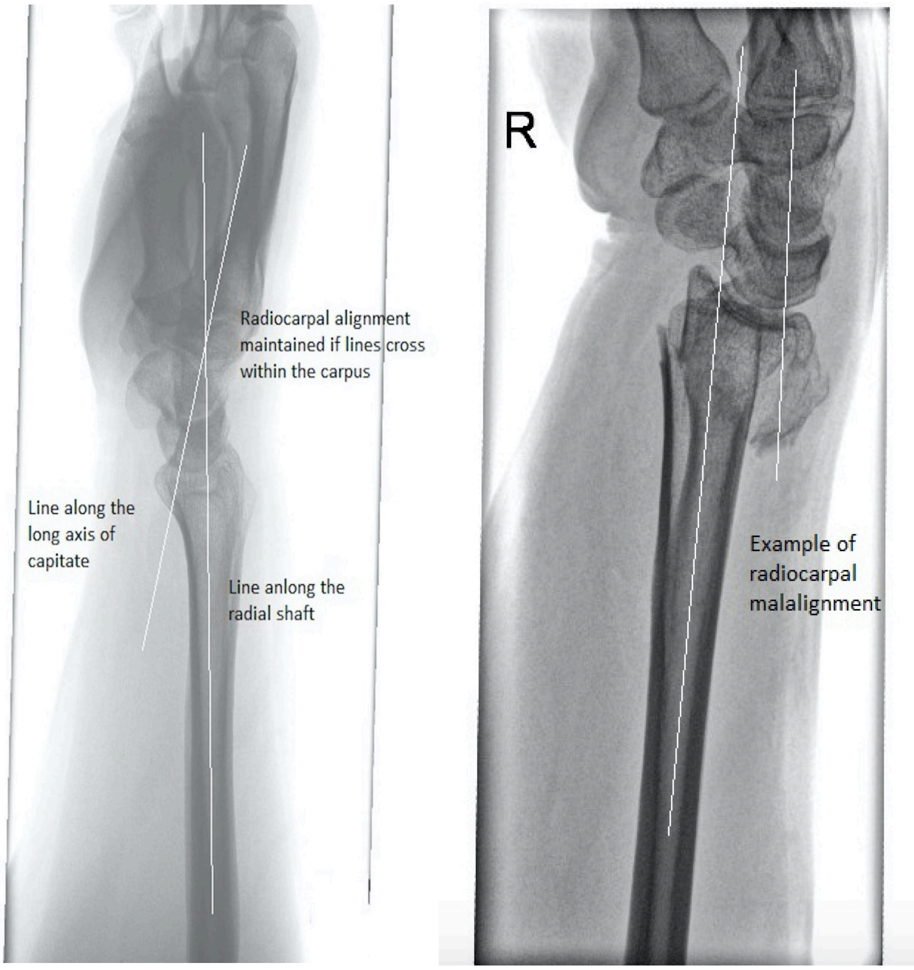

Figure 2-3: Radiographs illustrating measurement of radiocarpal alignment.

2.3.2.4 Ulnar variance

Displacement of the distal radius fracture fragment can result in relative shortening in relation to the ulna. If the ulna appears longer than the radius this is known as positive ulnar variance, if the ulna is shorter this is negative ulnar variance. This was measured on the PA view as the distance between two lines perpendicular to the long axis of the radius, one at the level of the ulnar aspect of the radial articular surface and another at the distal end of the ulna, Figure 2-4, (29). Ulnar variance was used as a measure of radial shortening. Positive ulnar variance was recorded as a positive value and negative ulnar variance as a negative value.

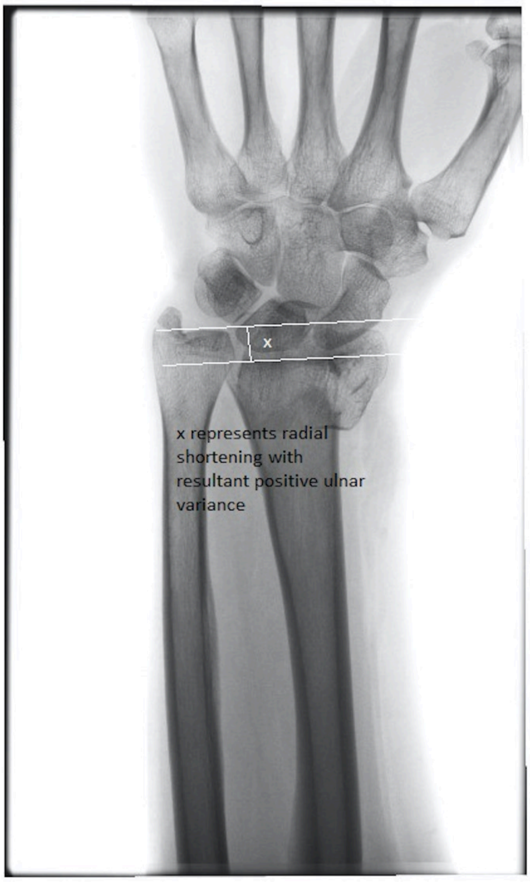

Figure 2-4: Radiograph illustrating measurement of radial shortening.

2.3.2.5 Palmar / dorsal tilt

This was measured on the lateral view as the angle between a line perpendicular to the long axis of the radius and a line joining the most distal points of the volar and dorsal lips of the distal radius. Dorsal tilt was recorded as positive values and palmar (volar) tilt as negative values, Figure 2-5, (29).

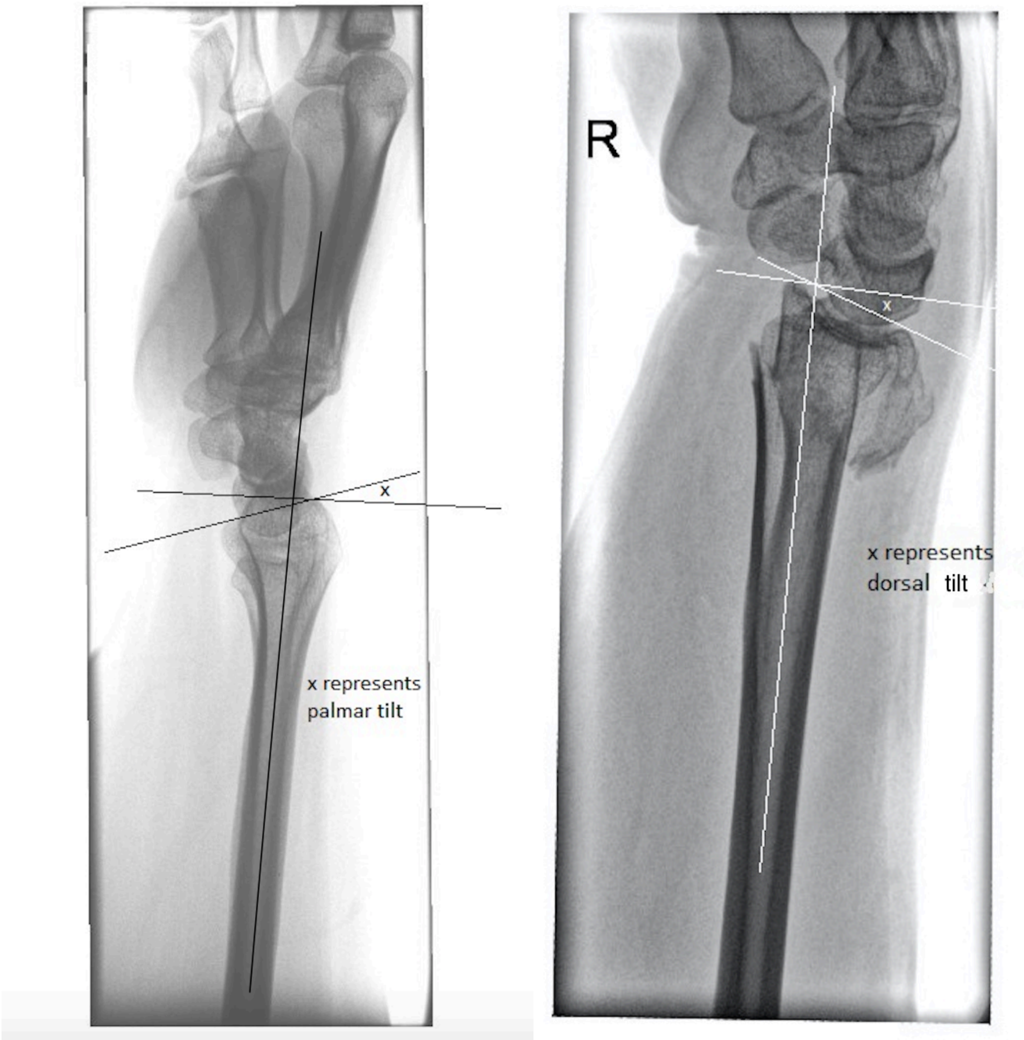

Figure 2-5: Radiographs illustrating how to measure of tilt.

2.3.3 Psychological assessment

2.3.3.1 Catastrophic thinking

The Pain Catastrophising Scale (PCS) is a 13 question scoring system of catastrophic thinking (66). Each question asks for the degree of agreement with a statement representative of catastrophic thinking. Each has five possible answers ranging from 0-4: 0. not at all; 1. slight degree; 2. moderate degree; 3. great degree; 4. all the time, giving a score of between 0 and 52. Higher scores reflect higher levels of catastrophic thinking. It has strong internal consistency, high test retest reliability and validity, demonstrated through associations with pain, disability, negative affect and pain related fear. Scores > 16 are recognised as being high (66, 169, 170).

2.3.3.2 Anxiety and Depression

The Hospital Anxiety and Depression Score (HADS) is a 14 item scoring system used to screen patients for symptoms of anxiety and depression (171). It has both an anxiety and depression subscale each with 7 items scored between 0-3 giving a score of between 0 and 21 for each. Its two-factor structure has been validated in adults following orthopaedic trauma (172, 173). It has high internal validity for both subscales, good internal consistency and good test retest reliability (174, 175). On each subscale, a total score of 0 to 7 is typically considered normal, 8 to 10 is borderline or suggestive of possible anxiety/depression, and >10 is indicative of mood disorder (175).

2.3.3.3 Fear-avoidance (anxiety / fear constructs)

The Tampa Scale for Kinesiophobia (TSK) measures fear of movement related to pain or fear of re-injury (176). It is a 17 item score assessment, each scored between 1 and 4, giving a total score between 17 and 68, with higher scores representing greater fear avoidance behaviour. A score of >39 is used to distinguish between high and low (177). It is valid and reliable for use in the acute setting, including distal radius fracture (113, 178-180).

2.3.3.4 Psychological distress

The PTSD Checklist – Civilian Version (PCL-C) is a 17-item self-reported questionnaire that assesses symptoms of PTSD in line with the Diagnostic and Statistical Manual of Mental Disorder 4th Edition (DSM-IV). Each question has five response options rated 1 to 5 giving a total score between 17 (low) and 85 (high). It is commonly used, valid and reliable (181, 182). To diagnose PTSD symptoms must persist for more than 3 months but in the acute setting the PCL-C is an indicator of psychological distress. A cut off PCL-C score ≥35 has a sensitivity of approximately 85% for the PTSD diagnosis (183, 184).

2.3.3.5 Self-efficacy

The General Self-efficacy Scale (GSES) is a reliable 10 item patient reported questionnaire used to assess beliefs about personal ability to cope with difficult situations – perceived self-efficacy (185, 186). Each item ranges from 1 to 4 giving a total score of 10 to 40. Illness specific measures of self-efficacy exist which allow assessment within a narrow context (187, 188). There is no validated context specific measure of self-efficacy for acute injury but the general self-efficacy scale is widely used (189), as such the general version is used in this thesis. There is no accepted cut off score to categorise patients on the basis of this score but the suggested technique is to use a median split to dichotomise the cohort if required (190).

2.3.3.6 Injury Perceptions

The Illness Perception Questionnaire – Revised (IQPr) is used to assess patients' perceptions of their injury (191). It comprises nine subscales outlined in Table 2-1. The Identity sub scale states 14 symptoms each with a yes/no response option referring to whether or not the patient has had this symptom in relation to their injury. Authors of the scoring system suggest symptoms referred to in the Identity subscale can be adapted depending on illness/injury in question. The symptoms used in this thesis have been used in other published research of studies into acute injury.

The remaining sub scales comprise between 4 and 18 questions, scored between 1 and 5.

IPQr subscale	**Description**	**Score possible range**
Identity	The number of symptoms attributed to the injury	0-14
Timeline (acute/chronic)	Length of recovery time	6 (short) – 30 (long)
Timeline (cyclical)	Fluctuation in level of symptoms	4 (constant) – 20 (fluctuate a lot with time)
Consequence	Consequence of injury on life	6 (low) – 30 (high)
Personal control	Level of personal control over recovery	6 (low) – 30 (high)
Treatment control	Level of control treatment has over recovery	5 (low) – 25 (high)
Injury coherence	Understanding of injury	5 (low) – 25 (high)
Emotion	Level of emotional response to injury	6 (low) – 30 (high)
Cause	Perceived cause of injury – 4 categories	
	Psychological	6 (low) – 30 (high)
	Exposure to a risk factor	7 (low) – 35 (high)
	Immune	3 (low) – 15 (high)
	Accident /chance	2 (low) -10 (high)

Table 2-1: Description of IPQr sub scales.

The IPQr has good internal and test / retest reliability as well as validity (191). There is no precedent for using a cut off to dichotomise patient groups based on scores so median split was used to categorise patients as high or low.

The Illness Perception Questionnaire Brief (IPQB) is a 9-item measure in which each question represents one dimension of illness perception (consequence, timeline acute chronic, timeline cyclical, personal control, treatment control, identity, coherence, emotional representation and cause). An overall score is calculated which represents the degree to which an illness or injury is perceived to be threatening (high) or benign (low) (192).

2.3.3.7 Locus of Control

The Recovery Locus of Control (RLOC) scale is designed to evaluate an individual's beliefs about the control they have over the recovery from a traumatic event (193). It is comprised of nine items each scored 1-5, giving a total score range of 9 (high external locus) to 45 (high internal locus). 'High external locus' refers to a belief that recovery is dependent on external factors outwith the patient's own control in contrast to a 'high internal locus' which refers to a mind-set where patients believe they have control over the recovery from and outcome of their injury. It has been shown to have good internal consistency and construct validity (193). There is no precedent for using a cut off to dichotomise patient groups based on scores. A median split was used to categorise patients as high or low.

2.3.4 Outcome measures

2.3.4.1 The Disability of Arm Shoulder and Hand (DASH) score

The DASH score is a patient reported scoring system used in the assessment of upper extremity conditions. It comprises 30 questions converted to a score out of 100, with a higher score representing greater disability (194, 195). It is responsive, reliable and valid in patients with distal radius fracture and is widely used to assess outcomes in this group (180, 196). It contains items that assess all three aspects of The WHO's ICF framework: impairment, activity limitation and participation restriction (197). It has been validated for use by telephone. Scores are calculated with a minimum of 27/30 responses.

2.3.4.2 Short Form 12

The Medical Outcomes Study Short Form 12 Health Survey (SF12) is a patient reported measure of general health. It consists of 12 questions and results in a physical component score (SF12-PCS) and a mental component score (SF12-MCS). Each score is between 0 and 100, with a higher score representing better health (198). It is validated for use in orthopaedic trauma populations (199).

2.3.4.3 Pain Experience

A numerical rating scale (NRS) was used to assess average pain over the preceding week. Measured on an 11 point Likert scale from 0 (no pain) to 10 (worst pain imaginable).

2.3.5 Clinical Assessment

All clinical assessment was carried out by a trained researcher, independent of the patients' treatment and blinded to treatment arm.

2.3.5.1 Grip strength

Grip strength on both the injured and uninjured side was measured in Kg force with a standard, adjustable-handle Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, IL) set to the second rung position, the optimal setting for measuring grip strength with this instrument (200) and with the elbow at 90 degrees flexion and the forearm in neutral rotation. The instrument was calibrated as per the manufacturer's instructions prior to starting the trial. The mean of three recordings was calculated and recorded as a percentage deficit relative to the strength of the contralateral hand. The deficit was adjusted to allow for dominance with a 10% increase in grip strength assumed for the dominant hand.

2.3.5.2 Range of motion

Wrist flexion, extension, radial and ulnar deviation and forearm pronation and supination on the injured side were measured in degrees from a neutral position using a full circle goniometer. Distance from index finger nail tip to palmar skin crease, with fingers in maximum active flexion, was measured with a ruler in millimetres.

2.3.5.3 Complex regional pain syndrome (CRPS)

In the prospective studies in Chapters 3 and 4 a diagnosis of CRPS was made if the diagnosis was recorded by the treating surgeon in their clinical notes.

In the RCT in Chapter 5, a diagnosis of CRPS was made using the IASP Modified Criteria, Table 2-2. Using these criteria, a diagnosis of CRPS can be made with varying degrees of sensitivity and specificity depending on how many signs and symptoms are present. When 2 sign categories and 4 symptom categories are present CRPS can be diagnosed with a sensitivity of 0.70 and a specificity of 0.94, the diagnostic criteria suggested for use in clinical research (4, 201).

1. Disproportionate pain	
2. Symptoms	
Sensory	Reports hyperaesthesia or allodynia
Vasomotor	Reports temperature asymmetry, skin colour changes or skin colour asymmetry
Sudomotor	Reports swelling, sweating changes or sweating asymmetry
Motor / trophic	Reports any of reduced range of motion, tremor, weakness, dystonia or trophic changes to hair, skin or nails
3. Signs	
Sensory	Evidence of hyperalgesia or allodynia
Vasomotor	Evidence of temperature asymmetry >1ºC, or skin colour changes or asymmetry
Sudomotor	Evidence of oedema, sweating changes or asymmetry
Motor / trophic	Evidence of reduced range of motion, motor dysfunction or trophic changes
4. No other better explanation of clinical picture	

Table 2-2: Modified International Association for the Study of Pain Diagnostic Criteria for Complex Regional Pain Syndrome (201, 202).

2.3.5.4 Adverse events

These were defined as an additional surgical intervention (this does not include surgical fixation of unstable fractures), tendon injury, infection, loss of fixation, iatrogenic nerve injury (including development of carpal tunnel syndrome) and additional surgical intervention. In Chapter 5 where stiffness and range of motion were outcome measures these were measured clinically as described in Section 2.3.5.

3 The association between psychological factors and outcomes after distal radius fracture.

3.1 Introduction

Psychosocial factors are associated with symptom intensity and magnitude of limitations after acute injury. The mechanism of these associations is not well understood and evidence looking specifically at distal radius fracture is very limited, Chapter 1. Prospective longitudinal studies to identify which psychological scores, measured early in recovery, are associated with longer term outcomes would help in the development of screening tools to identify patients at risk of poor outcome and aid decision making regarding treatment.

The aim of this study was to identify early psychological predictors of disability and pain intensity ten weeks after distal radius fracture. The primary null hypothesis was that there are no factors (demographic, radiographic, comorbidity, or psychosocial measures) associated with variation in DASH scores ten weeks after distal radius fracture. The secondary null hypotheses were that following distal radius fracture none of these factors are associated with variation in DASH score at nine months, pain intensity at ten weeks and nine months, additional surgical intervention and a diagnosis of CRPS.

3.2 Methods

3.2.1 Patients

All patients with distal radius fractures presenting within 4 weeks of injury to Royal Infirmary Edinburgh between August 2015 and February 2016 were assessed for eligibility for recruitment into the study. All skeletally mature patients age 16 and over were included, regardless of treatment type. Patients were excluded if they declined involvement, did not speak English, lacked the cognitive capacity to understand and complete questionnaires, were undertaking injury compensation proceedings, using illicit drugs or had a psychiatric diagnosis resulting in psychosis. Patients were treated routinely as per unit protocols, described in section 2.2. The study was approved by the Ethics Committee, Appendix 1.

Details of demographics, medical history, radiographic parameters (AO-OTA fracture classification, radiocarpal alignment, radial shortening and dorsal tilt), injury and treatment characteristics were collected prospectively. Patients completed psychological assessment questionnaires at recruitment (T1), 10 weeks (T2) and 9 months following injury (T3) and outcome questionnaires at T2 and T3. Psychological measures were HADS Depression, HADS Anxiety, Pain Catastrophising Scale (PCS), Tampa Scale for Kinesiophobia (TSK), Post Traumatic Stress Disorder Civilian Checklist (PCL-C), Illness Perception Questionnaire Brief (IPQB), General Self-Efficacy Scale (GSES) and Recovery Locus of Control (RLOC). Outcome measures were the DASH score and NRS pain score. Details of the patient assessment measures are in section 2.3. The 216 of 288 patients with complete outcome data at T2 and T3 formed the final study cohort, Figure 3-1. Characteristics of the study cohort and lost to follow up group, along with tests for statistically significant differences, Appendix 2.

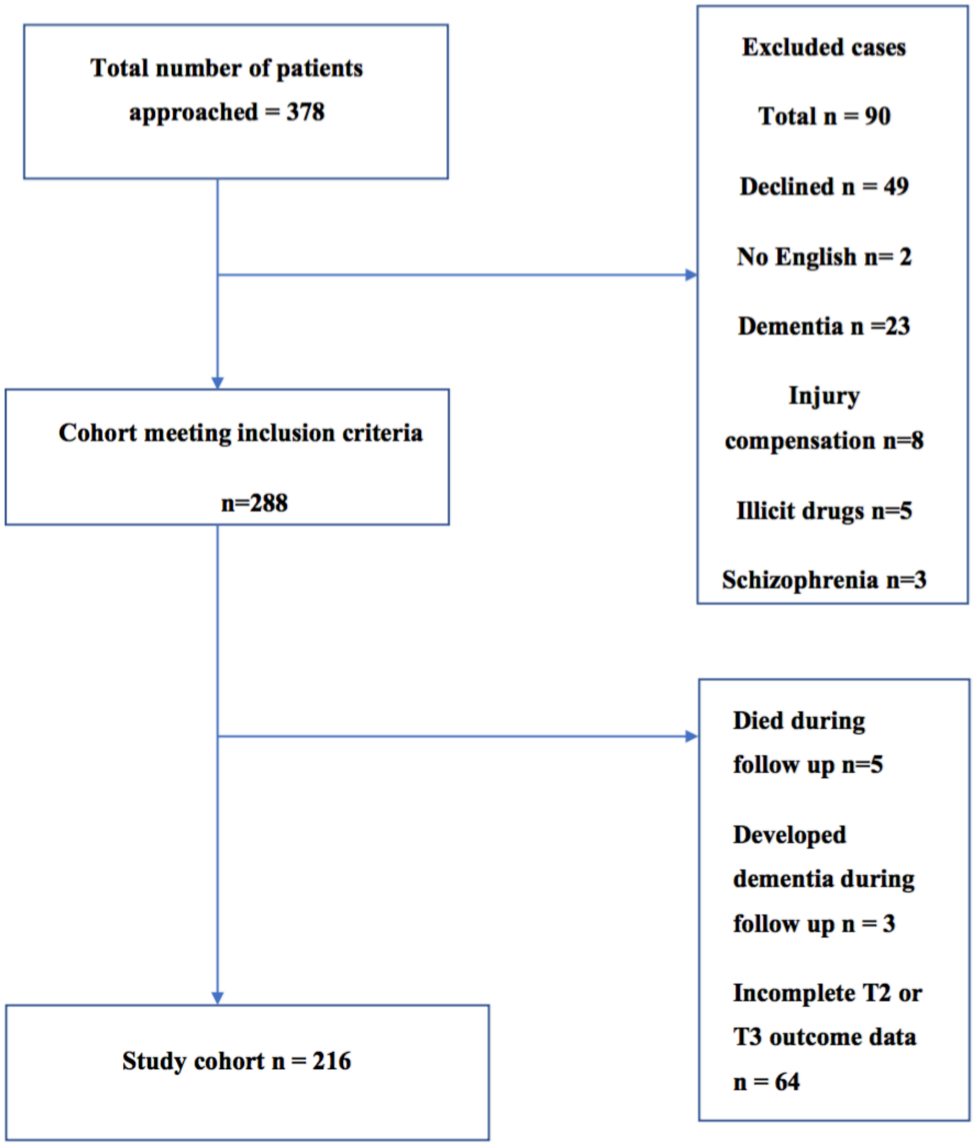

Figure 3-1: The association between psychological factors and outcomes after distal radius fracture: study cohort.

3.2.2 Statistical analysis

Descriptive statistics were used to present demographic, co-morbidity, injury, treatment, radiographic and psychological characteristics. Patients who did not complete follow up were compared to the study cohort using Mann Whitney U or parametric data and Chi Square Test and Fisher's Exact Tests for parametric data. Wilcoxon Signed Rank Test and Freidman's Test were used to assess change in outcome variables over time.

The response variables were DASH scores and pain intensity at 10 weeks and 9 months; additional surgical intervention and a diagnosis of CRPS. The explanatory variables were: age; gender; social deprivation quintile; number of medical comorbidities; AO-OTA fracture classification (grouped as A, B or C); nerve injury; multiple fractures; radiographic alignment at T2: RC alignment, radial shortening, dorsal tilt; surgical or non-operative management; time to presentation and follow up; and psychological measures (HADS anxiety, HADS depression, PCS, TSK, PCL-C, IPQB, GSES and RLOC). For continuous response variables (DASH and NRS pain) Spearman correlations, Mann Whitney U Tests, and Kruskal Wallis Tests were used for non-parametric data. Pearson correlations, T Tests and ANOVA for parametric data. Factors with $p<0.1$ in bivariate analysis were entered into multivariable linear regression models. For dichotomous response variables (additional surgical intervention and diagnosis of CRPS) Mann Whitney U Tests and Chi Square tests were used. Factors with $p<0.1$ in bivariate analysis were entered into binomial logistic regression models. Where there was correlation of >0.7 between factors in any regression analysis one was dropped from the model. Missing explanatory variable data was completed with mean imputation. Sample size was calculated, on the advice of a statistician consulted and acknowledged, based on 50 + 8k (where k = number of entry variables into bivariate analysis). This gave a sample size of 218. We anticipated a loss to follow up of 20%, so aimed to recruit 262 patients.

3.3 Results

Enrolment psychological scores are shown and compared to normative and chronic pain cohorts in Table 3-1. Details of threshold scores used to make a diagnosis of psychological disorder or categorise patients as high / low are in section 2.3.3. (PCS, HADS, TSK, PTSD are from recognised cut offs used in other work, the remainder are median split as no recognised threshold exists). The enrolment psychological scores of the study cohort were better than both chronic pain and normative populations. Only a minority of patients scored above threshold scores suggestive of psychological disturbance or 'high' levels of a particular psychological trait.

Psychological factor	**Distal radius fracture study cohort** Mean (range, SD, 95%CI)	**Reference normative population scores**	**Reference chronic pain population scores**	**N (%) of patients in cohort worse than threshold** **[cut off used]**
PCS	6.9 (0-47, 9.1, 6-8)	12 (0-52, 9.1)[α]	20.9 (0-50, 12.5)[ψ]	23 (11) [>16]
HADS Depression	3.1 (0-15, 3.2, 2.7-3.6)	female 4.1 (3.8)[χ] male 3.8 (3.7)[χ]	8.1[β]	25 (12) [>7]
HADS Anxiety	4.6 (0-16, 3.5, 4.1-5.1)	female 6.8 (4.2)[χ] male 5.5 (4)[χ]	9.3[β]	38 (19) [>7]
TSK	37.9 (22-55, 6, 37-39)	n/a	41.2 (9.4)[$]	82 (40) [39]
PCL-C (PTSD)	23.6 (17-71, 9.5, 22-25)	Gunshot wound 30 (22-48)[κ] Assault 30 (23-53)[κ] Fall 21 (18-28)[κ]	35 (13)[δ]	22 (11) [>34]
IPQB	33 (0-61, 12, 31-34)	n/a	n/a	101 (47) [>33]
GSES	31.9 (12-40, 5.3, 31-33)	n/a	29 (6)[λ]	96 (46) [>31]
RLOC	35.6 (20-45, 4.9, 35-36)	n/a	n/a	82 (40) [>36]

Table 3-1: Chapter 3 study cohort enrolment psychological scores. [α](203) [β](173), [$](204), [ψ](205) [χ](206), [κ](207), [δ](208), [λ](189). n/a = not available.

3.3.1 Disability and pain

The median DASH and NRS pain score improve with time and returned to near the quoted normal population value of 10 (209), Table 3-2.

	T1 (<3 weeks)	T2 (10 weeks)	T3 (9 months)	p
Median DASH (IQr)	n/a	28 (14-45)	13 (4-29)	**(<0.001)***
Median NRS pain score (IQr)	5 (2-6)	4 (2-6)	2 (1-4)	**(<0.001)**$^{\alpha}$

Table 3-2: Change in outcome variables over time. *Wilcoxon Signed Rank Test. α Friedman's Test.

The statistically significant associations between entry variables and DASH at 10 weeks, DASH at 9 months, pain score at 10 weeks and pain score at 9 months in bivariate analyses are seen in Table 3-3 and are summarised below.

Increased DASH at 10 weeks was associated with the following:

Demographic factors: increased age, female gender, increased social deprivation and increased number of medical comorbidities.

Injury factors: presence of a nerve injury, presence of multiple fractures, increased dorsal tilt at 6 weeks and increased radial shortening at 6 weeks.

Psychological factors: increased level of catastrophic thinking (PCS), increased HADS depression and anxiety score, increased psychological distress (PTSD), increased kinesiophobia (TSK), increased perception of threat from injury (IPQB), lower level of self-efficacy (GSES) and an external locus of control (lower RLOC).

Study design factors: shorter time to follow up.

Increased DASH at 9 months was associated with:

Demographic factors: increased age, female gender and increased number of medical comorbidities.

Injury factors: increased dorsal tilt at 6 weeks and increased radial shortening at 6 weeks.

Psychological factors: increased level of catastrophic thinking (PCS), increased HADS depression and anxiety score, increased psychological distress (PTSD), increased kinesiophobia (TSK), increased perception of threat from injury (IPQB), lower level of self-efficacy (GSES) and an external locus of control (lower RLOC).

Increased pain score at 6 weeks was associated with:

Demographic factors: increased age, increased level of social deprivation and increased number of medical comorbidities.

Injury factors: increased dorsal tilt at 6 weeks and increased radial shortening at 6 weeks.

Psychological factors: increased level of catastrophic thinking (PCS), increased HADS depression and anxiety score, increased psychological distress (PTSD), increased kinesiophobia (TSK), increased perception of threat from injury (IPQB), lower level of self-efficacy (GSES) and an external locus of control (lower RLOC).

Study design factor: shorter time to follow up.

Increased pain score at 9 months was associated with:

Demographic factors: increased level of social deprivation and increased number of medical comorbidities.

Injury factors: AO-OTA type C fractures, increased dorsal tilt at 6 weeks.

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Psychological factors: increased HADS depression and anxiety score, increased psychological distress (PTSD), increased perception of threat from injury (IPQB), lower level of self-efficacy (GSES) and an external locus of control (lower RLOC).

Entry variables	DASH T2	DASH T3	Pain T2	Pain T3
Demographic factors				
Age*	0.5 (<0.001)	0.4 (<0.001)	0.2 (0.006)	0.1 (0.264)
Gender $^{\alpha}$ (higher DASH scores in females)	0.003	<0.001	0.063	0.088
Index of Multiple Deprivation$^{\beta}$ (higher DASH and pain scores in more deprived categories)	0.035	0.054	0.042	0.004
Number of medical comorbidities*	0.4 (<0.001)	0.4 (<0.001)	0.2 (<0.001)	0.2 (0.002)
Injury Characteristics				
Nerve injury$^{\alpha}$ (higher DASH with nerve injury)	0.021	0.051	0.083	0.389
Presence of multiple fractures$^{\alpha}$ (higher DASH with multiple fractures)	0.032	0.129	0.841	0.239
AO-OTA classification (A,B,C)$^{\beta}$ (higher pain scores in group C)	0.571	0.082	0.347	0.037
Radiographic parameters T2				
Radiocarpal alignment maintained$^{\alpha}$	0.099	0.086	0.087	0.339
Dorsal tilt degrees *	0.2 (0.017)	0.2 (0.005)	0.2 (0.018)	0.1 (0.045)
Ulnar variance*	0.2 (0.001)	0.2 (<0.001)	0.2 (0.017)	0.1 (0.075)
Treatment details				
Surgical management $^{\alpha}$	0.303	0.387	0.995	0.137
Baseline psychological scores				
PCS*	0.4 (<0.001)	0.3 (<0.001)	0.3 (<0.001)	0.1 (0.052)
HADs Depression*	0.4 (<0.001)	0.4 (<0.001)	0.2 (0.001)	0.2 (0.001)

Entry variables	DASH T2	DASH T3	Pain T2	Pain T3
HADs Anxiety*	0.2 (0.021)	0.2 (0.003)	0.2 (<0.001)	0.2 (0.005)
PTSD*	0.4 (<0.001)	0.4 (<0.001)	0.3 (<0.001)	0.2 (0.010)
TSK*	0.2 (0.001)	0.2 (0.015)	0.2 (0.003)	0.1 (0.261)
IPQB*	0.4 (<0.001)	0.3 (<0.001)	0.4 (<0.001)	0.2 (0.001)
GSES*	-0.3 (<0.001)	-0.3 (<0.001)	-0.2 (<0.001)	-0.2 (0.005)
RLOC *	-0.2 (<0.001)	-0.2 (0.001)	-0.2 (0.003)	-0.1 (0.045)
Time to follow up				
Days to presentation*	0.1 (0.280)	0.1 (0.341)	0.0 (0.702)	0.0 (0.602)
Weeks to T2*	-0.2 (<0.001)	n/a	-0.2 (0.014)	n/a
Weeks to T3*	n/a	-0.1 (0.092)	n/a	-0.1 (0.123)

Table 3-3: Table of bivariate analysis between entry variables and the outcome variables DASH and pain score. ∗ Spearman's Correlation, presented as: correlation coefficient (p value). α Mann Whitney U Test, β Kruskal Wallis Test both presented as: p value only. Continuous entry variables are presented as: correlation coefficient (p value). Where correlation coefficient is positive higher entry variable correlates with higher DASH, where correlation coefficient is negative higher entry variable correlates with lower DASH. Categorical entry variables are presented as p value alone, the group associated with higher median DASH score is indicated where there is a significant difference. n/a = not applicable.

3.3.1.1 DASH at 10 weeks

In a multivariable regression model that predicted worse DASH score at 10 weeks ($F(21,194) = 9.1$, $p <0.001$, adj $R^2 = 0.4$) increased age, increased level of social deprivation, increased HADS depression score, increased IPQB (increased perception of threat for the injury), presence of a nerve injury and lower RLOC (belief in an external locus of control) were statistically significant variables, Table 3-4.

The following factors were included in the analysis but were not independently significant: female gender, number of medical comorbidities, presence of multiple fractures, dorsal tilt radial shortening and radiocarpal alignment at 6 weeks, level of catastrophic thinking (PCS), HADS anxiety score, psychological distress (PTSD), kinesiophobia (TSK) and time to follow up.

Variable	Regression Coefficient (Unstandardised)	Standardised coefficient	95% Confidence Limits	p value
Age	0.4	0.3	0.2 to 0.5	**<0.001**
SIMD quintile 1 (most deprived)	9.7	0.2	2.0 to 17.4	**0.014**
HADS Depression	1.5	0.2	0.4 to 2.6	**0.008**
IPQB	0.4	0.2	0.2 to 0.7	**0.001**
Nerve injury	16.0	0.1	3.3 to 28.6	**0.014**
RLOC	-0.6	-0.1	-1.1 to -0.1	**0.031**

Table 3-4: Multivariable linear regression analysis documenting statistically significant independent predictors of DASH at 10 weeks following distal radius fracture. Strongest predictors at top to weakest at bottom of table.

3.3.1.2 DASH at 9 months

In the model that predicted worse DASH scores at 9 months ($F(22,193) = 6.2$, $p < 0.001$, adj $R^2 = 0.3$) increased level of deprivation, increased HADs depression score, increased age, increased number of medical comorbidities, increased radial shortening at 6 weeks and lower RLOC (more external locus of control) were statistically significant variables, Table 3-5.

The following factors were included in the analysis but were not independently significant: female gender, dorsal tilt and radiocarpal alignment at 6 weeks, AO-OTA fracture classification, presence of a nerve injury, level of catastrophic thinking (PCS), HADS anxiety score, psychological distress (PTSD), kinesiophobia (TSK), perception of threat from injury (IPQB), level of self-efficacy (GSES) and time to follow up.

Variable	**Regression Coefficient**	**Standardised coefficient**	**95% Confidence Limits**	**p value**
SIMD quintile 1 (most deprived)	10.1	0.2	2.1 to 18.1	**0.014**
HADS Depression	1.4	0.2	0.3 to 2.5	**0.015**
Age	0.2	0.1	0 to 0.3	**0.040**
Number of medical comorbidities	1.6	0.1	0.1 to 3.2	**0.034**
Radial shortening	1.1	0.1	0.1 to 2.1	**0.035**
RLOC	-0.6	-0.1	-1.2 to -0.1	**0.027**

Table 3-5: Multivariable linear regression analysis documenting statistically significant independent predictors of DASH at 9 months following distal radius fracture. Strongest predictors at top to weakest at bottom of table.

3.3.1.3 NRS pain score at 10 weeks

In the model that predicted an increased pain score at 10 weeks ($F(20,195) = 4.9$, $p <0.001$, adj $R^2 = 0.3$) increased IPQB (belief that the injury is more threatening) and increased level of social deprivation were statistically significant variables, Table 3-6.

The following factors were included in the analysis but were not independently significant: age, female gender, number of medical comorbidities, presence of a nerve injury, dorsal tilt, radial shortening and radiocarpal alignment at 6 weeks, level of catastrophic thinking (PCS), HADS depression and anxiety score, psychological distress (PTSD), kinesiophobia (TSK), level of self-efficacy (GSES), locus of control (lower RLOC) and time to follow up.

Variable	Regression Coefficient	Standardised coefficient	95% Confidence Limits	p value
IPQB	0.1	0.3	0 to 0.1	**<0.001**
SIMD quintile 1 (most deprived)	1.0	0.1	0 to 2.0	**0.049**

Table 3-6: Multivariable linear regression analysis documenting statistically significant independent predictors of pain score 10 weeks following distal radius fracture. Strongest predictors at top to weakest at bottom of table

3.3.1.4 NRS pain score at 9 months

In the model that predicted increased pain score at 9 months ($F(17,198) = 3.6$, $p < 0.001$, adj $R^2 = 0.2$) an increased number of medical comorbidities was the only statistically significant variable, Table 3-7.

The following factors were included in the analysis but were not independently significant: female gender level of social deprivation, AO-OTA type C fracture, dorsal tilt and radial shortening at 6 weeks, level of catastrophic thinking (PCS), HADS depression and anxiety score, psychological distress (PTSD), perception of threat from injury (IPQB), level of self-efficacy (GSES) and locus of control (lower RLOC).

Variable	**Regression Coefficient**	**Standardised coefficient**	**95% Confidence Limits**	**p value**
Number of medical comorbidities	0.2	0.1	0 to 0.4	**0.047**

Table 3-7: Multivariable linear regression analysis documenting statistically significant independent predictors of pain score 9 months following distal radius fracture.

3.3.2 Additional surgical intervention and CRPS

Thirteen (6%) of patients had additional surgical intervention after completion of initial management. Ten patients (5%) were diagnosed with CRPS, Table 3-8.

Adverse Event		**n (%)**
Total cases of additional surgical intervention		13 (6)
Removal of metalwork	Total	5 (2)
	Failure of fixation	2 (1)
	Intra articular screws	2 (1)
	Pain	1 (1)
Corrective surgery for mal-union		5 (2)
Revision ORIF for non-union		1 (1)
Tendon repair		1 (1)
Carpal tunnel release		1 (1)
CRPS		10 (5)

Table 3-8: Frequency of adverse outcomes

The statistically significant associations between these adverse events and entry variables is seen in Table 3-9.

In bivariate analysis, a higher rate of additional surgical intervention was associated with female gender, nerve injury, loss of radiocarpal alignment, having operative treatment, increased level of catastrophic thinking (PCS) and increased perception of threat from injury (IPQB). A diagnosis of CRPS was associated with presence of a nerve injury and undergoing surgical management but no demographic or psychological factors.

Entry variables	**Additional surgical intervention**	**CRPS**
Demographic factors		
Age$^{\beta}$	0.414	0.407
Gender (higher rate in females) *	**0.005**	0.717
Index of Multiple Deprivation $^{\alpha}$	0.368	0.490
Number of medical comorbidities$^{\beta}$	0.327	0.961
Injury Characteristics		
Nerve injury (higher rates with nerve injury) *	**<0.001**	**0.036**
Presence of multiple fractures *	0.269	1.0
AO-OTA classification (A,B,C) (higher pain scores in group C) $^{\alpha}$	0.095	0.262
Radiographic parameters T2		
Radiocarpal alignment maintained * (higher rate when radiocarpal alignment not maintained)	**0.003**	1.0
Dorsal tilt degrees $^{\beta}$	0.581	0.597
Ulnar variance$^{\beta}$	0.217	0.996
Treatment details		

Entry variables	**Additional surgical intervention**	**CRPS**
Surgery* (higher rate following surgical management)	0.068	**0.036**
Baseline psychological scores		
PCS$^{\beta}$ (higher rate with higher PCS)	**0.013**	0.402
HADs Depression$^{\beta}$	0.522	0.561
HADs Anxiety$^{\beta}$	0.755	0.789
PTSD$^{\beta}$	0.203	0.474
TSK$^{\beta}$	0.140	0.771
IPQB$^{\beta}$ (higher rate with higher IPQB)	**0.038**	0.065
GSES$^{\beta}$	0.541	0.927
RLOC $^{\beta}$	0.358	0.089
Time to follow up		
Days to presentation$^{\beta}$	0.360	0.296
Weeks to T2$^{\beta}$	0.218	0.690
Weeks to T3 $^{\beta}$	0.263	0.616

Table 3-9: Table of bivariate analysis of entry variables and the outcome variables additional surgical intervention and CRPS. β Mann Whitney U Test, presented as: p value only. α Chi-square Test. * Fisher's Exact Test.

3.3.2.1 Additional surgical intervention

The logistic regression model that predicted additional surgical intervention was statistically significant χ^2 (7) = 37.2, $p < 0.001$, Table 3-10. The model explained 43% (Nagelkerke R^2) of the variance in additional surgical intervention and correctly classified 96% of cases. Sensitivity 46%; specificity 99%; positive predictive value 86%; negative predictive value 97%, Table 3-11. Presence of a nerve injury at enrolment and loss of radiocarpal malalignment at 10 week follow up were statistically significant independent predictors of additional surgical intervention. Surgical management, AO-OTA classification, enrolment PCS and IPQB were included in the analysis but were not independently significant.

Variable	B Coefficient	Odds ratio	95% Confidence Limits	p value
Evidence of nerve injury at enrolment	2.3	10.4	1.3 to 83.8	**0.028**
Surgical management	0.8	2.1	0.5 to 9.1	0.301
AO classification (A,B,C)	0.5	1.7	0.8 to 3.6	0.189
Enrolment PCS	0.1	1.1	1.0 to 1.1	0.067
Enrolment IPQB	0.0	1.0	0.9 to 1.1	0.837
Radiocarpal alignment maintained at T2	-1.9	0.1	0.0 to 0.6	**0.006**

Table 3-10: Logistic regression model predictive of additional surgical intervention.

Additional surgical intervention	**Predicted additional surgical intervention**		
	No	Yes	
No	202	1	Specificity = 99%
Yes	7	6	Sensitivity = 46%
	NPV = 97%	PPV = 86%	

Table 3-11: Sensitivity and specificity of a predictive model for additional surgical intervention.

3.3.2.2 CRPS

The logistic regression model that predicted a diagnosis of CRPS was statistically significant χ^2 (4) = 11.5, p = 0.021, Table 3-12. The model explained 20% (Nagelkerke R^2) of the variance in CRPS diagnosis and correctly classified 96% of cases. Sensitivity 10%; specificity 100%; positive predictive value 100%; negative predictive value 96%, Table 3-13. None of the entry variables (presence of a nerve injury, surgical management, perception of threat from injury (IPQB), or locus of control (RLOC)) were independently statistically significant.

Variable	B Coefficient	Odds ratio	95% Confidence Limits	p value
Evidence of nerve injury at enrolment	1.3	3.5	0.5 to 25.5	0.216
Surgical management	1.4	3.9	0.9 to 16.8	0.071
Enrolment IPQB	0.0	1.0	1.0 to 1.1	0.209
Enrolment RLOC	-0.1	0.9	0.9 to 0.8	0.314

Table 3-12: Logistic regression model predictive of diagnosis of CRPS.

Observed diagnosis of CRPS	Predicted diagnosis of CRPS		
	No	Yes	
No	206	0	Specificity = 100%
Yes	9	1	Sensitivity = 10%
	NPV = 96%	PPV = 100%	

Table 3-13: Sensitivity and specificity table of predictive model for diagnosis of CRPS.

3.4 Discussion

Little is known of the associations between psychosocial factors, measured early in recovery from distal radius fracture, and longer-term outcomes. The work in this chapter demonstrates that demographic factors are the most influential predictors of DASH and pain intensity at ten weeks and nine months following injury. Psychological and social factors measured at the time of presentation are associated with outcome and are more influential than injury or treatment characteristics.

3.4.1 Demographic factors

Increased age was associated with increased disability at nine months and was the factor most strongly associated with increased disability ten weeks after injury. This is unsurprising given the reduced functional level that comes with increasing age (210) and likely reflects the higher baseline levels of disability seen as patients get older. The use of pre-to-post injury change in DASH as the outcome measure would standardise for this but the use of retrospectively completed pre-injury DASH scores is affected by recall bias and this method has not been validated.

Level of social deprivation was associated with multiple outcomes (DASH at ten weeks and nine months and pain score at 10 weeks). It is well established that there is an increased incidence of fractures in more socially deprived groups (211). Socially deprived patients with distal radius fracture are more likely to be younger, male and have sustained high energy injuries (212). In keeping with results seen in this chapter poorer patient reported functional outcomes have been associated with increased social deprivation following proximal humerus fracture (213) and hip fracture (214). The association with social deprivation varies depending on the outcome measure used. Its influence is less profound on measures that more specifically assess impairment. A prospective study of 3,893 patients with distal radius fracture found that increased social deprivation was not associated with poorer functional outcomes (range of motion, grip strength and Moberg Pick-up Test). These measures are more specific to wrist impairment than the DASH score, which assesses not only impairment but also resultant disability and handicap (197). This highlights the importance of understanding individual outcome measures and the context in which they have been used when interpreting results.

The number of medical comorbidities a patient had at time of injury was associated with longer term outcomes, pain and disability at nine months. This is likely due to slower functional recovery from fracture in more frail populations as well as the incidental influence of comorbid conditions, which become more apparent as patients recover from the acute injury.

The association between these demographic factors and PROMS is strong but these factors are not modifiable in the context of treatment of distal radius fracture. The potentially modifiable factors most strongly associated with outcome following distal radius fracture are psychological and therefore these are of interest.

3.4.2 Psychological factors

Increased levels of depressive symptoms and a belief in an external locus of control during recovery were associated with increased disability at ten weeks and nine months. An increased perception that injury posed a threat to health was associated with increased disability and pain at early, 10 week, follow up. No psychological factors were independently associated with development of CRPS or undergoing additional surgical intervention.

These findings are in keeping with work in the wider orthopaedic literature. In cross sectional studies of patients with mixed upper limb conditions depressive symptoms have been associated with poorer grip strength, patient reported functional outcomes and pain (54, 95, 99). In a cross-sectional study of 594 patients with acute hand and wrist fractures, Ross et al found that depression mediated the relationship between pain and disability (215). Nota et al found that increased depressive symptoms at enrolment were associated with poorer functional score 8 months following injury in a longitudinal study of a mixed cohort of orthopaedic trauma patients (82). A longitudinal study of patients admitted to hospital with injuries (Injury Severity Score ≥9) found an association between illness perceptions at three months and functional outcomes at 6 months following injury (134).

Work detailed in Chapter 4 suggests that depression remains stable after distal radius fracture whereas illness perceptions evolve with time. This may account for the enduring association between depression and disability and the loss of association between illness perceptions and outcomes by nine months.

Clinically relevant depression is seen in as many as 45% of patients following orthopaedic trauma (95) but in the study cohort in this chapter only 12% of patients had scores indicative of depression. Comparison with the literature is limited as different scoring systems are widely used and assessment not standardised but suggests that the study cohort in this chapter has a psychological profile that is better suited to good recovery than average. This pattern is noted across the psychological factors measured and should be considered when generalising these results, Table 3-1. The general pattern of enrolment psychological scores seen in the study cohort in this chapter reflect acute injury rather than chronic pain. The bivariate analysis in Table 3-3 suggests that as enrolment psychological scores tend towards patterns seen in chronic pain they are associated with increased disability and increased pain intensity. Patients with chronic pain pattern psychological scores at enrolment may have chronic pain issues that predate their fracture or this may represent a maladaptive response to acute injury. These patients may represent a sub group at risk of poor outcome due to their psychological profile. The evolution of these psychological factors over time following injury is investigated in Chapter 4.

The incidence of CRPS was 5%, which closely matches figures from the existing literature (20). There is currently no consensus regarding the role that psychological factors play in the development of CRPS. Depression and stress have been implicated but it is unclear whether this is cause or effect due to the retrospective cross-sectional nature of studies (27, 216, 217). Personality type has not consistently been associated with CRPS (218, 219).

Enrolment recovery locus of control and IPQB were identified as factors in a model which predicted CRPS during recovery from distal radius fracture. However, none of the factors in the model were independently statistically significant. This may have been a result of the small number of cases of CRPS in the cohort resulting in insufficient variability in the data to allow any predictors to become significant. The model described correctly classified 96% of cases as not having CRPS but only has a specificity of 10%. Due to the small number of patients with CRPS in the study it essentially predicts no-one to have CRPS and therefore is not useful clinically. It is suggested that at least twenty cases are required to enable valid conclusions to be made (220). Beerthuizen et al found no associations between psychological factors and CRPS in a prospective trial of 596 patients (42, 8%, with CRPS) with isolated hand, wrist and lower limb fractures (26). However, they acknowledge that there may be associations with psychological factors out-with the scope of their study. They did not include measures of locus of control or illness perception.

The two psychological factors in the model that predicted CRPS were also independently associated with disability. It is suggested that disuse plays a role in the development of CRPS (221). It may be the case that the presence of these psychological factors results in disuse of the affected limb and in extreme cases the development of the symptoms, signs and radiographic features recognised as CRPS.

The cross-sectional studies referred to in section 1.1.4 identified associations between CRPS and psychological factors (depression, anxiety and stress) (25, 27). This suggests that these traits are more prevalent in patients with CRPS but does not establish causality or indicate if higher levels of these factors at time of injury are predictive of CRPS. Ultimately no psychological factors measured in this chapter were found to independently predict the development of CRPS. The validity of CRPS diagnosis in this study is limited as are the numbers of patients with CRPS.

Attempts should be made to assess for associations between a wider range of psychological factors, including illness perception and locus of control, and CRPS in larger cohorts of patients. This is difficult in prospective studies due to the relatively rare nature of this complication.

3.4.3 Physical factors

Injury, radiographic and treatment factors were associated with outcomes to a lesser degree than demographic and psychological factors. Nerve injury was associated with disability at ten weeks and degree of radial shortening with disability at nine months. Nerve injury and radiocarpal alignment were associated with additional surgical intervention. No other associations were found between biomedical factors and outcome in this study.

Radial shortening has been associated with outcome following distal radius fracture in a number of other studies but in general the associations between radiographic measures and patient reported outcomes are inconsistent as outlined in 1.1.4 (4, 29, 36-38). It should be noted that the cohort of patients studied in this chapter had treated distal radius fracture, the majority of these injuries were low energy and good radiographic outcomes achieved, Appendix 3. This may have reduced the influence of these factors on outcome.

The rate of additional surgical intervention was 5%, which closely matches figures seen in larger cohorts (17). Loss of radiocarpal alignment and presence of a nerve injury were the only factors independently associated with additional surgical intervention. These are both recognised indications for surgical intervention (29). This suggests treatment decisions are being made on the basis of objective biomedical findings. But, interestingly, nerve injury was associated with disability but radiocarpal alignment was not. High levels of catastrophic thinking and perceptions that the injury is threatening to health were in a model that significantly predicted additional surgical intervention, however, they were not significant as independent factors. As with CRPS, this may have been a result of the small number of cases of additional surgical intervention in the cohort resulting in insufficient variability in the data to allow any more predictors to become significant. It is rare for metal work to be removed at a patient's request or to specifically address pain issues before 1 year. It would be interesting to repeat this analysis at a later date, including these patients with more subjective reasons for additional surgery when the association with psychological factors may be stronger.

3.4.4 Limitations

This study had a number of limitations. Although the cohort is from a well-defined inclusive population, those lost to follow up were younger and had radiographically less severe injuries. Patients with cognitive impairment and psychosis were excluded. Baseline psychological scores in the study cohort were better than recognised normative values. Variation in baseline scores would be expected in different populations but the reasons for better scores this cohort are unclear. The trend is consistent throughout the thesis. These facts must be considered when generalising the results. The results do not establish causality. In the absence of manipulation of the factors associated with outcome this is not possible. Follow up was to 9 months and although the majority of recovery has occurred within this period (14, 16), outcomes can still be expected to improve beyond this point. The R^2 value in the multivariable regression models indicate that a proportion of the variance in outcome scores remains unexplained. The unexplained variance is a result of unmeasured biopsychosocial factors as well as 'data noise' (variance caused by loss of concentration, misunderstanding and lack of honesty when completing questionnaires). At each time point the models for predicting pain had more unexplained variance and identified fewer significant predictors than those predicting disability. This highlights how complex and poorly understood the experience of pain is.

The psychological questionnaires used were large in number and often in length, this can create questionnaire fatigue. As subjects lose interest or attention, questions or pages are missed, inaccurate answers given and validity of returned questionnaires suffers. Questionnaire fatigue can be reduced by the use of validated short form questionnaires, focused research questions and limiting number of follow up appointments.

The problem of multiplicity and resultant type 1 error must be considered in the type of bivariate analysis used. Attempts to limit this were made by rationalising the entry factors used and focusing on the primary outcome measure.

The study was powered for a sample size of 218, however, due to slightly larger loss to follow up than expected only 216 patients were available for analysis.

The assessment of patients with CRPS was limited by the lack of documentation of the number of signs and symptoms from the modified IASP diagnostic criteria for CRPS used by surgeons making this diagnosis, however, the incidence of CRPS was found to be 5%, which is similar to that seen in a similar large prospective trial where these criteria were used (7%) (26). The small number of patients with CRPS and additional surgical intervention limits the conclusion that can be drawn from these regression analyses and sensitivity / specificity calculations.

3.4.5 Conclusion

Outcome following distal radius fracture is multifactorial. A number of factors identifiable at time of injury are associated with long term outcomes. Demographic and social factors are predictive of outcome but are not modifiable in the context of acute injury. Predictive physical factors are addressed with well recognised orthopaedic management which aims to reconstitute anatomy. The potentially modifiable (155) psychological factors associated with outcomes, as identified in this study, are currently widely overlooked in the treatment of distal radius fracture. Some of these factors may be modifiable in the context of acute injury where as others may not. The impact of psychological as well as the physical factors on outcomes should be recognised. They may be effective targets for screening and treatment in this population. Future work should aim to identify other psychological factors that identify patients at risk of poor outcome and assess how and when best to identify these patients. The aim of treatment should be to optimise physical and psychological conditions to facilitate recovery from fracture.

4 Predictors of psychological response to distal radius fracture.

4.1 Introduction

Chapter 3 demonstrated that psychological factors are associated with pain and disability following distal radius fracture. An understanding of the psychological response to fracture and how it is affected by demographic, injury and treatment characteristics would aid clinical assessment of patients following injury and help with the development of supplementary care strategies to improve outcomes.

The psychological response to fracture of the distal radius fracture is not well understood. The available literature is discussed in Chapter 1. It is sparse, limited by study design and rarely focuses on distal radius fracture. The aim of this chapter is to identify associations between demographic, injury and treatment factors and change in psychological factors over time in a cohort of patients following distal radius fracture and to describe the evolution of a number of psychological factors over time following injury.

The primary null hypothesis was that factors (age, gender, social deprivation, marital status, medical comorbidities, injury characteristics, radiographic parameters, treatment type and time to follow up) are not associated with change in self-efficacy between enrolment and 10 weeks post injury.

The secondary null hypotheses were that the same factors are not associated with change in PCS or IPQr domains (identity, timeline acute / chronic, personal control and emotion) between time of injury and 10 week follow up and, finally, that there is no change in GSES, PCS, IPQr, HADS depression, HADS anxiety, PCL-C, TSK, and RLOC from enrolment to 9 months post injury.

4.2 Methods

4.2.1 Patients

This study was a sub group analysis from a larger prospective study designed to determine psychosocial factors that predict functional limitation and symptom severity after distal radius fracture, Chapter 3. The ethics committee approved the work, Appendix 1.

All patients with a distal radius fracture presenting within 4 weeks of injury to a University Hospital between August 2015 and February 2016 were assessed for eligibility for recruitment into the study. All skeletally mature patients age 16 and over were included, regardless of treatment type. Patients were excluded if they declined involvement, did not speak English, lacked the cognitive capacity to understand and complete questionnaires, were undertaking injury compensation proceedings, using illicit drugs, had a psychiatric diagnosis of psychosis or failed to complete assessment of core psychological measures (GSES, PCS, IPQr) at enrolment. These psychological factors were selected as 'key measures' for a number of reasons. Self-efficacy is considered to be one of the most important factors related to behaviour change (69). Catastrophic thinking is associated with outcomes in a number of other studies of trauma cohorts as discussed in Chapter 1. Illness perception is associated with pain and disability following distal radius fracture as seen in Chapter 3. They are all also potentially modifiable. For these reasons, they are of particular interest and a better understanding of each would be useful when considering the development and implementation of psychological interventions to supplement routine care in patients with distal radius fracture. Only IPQr domains (identity, timeline acute / chronic, personal control and emotion) were used as response variables to reduce the risk of Type 1 error in a cohort of this size. These specific domains were chosen as they represent a breadth of perception and were felt to be most clinically relevant.

Patients were treated routinely as per unit protocols, Section 2.2. Details of demographics, medical history, radiographic parameters, injury and treatment characteristics were prospectively collected. Patients completed psychological assessment questionnaires at enrolment (T1), 10 weeks (T2) and 9 months following injury (T3). Psychological measures were General Self-efficacy Scale (GSES), Pain Catastrophising Scale (PCS), Illness Perception Questionnaire Revised (IPQr), Hospital Anxiety and Depression Score (HADS) Depression, HADS Anxiety, Tampa Scale for Kinesiophobia (TSK), psychological distress (PCL-C) and Recovery Locus of Control (RLOC).

Two hundred and forty-six patients met the inclusion criteria. The study cohort comprised 153 patients who completed the key psychological assessments (GSES, PCS, IPQr) 10 weeks after injury, Figure 4-1. Cohort demographics are compared in Appendix 3. The study cohort was older (mean age 57 vs 49), had a different distribution of employment (proportionally fewer manual workers and students), higher enrolment RLOC (more external locus of control) and at enrolment expected to make a faster recovery than the cohort lost to follow up.

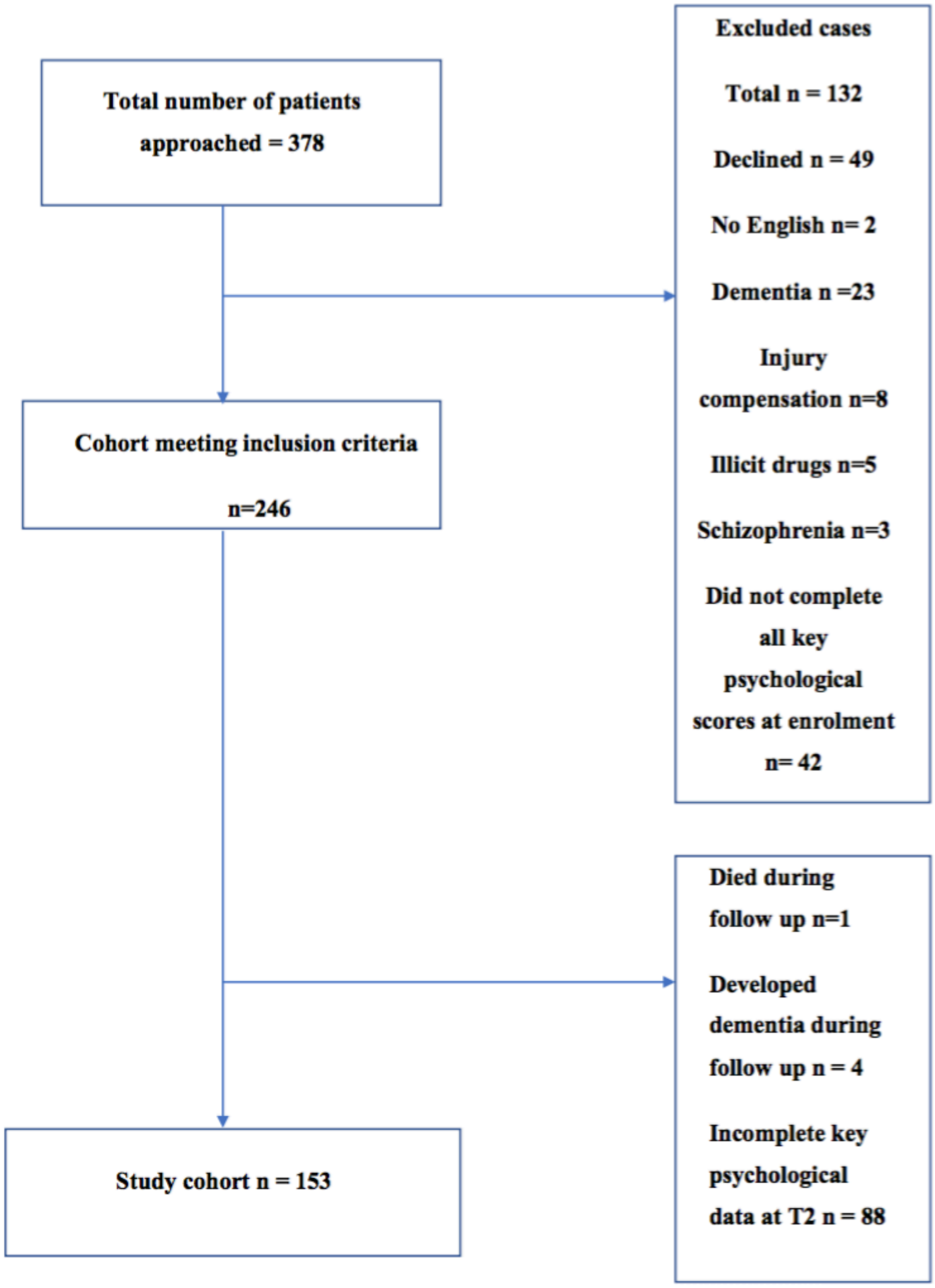

Figure 4-1:Predictors of psychological response to distal radius fracture: study cohort.

4.2.2 Statistical analysis

Descriptive statistics were used to present demographic, co-morbidity, injury, treatment, radiographic and psychological characteristics. Patients who did not complete follow up were compared to the study cohort using Mann Whitney U for non-parametric data and Chi Square Test and Fisher's Exact Tests for parametric data.

A within subjects design with one categorical independent variable (time) and a continuous dependant variable (psychological score) was used to assess the change in psychological measures over time (T1, T2, T3). A repeated measures ANOVA was used for parametric data or a Friedman's test for non-parametric data.

Multivariable linear regression analysis was used to identify demographic and injury factors associated with change in psychological measures. The response variables were change in GSES, PCS and 4 IPQR domains (identity, timeline acute / chronic, personal control and emotion) between time of injury and 10 weeks. The explanatory variables were: age; gender; social deprivation quintile; marital status, number of medical comorbidities; AO-OTA fracture classification (grouped as A, B or C); nerve injury; multiple fractures; radiographic alignment at T2: RC alignment, radial shortening, dorsal tilt; surgical management; time to presentation and follow up. Spearman correlations, Mann Whitney U Tests, and Kruskal Wallis Tests were used for non-parametric data. Pearson correlations, T Tests and ANOVA for parametric data. Factors with $p<0.1$ in bivariate analysis were entered into multivariable linear regression models. Where there was correlation of >0.7 between factors one was dropped from the model. Missing explanatory variable data was completed with mean imputation.

4.3 Results

4.3.1 Change in psychological scores over time

The change in psychological scores over time are seen in Table 4-1 and Figure 4-2 to Figure 4-16.

The following scores remained stable over time: there was no change in HADS depression, HADS anxiety, PCL-C, IPQR timeline cyclical and coherence from enrolment to 10 weeks and 9 months after injury.

The following scores changed over time in a way that is considered an improvement: PCS fell between enrolment and 10 weeks and enrolment and 9 months; TSK, IPQR identity, emotion and consequence fell at every time point. IPQR personal control and RLOC increased in the early period, between enrolment and 10 weeks. GSES increased in the late period, between 10 weeks and 9 months (T2 to T3).

The following changed in a direction that is considered to be worsening: IPQR timeline acute / chronic increased between enrolment and 10 weeks and enrolment and 9 months; IPQR treatment control fell by 9 months.

Psychological Measure	**T1**	**T2** Median (IQr)	**T3**	**$\chi^2(2)$ p**	**Post hoc pairwise comparisons (showing significant differences only)**
GSES	31 (29-36)	30 (29-34)	31 (29-37)	**13.4 0.001**	**T2-T3 (p=0.002)**
PCS	3 (1-10)	2 (0-7)	1 (0-4)	**21.2 <0.001**	**T1-T2 (p=0.012) T1-T3 (p=<0.001)**
IPQR Identity	3 (2-4)	3 (2-4)	1 (0-3)	**100.9 <0.001**	**T1-T2 (p=0.002) T2-T3 (p=<0.001) T1-T3 (p=<0.001)**
IPQR acute / chronic	11 (9-15)	14 (10-18)	15 (10-20)	**22.5 <0.001**	**T1-T2 (p=0.026) T1-T3 (p=<0.001)**
IPQR personal control	22 (20-24)	23 (21-26)	23 (20-25)	**10.8 0.005**	**T1-T2 (p=0.007)**
IPQR emotion	14 (11-18)	13 (9-18)	11 (6-14)	**74.7 <0.001**	**T1-T2 (p=0.039) T2-T3 (p=<0.001) T1-T3 (p=<0.001)**
IPQR cyclical	8 (7-12)	9 (8-12)	8 (5-12)	3.7 0.155	
IPQR consequence	14 (11-18)	12 (8-16)	9 (7-12)	**74.8 <0.001**	**T1-T2 (p=<0.001) T2-T3 (p=<0.001) T1-T3 (p=<0.001)**
IPQR treatment	20 (18-22)	20 (17-22)	18 (15-21)	**34.8 <0.001**	**T2-T3 (p=<0.001) T1-T3 (p=<0.001)**
IPQR coherence	23 (20-24)	24 (20-25)	24 (20-25)	1.1 0.563	
HADS Depression	2 (1-5)	2 (0-5)	1 (0-4)	0.5 0.775	
HADS Anxiety	4 (2-7)	3 (2-7)	3 (1-7)	2.7 0.265	
PCL-C (PTSD)	20 (17-26)	20 (17-26)	19 (17-25)	1.1 0.582	
TSK	38 (33-41)	35 (31-39)	34 (30-36)	**57.1 <0.001**	**T1-T2 (p=0.002) T2-T3 (p=<0.001) T1-T3 (p=<0.001)**
RLOC	36 (33-40)	38 (34-41)	37 (34-41)	**11.6 0.003**	**T1-T2 (p=0.005)**

Table 4-1: Change in Chapter 4 outcome variables over time. Friedman's Tests.

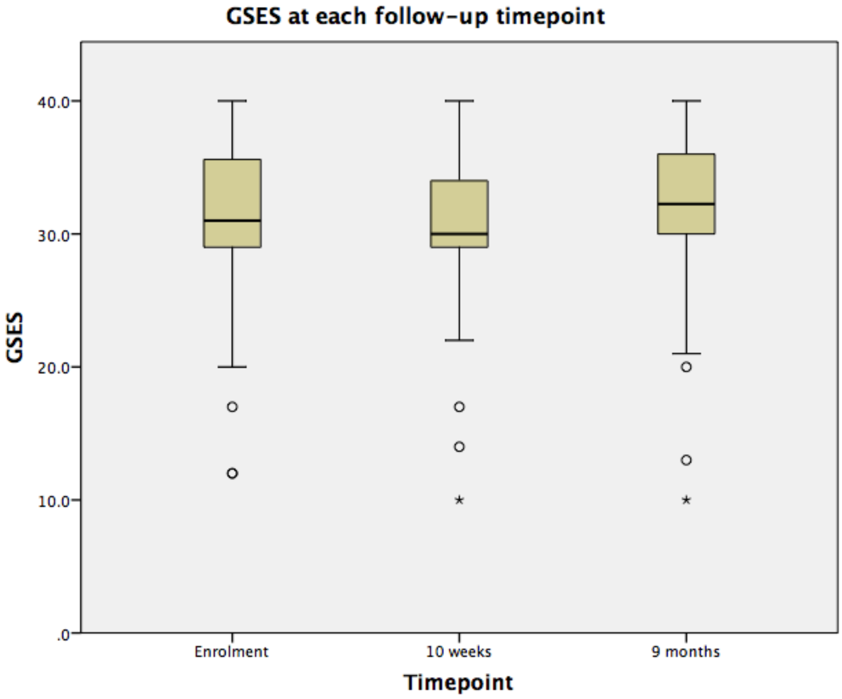

Figure 4-2: Graph of change in GSES over time (Friedman's Test, p=0.001). ° and * represent outliers.

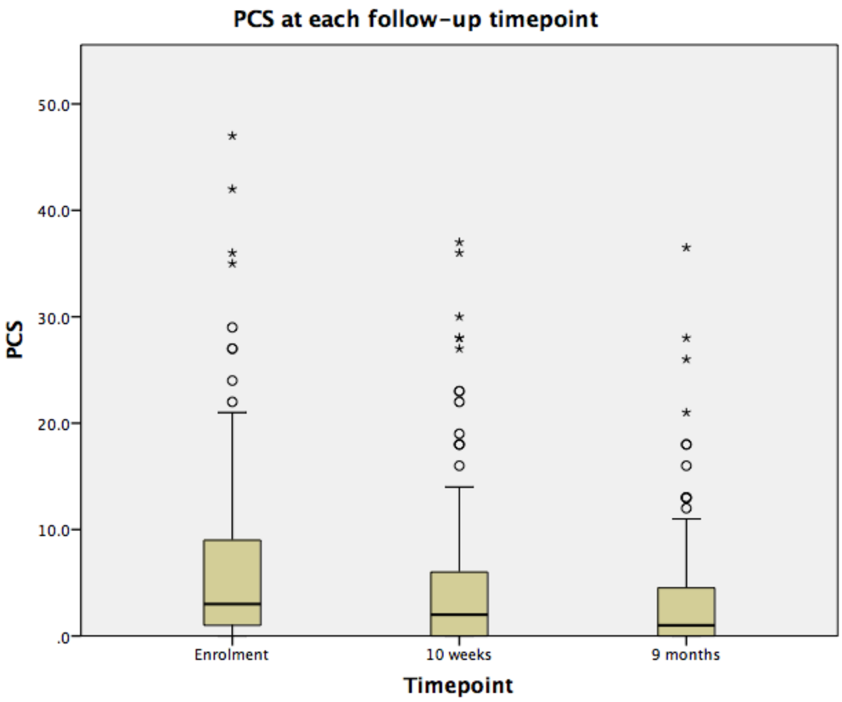

Figure 4-3: Graph of change in PCS over time (Friedman's Test, p<0.001). ° and * represent outliers.

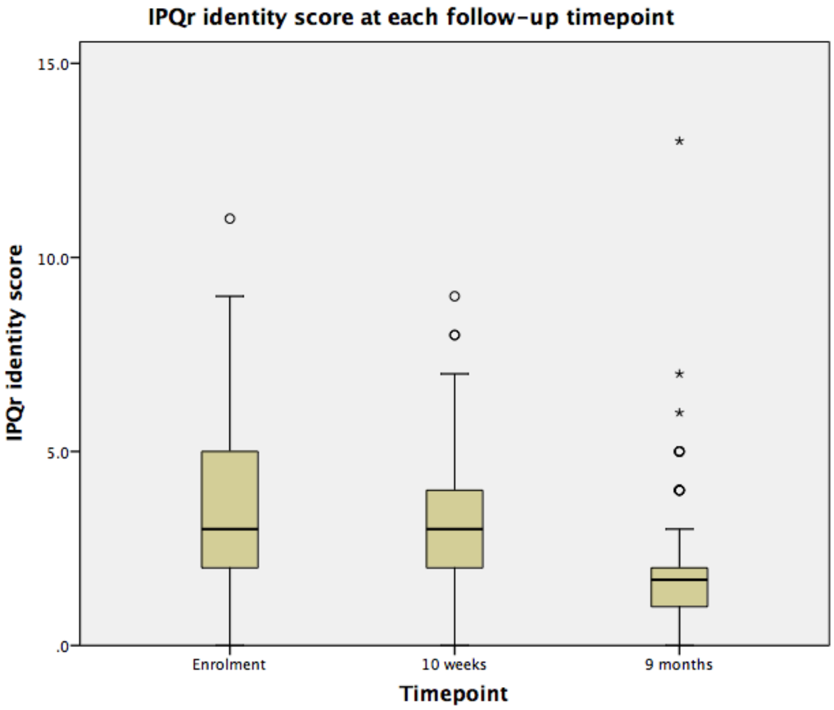

Figure 4-4: Graph of change in IPQr identity score over time (Friedman's Test, p<0.001). ° and ∗ represent outliers.

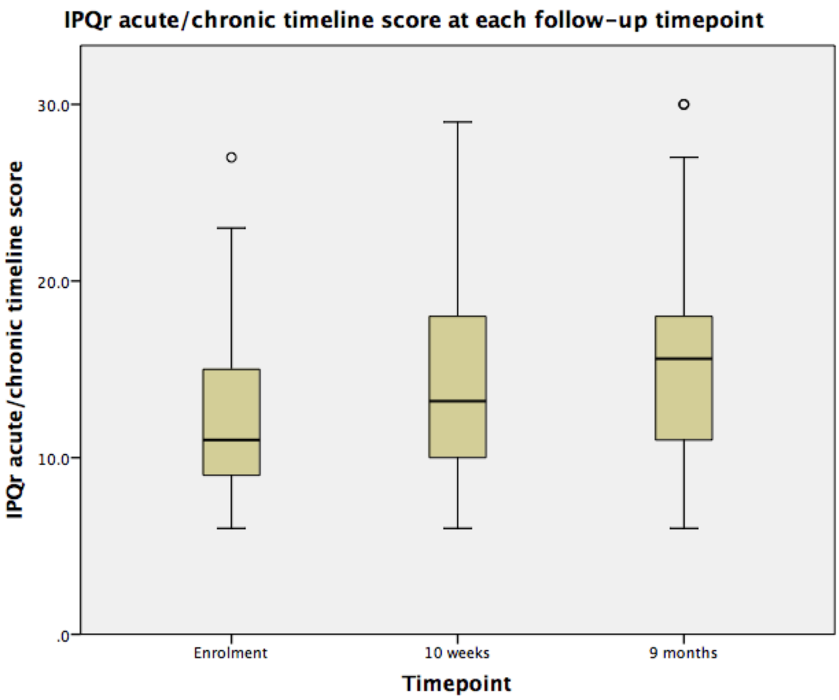

Figure 4-5: Graph of change in IPQr acute/chronic timeline score over time (Friedman's Test, p<0.001). ° and ∗ represent outliers.

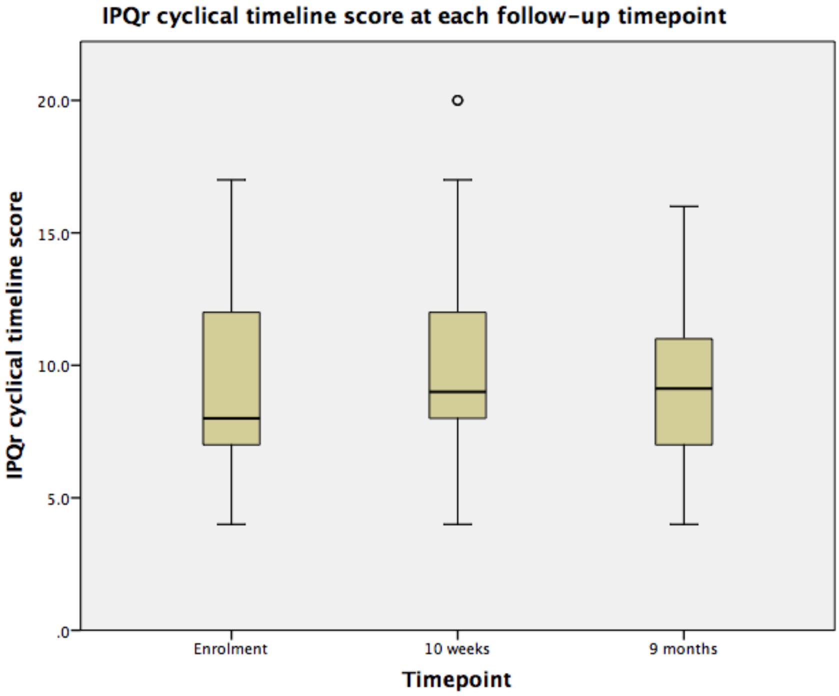

Figure 4-6: Graph of change in IPQr cyclical timeline score over time (Friedman's Test, p=0.155). ° and * represent outliers.

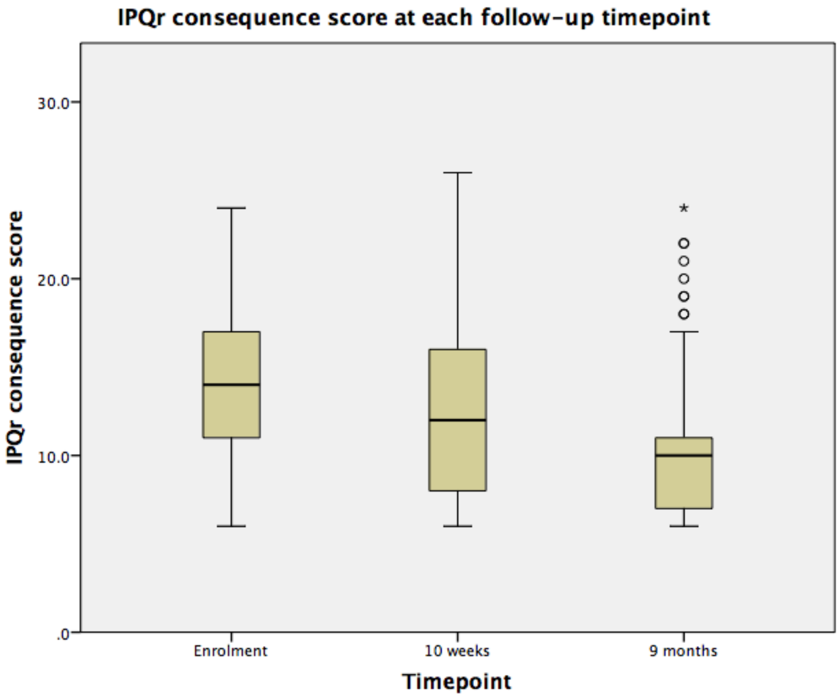

Figure 4-7: Graph of change in IPQr consequence score over time (Friedman's Test, p<0.001). ° and * represent outliers.

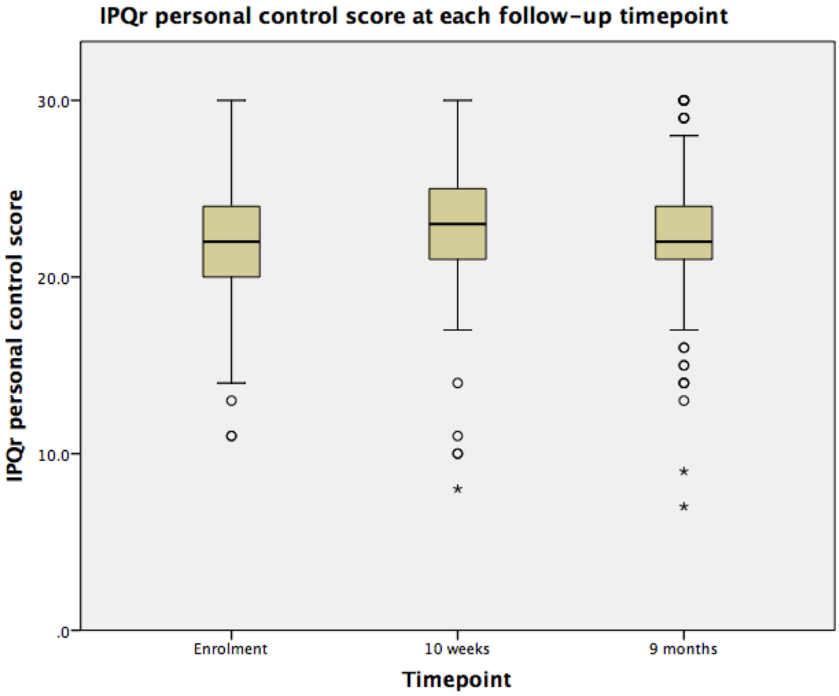

Figure 4-8: Graph of change in IPQr personal control score over time (Friedman's Test, p=0.005). ° and * represent outliers.

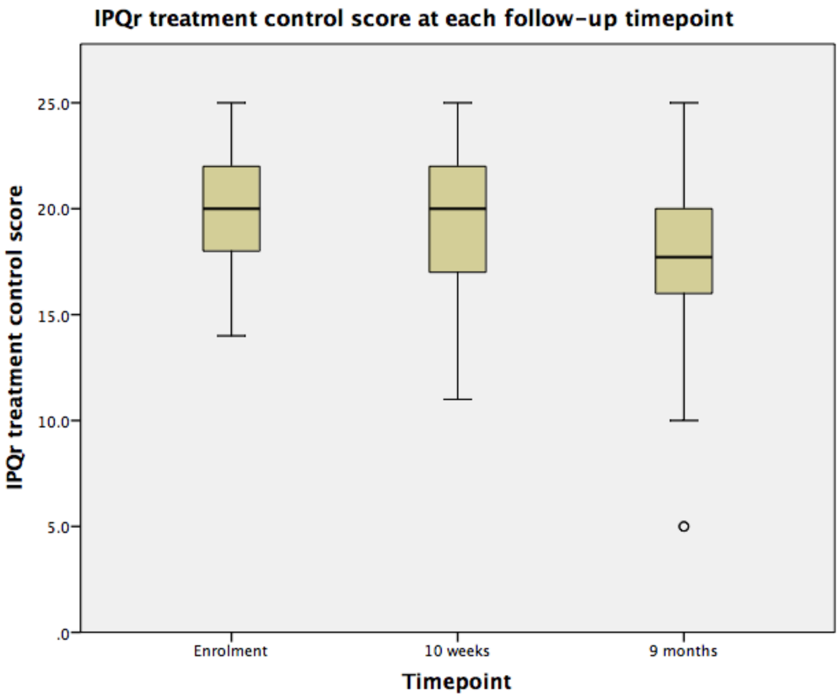

Figure 4-9: Graph of change in IPQr treatment control score over time (Friedman's Test, p<0.001). ° and * represent outliers.

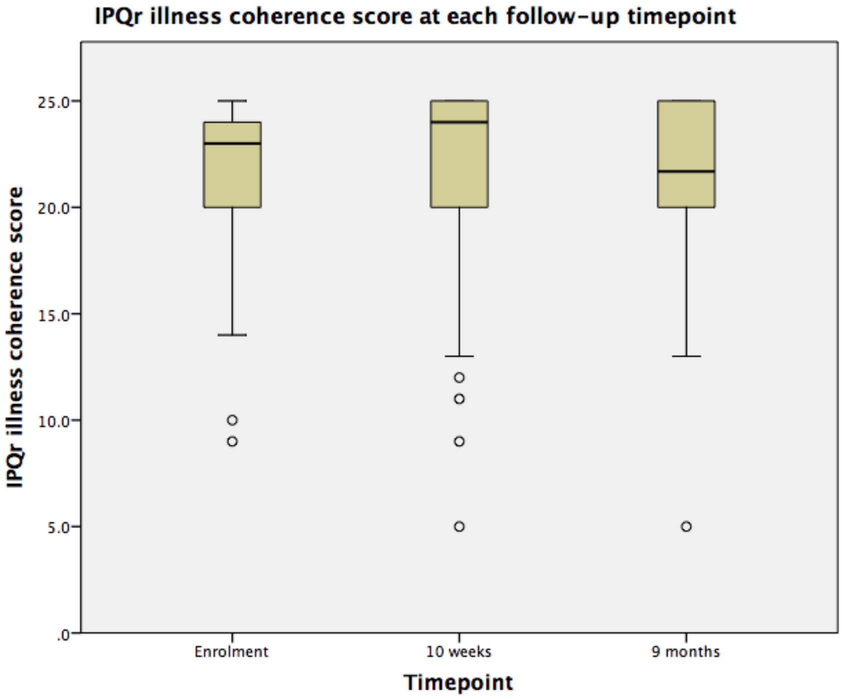

Figure 4-10: Graph of change in IPQr illness coherence score over time (Friedman's Test, p=0.563). ° and ∗ represent outliers.

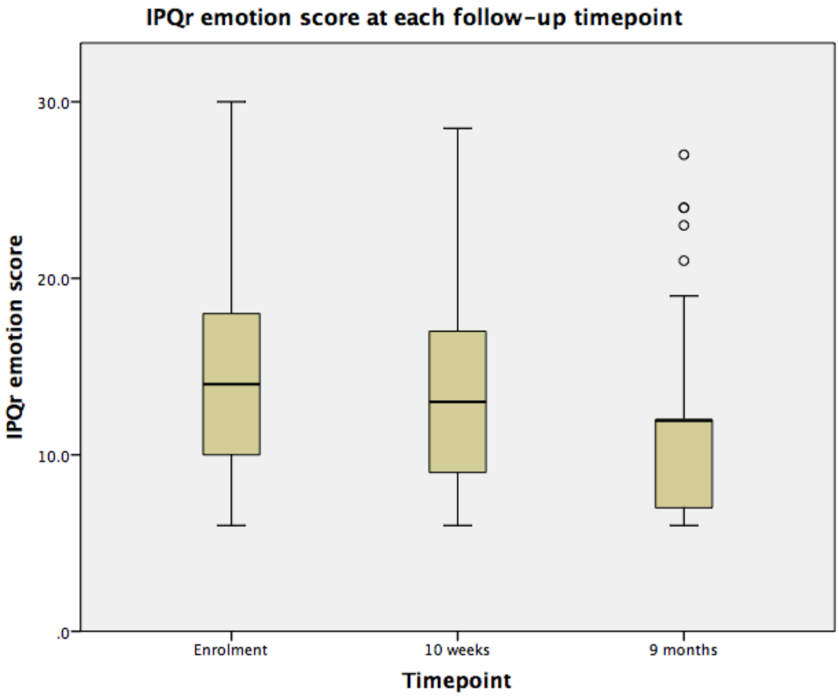

Figure 4-11: Graph of change in IPQr emotion score over time (Friedman's Test, p<0.001). ° and ∗ represent outliers.

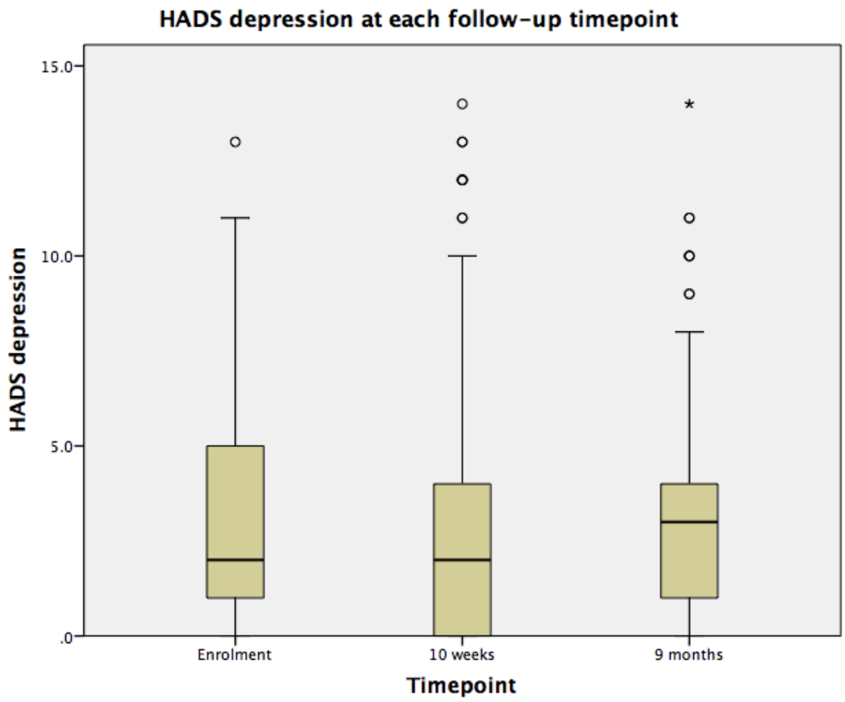

Figure 4-12: Graph of change in HADS depression over time (Friedman's Test, p=0.775). ° and * represent outliers.

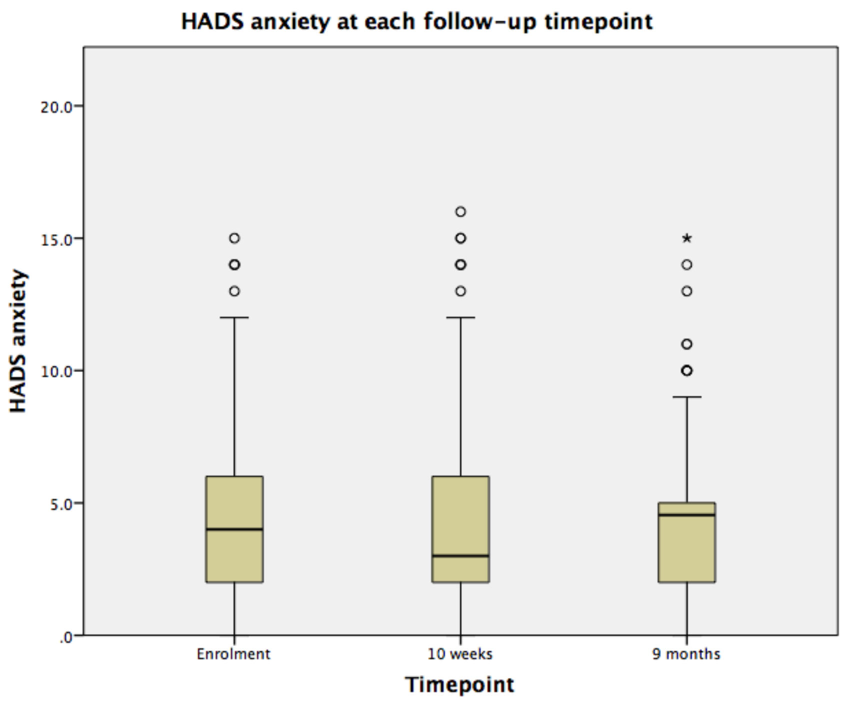

Figure 4-13: Graph of change in HADS anxiety over time (Friedman's Test, p=0.265). ° and * represent outliers.

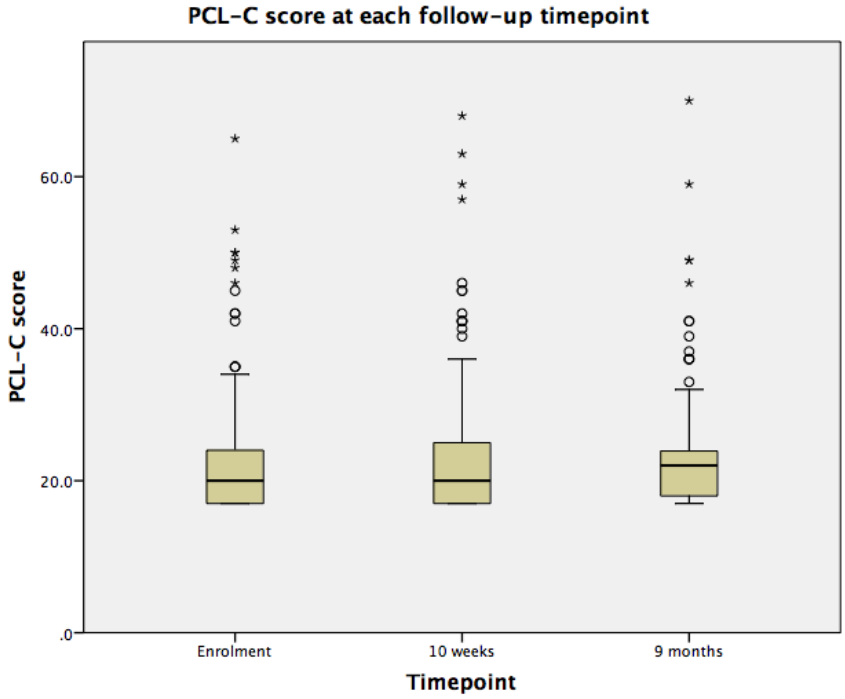

Figure 4-14: Graph of change in PCL-C score over time (Friedman's Test, p=0.582). ° and * represent outliers.

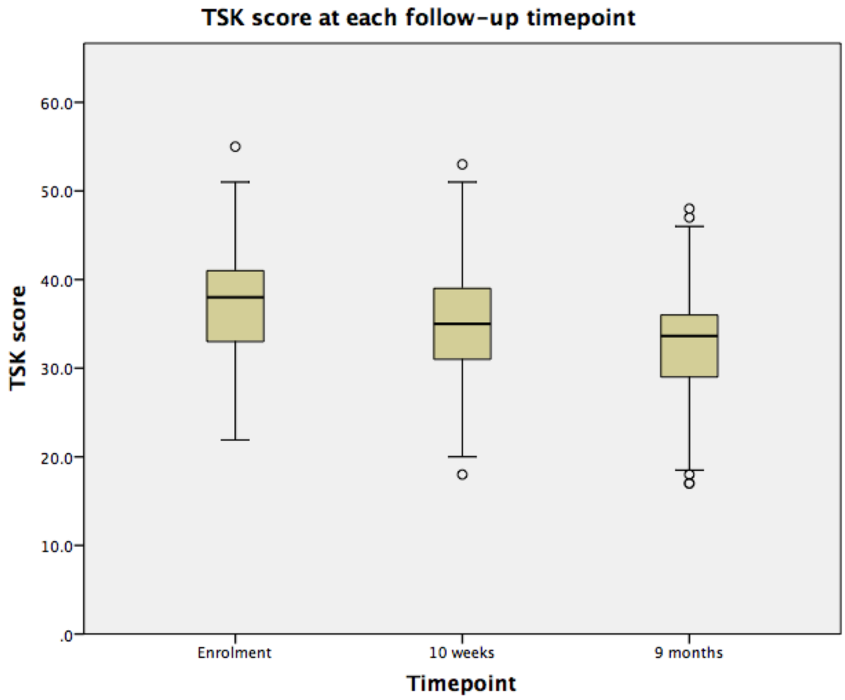

Figure 4-15: Graph of change in TSK score over time (Friedman's Test, p<0.001). ° and * represent outliers.

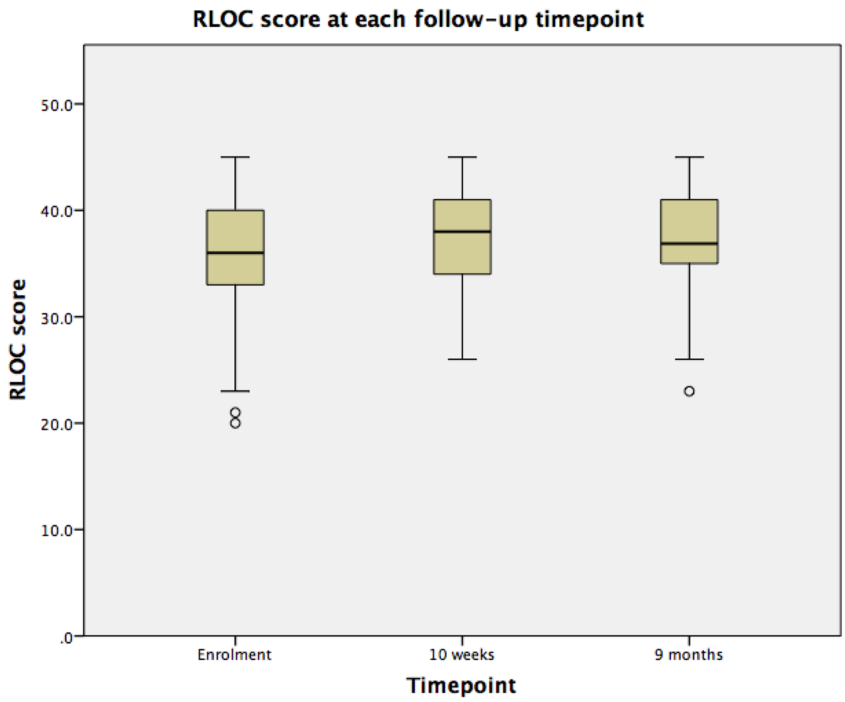

Figure 4-16: Graph of change in RLOC score over time (Friedman's Test, p=0.003). ° and * represent outliers.

4.3.2 Factors associated with change in psychological score.

On bivariate analysis, no explanatory variables were associated with magnitude of change in the key psychological scores GSES, PCS IPQr identity, IPQr timeline acute chronic or IPQr personal control ($p<0.05$), Table 4-2 and Table 4-3. There was a positive correlation between age and change in IPQr emotion, rs(153) = 0.196, p = 0.01, Table 4-3. Larger change in IPQr emotion associated with younger age.

	Association with change in score T1 to T2	
Factor	**GSES**	**PCS**
Age*	-0.1 (0.220)	0 (0.568)
Gender	0.586^{α}	0.550^{α}
Marital status	0.400^{α}	0.934^{α}
Index of Multiple Deprivation	0.591^{β}	0.102^{β}
Number of medical comorbidities*	0 (0.725)	0.1 (0.462)
Nerve injury	0.574^{α}	0.532^{α}
Presence of multiple fractures	0.606^{α}	0.522^{α}
AO-OTA classification (A,B,C)	0.152^{β}	0.165^{β}
Radiocarpal alignment maintained	0.372^{α}	0.512^{α}
Dorsal angulation degrees *	0 (0.612)	0.1 (0.291)
Ulnar variance (radial shortening)*	0 (0.892)	0 (0.655)
Surgical management	0.561^{γ}	0.947^{α}
Days to presentation*	-0.1 (0.454)	0.1 (0.303)
Weeks to T2*	0 (0.565)	0.1 (0.146)

Table 4-2: Table of bivariate analysis of entry variables and change in GSES and change in PCS. * Spearman's Correlation: correlation coefficient (p value). α ***Mann Whitney U Test,*** β ***Kruskal Wallis Test,*** γ ***Independent samples T Test.*** δ ***One way ANOV:. p value presented.***

	Association with change in score T1 to T2			
Factor	**IPQr identity**	**IPQr timeline acute / chronic**	**IPQr personal control**	**IPQr emotion**
Age*	0.0 (0.557)	0.1 (0.237)	0.0 (0.798)	**0.2 (0.015)**
Gender	0.799$^{\alpha}$	0.871$^{\alpha}$	0.887$^{\alpha}$	0.204$^{\gamma}$
Marital status	0.679$^{\alpha}$	0.569$^{\alpha}$	0.326$^{\alpha}$	0.796$^{\gamma}$
Index of Multiple Deprivation	0.344$^{\beta}$	0.825$^{\beta}$	0.641$^{\beta}$	0.382$^{\beta}$
Number of medical comorbidities*	0.0 (0.867)	0.0 (0.836)	-0.1 (0.335)	0.1 (0.266)
Nerve injury	0.928$^{\alpha}$	0.501$^{\alpha}$	0.817$^{\alpha}$	0.695$^{\gamma}$
Multiple fractures	0.596$^{\alpha}$	0.278$^{\alpha}$	0.088$^{\alpha}$	0.956$^{\gamma}$
AO-OTA classification (A,B,C)	0.408$^{\beta}$	0.362$^{\beta}$	0.579$^{\beta}$	0.389$^{\delta}$
Radiocarpal alignment maintained at T2.	0.517$^{\alpha}$	0.368$^{\alpha}$	0.645$^{\alpha}$	0.563$^{\gamma}$
T2 Dorsal tilt (degrees) *	0.0 (0.810)	0.2 (0.050)	0.0 (0.976)	0.1 (0.485)
T2 Ulnar variance (mm) (radial shortening)*	0.0 (0.993)	0.1 (0.076)	0.0 (0.838)	0.0 (0.586)
Surgical management	0.548$^{\alpha}$	0.597$^{\alpha}$	0.248$^{\alpha}$	0.766$^{\gamma}$
Days to presentation*	-0.1 (0.074)	0.0 (0.940)	0.0 (0.568)	-0.1 (0.169)
Weeks to T2*	-0.1 (0.118)	0.1 (0.314)	0.0 (0.589)	0.1 (0.114)

Table 4-3: Table of bivariate analysis of entry variable and change in selected IPQr subscales. * Spearman's Correlation: correlation coefficient (p value). α Mann Whitney U Test, β Kruskal Wallis Test, γ Independent samples T Test. δ One way ANOVA: p value presented.

Table 4-4 shows the change in IPQr emotion over time in different age groups. The fall in level of emotional response (improvement) is slower in the older age groups but the final level reached by 9 months is the same. Conversely, in younger patients the negative emotional impact of the injury falls more quickly.

Age range	Enrolment IPQR emotion	10 week IPQR emotion	9 month IPQR emotion	Change in IPQR emotion between enrolment and 10 weeks
	mean (range, SD, 95% CI)			
≤ 40	14 (6-28, 5, 12-16)	11 (6-27, 5, 9-13)	11 (6-25, 4, 10-12)	-2.9(-14-6, 5, -5 to-1)
41 - 60	15 (6-27, 5, 14-16)	13 (6-29, 5, 12-15)	11 (6-24, 5, 10-12)	-1.4 (-14-16, 5, -3-0)
61 - 80	15 (6-25, 5, 13-16)	14 (6-26, 5, 13-16)	11 (6-27, 5, 10-13)	-0.2 (-12-13, 5, -2-1)
>80	15 (6-30, 7, 11-18)	15 (6-26, 6, 12-19)	11 (6-17, 4, 9-14)	0.7 (-8-9, 5, -2-4)

Table 4-4: Mean and change in IPQr emotion over time grouped by patient age.

For the purposes of multivariable linear regression analysis only IPQr timeline acute chronic had more than one explanatory variable with significance < 0.1, Table 4-3. The multivariable linear regression model including these variables was not statistically significant. $F(2,150) = 1.560$ $p = 0.214$, adj $R^2 = 0.007$, Table 4-5.

Variable	Regression Coefficient (Unstandardised)	Standardised coefficient	95% Confidence Limits	p value
T2 Dorsal tilt (degrees)	0.1	0.3	0 to 0.1	**0.007**
T2 Ulnar variance (mm) (radial shortening)	5.2	0.3	1.5 to 8.9	**0.009**

Table 4-5: Multivariable linear regression analysis documenting predictors of change in IPQr timeline acute chronic between enrolment and 10 weeks following distal radius fracture.

4.4 Discussion

The psychological response to common, low energy fractures such as distal radius fracture is not known (222). Insight into how psychological factors evolve over time and what influences this change would help patient assessment and to target intervention. This chapter demonstrates that psychological response to fracture of the distal radius is difficult to predict with demographic, injury or treatment factors (including markers of injury severity and surgical management). It also shows that the psychological response to distal radius fracture is generally stable.

4.4.1 Predictors of psychological response

No entry variables were associated with change in general self-efficacy, catastrophic thinking, perceptions of recovery time, number of symptoms attributed to injury or perception of personal control over recovery in the first 10 weeks following distal radius fracture. The only association was between age and change in level of emotional response to injury, where the emotional impact of injury resolves more slowly in older patients.

In other studies, a number of demographic factors have been associated with resilience and psychological wellbeing during recovery from trauma. Bonanno et al carried out a study among survivors of the September 11th terrorist attacks in New York and found that gender, age, ethnicity, education, severity of trauma, income change, social support, chronic disease and past life stressors were all associated with psychological response to acute trauma. The level of trauma in this study compared to the study cohort in this chapter is clearly different. Perhaps associations are only evident in cohorts with significant psychological disturbance. In a study of 55 patients following distal radius and radial head fracture Golkari et al found being married was associated with a greater fall in PCS after injury but no demographic factors were associated with change in depression. An association with marital status was not demonstrated in this chapter. Mean enrolment PCS was significantly higher in Golkari's study (222) than the study cohort in this chapter, Appendix 3. Perhaps the psychological stability of the study cohort in this chapter makes identifying associations with these minimal psychological changes difficult.

Increasing age was associated with a slower dissipation of the emotional impact of fracture. Causality cannot be extrapolated from these findings. Whether the prolonged high emotional impact is because of higher levels of disability or vice versa remain unclear. Chapter 3 demonstrated independent associations between both age and illness perceptions and increased disability following distal radius fracture. This suggests that increasing age exposes the patient to multiple independent risk factors for poor functional recovery.

Undergoing elective orthopaedic day case surgery has a detrimental effect on psychological measures in the weeks following surgery (223). This does not appear to be the case with surgery following wrist fracture. No association between surgical/non-operative management and psychological response was identified in this chapter. It may be that the surgical intervention is not perceived as an additional burden over non-operative management in the context of acute fracture. Hall et al suggest that the psychological response to surgery is not solely driven by the nature of the surgical intervention but by a patient's perception and experience of the surgery (224). Different psychological response is seen in joint arthroplasty which is seen as an operation to improve well-being compared to laparotomy which is generally considered to represent a threat to well-being (225).

4.4.2 Psychological response to fracture

The psychological response to distal radius fracture is generally stable in this cohort of patients. Some factors remain unchanged and in those that do change the magnitude is small and likely to not be clinically significant but the trends demonstrated may be of clinical use.

General self-efficacy was stable in the first ten weeks then improved late in recovery, between ten weeks and nine months. Personal accomplishment is the most powerful mechanism by which self-efficacy can be increased (69). In standard rehabilitation protocols, personal accomplishment is most clearly demonstrated by improvement in wrist movement, which only becomes possible after a splint or cast has been removed at around six weeks. This may explain the lag time before self-efficacy improves. Interventions that improve self-efficacy and can be used early in the rehabilitation process may be beneficial.

Catastrophic thinking and kinesiophobia are reactive and improve with time following distal radius fracture. In a study of 55 patients with distal radius and radial head fracture Golkari et al found that catastrophic thinking decreased significantly in the first month following injury (222). This pattern is expected as a fracture heals. It may be that outliers who do not follow this normal pattern of psychological response are at risk of a worse outcome.

Depression, anxiety and symptoms of PTSD remain stable throughout recovery and probably reflect longstanding aspects of a patient's situation and personality in this cohort. However, Golkari et al found that depression decreased significantly in the first month following injury (222) and a case control study by Ponsford et al found that patients with orthopaedic injuries experienced a significantly greater increase in depressive symptoms over time than control (96). These studies use different measures and definitions of depression and so meaningful comparison is limited. Lack of standardisation is a recurring problem with literature in this area.

Illness perception domains improve with time or remain constant following injury with the exception of recovery time (timeline acute / chronic) which increases. In the majority of patients IPQr identity (number of symptoms associated with injury) falls at each time point as symptoms settle, patients take less analgesia and therefore have fewer associated side effects and sleep improves. IPQr personal control increases in the first 10 weeks then plateaus as most patients quickly learn their actions influence recovery. IPQr treatment control remains stable until 10 weeks then falls as the impact of medical treatment becomes less obvious and patient driven rehabilitation predominates. This move from high perceptions of treatment control to personal control during recovery is also reflected in the increase in RLOC, which shows a movement from external to internal control with time. IPQr coherence (perceived understanding of injury) is high and remains stable though out recovery indicating that patients believe they understand their injury well does not change. IPQr timeline cyclical is low and stable suggesting patients do not perceive symptoms from the injury to fluctuate much during the recovery period. The increase in expected recovery time (IPQr timeline acute / chronic) reflects a misconception at the time of injury that distal radius fracture is a benign injury from which a full recovery is quickly made. A longitudinal study by Lee et al that measured illness perceptions at time of injury and 3 months and 6 months after injury, in Taiwanese patients recovering from injuries with International Severity Scores ≥9, found different patterns of change in the illness perception subscales than those demonstrated in this chapter (133). They found that emotional response was labile, time line was constant, control and coherence improved early before plateauing and consequence increased late in the recovery period. This suggests that perceptions cannot be generalised across populations and are undoubtedly influenced by a multitude of factors such as type of injury, education, social support and health care system, as per the common sense model.

Chapter 3 identified associations between illness perceptions, locus of control, depression and functional outcome. It is unclear whether the best measure to identify patients at risk of poor recovery associated with psychological profile is the enrolment score or deviation from 'normal' trends demonstrated in this chapter. This should be the focus of future work.

4.4.3 Limitations

These results should be viewed in light of several limitations. This is a sub group analysis of patients from a larger prospective study. The level of missing data at 9 months was higher than anticipated, probably because of the nature of the patient group and injury being studied along with the response burden of the extensive psychological questionnaires. By nine months patients were disengaged with orthopaedic services and had little interest completing questionnaires regarding their recovery. The study cohort was older, had a different distribution of occupations, expectations of a faster recovery at enrolment and a more internal locus of control than the missing data cohort but were otherwise similar. It is unlikely that the loss of patients to follow up has altered the finding of the study. The trends of psychological scores over time are as would be expected during recovery from acute injury. The association between baseline psychological score and likelihood to complete questionnaire follow up is not known.

The study cohort had a psychological profile at enrolment that was well adapted to recovery. When compared to the prospective study from which the subgroup was derived median enrolment PCS and depression were lower, the ranges were smaller and the maximum values were lower. This suggests some bias has been introduced in the sub-group selection process. More dramatic, clinically significant, changes with time may be seen in cohorts with where this is not the case and enrolment psychological characteristic are not so well adapted. These factors must be considered when generalising results. The baseline psychological scores were measured at a mean of 10 days following injury, it is possible that there is a significant change in the psychological factors before this time point. The unpredictable nature of trauma patients and their presentation to medical services makes study of this initial period logistically very difficult. Questionnaire burden and fatigue will have adversely affected both the follow up rate and the validity of responses received. Future work should use more focused questionnaires or computer based systems that reduce question repetition and number and therefore reduce fatigue.

4.4.4 Conclusion

This study has demonstrated that demographic, injury and treatment factors cannot be relied upon to predict the psychological response to distal radius fracture and there is little variation in psychological scores after injury in a cohort with relatively stable baseline psychological traits. This information is useful clinically when considering the timing and targeting of screening tools to predict outcome based on psychological profiles. Investigation in less psychologically stable more complete cohorts with higher levels of psychological distress, catastrophic thinking, kinesiophobia, depression and anxiety would be useful to corroborate the trends seen in this chapter. These may find factors predictive of psychological response to fracture and more clinically significant changes in these measures over time.

5 Prospective double blind randomised controlled trial of a psychological workbook versus an information workbook after distal radius fracture.

5.1 Introduction

Chapter 1 describes numerous examples of correlations between outcomes such as disability and pain intensity and psychological factors and less effective coping strategies following injury. Chapter 3 demonstrates the role of psychological factors in recovery from distal radius fracture. Interventions that target psychological factors improve outcomes for back pain, osteoarthritis, and myocardial infarction (141, 145, 153, 154, 226, 227). However, the evidence regarding psychological interventions after acute injury is limited.

The effectiveness of a psychological interventions is primarily mediated by its influence on self-efficacy; an individual's confidence in their ability to perform a given behaviour (e.g. engagement with rehabilitation, performance of exercises, use of their arm, etc). Increased self-efficacy is associated with improved pain, disability and functional outcome in a number of musculoskeletal conditions (228-231). For these reasons, an intervention to target self-efficacy was used in this chapter. The LEARN approach describes a stepwise method to affecting this change, Figure 5-1. LEARN: **(L) L**earn exercise/activity, **(E) E**ncourage or cue, **(A) A**ddress unpleasant symptoms, **(R) R**einforce from other's experience/**R**ole model and **(N) N**egate disability (say no to inability/promote confidence and a positive mind-set). It is a suggested template for developing interventions for use in distal radius fracture (41). A psychological workbook was developed and tested, which encompassed the LEARN approach, to supplement routine treatment of distal radius fractures in a fracture clinic setting.

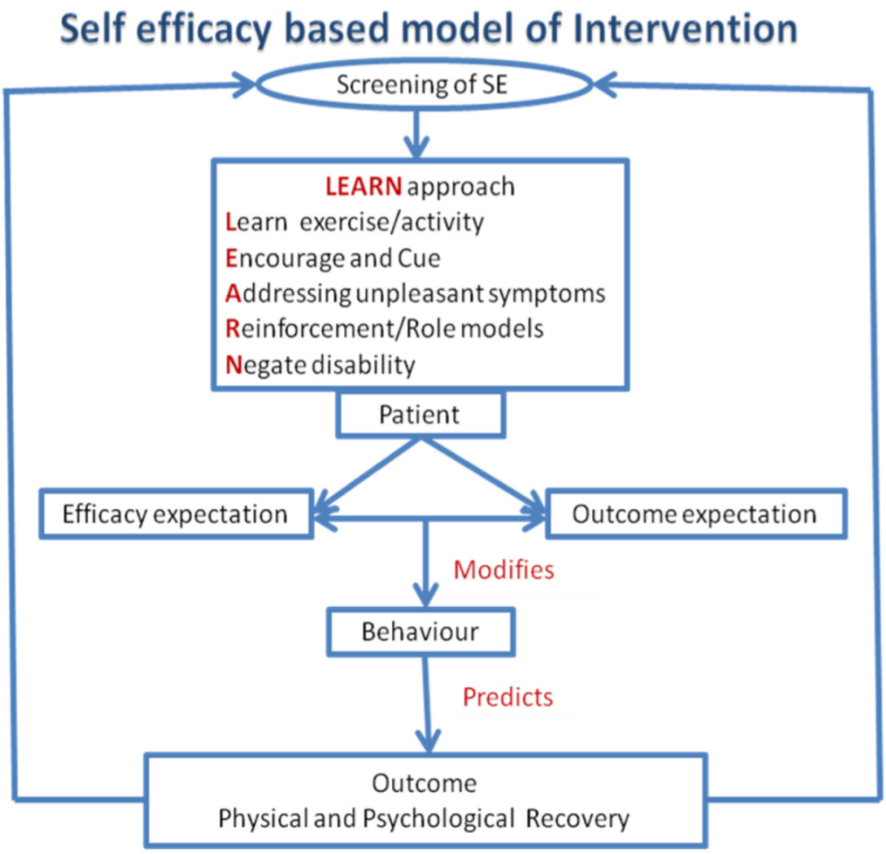

Figure 5-1: LEARN approach intervention flow diagram. (41)

The aim of this study was to compare the functional outcomes between patients given a psychological workbook and those given an information workbook in the otherwise routine management of distal radius fracture, in the short (6 weeks) and longer term (6 months).

The primary null hypothesis was that there are no factors (use of a workbook aimed at optimising psychological response to injury, demographic, radiographic, medical or psychosocial) associated with DASH score 6 weeks after injury. The secondary null hypotheses were that none of these factors were associated with NRS pain score at 6 weeks or DASH, NRS pain score or grip strength at 6 months after injury.

5.2 Methods

5.2.1 Patients and study design

A prospective double blind randomised controlled trial comparing a psychological workbook with an information only workbook in the otherwise routine treatment of distal radius fracture was performed. Patients were recruited from the Royal Infirmary Edinburgh between March 2016 and August 2016 and reviewed at 6 weeks and 6 months following injury. Ethical and clinical trial committees approved and authorised the work, Appendix 1. The study was registered with ClinicalTrials.gov (ID NCT02720055).

Patients with distal radius fracture were identified on presentation to an orthopaedic clinic. Patients meeting inclusion criteria were recruited into the study, Table 5-1.

Inclusion Criteria	**Exclusion Criteria**
1. Age 18 and over. 2. Isolated distal radius fracture undergoing management with manipulation and cast / cast alone / operative management. 3. Recruitment within three weeks of injury	1. Cognitive impairment preventing informed consent or completion of questionnaires 2. Non-English speaking 3. Open fracture 4. Temporary residents unable to attend follow up 5. Patients with multiple fractures 6. Undertaking injury compensation proceedings 7. Illicit drugs use 8. Psychiatric diagnosis resulting in psychosis.

Table 5-1: RCT: Inclusion and exclusion criteria.

5.2.2 Randomisation

Randomisation was stratified based on age, gender and operative / non-operative treatment. Patients were assigned to a group (1-8) based on these factors. Block randomisation was then carried out using a computer-generated sequence, Figure 5-2.

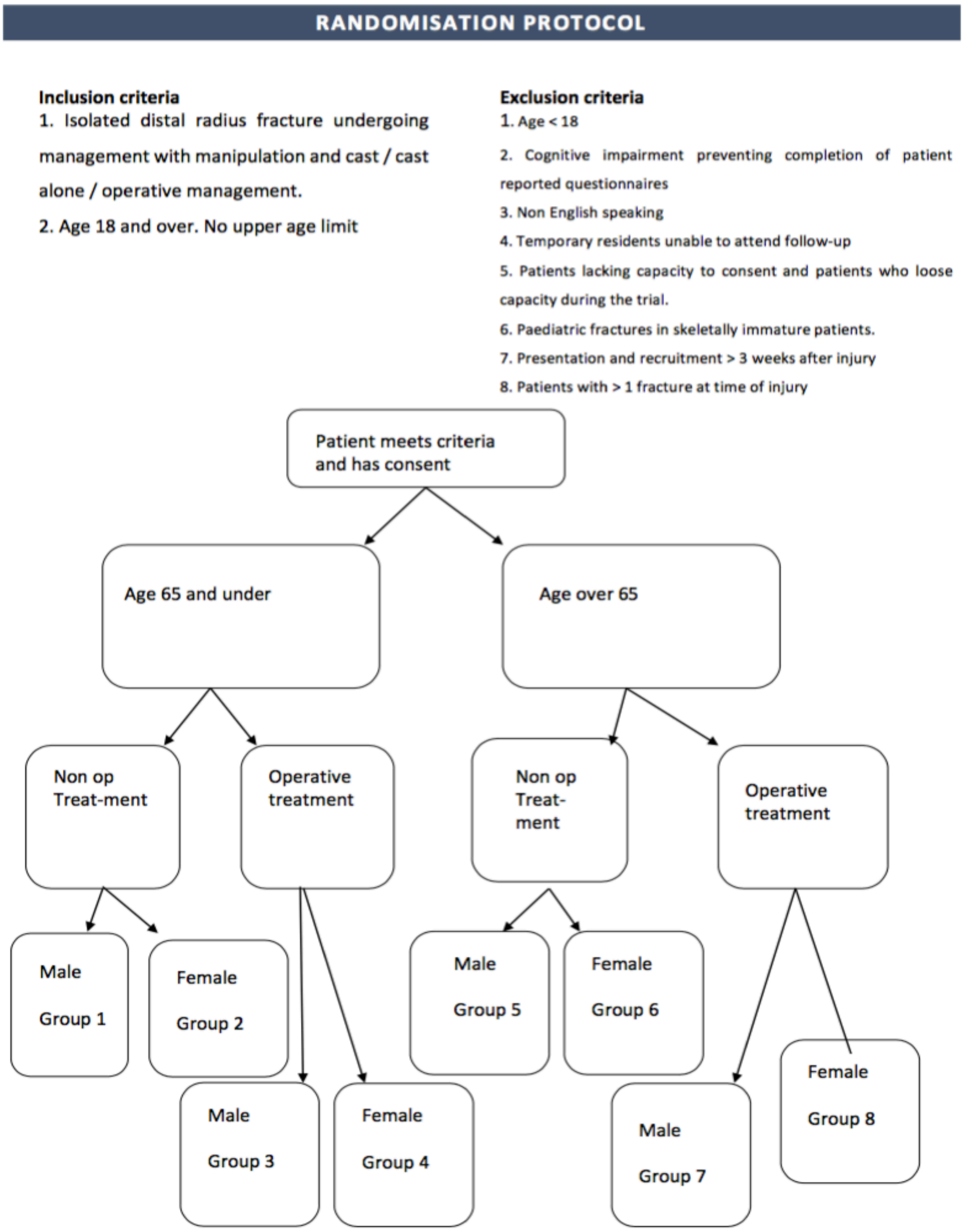

Figure 5-2: RCT: randomisation protocol.

5.2.3 Blinding

Participants were aware there were two workbooks but not of their content. The workbooks looked the same. Researchers collecting data were blinded to assignment.

5.2.4 Management protocol

Fracture management was in line with hospital policy, Section 2.2. After randomisation, the patient was given a workbook and instructed how to use it. Two workbooks were designed, one psychological intervention workbook (developed in collaboration with a Health Psychology PhD student at University of Strathclyde and agreed upon for use in this trial, noted in Acknowledgements) and one information only workbook. Workbooks can be seen in Appendix 5 and 6.

Study Intervention: Psychological Intervention Workbook

The psychological intervention workbook was designed, using the LEARN approach, to change beliefs and behaviour by improving self-efficacy (41), Figure 5-1. The workbook comprised two parts: an information/psychological exercise section and a goal diary. The book described exercises and activities that patients could undertake from the time of injury (**L**: learn exercises/activities). A progress diary was used to encourage progress (**E**: encourage and cue). Information regarding expectations, healthy eating, stretching exercises, pain management, stress reduction, and improving sleep was used to address unpleasant symptoms (**A**: address unpleasant symptoms) and was reinforced by describing the experiences of fictional patients in vignettes (**R**: reinforcement/role models). The book aimed to negate disability (**N**: negate disability) by using activities to focus on what individual patients were able to do rather than their activity limitations. Pain was normalised and safe movement encouraged at every opportunity.

The goal diary was designed to engage patients with all five components of the LEARN model through the inclusion of specific behaviour change techniques (232).

It asked patients to set and write down three personal recovery goals specific to their lifestyle that they would work towards over a 6-week period. It then took the patient through planning a step by step approach to achieving these goals by utilising learned activities described in the instructional book. It facilitated a weekly review of progress and allowed modification of strategy if required.

The workbook was reviewed in a focus group of 6 patients with distal radius fractures. The group contained males and females of varying age, treatment type and time from injury. The consensus was that the workbook was useful and informative. No objections were raised against the workbook, Appendix 4.

Study Control: Information-only Workbook

Patients randomised to the control group received an information-only workbook. This contained details of a number of hand and wrist stretching exercises and advised the patient to begin work on these three times per day as soon as they felt able. This book was a reformatted version of a leaflet given to patients as part of routine care following a wrist fracture within the Department of Orthopaedics, Royal Infirmary Edinburgh. Of note these exercises were also included in the psychological workbook. The front cover and format matched the psychological intervention workbook to aid blinding.

5.2.5 Follow up, patient assessment and outcome measures

Both treatment groups followed the same follow up schedule and the guidelines for clinical care were the same in each group.

At enrolment demographic details, medical and psychiatric history, baseline radiographic parameters (radiocarpal alignment, dorsal tilt, radial shortening), injury and treatment characteristics and psychological scores (GSES, PCS, TSK, HADS depression, HADS anxiety, PCL-C, IPQr, RLOC) were measured.

Six weeks after injury (T2) radiographic parameters, GSES, and patient reported outcome measures (DASH score, NRS pain score and Short Form 12 (SF12) were measured. Six months after injury (T3), wrist and finger motion and grip strength were measured, adverse events recorded, and GSES and outcome measurements repeated. Follow up schedule is shown in Figure 5-3. All measurements were taken as described in section 2.3.

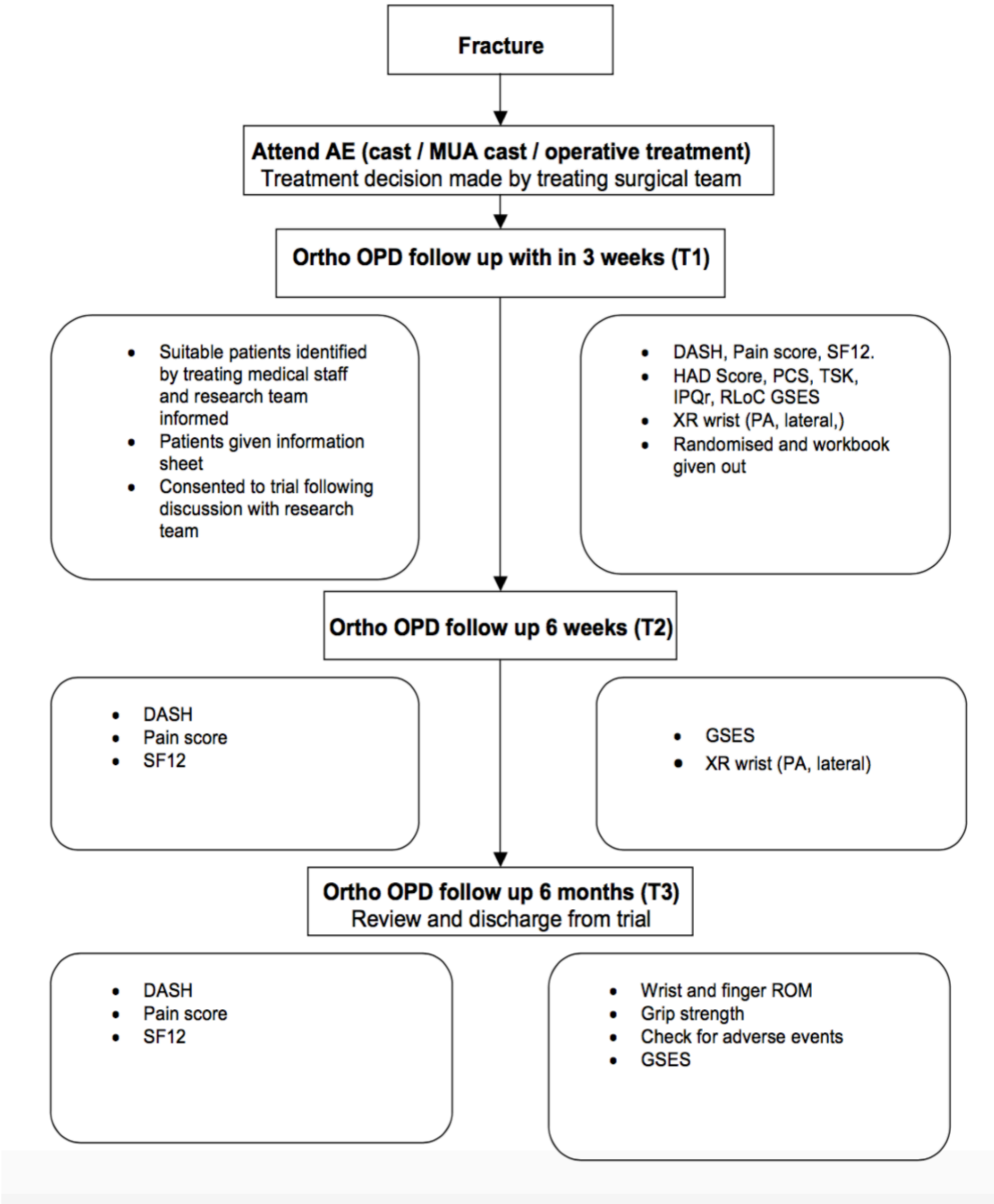

Figure 5-3: RCT: follow up schedule.

5.2.6 Patients

During recruitment 191 patients who met the inclusion criteria were approached, 52 (27%) declined participation. A total of 139 were recruited. All 74 (100%) of patients randomised to psychological workbook and 63 of 65 (97%) of patients randomised to information workbook were given allocated treatment. Eight patients (6%) were lost to follow up by 6 weeks. The remaining cohort of 129 patients were included in the analysis (66 in the psychological workbook group and 63 in the information workbook group), Figure 5-4.

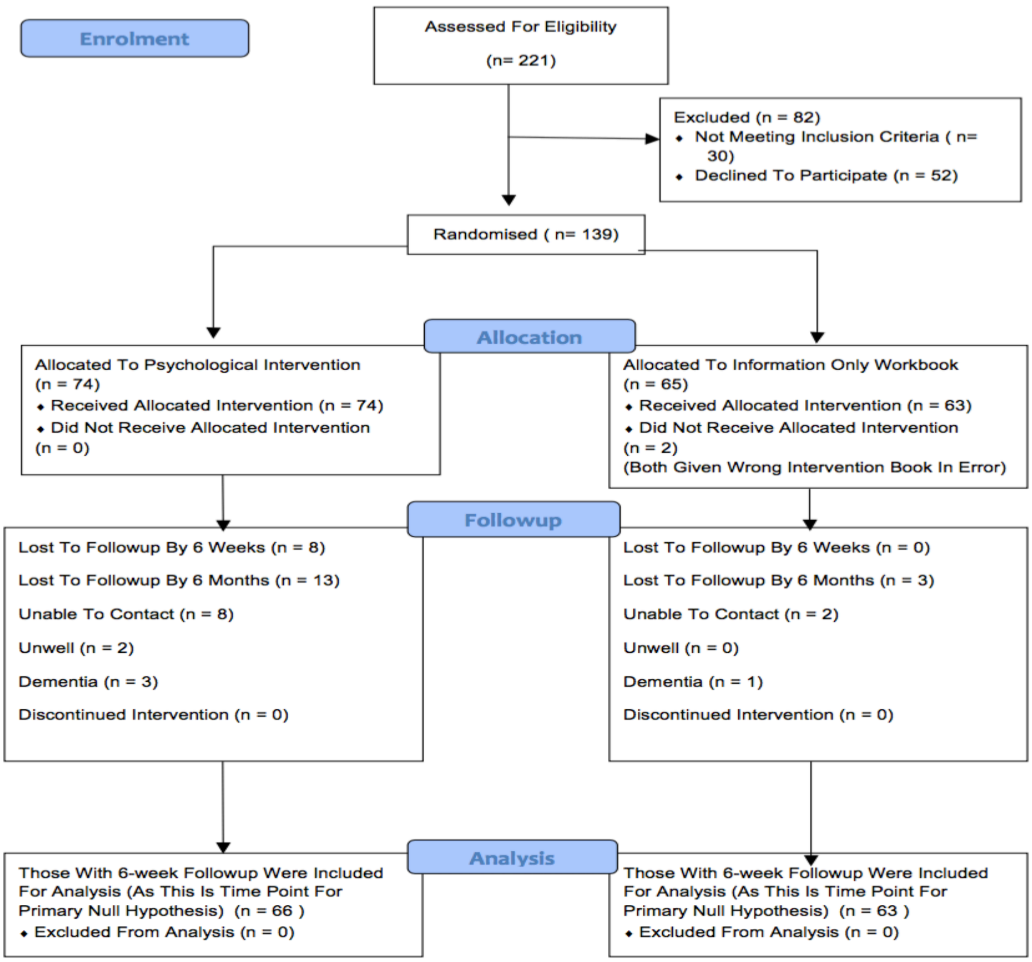

Figure 5-4: RCT: CONSORT flow diagram of patients.

Demographics, injury characteristics, treatment details and enrolment psychological scores were recorded for each, Appendix 7. Patients in the psychological workbook group were younger, had fewer medical comorbidities and were less deprived, but had more formal diagnoses of psychiatric illness, than the information workbook group. Enrolment psychological scores were better than chronic pain populations and normative population scores. Only a small proportion of patients had enrolment scores higher than recognised thresholds for psychiatric disorder or that categorised them as 'high scorers'.

5.2.7 Statistical analysis

5.2.7.1 Power Analysis

The primary outcome measure was the DASH score. In a pilot study of sixty patients with distal radius fracture who were evaluated 8 weeks following injury, the mean DASH score was 29 and the standard deviation (SD) was 19. A sample size of 126 was estimated to provide power (90%) to identify minimum difference between the treatment group and control of 10 points (the recognised minimal clinically significant difference in DASH), with alpha set at 0.05. Anticipated a dropout rate was 10% and therefore the aim, to enrol 139 patients into the study.

5.2.7.2 Statistical analysis

Descriptive statistics were used to present demographic, co-morbidity, injury, treatment, radiographic and enrolment psychological characteristics. An intention to treat principle was adhered to. Missing data was completed with mean imputation.

The response variables were DASH score and NRS pain score at 6 weeks and 6 months, and grip strength at 6 months. The explanatory variables were: age; number of medical comorbidities; Scottish Index of Multiple Deprivation quintile (SIMD); injury to the dominant side; AO-OTA fracture Group (A, B or C); nerve injury; radiographic alignment at T2 (RC alignment, radial shortening, dorsal tilt); surgical or non-operative management; time to presentation and follow up; psychological measures (HADS, PCS, TSK, PCL-C, GSES, IPQr personal control, IPQr emotion and RLOC), and workbook assignment. Adverse events were not included as entry factors because they are somewhat subjective (e.g. stiffness, malunion requiring osteotomy), they are known to be related to psychological factors (233), the time of onset was often not clear and rates of individual adverse events was low.

In bivariate analysis, outcomes were compared using median scores and Mann Whitney U tests for non-parametric data and mean scores and Independent Samples T-tests for parametric data. Spearman correlations, Mann Whitney U Tests, and Kruskal Wallis Tests were used for non-parametric data. Pearson correlations, T Tests and ANOVA for parametric data.

Factors with $p<0.1$ in bivariate analysis were entered into multivariable linear regression models to determine factors independently associated with each response variable. Where there was correlation of >0.7 between factors the least clinically relevant was dropped from the model.

GSES in each treatment group at each time point was compared with a Mann Whitney U Test.

A sub group of patients, based on enrolment psychological scores of GSES to include patients with enrolment GSES < (cohort median – interquartile range), was analysed.

5.3 Results

5.3.1 Six week follow up

5.3.1.1 Outcomes

Six weeks after distal radius fracture use of a psychological workbook was not associated with improved DASH (psychological workbook DASH: 38 [range, 21-48]; information workbook DASH: 35 [range, 21-53]; difference of medians: 3; p = 0.949) nor NRS pain score (psychological workbook NRS pain score: 3 [range, 1-5]; information workbook NRS pain score: 2 [range, 1-4]; difference of medians: 1; p = 0.128, when compared with the information workbook, Table 5-2.

	Psychological workbook group median (IQr)	**Information workbook group median (IQr)**	**p value**
DASH	38 (21-48)	35 (21-53)	0.949
SF12 mental component (mental)	53 (44-58)	54 (51-59)	0.099
SF12 physical component (physical)	46 (35-51)	42 (35-52)	0.559
NRS pain score	3 (1-5)	2 (1-4)	0.128

Table 5-2: Six week outcomes compared between treatment groups. Mann Whitney U tests. *Chi-square test.

5.3.1.2 Bivariate analysis

Increased DASH at 6 weeks was associated with increased age, increased number of medical comorbidities, AO-OTA fracture type C, increased radial shortening and dorsal tilt, radiographic features at 6 weeks (radial shortening and dorsal tilt), lower self-efficacy at enrolment (GSES), higher enrolment measures of catastrophic thinking (PCS), HADS depression, HADS anxiety, psychological distress (PCL-C), emotional impact of injury (IPQr emotion) and an external locus of control (lower RLOC) at enrolment, Table 5-3.

Increased NRS pain score at 6 weeks was associated with increased number of medical comorbidities, undergoing surgical management, higher enrolment levels of catastrophic thinking (PCS), HADS anxiety, psychological distress (PCL-C) and emotional response to injury (IPQr emotion), Table 5-3.

Entry variable	**Six week outcome**	
	DASH	**NRS pain score**
Age*	**0.2 (0.016)**	0.2 (0.067)
Number of comorbidities*	**0.2 (0.02)**	**0.3 (0.002)**
Injury to dominant side	0.156^{γ}	0.746^{α}
SIMD	0.334^{δ}	0.629^{β}
AO OTA classification (Group C with higher DASH)	**0.028^{δ}**	0.756^{β}
Nerve injury	0.414^{γ}	1.000^{α}
Radiocarpal alignment maintained (T2)	0.074^{γ}	0.858^{α}
Radial shortening (T2) *	**0.3 (<0.001)**	0.2 (0.055)
Dorsal tilt (T2) *	**0.2 (0.032)**	0.1 (0.217)

Entry variable	**Six week outcome**	
	DASH	**NRS pain score**
Surgical management (Surgical management with higher DASH, pain score and lower grip strength)	0.068$^{\gamma}$	**0.008$^{\alpha}$**
Use of psychological intervention workbook	0.949$^{\gamma}$	0.128$^{\alpha}$
GSES*	**-0.2 (0.008)**	-0.1 (0.159)
PCS*	**0.4 (<0.001)**	**0.3 (0.001)**
HADS depression*	**0.2 (0.010)**	0.1 (0.109)
HADS anxiety*	**0.2 (0.007)**	**0.2 (0.019)**
TSK	**0.2 (0.005) $^{\phi}$**	0.1 (0.394) *
PTSD*	**0.3 (0.001)**	**0.3 (0.001)**
IPQr personal control*	-0.2 (0.054)	-0.2 (0.072)
IPQr emotion*	**0.4 (<0.001)**	**0.3 (0.001)**
RLOC*	**-0.2 (0.028)**	-0.1 (0.505)
Days to presentation*	0.1 (0.107)	0.0 (0.626)
Weeks to follow up*	0.1 (0.305)	0.1 (0.103)

Table 5-3: Table of bivariate analysis of entry variables and 6-week functional outcomes. * Spearman's Correlation, ϕ Pearson's Correlation: correlation coefficient (p value). α Mann Whitney U Test, β Kruskal Wallis Test, γ Independent samples T Test. δ One way ANOVA. Continuous entry variables are presented as: correlation coefficient (p value). There correlation coefficient is positive, higher entry variable correlates with higher DASH, where correlation coefficient is negative, higher entry variable correlates with lower DASH. Categorical variables are presented as p value alone, the groups with higher median outcome score is indicated where there is a significant difference.

5.3.1.3 Multivariable regression analysis

Improved DASH scores were associated with less radial shortening (β = 0.2, p = 0.009), less dorsal tilt (β = 0.2, p = 0.035), and non-operative treatment (β = 0.2, p = 0.027). In a multivariable regression model that predicted DASH at 6 weeks, $F(16,110) = 4.7$, $p <0.001$, adj $R^2 = 0.3$. Table 5-4.

Variable	Regression coefficient (unstandardized)	Standardized coefficient	95% confidence limits	p value
Age	0.2	0.2	0–0.4	0.059
Number of medical comorbidities	1.5	0.1	-0.8 to 3.8	0.202
AO classification	0.1	0.0	-3.5 to 3.6	0.973
Maintenance of radiocarpal alignment at 6 weeks	0.1	0.0	-7.8 to 8.0	0.988
Radial shortening at 6 weeks	2.0	0.2	0.5–3.6	**0.009**
Dorsal tilt at 6 weeks	0.3	0.2	0–0.7	**0.035**
Non-operative management	8.5	0.2	1.0–16.0	**0.027**
Enrolment GSES	-0.5	-0.1	-1.3 to 0.2	0.183
Enrolment PCS	0.4	0.1	-0.1 to 0.8	0.151
Enrolment HADS depression	-0.4	-0.1	-2.0 to 1.2	0.591
Enrolment HADS anxiety	0.4	0.1	-1 to 1.7	0.595
Enrolment TSK	0.5	0.1	-0.2 to 1.1	0.140
Enrolment PTSD	0.2	0.1	-0.3 to 0.7	0.472
Enrolment IPQr personal control	-0.3	0.0	-1.2 to 0.6	0.560
Enrolment IPQr emotional control	0.4	0.1	-0.4 to 1.1	0.318
Enrolment RLOC	-0.3	-0.1	-1.1 to 0.5	0.519

Table 5-4: Multivariable linear regression analysis for predictors of DASH at 6 weeks after distal radius fracture.

Improved NRS pain score was associated with non-operative treatment (β = 0.2, p = 0.021) and lower enrolment PTSD score (β = 0.2, p = 0.046). In a multivariable regression model that predicted NRS pain score at 6 weeks, $F\ (9,119) = 3.8$, $p < 0.001$, adj $R^2 = 0.2$, Table 5-5.

Variable	Regression coefficient (unstandardized)	Standardized coefficient	95% confidence limits	p value
Age	0	0.1	0.0–0.0	0.210
Number of medical comorbidities	0.1	0.1	-0.1 to 0.4	0.342
Radial shortening at 6 weeks (mm)	0.1	0.2	-0.1 to 0.3	0.216
Surgical management	1.0	0.2	0.2–1.9	**0.021**
Enrolment PCS	0	0	0.0–0.1	0.667
Enrolment HADS anxiety	0	0	-0.1 to 0.1	0.745
Enrolment PTSD	0.1	0.2	0.0–0.1	**0.046**
Enrolment IPQr personal control	0	-0.1	-0.1 to 0.1	0.489
IPQr emotional response	0	0.1	-0.1 to 0.1	0.497

Table 5-5: Multivariable linear regression analysis for predictors of NRS pain score at 6 weeks after distal radius fracture.

5.3.2 Six month follow up

5.3.2.1 Outcomes

At 6 months, use of a psychological workbook was not associated with improved DASH (psychological workbook DASH score: 11 [range, 5-28]; information workbook DASH score: 11 [range, 3-20]; difference of medians: 0; p = 0.367) nor NRS (psychological workbook NRS pain score: 1 [range, 0-2]; information workbook NRS pain score: 1 [range, 0-2]; difference of medians: 0; p = 0.704), when compared with information only workbook, Table 5-6.

	Psychological workbook group **median (IQr)**	**Information workbook group** **median (IQr)**	**p value**
DASH	11 (5-28)	11 (3-20)	0.367
SF12 metal component (MCS)	54 (48-58)	55 (53-58)	0.120
SF12 physical component (PCS)	54 (45-56)	48 (42-55)	0.076
NRS pain score	1 (0-2)	1 (0-2)	0.704
Finger stiffness (fingertip to palm distance mm)	0 (0-6)	0 (0-6)	0.114
Grip strength	82 (67-91)	81 (66-96)	0.996

Table 5-6: Six month outcomes compared between treatment groups. Mann Whitney U tests. *Chi-square test.

5.3.2.2 Bivariate analysis

Increased DASH at 6 months was associated with increasing age, increased number of medical comorbidities, increased radial shortening at 6 weeks, lower self-efficacy (GSES) and perception of personal control (IPQr personal control) at enrolment, higher enrolment levels of catastrophic thinking (PCS), HADS anxiety and depression, psychological distress (PCL-C), emotional response to injury (IPQr emotion), Table 5-7.

Increased NRS pain score at 6 months was associated with increased number of medical comorbidities, higher levels of kinesiophobia (TSK), psychological distress (PCL-C), emotional response to injury (IPQr emotion) and lower perception of personal control (IPQr personal control), Table 5-7.

Increased grip strength at 6 months was associated with younger age, less radial shortening at 6 weeks, undergoing surgical management and a lower level of emotional response to injury (IPQR emotion), Table 5-7.

Entry variable	**Six month outcomes**		
	DASH	**NRS pain score**	**grip strength**
Age*	**0.2 (0.009)**	0.0 (0.696)	**-0.2 (0.013)**
Number of comorbidities*	**0.3 (<0.001)**	**0.2 (0.007)**	-0.1 (0.435)
Injury to dominant side	0.987^{α}	0.431^{α}	n/a
SIMD	0.111^{β}	0.058^{β}	0.571^{β}
AO OTA classification (Group C with higher DASH)	0.106^{β}	0.426^{β}	0.076^{β}
Nerve injury	0.916^{α}	0.858^{α}	0.388^{α}
Radiocarpal alignment maintained (T2)	0.820^{α}	0.375^{α}	0.892^{α}
Radial shortening (T2) *	**0.2 (0.025)**	0.1 (0.429)	**-0.2 (0.042)**
Dorsal tilt (T2)*	0.1 (0.524)	0.1 (0.407)	-0.1 (0.366)
Surgical management (Surgical management with higher DASH, pain score and lower grip strength)	**0.017^{α}**	0.565^{α}	**0.012^{α}**
Use of psychological intervention workbook	0.367^{α}	0.704^{α}	0.996^{α}
GSES*	**-0.2 (0.036)**	-0.1 (0.192)	0.0 (0.701)
PCS*	**0.3 (<0.001)**	**0.2 (0.017)**	-0.1 (0.168)
HADS depression*	**0.2 (0.027)**	0.1 (0.461)	0.0 (0.736)
HADS anxiety*	**0.2 (0.012)**	0.1 (0.092)	0.0 (0.842)

Entry variable	**Six month outcomes**		
	DASH	**NRS pain score**	**grip strength**
TSK	0.1 (0.095) *	**0.2 (0.036) ***	-0.1 (0.428)*
PTSD*	**0.3 (<0.001)**	**0.3 (0.001)**	-0.1 (0.441)
IPQR personal control*	**-0.2 (0.014)**	**-0.2 (0.024)**	0.2 (0.090)
IPQR emotion*	**0.4 (<0.001)**	**0.3 (0.001)**	**-0.2 (0.022)**
RLOC*	-0.1 (0.140)	0.0 (0.667)	0.1 (0.333)
Days to presentation*	0.1 (0.166)	0.0 (0.937)	-0.1 (0.132)
Weeks to follow up*	-0.1 (0.116)	-0.1 (0.467)	0.0 (0.638)

Table 5-7: Table of bivariate analysis of entry variables and 6-month functional outcomes. * Spearman's Correlation, ϕ Pearson's Correlation: correlation coefficient (p value). α Mann Whitney U Test, β Kruskal Wallis Test, γ Independent samples T Test. δ One way ANOVA. Continuous entry variables are presented as: correlation coefficient (p value).

5.3.2.3 Multivariable regression analysis

Improved DASH was associated with having fewer medical comorbidities (β = 0.3, p < 0.001) and lower enrolment PTSD (β = 0.3, p = 0.011). In a model that predicted DASH score at 6 months, $F(12,116) = 5.2$, $p < 0.001$, adj $R^2 = 0.3$, Table 5-8.

Variable	**Regression coefficient (unstandardized)**	**Standardized coefficient**	**95% confidence limits**	**p value**
Age	0.1	0.1	-0.1 to 0.3	0.264
Number of medical comorbidities	3.6	0.3	1.7–5.5	**< 0.001**
Radial shortening at 6 weeks	1.0	0.1	-0.3 to 2.2	0.122
Non-operative management	5.8	0.2	-0.1 to 11.8	0.055
Enrolment GSES	0	0	-0.6 to 0.6	0.937
Enrolment PCS	-0.2	-0.1	-0.6 to 0.2	0.326
Enrolment HADS depression	0.3	0	-1.6 to 1.0	0.679
Enrolment HADS anxiety	0.2	0	-1.0 to 1.3	0.771
Enrolment TSK	0.4	0.1	-0.1 to 0.9	0.130
Enrolment PTSD	0.6	0.3	0.1–1.0	**0.011**
Enrolment IPQr personal control	0.1	0	-0.7 to 0.8	0.883
Enrolment IPQr emotional control	0.5	0.1	-0.1 to 1.0	0.124

Table 5-8: Multivariable linear regression analysis for predictors of DASH at 6 months after distal radius fracture.

Improved NRS pain score was associated with having fewer medical comorbidities (β = 0.2, p = 0.045), lower enrolment PTSD score (β = 0.3, p = 0.008), and lower enrolment TSK score (β = 0.2, p = 0.042). In a model that predicted NRS pain score at 6 months, F(8,119) = 4.3, p <0.001, adj R^2 = 0.2, Table 5-9.

Variable	**Regression coefficient (unstandardized)**	**Standardized coefficient**	**95% confidence limits**	**p value**
Number of medical comorbidities	0.2	0.2	0.0–0.5	**0.045**
SIMD quintile	-0.1	-0.1	-0.4 to 0.1	0.236
Enrolment PCS	0.0	0.0	-0.1 to 0.1	0.975
Enrolment HADS anxiety	-0.1	-0.1	-0.2 to 0.0	0.251
Enrolment TSK	0.1	0.2	0.0–0.1	0.042
Enrolment PTSD	0.1	0.3	0.0–0.1	**0.008**
Enrolment IPQr personal control	-0.1	-0.1	-0.2 to 0.0	0.180
Enrolment IPQr emotional	0.0	0.1	-0.1 to 0.1	0.487

Table 5-9: Multivariable linear regression analysis for predictors of NRS pain score at 6 months after distal radius fracture.

Improved grip strength was associated with not undergoing surgical management (β = -2.4, p = 0.010). In a model that predicted grip strength at 6 months, F(6,122) = 2.3, p = 0.041, adj R^2 = 0.1, Table 5-10.

Variable	Regression Coefficient	Standardised coefficient	95% Confidence Limits	p value
Surgical management	-17.4	-0.2	-30.5 to -4.2	**0.010**
Age	-0.3	-0.1	-0.6 to 0.1	0.125
AO classification ABC	3.1	0.1	-3.4 to 9.5	0.348
Radial shortening at 6 weeks	-2.0	1.4	-4.7 to 0.7	0.143
Enrolment IPQr personal control	-0.2	0.0	-1.7 to 1.4	0.822
Enrolment IPQr emotion	-0.3	0.0	-1.3 to 0.8	0.601

Table 5-10: Multivariable linear regression analysis for predictors of grip strength at 6 months after distal radius fracture.

5.3.1 Longitudinal analysis

In both treatment groups, between 6 weeks and 6 months, there were significant improvements in DASH score p < 0.001), SF12 (physical) (p < 0.001) and NRS pain score (p < 0.001), whereas SF12 (mental) (p = 0.391) remained stable, Table 5-2 and Table 5-6.

GSES did not differ between treatment groups at any time, Table 5-11.

Measurement	Psychological intervention workbook group median (IQr)	Information only workbook group median (IQr)	p value
GSES at enrolment	31 (28-35)	32 (30-35)	0.483
GSES at 6 weeks	31 (29-35)	31 (29-36)	0.780
GSES at 6 months	31 (29-36)	33 (30-38)	0.096

Table 5-11: Comparison of General Self-efficacy Score between treatment groups at each time point.

At time of final follow up, 6 months, there was no difference in adverse events between groups, Table 5-12.

Adverse event	n (%)	n (%)	
Total	**9 (14)**	**6 (10)**	**0.635***
Median nerve symptoms following surgery	1 (2)	1 (2)	
Carpal tunnel syndrome	0	1 (2)	
Early OA	0	1 (2)	
Mal-union with corrective surgery	4 (6)	2 (3)	
Tendon injury	3 (5)	0	
CRPS	1 (2)	1 (2)	

Table 5-12: Adverse events at time of final follow up compared between treatment groups. *Chi-square test.

5.3.2 Subgroup analysis

As a result of the small number of cases in the subgroup descriptive statistics were used. The six week median (IQr) DASH was better in the psychological workbook group, 41 (33-54), than the information workbook group, 49 (30-58) but by six months DASH was better in the information workbook group, 14 (11-21), than the psychological workbook group, 18 (6-33), Table 5-13. The demographic, injury and treatment details of patients in the subgroup can be seen in Appendix 7.

Time point	**Outcome measure**	**Psychological workbook group**	**information only workbook group**
		n=13	**n=9**
6 week	DASH	41 (33-54)	49 (30-58)
	NRS pain score	4 (1.5-4.5)	3 (2-4.5)
6 month	DASH	18 (6-33)	14 (11-21)
	NRS pain score	1 (0-2.5)	1 (1-1.9)
	Grip strength	85 (64-94)	75 (55-89)

Table 5-13: Comparison of outcomes in subgroup with enrolment GSES <28, presented as median (IQr).

GSES improved with time in both groups but improvement was no better in the psychological workbook group than control, Table 5-14.

Measurement	**Psychological intervention workbook group median (IQr)**	**Information only workbook group median (IQr)**
GSES at enrolment	26 (25-27)	24 (22-25)
GSES at 6 weeks	28 (26-31)	28 (24-31)
GSES at 6 months	29 (27-30)	29 (28-31)

Table 5-14: Comparison of GSES in each subgroup, presented as median (IQr).

Post hoc analysis of outcomes by treatment type was carried out.

Measurement	Surgical management	Non-operative management
Radiocarpal alignment maintained n (%)	26 (90)	74 (75)
Dorsal tilt degrees Mean (range, SD, 95% CI)	-6 (-20 to 7, 7, -9 to -4)	1 (-26 to 27, 11, -2 to 3)
Ulnar variance (mm) Mean (range, SD, 95% CI)	1 (-5 to 5, 2, 0 to 2)	2 (-2 to 9, 2, 1 to 2)
Complications n (%)	8 (27)	6 (6)
Nature of complication		
Medina nerve symptoms	2	1
Symptomatic mal-union requiring osteotomy	1	5
CRPS	1	0
Flexor tendonitis	1	0
Tendon rupture	2	0
Early OA	1	0

Table 5-15: Post hoc analysis comparing operative and non-operative patients regardless of treatment group.

5.4 Discussion

Self-efficacy is associated with recovery following acute orthopaedic trauma (105, 122, 123). Psychological interventions to teach effective coping strategies and change perceptions are associated with increased self-efficacy (145, 149) and reduced disability in musculoskeletal conditions (149). This chapter represents an attempt to improve outcomes after fracture of the distal radius by bolstering self-efficacy using a LEARN approach (41). We found that the use of a psychological workbook in addition to routine treatment of distal radius fracture did not reduce disability or symptom intensity compared with an information-only workbook in this inclusive cohort of already psychologically well adapted patients.

5.4.1 Impact of psychological intervention

Despite the theoretical potential for benefit the use of a psychological workbook did not reduce short-term (6-week) or longer-term (6-month) disability or symptom intensity after distal radius fracture. The intervention was designed to improve outcomes through its action on self-efficacy. However, intervention had no effect on GSES over control.

It may be that there is no role for psychological intervention of any sort in improving recovery from distal radius fracture. This seems unlikely given the associations between psychological factors and outcomes and the benefit of such interventions in other musculoskeletal pathologies, Chapter 1, Chapter 3. A recent pilot randomised controlled trial in patients with acute musculoskeletal trauma demonstrated that disability, pain, and psychological response to injury could be improved with psychological intervention (137). The reasons for failure in this instance may be methodological, related to the specific intervention used or related to the cohort in which it was applied.

Methodological

The study was a prospective, randomised and double blind design controlled trial. It was adequately powered and patient retention was good (6% lost to follow up). It included an information only workbook as a placebo intervention in the control group. A recruitment rate of 73% of patients approached is consistent with studies of this type (137). The aforementioned pilot study, by its nature, was underpowered; it also had a high attrition rate (50%) in the control group, which did not have a placebo intervention (137). Focus group feedback for the workbooks was very positive and the intervention may have had a positive impact on recovery out with the scope of the outcome measures used. Patients were recruited up to three weeks after injury and follow up was at six weeks following injury. Due to this study design some patients had less than six weeks use of the workbook at time of follow up. The three week time limit for inclusion was set due to the variable nature of presentation of distal radius fracture patients to the orthopaedic service and a desire to keep the cohort inclusive and recruitment high.

Intervention

There may have been issues with the intervention. It was delivered in the form of a workbook as opposed to a face to face intervention as used in the aforementioned pilot study (137). However, there is evidence that interventions delivered remotely can be effective (227, 234) and the aim was to develop a low cost, accessible, intervention for use in a fracture clinic setting. The feedback received from the focus group was positive in terms of engagement (how much time patients spent using workbooks). Engagement with workbooks was not quantified and in reality, it may have been low. The LEARN and goal setting approach itself may have been ineffective. The rationale for targeting self-efficacy is laid out in this chapter's introduction, 5.1. However, this may have been the wrong factor to target. Chapter 3 did not identify associations between GSES and outcome. The pilot study used therapy sessions to target ineffective coping strategies and psychological distress, but did not specifically focus on self-efficacy. GSES is a general measure of self-efficacy, a measure of self-efficacy with specific relation to recovery from wrist injury may have been associated with outcome and more amenable to change. Ultimately, this was an efficacy trial and therefore not designed to answer these questions of effectiveness (the aim was to assess the intervention in a “real” fracture clinic setting rather than under “ideal” test conditions).

Cohort

The intervention may have been better targeted at a more specific cohort of patients. Inclusion criteria were not based on enrolment psychological scores. As seen in Chapters 3 and 4, this was a psychological well adapted and stable cohort from time of enrolment. DASH, pain scores and SF 12 physical component improved with time from a poor post injury position, whereas, SF 12 mental component remained high (good) and stable throughout. The pilot study only included patients with high enrolment levels of depression and pain anxiety. Studies of psychological intervention in patients with back pain have shown that intervention is most effective in patients with poorer coping strategies (141, 226, 235). The psychological intervention may have been more effective if targeted to patients with relatively low self-efficacy or high levels of stress or distress. However, the sub group analysis of patients with low enrolment GSES demonstrated improved GSES in both treatment arms at each time point following injury but the change was no better in the psychological workbook group than control. DASH was better at 6 weeks in the psychological workbook group but the opposite was true by 6 months. Results from the sub-group analysis must be interpreted with caution as sample size was considered too small to test for statistical significance.

5.4.2 Associations

At short term follow up, 6-weeks, increased radial shortening, increased dorsal tilt and undergoing surgical management were associated with increased level of disability. Increased level of psychological distress and undergoing surgical management were associated with increased level of pain.

At longer term follow up, 6-months, increased number of medical comorbidities and increased level of psychological distress were associated with increased disability and increased number of medical comorbidities, increased level of kinesiophobia and increased level of psychological distress were associated with increased level of pain.

There are a number of reasons why pain and disability are higher at 6 weeks in the surgically managed as opposed to the non-operatively managed group. Post hoc analysis comparing these groups found that radiographic outcomes are marginally better in the operatively managed group but the complication rate is also much higher in this group (27% compared to 6%). This proportion is high and may be explained by the small number of cases in this cohort. In the larger cohort seen in Chapter 3, this percentage is lower (19%). Secondly, the surgically managed group probably presented with more severe injuries. Thirdly, patients undergoing surgical intervention were recruited to the trial at time of first presentation to orthopaedic service, the date of surgery may have been up to a week after this, they therefore completed their six week assessment at five weeks post op. There is no evidence that the difference in outcomes is due to psychological response relating to treatment method. Chapter 4 demonstrates that undergoing surgical intervention does not alter psychological response to distal radius fracture.

The associations at 6 months between increased radial shortening and increased dorsal tilt and outcomes has been recognised in previous work, Chapter 1. At this time there are no longer any injury or treatment factors associated with pain or disability and presence of multiple medical comorbidities is the most influential factor. This highlights the increased impact that factors unrelated to the initial injury have on PROMS as time passes.

The psychological factors, psychological distress and kinesiophobia, were associated with outcomes after fracture. These finding have been seen in other cohorts of orthopaedic trauma patients (44, 78, 85). Work in Chapter 3 also found associations between psychological factors and PROMS in a study based in the same inclusive population. However, it found depression, illness perception and recovery locus of control, rather than psychological distress and kinesiophobia were associated with outcome. These differing results may be due to the differences in methodology between the studies. This highlights the limitations of comparing studies across the literature in this area and the difficulty reaching consensus on the most important factors associated with outcome.

5.4.3 Limitations

This study had a number of limitations. Patients were only followed up for 6 months. Patients can continue to improve for a year after injury, however, in this study the focus on early recovery because level of disability is most varied in this time period. Compliance with workbook was not assessed during follow up, this information would have helped draw conclusions regarding effectiveness of the intervention. Using an online workbook that logged patients' diary entries and interaction with specific psychological exercises would allow compliance to be monitored. For unclear reasons, the psychologic workbook group had more patients from higher socioeconomic quintiles (less social deprivation) and more patients with preinjury diagnoses of anxiety and depression. This was despite stratified randomisation being used to evenly distribute treatment type, age, and gender between the two treatment groups. The associations between fracture site, injury severity, and psychological response to injury is unclear (95, 236, 237). Psychological response may vary between patient groups with different fractures and severity of injury; thus, the utility of a psychological intervention may differ in other trauma populations. Results should be extrapolated with caution. A less extensive selection of psychological and follow up questionnaires was used in this study compared to Chapter 3 and 4, however, the issue of questionnaire fatigue must still be considered.

5.4.4 Conclusion

This chapter demonstrates that there is no benefit from the untargeted use of a psychological workbook based on the LEARN approach and goal-setting strategies in patients with distal radius fracture. Future research should investigate if there is a subgroup of patients with a negative psychological response to injury that benefit from psychological intervention and, if so, how best to identify these patients and intervene.

6 Conclusions

There are many situations in medicine where recovery from illness or injury does not correlate well with the underlying pathophysiological process. In numerous musculoskeletal conditions psychological factors such as depression, psychological distress and catastrophic thinking play an important but poorly understood role in the experience of pain and disability. Very little is known of the impact these and other psychological factors have on recovery from distal radius fracture. This is a common fracture. An understanding of these relationships in this population would aid the clinical assessment of patients following injury, interpretation of outcome data, guide prognosis and treatment and perhaps provide a target for additional psychological intervention to supplement routine orthopaedic care and improve health.

The Trauma Unit in the Department of Orthopaedics at the Royal Infirmary of Edinburgh is the sole provider of orthopaedic trauma care for a population of over 500,000 people. This captive population provides a good environment for the study and follow up of trauma patients. It was in this population that two prospective studies and a double blind randomised controlled trial were undertaken to explore the relationships between psychological factors, pain and disability following distal radius fracture.

The first prospective study, of associations between psychosocial factors and longer-term patient reported outcomes, demonstrates that psychological factors are more influential than injury or treatment characteristics in the prediction of disability and pain intensity following routinely treated distal radius fracture. Increased symptoms of depression, increased patient perceived threat from injury and an external locus of control are the potentially modifiable psychological factors most strongly associated with increased disability and increased patient perceived threat from injury is associated with increased pain intensity. Illness perceptions and locus of control are factors in a regression model that predicts CRPS but are not themselves independent predictors. This work highlights the influential role psychological factors play in recovery from distal radius fracture. These factors should be considered when interpreting PROMS data and in the clinical assessment of pain and disability and may prove to be targets for intervention that could improve outcomes after distal radius fracture.

The second prospective study, of the evolution of psychological response to injury, demonstrates that changes in psychological factors up to nine months following distal radius fracture are small. However, the trends demonstrated are interesting. In this cohort of patients with largely stable psychological traits demographic, injury and treatment factors cannot be relied upon to predict the psychological response to fracture. This information is useful clinically when considering the timing and targeting of screening tools that use psychological profiling to predict outcomes.

The RCT of a LEARN based psychological workbook used to supplement routine care of distal radius fracture by bolstering self-efficacy failed to demonstrate any improvement in outcomes with this additional intervention. Given their sound theoretical basis and the examples of benefit from psychological interventions in other musculoskeletal conditions the potential for such interventions in distal radius fracture should not be disregarded entirely on the basis of this trial.

The research in this thesis has been carried out in a population that have a stable and positive psychological response to distal radius fracture. It has demonstrated the importance of psychological factors in recovery and that psychological response evolves with time but not that these can be manipulated to effect a positive change in outcomes. Future work should focus on identifying other discriminatory psychological constructs and the threshold scores that identify patients at risk of poor outcome and aim to establish causality by modifying these factors. Psychological intervention should then be tested in trials targeting patients with negative psychological response to injury. The most effective target for intervention has not been established. Based on the results seen in this thesis further investigation focusing on illness perception, locus of control and depression in less well adapted, less stable, cohorts would be worthwhile.

In clinical orthopaedic practice, high quality surgical care is essential to optimise treatment of distal radius fracture. In addition to this, a recognition of the impact that psychological factors have on patient reported outcomes and the symptoms patients display is important. How best to target these factors and deliver supplementary care that can improve outcomes is yet to be established but provides a focus for future work with great potential. It is likely that intervention would be best delivered by psychologists with appropriate training, out with the fracture clinic setting, but in the interim an awareness from clinicians, empathy and support may provide the most effective adjuncts to routine fracture care.

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Appendices

Appendix 1: Ethical Approval

South East Scotland Research Ethics Service

Waverley Gate
2-4 Waterloo Place
Edinburgh
EH1 3EG

NHS Lothian

Name: Stuart Goudie
Address: Trauma & Orthopaedic Surgery
Royal Infirmary of Edinburgh
Edinburgh

Date: 25/03/2015
Your Ref:
Our Ref: NR/1502AB15
Enquiries to: Alex Bailey
Direct Line: 0131 465 5679
Email: alex.bailey@nhslothian.scot.nhs.uk

Dear Stuart,

Project Title: Psychological factors that impact on outcome following trauma

You have sought advice from the South East Scotland Research Ethics Service on the above project. This has been considered by the Scientific Officer and you are advised that, based on the submitted documentation (email correspondence and Prospectivestudymethod), it does not need NHS ethical review under the terms of the Governance Arrangements for Research Ethics Committees (A Harmonised Edition).

The advice is based on the following:

- *The project is a survey seeking the views of NHS patients on service delivery*

If the project is considered to be health-related research you will require a sponsor and ethical approval as outlined in The Research Governance Framework for Health and Community Care. You may wish to contact your employer or professional body to arrange this. You may also require NHS management permission (R&D approval). You should contact the relevant NHS R&D departments to organise this.

For projects that are not research and will be conducted within the NHS you should contact the relevant local clinical governance team who will inform you of the relevant governance procedures required before the project commences.

This letter should not be interpreted as giving a form of ethical approval or any endorsement of the project, but it may be provided to a journal or other body as evidence that NHS ethical approval is not required. However, if you, your sponsor/funder feels that the project requires ethical review by an NHS REC, please write setting out your reasons and we will be pleased to consider further. You should retain a copy of this letter with your project file as evidence that you have sought advice from the South East Scotland Research Ethics Service.

Yours sincerely,

Alex Bailey
Scientific Officer
South East Scotland Research Ethics Service

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1

University Hospitals Division

Queen's Medical Research Institute
47 Little France Crescent, Edinburgh, EH16 4TJ

NHS Lothian

FM/GM/Approval

8th March 2016

Mr Stuart Goudie
Department of Orthopaedics
Royal Infirmary of Edinburgh
51 Little France Crescent
EH16 4SA

Research & Development
Room E1.12
Tel: 0131 242 3330

Email:
R&DOffice@nhslothian.scot.nhs.uk

Director: Professor David E Newby

Dear Mr Goudie,

Lothian R&D Project No: 2016/0037

Title of Research: Routine Exercises and Either a Psychological (Therapy-based) or a Placebo (Informational) Intervention Workbook After Distal Radius Fracture. A Double Blind Randomised Control Trial.

REC No: 16/NS/0017

Participant Information Sheet:
Version 2 Dated 16th February 2016

Consent Form:
Version 2 Dated 16th February 2016

Protocol: Version 2 Dated 16th February 2016

I am pleased to inform you that this study has been approved for NHS Lothian and you may proceed with your research, subject to the conditions below. This letter provides Site Specific approval for NHS Lothian.

Please note that the NHS Lothian R&D Office must be informed if there are any changes to the study such as amendments to the protocol, recruitment, funding, personnel or resource input required of NHS Lothian.

Substantial amendments to the protocol will require approval from the ethics committee which approved your study and the MHRA where applicable.

Please inform this office when recruitment has closed and when the study has been completed.

I wish you every success with your study.

Yours sincerely

Fiona McArdle.

Ms Fiona McArdle
Deputy R&D Director

cc: Mr Michael Pearson, General Manager, Surgical Services Directorate, RIE

STA034

Appendix 2: Chapter 3 patient demographics, injury characteristics and treatment details

	n (%)		
	Study cohort	**Incomplete follow up**	**p value**
	n=216	**n=72**	
Patient demographics			
Mean age (range, SD, 95%CI)	57 (16-95, 19, 54-59)	48 (16-82, 21, 43-53)	**0.003***
Gender Male	55 (25)	25 (35)	
Female	161 (75)	47 (65)	0.129$^{\alpha}$
Previous wrist fracture (n=265)	51 (26)	21 (32)	0.327$^{\alpha}$
Smoker	38 (18)	18 (25)	0.169$^{\alpha}$
Alcohol excess	20 (9)	12 (17)	0.083$^{\alpha}$
Dependants	44 (20)	22 (31)	0.075$^{\alpha}$
Marital status			
Single	96 (44)	35 (49)	
Married / partner	120 (56)	37 (51)	0.539$^{\alpha}$
Education level (n=262)			
Left school before 16	49 (25)	8 (13)	
High school exams	67 (34)	22 (35)	
College/University	83 (41)	33 (52)	0.112$^{\alpha}$
Employment			
Manual work	31 (14)	9 (12)	
Non-manual work	57 (27)	16 (22)	
Self-employed	7 (3)	3 (4)	
Student	13 (6)	10 (14)	
Retired	87 (40)	21 (29)	
Long term sick	4 (2)	2 (3)	
Not working	10 (5)	7 (10)	

	n (%)		
	Study cohort	Incomplete follow up	p value
	n=216	n=72	
Other	7 (3)	4 (6)	0.191$^{\alpha}$
Index of Multiple Deprivation (n=281)			
(Most deprived) 1	27 (13)	12 (17)	
2	43 (20)	18 (26)	
3	35 (17)	3 (4)	
4	37 (18)	12 (17)	
(Least deprived) 5	69 (32)	25 (36)	0.115$^{\alpha}$
Past medical history			
Mean number of medical comorbidities (range, SD, 95%CI)	1.4 (0-15, 1.8, 1.1-1.6)	1.1 (0-7, 1.7, 0.7-1.5)	0.091*
Heart disease	17 (8)	10 (14)	0.129$^{\alpha}$
High blood pressure	50 (23)	11 (15)	0.157$^{\alpha}$
Diabetes	17 (8)	5 (7)	0.798$^{\alpha}$
Stomach ulcers	4 (2)	3 (4)	0.372$^{\beta}$
Kidney disease	6 (3)	0 (0)	0.342$^{\beta}$
Liver disease	4 (2)	1 (1)	0.100$^{\beta}$
Cancer	10 (5)	2 (3)	0.736$^{\beta}$
Thyroid disease	10 (5)	1 (1)	0.302$^{\beta}$
Lung disease	9 (4)	4 (6)	0.743$^{\beta}$
Anaemia	13 (6)	6 (8)	0.583$^{\beta}$
Chronic fatigue syndrome	3 (1)	0 (0)	0.576$^{\beta}$
Irritable bowel syndrome	23 (11)	10 (14)	0.455$^{\alpha}$

	n (%)		
	Study cohort	Incomplete follow up	p value
	n=216	n=72	
Osteoarthritis	36 (17)	4 (6)	**0.018^{α}**
Back pain	52 (24)	13 (18)	0.290^{α}
Rheumatoid arthritis	9 (4)	1 (1)	0.460^{β}
Psychiatric history			
Anxiety	31 (14)	16 (22)	0.118^{α}
Depression	37 (17)	13 (18)	0.857^{α}
Post-traumatic stress disorder	2 (1)	3 (4)	0.102^{β}
Obsessive compulsive disorder	1 (1)	1 (1)	0.438^{β}
Preinjury medication			
Opiates	28 (13)	9 (13)	0.919^{α}
Benzodiazepines	4 (2)	1 (1)	1.000^{β}
Neuropathic analgesia	6 (3)	2 (3)	1.000^{β}
Injury characteristics			
Mechanism of injury Fall<2m	150 (69)	47 (65)	
Fall>2m	24 (11)	4 (6)	
Sport	27 (13)	12 (16)	
Bicycle	7 (3)	4 (6)	
Twist	3 (1)	2 (3)	
Assault	1 (1)	1 (1)	
RTA	4 (2)	2 (3)	0.571^{α}
Injured side Right	80 (37)	26 (36)	
Left	31 (61)	45 (63)	0.876^{α}

	n (%)		
	Study cohort	Incomplete follow up	p value
	n=216	n=72	
Bilateral	5 (2)	1 (1)	
Dominant side affected	87 (40)	28 (39)	0.835$^{\alpha}$
Open injury	6 (3)	0 (0)	0.342$^{\beta}$
Nerve injury	7 (3)	2 (3)	1.000$^{\beta}$
Multiple fractures	18 (8)	3 (4)	0.239$^{\alpha}$
AO-OTA classification A	113 (52)	46 (64)	
B	42 (20)	10 (14)	
C	61 (28)	16 (22)	0.227$^{\alpha}$
Radiographic parameters T1			
Radiocarpal alignment maintained			
Yes	95 (44)	43 (60)	
No	121 (56)	29 (40)	**0.021$^{\alpha}$**
Dorsal tilt degrees Mean (range, SD, 95%CI)	8 (-33-49, 19, 6-11)	4 (-19-52, 17, 0-7)	0.063*
Ulnar variance Mean mm (range, SD, 95%CI)	2 (-7-13, 3, 2-3)	1 (-3-10, 3, 1-2)	**0.045***
Radiographic parameters T2			
Radiocarpal alignment maintained			
Yes	151 (70)	55 (76)	
No	65 (30)	17 (24)	0.291$^{\alpha}$
Dorsal tilt degrees Mean (range, SD, 95%CI)	0 (-39-43, 14, -2-2)	-2 (-12-31, 11, -5-1)	0.302*
Ulnar variance	1 (-4-11, 3, 1-2)	1 (-7-10, 2, 0-1)	0.192*

	n (%)		
	Study cohort	**Incomplete follow up**	**p value**
	n=216	**n=72**	
Mean mm (range, SD, 95%CI)			
Treatment details			
Treatment Surgical	76 (35)	14 (19)	
Non-operative	140 (65)	58 (81)	**0.025**$^{\alpha}$
Specific treatment ORIF	67 (31)	14 (19)	
K-wire	8 (4)	(0)	
Ex fix	1 (1)	(0)	
Cast	95 (44)	44 (62)	
MUA cast	45 (21)	14 (19)	**0.032**$^{\alpha}$
Enrolment psychological scores Median (IQr)			
PCS	4 (0-9)	4 (0-9)	0.204*
HADs Depression	2 (1-5)	2 (1-4)	0.227*
HADs Anxiety	4 (2-7)	4 (2-6)	0.565*
PTSD	20 (17-26)	19 (17-21)	**0.039***
TSK	38 (34-42)	36 (33-40)	0.050*
IPQB	33 (25-41)	33 (21-41)	0.586*
GSES	31 (29-36)	31 (30-36)	0.645*
RLOC	36 (32-39)	35 (31-39)	0.200*
Time to follow up Mean (range, SD, 95%CI)			
Days to presentation	9 (0-28, 7, 8-9)	9 (0-28, 6, 7-10)	0.392*
Weeks to T2	10 (6-19, 2, 9.4-9.9)	n/a	
Weeks to T3	37 (28-52, 3, 36.9-37.7)	n/a	

Chapter 3 patient demographics, injury characteristics and treatment details. *Mann Whitney U Test, $^{\alpha}$ ***Chi Square Test, β Fisher's Exact Test.***

Appendix 3: Chapter 4 patient demographics, injury characteristics and treatment details

	n (%)		
	Study cohort	**Patients lost to follow up** (Key psychological scores (GSES, PCS and 4 IPQR domains) incomplete 10 weeks after injury)	**p value**
	n=153	**n=93**	
Patient demographics			
Mean age (range, SD, 95%CI)	57 (17-95, 17, 54-59)	49 (16-88, 22, 44-54)	**0.012***
Gender Male	38 (25)	33 (35)	
Female	115 (75)	60 (65)	0.083^{α}
Previous wrist fracture (n=227)	40 (26)	20 (22)	0.397^{α}
Smoker	26 (17)	20 (22)	0.379^{α}
Alcohol excess	18 (12)	9 (10)	0.612^{α}
Dependants	39 (26)	19 (20)	0.365^{α}
Marital status			
Single	62 (41)	48 (52)	
Married / partner	91 (59)	45 (48)	0.090^{α}
Education level (n=228)			
Left school before 16	26 (17)	21 (23)	
High school exams	50 (33)	28 (30)	
College/University	67 (44)	36 (39)	0.496^{α}
Employment			
Manual work	19 (12)	15 (16)	
Non-manual work	25 (30)	21 (24)	
Self-employed	8 (5)	2 (2)	
Student	6 (4)	16 (17)	
Retired	57 (37)	30 (32)	
Long term sick	3 (2)	2 (2)	
Not working	9 (6)	4 (4)	
Other	6 (4)	3 (3)	**0.035^{α}**
Index of Multiple Deprivation (240)			
(Most deprived) 1	14 (9)	15 (17)	
2	29 (19)	23 (25)	
3	20 (13)	15 (17)	
4	28 (19)	13 (14)	
(Least deprived) 5	59 (40)	24 (27)	0.129^{α}
Past medical history			
Mean number of medical comorbidities (range, SD, 95%CI)	1.2 (0-6, 1.4, 1-1.4)	1.2 (0-15, 2, 0.8-1.7)	0.521*
Heart disease	8 (5)	9 (10)	0.182^{α}
High blood pressure	33 (22)	19 (20)	0.832^{α}
Diabetes	11 (7)	10 (11)	0.332^{α}
Stomach ulcers	1 (1)	2 (2)	0.300^{β}
Kidney disease	3 (2)	3 (3)	0.533^{β}

	n (%)		
	Study cohort	**Patients lost to follow up** (Key psychological scores (GSES, PCS and 4 IPQR domains) incomplete 10 weeks after injury)	**p value**
	n=153	**n=93**	
Liver disease	0 (0)	5 (5)	**0.007^{β}**
Cancer	6 (4)	3 (3)	1.000^{β}
Thyroid disease	4 (3)	4 (4)	0.481^{β}
Lung disease	2 (1)	4 (4)	0.203^{β}
Anaemia	6 (4)	9 (10)	0.067^{α}
Chronic fatigue syndrome	1 (1)	1 (1)	1.000^{β}
Irritable bowel syndrome	14 (9)	8 (9)	0.884^{α}
Osteoarthritis	23 (15)	11 (12)	0.480^{α}
Back pain	41 (27)	15 (16)	0.053^{α}
Rheumatoid arthritis	5 (3)	4 (4)	0.733^{β}
Psychiatric history			
Anxiety	17 (11)	19 (20)	0.062^{α}
Depression	28 (18)	10 (11)	0.112^{α}
Post-traumatic stress disorder	2 (1)	1 (1)	1.000^{β}
Pre-injury medication			
Opiates	19 (12)	9 (10)	0.544^{α}
Benzodiazepines	2 (1)	1 (1)	1.000^{β}
Neuropathic analgesia	4 (3)	2 (1)	0.653^{β}
Injury characteristics			
Mechanism of injury Fall<2m	109 (71)	59 (64)	
Fall>2m	15 (10)	9 (10)	
Sport	18 (12)	15 (16)	
Bicycle	6 (4)	5 (5)	
Twist	2 (1)	3 (3)	
Assault	1 (1)	0 (0)	
RTA	2 (1)	2 (2)	0.741^{α}
Injured side Right	54 (35)	31 (33)	
Left	97 (64)	58 (62)	0.333^{α}
Bilateral	2 (1)	4 (4)	
Dominant side affected	58 (38)	36 (39)	0.900^{α}
Open injury	3 (2)	2 (2)	1.000^{β}
Nerve injury	6 (4)	2 (2)	0.714^{β}
Multiple fractures	10 (7)	9 (10)	0.461^{α}
AO-OTA classification A	82 (53)	48 (52)	
B	29 (19)	17 (18)	
C	42 (28)	28 (30)	0.905^{α}

	n (%)		
	Study cohort	**Patients lost to follow up** (Key psychological scores (GSES, PCS and 4 IPQR domains) incomplete 10 weeks after injury)	**p value**
	n=153	**n=93**	
Radiographic parameters T1 (n=243)			
Radiocarpal alignment maintained	70 (46)	51 (55)	0.167$^{\alpha}$
Dorsal tilt degrees Mean (range, SD, 95%CI)	8 (-25-49, 18, 6-11)	4 (-33-52, 18, 0-8)	0.060*
Ulnar variance Mean mm (range, SD, 95%CI)	2 (-7-13, 3, 1-3)	2 (-3-10, 3, 1-2)	0.372*
Radiographic parameters T2			
Radiocarpal alignment maintained	112 (73)	65 (70)	0.575$^{\alpha}$
Dorsal tilt degrees Mean (range, SD, 95%CI)	-1 (-30-43, 14, -3-1)	-1 (-39-32, 13, -4-2)	0.631*
Ulnar variance Mean mm (range, SD, 95%CI)	1 (-4-11, 3, 1-2)	1 (-4-9, 2, 0-1)	0.375*
Treatment details			
Treatment Surgical	54 (35)	25 (27)	
Non-operative	99 (65)	68 (73)	0.171$^{\alpha}$
ORIF	50 (33)	22 (24)	
K-wire	3 (2)	3 (3)	
Ex fix	1 (1)	0 (0)	
Cast	72 (46)	49 (53)	
MUA cast	27 (18)	19 (20)	0.082$^{\alpha}$
Baseline psychological scores Median (IQr)			
PCS	3 (1-10)	3 (0-8)	0.080*
HADs Depression	2 (1-5)	2 (1-4)	0.353*
HADs Anxiety	4 (2-7)	4 (2-7)	0.592*
PTSD	20 (17-25)	19 (17-24)	0.428*
TSK	38 (33-41)	38 (34-43)	0.258$^{\phi}$
IPQR Identity	3 (2-5)	3 (2-5)	0.806*
IPQR timeline acute/chronic	11 (9-15)	12 (10-17)	**0.022***
IPQR timeline cyclical	8 (7-12)	9 (8-12)	0.627*
IPQR consequence	14 (11-18)	14 (12-18)	0.994*
IPQR personal control	22 (20-24)	22 (18-24)	0.077*

	n (%)		
	Study cohort	**Patients lost to follow up** (Key psychological scores (GSES, PCS and 4 IPQR domains) incomplete 10 weeks after injury)	**p value**
	n=153	**n=93**	
IPQR treatment control	20 (18-22)	20 (17-21)	0.225*
IPQR coherence	23 (20-24)	23 (20-24)	0.291*
IPQR emotion	14 (11-18)	14 (12-18)	0.547*
GSES	31 (29-36)	32 (30-38)	0.117*
RLOC	36 (33-40)	34 (31-38)	**0.003***
Time to follow up Mean (range, SD, 95%CI)			
Days to presentation	9 (0-28, 7, 8-10)	9 (0-28, 6, 7-9)	0.733*
Weeks to T2	10 (6-19, 2, 9-10)	n/a	
Weeks to T3	37 (28-47, 3, 36-37)	n/a	

Chapter 4 patient demographics, injury characteristics and treatment details. *Mann Whitney U Test, $^{\phi}$ Independent samples T Test. α Chi Square Test, β Fisher's Exact Test.

Appendix 4: Chapter 5 psychological intervention design focus group notes

Focus Group Notes 07/12/15

Focus group consisted of 6 randomly patients selected patients attending Edinburgh Royal Infirmary following distal radius fracture. All at different stages of recovery, within 9 months of injury. Interviewed by Gail McMillan PhD student in Health Psychology. Patient views anonymised and referred to by individual identification number 1-6. All questions relate to psychological intervention workbook.

Q1: Thoughts about language/tone? Too formal/technical?

5/4/2 - not too technical
1 - got a 'fright' from the number of pages
(All agree about paper being understandable)

6 - needs instruction for this type of thing
1 - wishes they had it when they first broke their wrist; you do what everyone tells you and it doesn't sink in (6 agrees)

6 - would've liked info given about food/nutrition at time of break
2 - descriptions of how pain should feel made them more at ease

Q2: Content?

2/4 agreed on liking content
4 - it focused on straight-to-cast breaks, no mention of plate procedures. Bone realignment is a big thing in itself and traumatic. **A broader range for all kinds of fractures would be good**

1 - wasn't encouraged enough to do exercise with cast on - led to frozen shoulder. With advice given in booklet, would have concentrated more - within first few weeks was left to get on with it. Would've been helpful.

Thoughts about stories?

6 - different circumstances were informational
1 - keeping diary would've been a good idea

Q3: Goal Diary

6 - would use for health reasons only as is a positive person anyway
5 - goal diaries are good if you can discuss it with somebody to assess progress. If it's too lengthy, wouldn't do it. At a follow up, such as physio would be helpful as you must be held accountable
4 - shock, can't do things
2 - lot of things you want to do but can't i.e. drive

5 - would be good to write down goals to think about your short term/long term goals

Q4: Overall Layout

1 - would've liked to spend more time looking at it
4 - if given when cast first on, would've given them more time to read it
1 - would know what to expect from break
2 - section on pain - physio
6 - liked how the layout was. It felt heavy at first but only had to read half of it. **Having two separate books - one diary and one leaflet.**
5 agrees.

Q5: How helpful if was given at time of break?

4/1 - would've helped
2 (currently has a break) - put them at ease reading about pain. Stress/feeling down, can relate to that
1 - would've been better at the time, felt they couldn't do what they wanted to and felt guilty. After reading through, don't feel bad because that's what is expected

Q6: What would you definitely use/not use?

6 - would use healthy eating
4 - it's all relevant, individual circumstances added help
5 - if you've not had a break it could be helpful to read
2 - some people don't realise how hard it is, daughter doesn't realise how big a loss of the hand is. Every task is a nightmare

6 - even things like going to the bathroom can be problematic

Q7: Time scale realistic?

5 - wouldn't fit it all in but would start it
6 - agreed that less would be better in the goal diary section
5 - **a list of exercises that are necessary would be better.** You could tick them off, can see what you're doing/not doing. Make it as convenient as possible would be the best.
Goals - would like to speak to someone about reaching goals and problems faced
Having a list with grids to check them off and a rating of 1-10 of pain would help as they find it difficult to rate pain.

6 - progress thing to look back on progress.

Q8: Anything missed?

4 - plate put in
6 - happy with it - health/movement sections are what you're looking for

More/Less of?

5 - more about different types of break
6 - rehabilitation aspect is good - still watch what you're doing even after cast is off
4 - mention pain after cast is off

List of resources?
All agree would be helpful.
4 - would've preferred it at the time of break
5 - a pamphlet with resources would be good

Appendix 5: Chapter 5 psychological intervention workbook

Where blank workbook pages are seen this is to improve formatting of the final published workbook that patients used.

Recovery from a Broken Wrist

RECOVERY WORKBOOK

NHS Lothian & University of Strathclyde

(These materials have been developed by NHS Lothian in collaboration with The University of Strathclyde)

Contents

Introduction

This book is for people who have a broken wrist. It contains advice and activities that will give you the best possible chance of making a full and quick recovery.

It should be used along with the **Goal Diary**.

Your whole body and mind are involved in the healing process and this book is written in sections to help you do everything you can in each of these areas. Many of these can be done while your wrist is still in plaster. At the end of each section there are activities which will help you recover.

You may find the thought of reading this overwhelming right now. Go at your own pace. Try reading one page a day, only read the sections relevant to you or use it for reference when you are working with the Goal Diary.

Sections

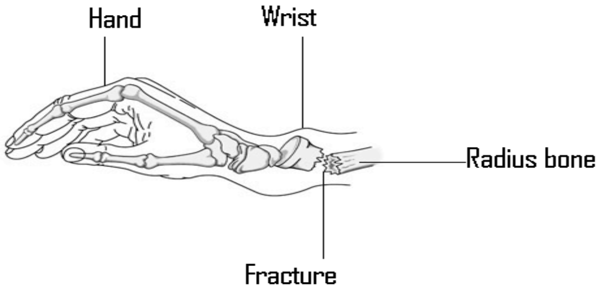
- **Information about your broken wrist and treatment** – What to expect and what is normal
- **Taking care of your body** – Eating well, exercise, rest
- **Physiotherapy exercises** – Exercises and advice – how and when to do them.
- **Managing your pain** – What to expect and how to deal with pain.
- **Dealing with frustration, stress and worries** – Strategies to help you put yourself in the best frame of mind to recovery well.
- **Improving your sleep** – Sleeping well is important while your body heals. Here are tips and advice to help you improve your sleep.
- **Further Resources** – links to other places that you might find useful.

We hope you find this workbook useful and feel confident taking control of your recovery.

Information About Your Broken Wrist and Treatment.

Your Break

- You have broken a bone in your wrist called the radius.
- This is a very common injury
- It can affect people of all ages



What Symptoms to Expect

Did you know?

- **Swelling** is normal and shows that the body is starting to repair the damage. This can last for months after the injury.
- **Pain** is a normal reaction which can occur throughout the healing process.
- **Feeling annoyed or stressed** is very common after this kind of injury. It is important to work through this and remember things will improve as you recover.
- **Feeling tired** is not unusual - a break requires the body to heal and healing can increase the amount of energy you use throughout the day.

Your Treatment

Depending on the type of break you have you will be treated in one of the following ways

- Plaster cast or wrist splint
- Manipulation and plaster cast (where your wrist is ‘pulled’ then set in plaster)
- With an operation to fix the break

The aim of each of these treatments is the same – to realign the break and hold it in the correct position as it heals. Your wrist will be supported in a cast or a splint until your doctor feels the bone is strong enough for you to start moving your wrist.

When your cast or splint comes off swelling, soreness, and stiffness are normal.

By this stage the bone is strong enough for you to begin moving the wrist. Movement is essential for muscles and tendons to recover strength and helps loosen the stiffness in your wrist.

At this stage you must move and use the wrist to loosen the stiffness and help it recover!

Did you know?

- It usually takes about 6 weeks for the bone to heal.
- Most patients are allowed to return to any sport or activity within 3 months of injury.
- Your wrist can continue to improve for at least one year.

Everyone recovers slightly differently. There may be times when you feel things are not going well as you would like.

This Workbook and the Goal Diary will help you recover as best as you can.

Taking Care of Your Body

Your whole body and mind are involved in the recovery from a broken wrist. This means you have the power to influence the healing process even before your cast or splint is off.

Eating well

The body requires many vitamins and minerals while it heals. Bone is made up of nearly 70% minerals so it is important to eat a nutrient-rich diet.

Protein, calcium, Vitamins D, K and B6 are involved in bone healing. They are essential for new bone to form and allow the soft 'rubber-like' material in new bone to become harder and stronger. Vitamin C is essential for bone health and can help reduce pain.

Some foods which include these vitamins are:-

- Chicken
- Turkey
- Fish
- Wholegrain cereals and bread e.g. oatmeal, brown rice
- Eggs
- Milk – diary, almond, soy
- Beans and legumes e.g. home made lentil soup
- Vegetables e.g. broccoli, spinach, carrots
- Potatoes
- Fruits e.g. oranges, blueberries, strawberries, apples
- Nuts (not roasted and salted) e.g. walnuts, almonds, cashews

We suggest you have three square meals a day and try to include these types of food as much as possible.

In the Goal Diary you could set a goal to eat well while you recover and make a meal planner to help you do this.

For more nutritional advice to improve bone health visit The NHS website:
http://www.nhs.uk/Livewell/healthy-bones/Pages/food-and-diet-for-strong-bones.aspx

Keep physically active

This can help healing by improving circulation, keeping you fit and strengthening muscles. It also puts you in a good mood. You may not be able to swim or play tennis for a while but even low intensity exercise will help recovery.

Walking to the local shop or using the stairs instead of the lift are good places to start.

Why not use the Goal Diary and aim for 15 – 30 minutes of walking per day. If you play sport you could use this as the first step in your plan to return to full activity.

Rest

Recovery can be tiring work. Make sure you have time to relax and get a good night's sleep. This will help the healing process.

Talk to friends and family

Make sure you get support when you need it. Plan to do social activities, chat on the phone or ask for help with some activities e.g. driving to the shops.

Smoking and excess alcohol

These can slow healing and increase pain as they reduce blood flow to the injury – this can increase the chance of complications. If you are thinking about trying to cut down or quit smoking please contact your GP for advice.

Activity 1

Think of three ways that you can take care of your body and help your wrist recover e.g. make a meal plan so I'll get the nutrition I need

1. ____________________________________

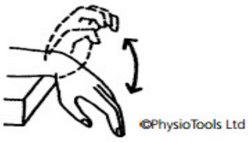
2. ____________________________________

3. ____________________________________

Physiotherapy Exercises – Wrist Exercise Sheet

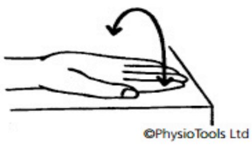
Find time to do these exercises 3 times per day once your wrist is out of plaster/splint. Use this section and the ***Goal Diary*** to help you. Read the next 5 pages for more tips and advice.

1. Rest forearm on a table with hand over the edge. Bend hand towards floor and then raise up towards the ceiling. Check that the movement only takes place at the wrist.



2. Rest the palm of your hand on the table. Tilt the hand one way and then the other.

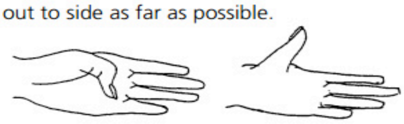
3. Place your forearm on the table. Turn your palm down, and then up, keeping the elbow still.



4. Touch your thumb to the tip of each finger. Repeat this as quickly as possible.

5. Make a tight fist, ensuring your knuckles are bent to a right angle. Use your other hand to help if necessary. Then fully straighten the fingers.

6. With the palm of your hand facing upwards, bend thumb across palm of hand to base of little finger and then stretch out to side as far as possible.



Physiotherapy Exercises – Getting the balance right

Being unable to move your wrist for several weeks means that the soft tissues (muscles, ligaments and tendons) will get weaker and stiff. The only way this will get better is with movement and hard work. It is important to get the right balance between protecting your wrist and getting it moving again.

Over protecting your wrist and avoiding movement can lead to long-term stiffness and pain. However, forcing movements before the bone has healed can lead to further injury.

Some help getting the right balance

- While you have your cast or splint on you should regularly wiggle your fingers; gently bend a straighten your elbow; lift your arm above your head to move your shoulder.
- As soon as your cast comes off it is very important you get your wrist moving again. **At this stage you can start doing the exercises on the *Wrist Exercise Sheet* on page 11 and plan this using the Goal Diary.**
- Discomfort or dull pain while doing your exercises doesn't mean you are doing further damage to your wrist. This is normal and will improve with time.
- Avoid forcing your wrist to move beyond a point that gives you sharp pain. For more information on pain see the ***Managing Your Pain*** section on page 17.
- Avoid using weights to force your wrist to move. Movement will return with time and regular gentle exercise.
- Avoid lifting anything heavier than a cup of tea for the first 6 weeks.
- After 6 weeks gradually increase the weight you lift as pain allows.

Physiotherapy Exercises - Tips

It will help your recovery to:

Use the Goal Diary

- Set yourself a target of how many times each day you will do the exercises on the ***Wrist Exercise Sheet*** on page 11.
- When will you do them? How will you fit this into your daily routine?
- Think of what might make it difficult to do these exercises and how you will overcome these challenges.
- At times you might feel like you are taking 2 steps forward and 1 step back. By using the **Goal Diary** to record your progress you should be able to see steady improvement over a number of weeks.
- Pace yourself—Try working your way up to normal activities using your **Goal Diary** e.g. Week 1—shampoo with both hands for 1 minute, Week 2—shampoo with both hands for 2 minutes.

Expect some pain and discomfort

- Discomfort or dull pain while doing your exercises doesn't mean you are doing further damage to your wrist. The pain will decrease as the muscles get stronger and looser. For more information see ***Managing You Pain*** on page 17.

Rest

- Its ok to rest your wrist and hand in between exercise sessions.
- Some days your wrist might be more painful and swollen than others. When this happens you can reduce them amount of the exercises you are doing, or do less heavy work. Once this settles start building up your activity again.

Plan activities

- Spread out activities that you find challenging. So you can get things done without overdoing it. e.g. Monday - shopping, Tuesday - ironing, Wednesday - gardening.

Take time for yourself

- Even if you have other responsibilities or if you are out with friends, make sure you fit your exercises into your life. Family and friends will understand.

Remember it's OK to get frustrated

- This is understandable. Just don't give up. Things like using cutlery, brushing your teeth and doing up buttons will get easier with time and practice.

John's Story

John's hand and wrist were more stiff and sore than he expected when his cast came off. He was unsure about doing his exercises as he had some pain when moving his wrist. He also felt tired throughout the day meaning he could be forgetful and did not feel up to doing his normal activities.

John used the Goal Diary and set himself a long-term goal of getting back to playing tennis. He read the Physiotherapy section of the Workbook and knew that his pain, stiffness and tiredness were a normal part of recovery. He had read that doing his exercises would help reduce the stiffness and his pain would improve as the muscles grew stronger.

He used his Goal Diary to set targets for a gradual return to tennis and plan what times of the day he would do his exercises. He set an alarm to remind him it was time for his exercises. He began by holding his tennis racket in the first week after his cast came off, then bouncing a ball on the racket after 3 weeks later, after another 2 months he began to softly hit balls again. He had to make some adjustments to his target times but was able to achieve his goals in the end and saw steady progress in the Goal Diary.

Activity 2

A: Think of three times of the day when you can do your exercises:

It may be useful to plan *when*, *where* and *how* e.g. after dinner I'll set aside 15 minutes before the soaps come on.

1.______________________________________

2.______________________________________

3.______________________________________

B: Think of three ways to help you achieve this:

e.g. set an alarm

1._____________________________________

2._____________________________________

3._____________________________________

If you have not noticed any change in stiffness, pain or function after a few weeks then contact your GP or physiotherapy services.

Managing Your Pain

It is human nature to believe that pain means there is something wrong. It is common for people who have a broken wrist to think that pain while doing physiotherapy exercises means there will be further damage.

However, this is not always the case. **You should expect to experience some pain. This is a normal part of recovery and you may be aware of it for several months**.

It is important to recognise different types of pain as these mean different things:

Dull, achy pain
This type of pain is normal during recovery. It does not mean that if you move your wrist you will damage it. It is important that you continue to do the movement exercises as these will help your wrist recover. Over time the exercises will reduce the pain and stiffness in your wrist.

Sharp or excruciating pain
This kind of pain may mean you are doing too much too soon with your exercises. You should rest and if this pain does not go away get help from your GP or physiotherapist.

Tips for Controlling Pain

- **Pain relief** – taking painkillers is a normal part of recovery and can help your progress. If you know an activity will make your wrist uncomfortable (like doing your physiotherapy exercises or making a meal) plan to take pain killers before you start in anticipation of some pain. Speak to your GP or pharmacy about using paracetamol or a suitable alternative.
- **Apply heat** – using a hot water bottle or heat pack can reduce muscle pain and help with relaxation. Heat can be applied as often as required. Always follow instructions for safe use.
- **Pace yourself** –Gradually build back up to full activity, plan how you will do this with the **Goal Diary**. For example, start by lifting a cup of tea, the next week try an empty kettle, the next week try a kettle with enough water for one cup…… eventually you will be able to lift a full kettle again.
- **Distract yourself** – It is important you continue to do things that you enjoy. Make plans to go out with friends, watch films, start reading a new book. You could even challenge yourself to find a new hobby.
- **Relaxation** – Pain can be distressing and tiring. This is completely natural and understandable. Find time to relax throughout your day. Talk to friends and family about how you feel. See the ***Relaxation Technique*** on page 22.

Jane's Story

Jane had always kept herself busy since she retired two years ago. She was on the committee for her local primary school and wrote minutes for the meetings. She was struggling to do this because her wrist was sore. She did not want to give up her busy social life altogether but realised she would have to adapt.

She used her Goal Diary to plan her return to normal writing and keep a record of her pain levels. She continued to attended the committee meetings but at first asked another member to write the minutes. When she got her plaster off she took painkillers every day. She practised gripping a pen and took regular breaks while writing things. She set herself a target for each week. In the first week her target was to write a sentence, the second week half a page, third week two pages and she planned to take the minutes at the meeting in a months time.

After a month Jane looked back at her progress in her Goal Diary and saw that her pain levels had improved and she needed less painkillers. She was pleased at how far she had come and had the confidence to take the minutes at the next committee meeting.

Activity 3

A: Think of three daily activities that you have found painful:
e.g. loading the washing machine

1. ______________________________

2. ______________________________

3. ______________________________

B: Think of three ways that you can manage this pain:
e.g. loading half the amount of clothes

1. ______________________________

2. ______________________________

3. ______________________________

Dealing with Frustration, Stress and Worries

It's normal to feel frustrated, stressed and worried when you are recovering from an injury. These negative feelings may come from being tired, unable to do the things you normally do and being out of your routine. Pain can exaggerate these feelings.

Negative feelings can slow recovery so it is important to stay positive and try to control these.

Tips for Managing Stress

- **Use the Goal Diary** – If you are feeling overwhelmed by it may help to write down your thoughts. Use the **Goal Diary** to set realistic goals and break your plan into manageable bite size chunks.
- **Talk to someone** – Don't be afraid to ask for help while you're recovering. Discussing your worries can help put them into perspective. Talking through problems with friends and family can be very helpful.
- **Physical activity** – Going for a walk, to a gym class or even doing some housework can help release stress-fighting hormones. While exercising, let go of worries and focus on the movements your body is making, for example the feeling of the pavement on your feet.
- **Plan fun activities** – Do things you enjoy, go to any clubs you are a part of and make plans with friends. This will help take your mind off your worries and will make you feel good.
- **Reframe your problems** – Try to view things as if they are a challenge which you can overcome rather than a problem you cannot solve. Write challenges down and plan how you will overcome them in the **Goal Diary**.
- **Look at the bigger picture** – How important is this issue? Adjust your expectations – don't be so hard on yourself. Accept when something cannot be changed and try to let go. You are recovering from an injury and will get better with time.
- **Try relaxation techniques** – page 22.

Relaxation Technique

This technique eases muscle tension and helps you relax. Try to do this exercise in a comfortable, soothing environment. Put calming music on or shut out other noise and distractions.

For each area of your body, hold the tension for a few seconds then release the tension. Do each exercise three times. Focus on the feeling of the tension leaving your body.

- **Arms –** Make a fist and bring your hand up toward the shoulder, bending at the elbow, then back down and release the fist. Then relax.
- **Wrists and hands –** Open your hand as wide as you can and then release. This will also help release stiffness form your injury.
- **Legs –** Lie down. With one leg at a time slowly bend you knee up towards your chest, hold for 5 seconds, then straighten your leg out again. Repeat with the other leg. Then relax.
- **Chest –** Breathe in slowly and deeply until you feel your lungs at full capacity, then slowly breathe out until you have completely exhaled, then relax.
- **Shoulders –** Slowly bring one shoulder up toward your face, and then slowly back down. Repeat with your other shoulder. Then relax.
- **Neck –** Facing forward, slowly move your head toward your right shoulder, and then slowly back up. Repeat with your left side. Then relax.
- **Face –** Slowly bring your face into a frowning expression, then back to a neutral expression, smile, then relax.
- **Relax –** Once you have gone through all the exercises, lie still and relax.

Why not plan to do these exercises regularly using your Goal Diary?

Jake's Story

Jake did not feel like himself after he broke his wrist. He lived alone and found it difficult to wash and get dressed in the morning. He felt like the things he needed to do were piling up and began to think 'why bother trying?' He was staying in bed later, sometimes into the afternoon. He noticed he was more irritable than usual and began to cancel plans and activities.

One day, Jake met with a friend and they talked about his broken wrist. The friend offered to pick up shopping for Jake and help him around the house. This took a weight off his mind. She also encouraged him to go out and do things he enjoyed. He was reluctant at first as he often felt tense and in a bad mood. He used his Goal Diary and set a target to go out for a walk every morning and do relaxation exercises when ever he felt stressed. After doing this for a week he felt a bit better. With the help of his friend, Jake was managing better around the house and he noticed that he began to feel more like his old self. He gradually returned to his normal routine, even though it was tiring. He made plans to do something fun each week, this gave him something to look forward to and helped him cope.

Activity 4

A: Think of three stressful situations that you have overcome in the past:

1.______________________________________

2.______________________________________

3.______________________________________

B: Think of three ways that you managed this stress in the past:
e.g. I spoke to my friends and they supported me

1.______________________________________

2.______________________________________

3.______________________________________

If you continue to have negative or worrying thoughts, or have noticed that your mood has been low for a while or you are having trouble sleeping or eating that last more than a few weeks please see your GP for further advice.

Improving Your Sleep

Having a good and regular sleep pattern makes you feel better and can improve your recovery. Try to get 7-8 hours of uninterrupted sleep each night.

You may have trouble sleeping after your injury. This can happen because of discomfort, worrying about things or being afraid that you will hurt your wrist in your sleep.

Tips to Improve Sleep

- **Prepare for sleep** – It can be difficult to sleep if you are doing work right before bed, thinking about things, or on your smartphone. At least an hour before sleep, begin to wind down and do activities that are relaxing, such as reading a book.
- **Make a relaxing environment** – Prepare your bedroom by closing blinds, putting on low lighting, listening to quiet, calming music, and making sure it is warm enough.
- **Use relaxation techniques** - See the ***Relaxation Technique*** on page 22 while lying in your bed.
- **Avoid caffeine** – Try not to drink caffeinated drinks (tea, coffee, coca cola) 6 hours before going bed.
- **Stick to a routine** – get into a routine of going to bed and getting up at the same time each day. Your body will get used to this and your sleep will improve.
- **If you're struggling to fall asleep** – If you have tried to sleep and find that you can't after 30 minutes, try a relaxation exercise. If this doesn't work, get up, go to another room. Do something relaxing, such as reading in low level lighting until you are truly tired.
- **Worrying thoughts** – if you can't fall asleep because you have thoughts going round and round in your head, try getting up and writing the thoughts down on a bit of paper. Decide to 'sleep on it' and think about it tomorrow.
- **Fear of further injury** – it is important to remember that your doctor will tell you when they feel it is safe for you to move your wrist. Normal sleep movements are unlikely to harm your wrist. If you have discomfort, put an extra pillow beside you and prop your hand and wrist up on it while you sleep. You will be unlikely to roll over onto your arm this way.
- **Use the Goal Diary** – make sleeping well one of your goals. Plan how you will achieve this and watch your progress using the Goal Diary.

Hannah's story

Hannah broke her wrist playing volleyball. She worried about how she would get to sleep. She couldn't relax and tried several different sleeping positions. She was scared she would roll over onto her wrist during the night. Being unable to sleep made her worry even more.
She tried to go to sleep in a chair in the living room as she felt safer doing this. She was still very tired all the time, she had muscle aches in her back, neck and wrist and had troubling concentrating at work during the day.

Hannah began to use the Sleeping Tips in her Workbook. She planned how she would improve things and set targets using her Goal Diary. Before going to bed each night she made a list of the things she had to do the next day, this cleared her mind and helped her relax. She set a target of going to bed at the same time each night and set an alarm for each morning. She started sleeping in her bed again and read a book in bed until she felt tired. She propped her wrist up on a pillow and reminded herself that it was safe for her to fall asleep. As her sleep pattern gradually improved and she became more confident she wouldn't injure her wrist in bed she began to feel much better.

Activity 5

A: Think of three goals which would improve your sleep:
e.g. Get 8 hours uninterrupted sleep a night

1. ____________________________________

2. ____________________________________

3. ____________________________________

B: Think of three ways that you can achieve this:
e.g. go to bed at 10pm, set alarm and get up as soon as it goes off.

1. ____________________________________

2. ____________________________________

3. ____________________________________

Further Resources

What to expect

If you have any questions about your injury or recovery please ask your doctor, physiotherapist or nurse. We are here to help or will find someone who can.

Speak to friends and relatives who have broken their wrist in the past – find out what is normal, what to expect and ask how they coped with different challenges.

Nutrition
For nutritional advice to improve bone health visit The NHS website:
http://www.nhs.uk/Livewell/healthy-bones/Pages/food-and-diet-for-strong-bones.aspx

Worries, low mood, frustration

Wellbeing Glasgow

Have information, self-help guides and relaxation guides on their website.
The service has psychologists, counsellors and trained self-help workers who have put together these resources.

http://wellbeing-glasgow.org.uk/

Telephone: 0141 232 2555 between 8.30am to 4.30pm

Email: South.PCMHT@ggc.scot.nhs.uk

Steps for Stress

Is a website created by the Scottish Government to help manage stress and enjoy life more. There is information, advice and you can download relaxation exercises.
http://www.stepsforstress.org/

Stress Control

Is a service provided by NHS Lothian. The course runs in many areas across Lothian. The course helps you control stressful thoughts and reactions in your body, recognise and manage panic, and manage sleep.

http://www.nhslothian.scot.nhs.uk/Services/A-Z/StressControl/Pages/default.aspx

If you feel that these resources aren't right for you and stress, feeling low or worries are getting in the way of your life, contact your GP.

Recovery from a Broken Wrist

GOAL DIARY

NHS Lothian & University of Strathclyde

(These materials have been developed by NHS Lothian in collaboration with The University of Strathclyde)

Contents

Introduction

Use this **Goal Diary** along with the **Recovery Workbook** to set goals and track the progress of your recovery.

This will really help you recover better and get back to normal faster.

Goals give you something to work towards, keep you motivated and you will feel good when you achieve them.

Setting targets and planning your recovery helps you identify challenges and think of ways to deal with these. You can start right away, even while you are still in plaster or a splint.

This Goal Diary has space for you to set 3 different goals and track your progress with each over the next 6 weeks. The goals you set will depend on your age, how active you normally are and what hobbies you have.

If you fill this book or the time frame for your goal is more than 6 weeks we will give you another diary at your next appointment. Just ask.

Please take time to do this, it is a great way you can help yourself recovery from your injury.

We hope you will find it very helpful.

How to use this Goal Diary

Use the following information and the examples as a guide.
Each section of coloured paper is for setting one goal and recording your progress towards achieving it.

Setting Your Goals

At the start of each seciton fill in the **Goal Setting Table** to set your goal.

1. **In the 'Goal' box write down your goal.**
   This can be anything at all. It should be something you want to return to doing as you recover from your injury. It can be anything from:

   Getting dressed without help to playing a rugby match

   Doing your own shopping to riding a bike.

   Returning to a full days work to catching the bus into town.

   What you choose will depend on you and what you normally do.

2. **In the 'Set a specific tartget' box write down specific details**.
   (Where and by when you will complete your goal)

3. **In the 'Make a plan of how you will achieve this' box write exactly how you will work towards and achieve your goal.**
   Think about each step you will take to build up to your final goal.

4. **In the 'What will make achieving your goal challenging?' box write down what may make achieving each step towards your goal difficult.**

5. **In the 'How will you overcome these challenges?' box write down how you think you can overcome these challenges.**

.

Goal Setting Table - Example

Goal Example Walk my dog.
Set a specific target (when, where?) In 6 weeks time I will be able to walk my dog once round the park.
Make a plan of how you will achieve this? I will build up the distance I walk slowly, going a bit further each day. Start walking from bedroom to kitchen, then from front door to the end of the street, then half way round park, then full lap of park.
What will make achieving your goal challenging? 1. I have lost confidence walking outside in icy conditions since my fall. 2. Dog can be excitable and makes me unsteady on my feet. 3. My grip is weak and stiff which makes holding lead difficult.
How will you overcome these challenges? 1. I will walk later in the day once ice has had a chance to melt. I will walk a different path that gets less icy. 2. I will walk with a friend who can take the lead if need be. Until I get my confidence back. 3. I will keep my fingers and elbow moving while in plaster to reduce stiffness. I will do the wrist exercises in the Recovery Workbook three times a day.

Recording your progress

Daily Review

Each day try to take a step towards achieving your goal (no matter how small) and record this with a tick in the table.

Weekly Review

At the end of each week circle the number that matches how you feel.

1. How confident you feel about achieving your goal
2. How close you feel to achieving your goal
3. How happy you are with your progress

Think about your progress and what you could do to improve things. Write down your ideas in the box.

Look back at previous weeks and see how your scores are changing.

(Try to do this on the same day each week, choose a day that suits, when you will have 10 minutes free to do it.)

Be flexible and remember you can always adjust your goals depending how your getting on.

To help you achive your goals

- Use the **Recovery Workbook** for tips and advice
- Ask family and firends for help and support
- Speak to your doctors, nurses and physiotherapists

Example

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
✓	✓		✓			✓

Weekly Review

How confident do you feel?

1 2 3 4 5 (6) 7 8 9 10

Not Confident — Very Confident

How close are you to achieving your goal?

1 2 3 4 5 (6) 7 8 9 10

Unable — Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 (8) 9 10

Unhappy — Very Happy

Is there anything you could do differently during the next week?

Now its your turn……

Goal 1
Set a specific target (*when, where?)*
Make a plan of how you will achieve this?
What will make achieving your goal challenging?
How will you overcome these challenges?

Goal 1 Week 1

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 1 Week 2

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 1 Week 3

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 1 Week 4

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 1 Week 5

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 1 Week 6

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2
Set a specific target (*when, where?)*
Make a plan of how you will achieve this?
What will make achieving your goal challenging?
How will you overcome these challenges?

Goal 2 Week 1

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2 Week 2

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2 Week 3

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2 Week 4

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2 Week 5

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 2 Week 6

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3
Set a specific target (*when, where?)*
Make a plan of how you will achieve this?
What will make achieving your goal challenging?
How will you overcome these challenges?

Goal 3 Week 1

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3 Week 2

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3 Week 3

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3 Week 4

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3 Week 5

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy Very Happy

Is there anything you could do differently during the next week?

Goal 3 Week 6

Daily Review

Each day you take a step towards achieving your goal (no matter how small) Tick the box.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Weekly Review

How confident do you feel?

1 2 3 4 5 6 7 8 9 10

Not Confident — Very Confident

How close are you to achieving your goal?

1 2 3 4 5 6 7 8 9 10

Unable — Goal achieved

How happy are you with your progress so far?

1 2 3 4 5 6 7 8 9 10

Unhappy — Very Happy

Is there anything you could do differently during the next week?

Appendix 6: Chapter 5 information-only workbook

Recovery from a Broken Wrist

RECOVERY WORKBOOK

NHS Lothian & University of Strathclyde

(These materials have been developed by NHS Lothian in collaboration with The University of Strathclyde)

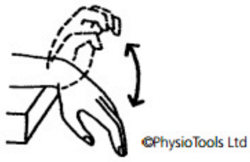
Introduction

In this workbook you will find physiotherapy exercises to help your recovery from your broken wrist.

Once your cast or splint comes off we recommend you work through these exercises 3 times per day, if you feel able.

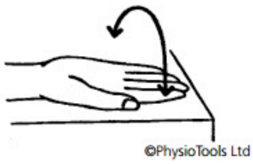
If you have any questions or concerns about your recovery please discuss these with your GP or orthopaedic doctor at one of you follow up appointment.

1. Rest forearm on a table with hand over the edge. Bend hand towards floor and then raise up towards the ceiling. Check that the movement only takes place at the wrist.

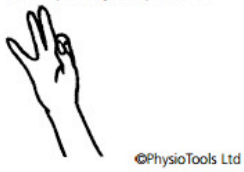


2. Rest the palm of your hand on the table. Tilt the hand one way and then the other.

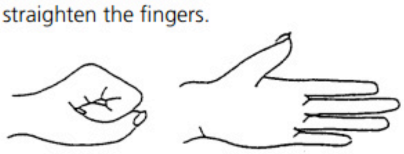
3. Place your forearm on the table. Turn your palm down, and then up, keeping the elbow still.



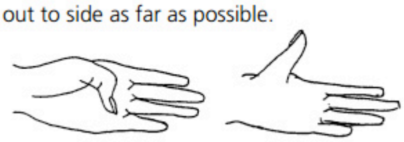
4. Touch your thumb to the tip of each finger. Repeat this as quickly as possible.



5. Make a tight fist, ensuring your knuckles are bent to a right angle. Use your other hand to help if necessary. Then fully straighten the fingers.



6. With the palm of your hand facing upwards, bend thumb across palm of hand to base of little finger and then stretch out to side as far as possible.



Appendix 7: Chapter 5 patient demographics, injury characteristics and treatment details

	Psychological intervention workbook group n=66	Information only workbook group n=63	P value
Demographics			
Mean age (range, SD, 95%CI)	55 (18-83, 16, 52-59)	59 (18-88, 17, 55-63)	0.245
Gender Male	17	20	
Female	49	43	0.452
Previous wrist fracture	13	11	0.744
Smoker	12	7	0.257
Alcohol excess	9 (n=65)	3	0.078
Dependants	14 (n=65)	13 (n=60)	0.986
Marital status			
Single	29	29	
Married / partner	37	34	0.811
Education level (n=262)	(n=64)	(n=60)	
Left school before 16	9	13	
High school exams	23	18	
College/University	32	29	0.507
Employment			
Manual work	13	15	
Non-manual work	20	9	
Self-employed	2	3	
Student	2	3	
Retired	22	29	
Long term sick	2	1	
Not working	4	1	
Other	1	2	0.326
Scottish Index of Multiple Deprivation			
(Most deprived) 1	5	11	
2	11	12	
3	7	11	
4	12	9	
(Least deprived) 5	31	19	0.173
Mean number of medical comorbidities (range, SD, 95%CI)	0.9 (0-6, 1.2, 0.6-1.2)	1.4 (0-6, 1.6, 1-1.8)	0.037
Psychiatric history			
Anxiety	15	7	0.080
Depression	12	6	0.156
Post-traumatic stress disorder	0	0	
Obsessive compulsive disorder	0	0	
Pre-injury medication use			
Opiates	9	10	0.720
Neuropathic analgesia	2	1	0.587
Injury characteristics			
Mechanism of injury Fall<2m	47	42	

		Psychological intervention workbook group n=66	Information only workbook group n=63	P value
	Fall>2m	8	8	
	Sport	10	11	
	Bicycle	1	2	0.898
Injured side	Right	28	26	
	Left	38	37	0.894
Dominant side affected		32	25	0.314
Nerve injury		0	2	0.145
AO-OTA classification	A	35	34	
	B	16	9	
	C	15	20	0.270
Radiographic details of injury				
Radiocarpal alignment maintained		38	37	0.894
Dorsal tilt degrees Mean (range, SD, 95%CI)		6 (-22-77, 18, 1-10)	7 (-26-57, 17, 3-11)	0.341
Ulnar variance Mean mm (range, SD, 95%CI)		1 (-9-11, 3, 1-2)	2 (-4-13, 3, 1-2)	0.976
T2 Radiocarpal alignment maintained		51 (n=65)	49 (n=62)	0.937
T2 Dorsal tilt degrees Mean (range, SD, 95%CI)		0 (-26-27, 11, -3-3)	-2 (-18-26, 10, -4-1)	0.261
T2 Ulnar variance Mean mm (range, SD, 95%CI)		1 (-4-5, 2, 1-2)	2 (-5-9, 2, 1-2)	0.701
Treatment				
	Surgical	18	12	
	Non-operative	48	51	0.269
Specific treatment	ORIF	18	12	
	Cast	36	33	
	Manipulation and cast	12	18	0.292
Follow up Mean (range, SD, 95%CI)				
	Days to presentation	13 (3-21, 5, 12-14)	12 (5-21, 5, 11-14)	0.298
	Weeks to T2	6 (4-14, 1, 6-7)	7 (4-16, 2, 6-7)	0.471
	Weeks to T3	27 (21-36, 3, 26-27)	26 (23-32, 2, 26-27)	0.318

Chapter 5 patient demographics, injury characteristics and treatment details.

Psychological scores	Psychological workbook group at enrolment		Information workbook group at enrolment		Reference normative population scores	Reference chronic pain population scores
	Median (IQr)	N (%) worse than threshold [threshold score]	Median (IQr)	N (%) worse than threshold [threshold score]		
PCS	5 (0-8)	5 (8) [>16]	4 (0-7)	5 (9) [>16]	12 (0-52, 9.1)[α]	20.9 (0-50, 12.5)[ψ]
HADs Depression	2 (1-4)	4 (7) [>7]	2 (1-4)	4 (7) [>7]	female 4.1 (3.8)[χ] male 3.8 (3.7)[χ]	8.1[β]
HADs Anxiety	5 (2-7)	15 (24) [>7]	4 (2-5)	8 (14) [>7]	female 6.8 (4.2)[χ] male 5.5 (4)[χ]	9.3[β]
PTSD	21 (18-24)	5 (8) [>34]	20 (18-24)	4 (7) [>34]	Gunshot wound 30 (22-48)[κ] Assault 30 (23-53)[κ] Fall 21 (18-28)[κ]	35 (13)[δ]
TSK	35 (32-39)	14 (23) [>39]	37 (34-39)	13 (23) [>39]	n/a	41.2 (9.4)[$]
GSES	31 (28-35)	28 (45) [>31]	32 (30-35)	21 (36) [>31]	n/a	29 (6)[λ]
RLOC	39 (35-42)	23 [>39]	37 (34-40)	35 (59) [>39]	n/a	n/a
IPQR identity	4 (3-5)	39 (63) [>4]	3 (2-5)	29 (50) [>4]	n/a	n/a

Psychological scores	**Psychological workbook group at enrolment**		**Information workbook group at enrolment**		**Reference normative population scores**	**Reference chronic pain population scores**
	Median (IQr)	**N (%) worse than threshold [threshold score]**	**Median (IQr)**	**N (%) worse than threshold [threshold score]**		
IPQR timeline acute chronic	11 (9-14)	26 (42) [>11]	12 (9-14)	30 (50) [>11]	n/a	n/a
IPQR timeline cyclical	10 (8-13)	34 (55) [>10]	9 (8-11)	24 (41) [>10]	n/a	n/a
IPQR consequence	14 (12-18)	29 (47) [>14]	14 (11-16)	26 (43) [>14]	n/a	n/a
IPQR personal control	23 (22-26)	26 (42) [>23]	23 (21-24)	29 (48) [>23]	n/a	n/a
IPQR treatment control	20 (19-23)	22 (35) [>20]	20 (18-21)	31 (53) [>20]	n/a	n/a
IPQR coherence	24 (20-25)	28 (45) [>24]	23 (20-24)	30 (51) [>24]	n/a	n/a
IPQR emotion	14 (9-19)	31 (50) [>14]	14 (11-17)	30 (50) [>14]	n/a	n/a

Chapter 5 enrolment psychological scores with comparison to population and chronic pain cohorts. ***[α] (203), [β] (173), [$](204), [Ψ] (205) [χ] (206), [κ](207) , [δ](208), [λ](189). Enrolment psychological scores are compared to normative and chronic pain populations and scores are compared to threshold scores that represent cut off for diagnosis of psychological disorder or categorise patients as high / low. Details of threshold scores are in section 2.3.3. (PCS, HADS, TSK, PTSD are from recognised cut offs used in other work, the remainder are median split as no recognised threshold exists).***

	Psychological intervention workbook group **n=13**	**Information only workbook group** **n=9**	**P value**
Demographics			
Mean age (range, SD, 95%CI)	54 (18-83, 19, 43-66)	63 (38-83, 17, 52-75)	0.245
Gender Male	3	3	
Female	10	6	0.452
Previous wrist fracture	3	3	0.744
Smoker	2	3	0.257
Alcohol excess	3	0	0.078
Dependants	1	1	0.986
Marital status			
Single	7	4	
Married / partner	6	4	0.811
Education level			
Left school before 16	2	5	
High school exams	6	3	
College/University	5	1	0.507
Employment			
Manual work	1	2	
Non-manual work	5	0	
Self-employed	0	0	
Student	0	0	
Retired	3	7	
Long term sick	1	0	
Not working	2	0	
Other	0	0	0.326
Scottish Index of Multiple Deprivation			
(Most deprived) 1	1	2	
2	2	3	
3	3	1	
4	3	0	
(Least deprived) 5	4	2	0.173
Mean number of medical comorbidities (range, SD, 95%CI)	1.3 (0-6, 1.7, 0.3-2.3)	1.7 (0-5, 1.6, 0.5-2.9)	0.037
Psychiatric history			
Anxiety	4	2	0.080
Depression	3	3	0.156
Post-traumatic stress disorder	0	0	
Obsessive compulsive disorder	0	0	
Pre-injury medication use			
Opiates	0	3	
Neuropathic analgesia	1	0	
Injury characteristics			

		Psychological intervention workbook group n=13	Information only workbook group n=9	P value
Mechanism of injury	Fall<2m	10	2	
	Fall>2m	1	6	
	Sport	2	1	
	Bicycle	0	0	0.898
Injured side	Right	9	5	
	Left	4	4	0.894
Dominant side affected		9	6	0.314
Nerve injury		0	0	0.145
AO-OTA classification				
A		6	4	
B		3	1	
C		4	4	0.270
Radiographic details of injury				
Radiocarpal alignment maintained		8	5	0.894
Dorsal tilt degrees Mean (range, SD, 95%CI)		-1 (-14-15, 7, -5-4)	-4 (-14-14, 10, -12-4)	0.341
Ulnar variance Mean mm (range, SD, 95%CI)		1 (-9-10, 4, -2-3)	1 (-2-5, 3, 0-3)	0.976
T2 Radiocarpal alignment maintained		12	7	0.765
T2 Dorsal tilt degrees Mean (range, SD, 95%CI)		0 (-26-27, 11, -3-3)	-2 (-18-26, 10, -4-1)	0.325
T2 Ulnar variance Mean mm (range, SD, 95%CI)		1 (-4-4, 2, 0-2)	2 (0-3, 1, 1-3)	0.388
Treatment				
Surgical		4	3	
Non-operative		9	6	0.269
Specific treatment	ORIF	4	3	
Cast		6	4	
Manipulation and cast		3	2	0.292
Follow up Mean (range, SD, 95%CI)				
Days to presentation		13 (5-21, 5, 10-18)	11 (8-18, 4, 6-16)	0.298
Weeks to T2		7 (5-10, 2, 5-8)	8 (6-15, 4, 4-13)	0.471
Weeks to T3		28 (25-36, 4, 25-31)	27 (25-29, 2, 25-28)	0.318

Chapter 5 RCT Sub-group patient demographics, injury characteristics and treatment details.

Appendix 8: Publication in Clinical Orthopaedics and Related Research

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Comprehensive Orthopaedic Care

Is Use of a Psychological Workbook Associated With Improved Disabilities of the Arm, Shoulder and Hand Scores in Patients With Distal Radius Fracture?

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Abstract

Background Symptom intensity and magnitude of limitations correlate with stress, distress, and less effective coping strategies. It is unclear if interventions to target these factors can be used to improve outcomes after distal radius fracture in either the short- or longer term.

Questions/purposes (1) Are there any factors (including the use of a workbook aimed at optimizing psychological response to injury, demographic, radiographic, medical, or psychosocial) associated with improved Disabilities of the Arm, Shoulder and Hand (DASH) and Numerical Rating Scale pain (NRS pain) scores at 6 weeks after management of distal radius fracture? (2) Are any of these factors associated with improved DASH and NRS pain scores at 6 months after management of distal radius fracture?

Methods We conducted a double-blind randomized controlled trial comparing a workbook designed to optimize rehabilitation by improving psychological response to injury using recognized psychological techniques (the LEARN technique and goal setting) versus a workbook containing details of stretching exercises in the otherwise routine management of distal radius fracture. Patients older than 18 years of age with an isolated distal radius fracture were recruited within 3 weeks of injury from a single academic teaching hospital between March and August 2016. During recruitment, 191 patients who met the inclusion criteria were approached; 52 (27%) declined participation and 139 were enrolled. Eight patients (6%) were lost to followup by 6 weeks. The remaining cohort of 129 patients

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Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.
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was included in the analysis. DASH scores and NRS pain scores were recorded at 6 weeks and 6 months after injury. Multivariable regression analysis was used to identify factors associated with outcome scores.

Results At 6 weeks after distal radius fracture, when compared with an information-only workbook, use of a psychologic workbook was not associated with improved DASH (workbook DASH: 38 [range, 21-48]; control DASH: 35 [range, 21-53]; difference of medians: 3; p = 0.949) nor NRS pain scores (workbook NRS: 3 [range, 1-5]; control NRS: 2 [range, 1-4]; difference of medians: 1; p = 0.128). Improved DASH scores were associated with less radial shortening (β = 0.2, p = 0.009), less dorsal tilt (β = 0.2, p = 0.035), and nonoperative treatment (β = 0.2, p = 0.027). Improved NRS pain scores were associated with nonoperative treatment (β = 0.2, p = 0.021) and no posttraumatic stress disorder (PTSD) (β = 0.2, p = 0.046). At 6 months, use of a psychologic workbook was not associated with improved DASH (workbook DASH: 11 [range, 5-28]; control DASH: 11 [range, 3-20]; difference of medians: 0; p = 0.367) nor NRS pain scores (workbook NRS: 1 [range, 0-2]; control NRS: 1 [range, 0-2]; difference of medians: 0; p = 0.704). Improved DASH score at 6 months was associated with having fewer medical comorbidities (β = 0.3, p < 0.001) and lower enrollment PTSD (β = 0.3, p < 0.011). Lower NRS pain scores at 6 months were associated with having fewer medical comorbidities (β = 0.2, p = 0.045), lower enrollment PTSD (β = 0.3, p = 0.008), and lower enrollment Tampa Scale for Kinesiophobia (β = 0.2, p = 0.042).

Conclusions Our study demonstrates that there is no benefit from the untargeted use of a psychological workbook based on the LEARN approach and goal-setting strategies in patients with distal radius fracture. Future research should investigate if there is a subgroup of patients with a negative psychological response to injury that benefits from psychological intervention and, if so, how best to identify these patients and intervene.

Level of Evidence Level II, therapeutic study.

Introduction

Distal radius fracture is a common injury. The majority of people recover well but a proportion have ongoing pain, stiffness, and functional limitation. Associations between these functional outcomes and injury characteristics, treatment methods, and radiographic outcomes are inconsistent. A deformed wrist is not always painful, stiff, and functionally limiting.

Patient stress, distress, and suboptimal coping strategies are associated with greater symptom intensity and magnitude of limitations in a variety of health conditions. Interventions that target psychologic factors improve outcomes for back pain, osteoarthritis, and myocardial infarction [7, 8, 19, 25, 45, 54]. However, the evidence regarding psychologic interventions after acute injury is limited.

The effectiveness of psychologic interventions is primarily mediated by their influence on self-efficacy: an individual's confidence in their ability to perform a given behavior (eg, engagement with rehabilitation, performance of exercises, use of their arm, etc). Increased self-efficacy is associated with improved pain, disability, and functional outcome in a number of musculoskeletal conditions [14, 38, 46, 59]. The LEARN approach describes a stepwise method to affect change in self-efficacy: LEARN: L = learn exercise/activity; E = encourage or cue; A = address unpleasant symptoms; R = reinforcement from other's experience/role model; and n = negate disability (say no to inability/promote confidence and a positive mindset; Fig. 1). It has been suggested as a template for developing interventions for use in distal radius fracture [15].

There is potential for interventions that target psychologic factors such as self-efficacy to supplement routine orthopaedic care and improve outcomes. We developed and tested a psychologic workbook, which encompassed the LEARN approach, to supplement routine treatment of distal radius fractures in a fracture clinic setting. We wanted to assess the impact of such intervention on both short- and longer term recovery.

Study Questions

(1) Are there any factors (including the use of a workbook aimed at optimizing psychological response to injury, demographic, radiographic, medical, or psychosocial) associated with improved Disabilities of the Arm, Shoulder and Hand (DASH) and Numerical Rating Scale pain (NRS pain) scores at 6 weeks after management of distal radius fracture? (2) Are any of these factors associated with improved DASH and NRS pain scores at 6 months after management of distal radius fracture?

Patients and Methods

We conducted a double-blind randomized controlled trial comparing a psychologic workbook with an information-only workbook in the otherwise routine treatment of distal radius fracture. Patients were recruited from a single academic teaching hospital between March 2016 and August 2016 and followed up at 6 weeks and 6 months. The study population was inclusive because the treating hospital is the sole provider of orthopaedic care for the region. Ethical and clinical trial committees approved and authorized the work.

Patients with distal radius fracture were identified on presentation to the orthopaedic clinic. Diagnosis was made

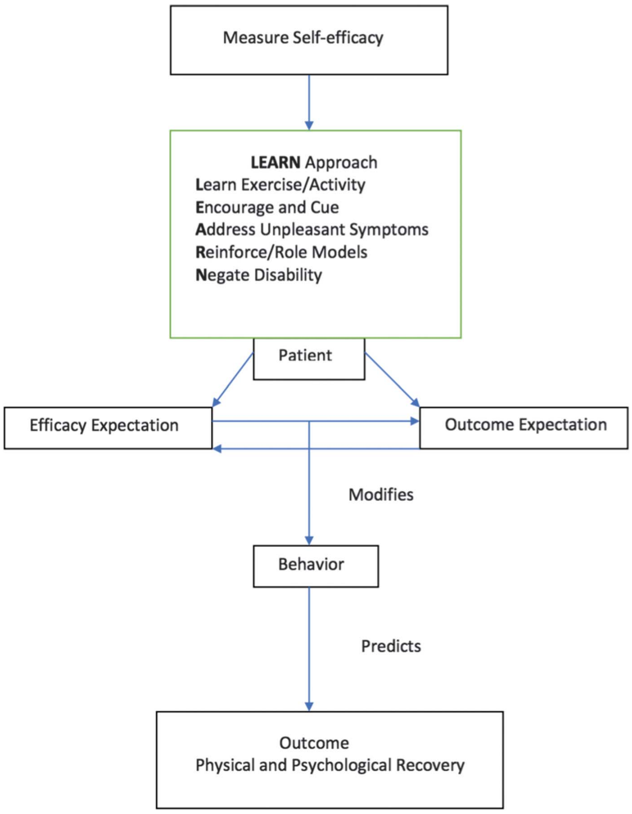

Fig. 1 Diagram illustrating the LEARN approach to modifying self-efficacy.

based on the presence of disruption of cortical bone in the distal one-third of the radius on radiographs of the wrist. The inclusion criteria were age 18 years and older; patients with isolated distal radius fracture undergoing management with manipulation and cast/cast alone/operative management; and recruitment within 3 weeks of injury. Exclusion criteria were cognitive impairment preventing informed consent or completion of questionnaires; non-English-speaking; open fracture; temporary residents unable to attend followup; patients with multiple fractures; undertaking injury compensation proceedings; illicit drug use; and a psychiatric diagnosis resulting in psychosis.

Fracture treatment was in line with hospital policy and independent from the study. After randomization, the patient was given a workbook and instructed on how to use it. Randomization was stratified based on age (older than 65 years:65 years and younger), gender (male:female), and treatment (operative:nonoperative). Patients were assigned to a group (A-H) based on these three criteria. Block randomization was then carried out within each group using a computer-generated sequence.

Study Intervention: Psychologic Workbook

The psychologic workbook was designed using the LEARN approach to change beliefs and behavior by improving self-efficacy (Fig. 1). The workbook comprised two parts: an information section and a goal diary. The book described exercises and activities that patients could undertake from the time of injury (**L**: learn exercises/activities). A progress diary was used to encourage progress (**E:** encourage and cue). Information regarding expectations, healthy eating, stretching exercises, pain management, stress reduction, and improving sleep was used to address unpleasant symptoms (**A**: address unpleasant symptoms) and was reinforced by describing the experiences of fictional patients in vignettes (**R**: reinforcement/role models). The book aimed to negate disability (**N**: negate disability) by using activities to focus on what individual patients were able to do rather than their activity limitations. Pain was normalized and safe movement encouraged at every opportunity.

The goal diary was designed to engage patients with all five components of the LEARN model through the inclusion of specific behavior change techniques [35]. It asked patients to set and write down three personal recovery goals specific to their lifestyle that they would work toward over a 6-week period. It then took the patient through planning a step-by-step approach to achieving these goals by utilizing learned activities described in the instructional book. It facilitated a weekly review of progress and allowed modification of the strategy if required.

Study Control: Information-only Workbook

Patients randomized into the control group received an information-only workbook. The information-only workbook contained details of a number of hand and wrist stretching exercises and advised the patient to begin work on these three times per day as soon as they felt able. Of note, these exercises were also included in the psychologic workbook. Both the psychologic intervention workbook and the information-only control workbook had matching covers to aid in blinding. Both treatment groups followed the same followup schedule and the guidelines for clinical care were the same in each group.

Patient Assessment and Outcome Measures

Demographic details, medical and psychiatric history, baseline radiographic parameters (radiocarpal alignment, dorsal tilt, radial shortening), injury and treatment characteristics, and psychologic scores (General Self-efficacy Scale [GSES], Pain Catastrophising Scale [PCS], Tampa Scale for Kinesiophobia [TSK], Hospital Anxiety and Depression Scale [HADS], Post Trauma Stress Disorder Civilian Checklist [PCL-C], Illness Perception Questionnaire–Revised [IPQR], Recovery Locus of Control [RLOC]) were measured at enrollment.

Six weeks after injury radiographic parameters, GSES, and patient-reported outcome measures (DASH score, NRS pain score, and SF-12) were measured.

Six months after injury, we measured wrist and finger motion and grip strength, recorded adverse events, and repeated GSES and outcome measures.

All measurements were taken by researchers not involved in the routine management of these patients and blinded to patient treatment group.

Assessment Tools

The GSES is a widely used 10-item measure of self-efficacy. Each item is scored from 1 to 4 giving a total score between 10 and 40 (10 low:40 high). It is used to assess self-confidence in ability to cope with difficult situations (perceived self-efficacy) [23, 48].

The PCS [50] is a 13-item measure of catastrophic thinking. Each item asks about the degree of agreement with a statement representative of catastrophic thinking; each item is scored 0 to 4, giving a total score between 0 and 52. Higher scores reflect higher levels of catastrophic thinking.

The TSK [27] is a 17-item measure of fear of movement associated with pain or reinjury. Each item is scored between 1 and 4, giving a scale range of 17 to 68; higher scores represent greater fear avoidance behavior.

Depression and anxiety were measured separately by the 14-item HADS [60]. Seven items measure each of depression and anxiety; items are scored 0 to 3, generating a total score between 0 and 21 for each (higher scores indicating more anxiety and depression). The HADS is designed to measure both facets of mood free from confounding with somatic symptoms.

The PCL-C is a 17-item measure of posttraumatic stress disorder (PTSD) symptoms based on the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition. Each question has five response options rated 1 to 5 giving a total score between 17 (low) and 85 (high). It is commonly used, valid, and reliable [13, 20]. To diagnose PTSD, symptoms must persist for > 3 months, but in the acute setting, the PCL-C can be used as an indicator of psychologic distress.

The IPQR is a nine-item measure of a patient's perceptions of their illness/injury. Each item is assessed with a number of questions and is scored individually (Table 1) [29].

The RLOC is designed to evaluate an individual's beliefs about the control they have over recovery from a traumatic event [44]. It is comprised of nine items each scored 1 to 5, giving a total score range of 9 (high external locus) to 45 (high internal locus). "High external locus" refers to a belief that recovery is dependent on external factors with the patient's own control in contrast to "high

Table 1. Explanation of IPQR subscales

IPQR subscale	Description	Score possible range
Identity	The number of symptoms attributed to the injury	0-14
Timeline (acute/chronic)	Length of recovery time	6 (short)–30 (long)
Timeline (cyclical)	Fluctuation in level of symptoms	4 (constant)–20 (fluctuate a lot with time)
Consequence	Consequence of injury on life	6 (low)–30 (high)
Personal control	Level of personal control over recovery	6 (low)–30 (high)
Treatment control	Level of control treatment has over recovery	5 (low)–25 (high)
Injury coherence	Understanding of injury	5 (low)–25 (high)
Emotion	Level of emotional response to injury	6 (low)–30 (high)
Cause	Perceived cause of injury–4 categories	
	Psychological	6 (low)–30 (high)
	Exposure to a risk factor	7 (low)–35 (high)
	Immune	3 (low)–15 (high)
	Accident/chance	2 (low)-10 (high)

IPQR = Illness Perception Questionnaire–Revised.

internal locus," which refers to a mindset in which patients believe they have control over the recovery from and outcome of their injury. All scores used have been shown to be reliable and valid in populations similar to ours [2, 9, 17, 18, 22, 32, 36, 37, 41, 43, 43, 44, 51, 55].

The DASH score is responsive, reliable, and valid in patients with distal radius fracture and is widely used to assess outcomes in this group [26, 32]. It comprises 30 questions converted to a score out of 100 with a higher score representing greater disability [10, 21]. The NRS pain score was used to assess average pain intensity over the preceding week measured on an 11-point Likert scale from 0 (no pain) to 10 (worst pain imaginable).

All radiographic assessment was carried out by a single member of the research team (SG) using a picture archiving and communication system (Carestream, Version 11.40.1253; Carestream Health, Rochester, NY, USA). Posteroanterior (PA) and lateral radiographs of the wrist were taken in the standard manner. Carpal alignment was assessed on the lateral view by drawing a line along the long axis of the capitate and another along the long axis of the radius. If the lines intersected within the carpus, then radiocarpal alignment was maintained [34]. Ulnar variance (used as a measure of radial shortening) was measured on the PA view as the distance between two lines perpendicular to the long axis of the radius, one at the level of the radial articular surface and another at the distal end of the ulna [39]. Tilt was measured on the lateral view as the angle between a line perpendicular to the long axis of the radius and a line joining the most distal points of the volar and dorsal lips of the distal radius. Dorsal tilt was recorded as positive values and volar tilt as negative values [39]. Grip strength on both the injured and uninjured sides was measured in kilograms with a standard, adjustable handle Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, IL, USA) set to the second rung position, the optimal setting for measuring grip strength with this instrument [53], the elbow at 90° flexion, and the forearm in neutral rotation. The mean of three recordings was calculated and recorded as a percentage deficit relative to the strength of the contralateral hand. The deficit was adjusted to allow for dominance with a 10% increase in grip strength assumed for the dominant hand. The distance from the index fingernail tip to the palmar skin crease during maximal flexion was measured with a ruler in millimeters.

Patients

During recruitment, 191 patients who met the inclusion criteria were approached; 52 (27%) declined participation and 139 were enrolled. All 74 (100%) patients randomized to the psychologic workbook and 63 of 65 (97%) of patients randomized to the information-only workbook were given allocated treatment. Eight patients (6%) were lost to followup by 6 weeks. The remaining cohort of 129 patients was included in the analysis (66 in the psychologic workbook group and 63 in the information-only workbook group; Fig. 2).

Demographics, injury and radiographic characteristics, treatment details, and enrollment psychologic scores in each treatment group were similar (Tables 2, 3). The enrollment psychologic scores of our study population were better than recognized population normal values (Table 3).

Statistical Analysis

The primary outcome measure was the DASH score. In a pilot study of 60 patients with distal radius fracture who were evaluated 8 weeks after injury, mean DASH score was 29 (SD 19). A sample size of 126 was estimated to provide power (90%) to identify a minimum difference between the psychologic workbook and the information-only workbook of 10 points (the recognized minimal clinically significant difference in DASH) with α set at 0.05. We anticipated a dropout rate of 10% and therefore aimed to enroll 139 patients.

Descriptive statistics were used to present demographic, comorbidity, injury, treatment, radiographic, and enrollment psychologic characteristics. We adhered to intention-to-treat principles. The response variables were DASH score and NRS pain score at 6 weeks and 6 months and grip strength at 6 months. The explanatory variables were age; number of medical comorbidities; Scottish Index of Multiple Deprivation quintile; injury to the dominant side; AO-OTA fracture group (A, B, or C); nerve injury; radiographic alignment at 6 weeks (radiocarpal alignment, radial shortening, dorsal tilt); surgical or nonoperative management; time to presentation and followup; psychologic measures (HADS, PCS, TSK, PCL-C, GSES, IPQR

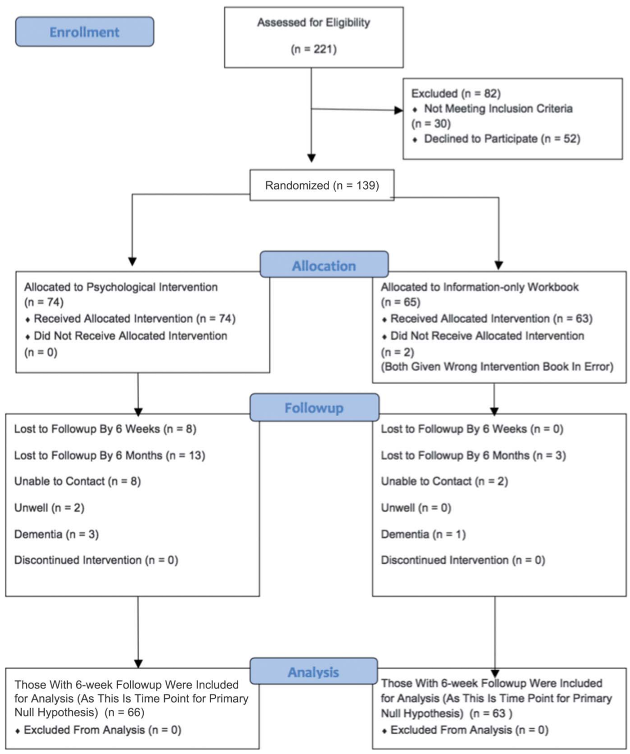

Fig. 2 Flow diagram shows patients recruited to the trial.

Table 2. Patient demographics, injury characteristics, and treatment details

Demographics	Psychologic intervention workbook group (n = 66)	Information-only workbook group (n = 63)	p value
Mean age (years; range, SD, 95% CI)	55 (18-83, 16, 52-59)	59 (18-88, 17, 55-63)	0.245
Gender			
Male	17	20	
Female	49	43	0.452
Previous wrist fracture	13	11	0.744
Smoker	12	7	0.257
Alcohol excess	9 (n = 65)	3	0.078
Dependents	14 (n = 65)	13 (n = 60)	0.986
Marital status			
Single	29	29	
Married/partner	37	34	0.811
Education level (n = 262)	(n = 64)	(n = 60)	
Left school before age 16 years	9	13	
High school examinations	23	18	
College/university	32	29	0.507
Employment			
Manual work	13	15	
Nonmanual work	20	9	
Self-employed	2	3	
Student	2	3	
Retired	22	29	
Long-term sick	2	1	
Not working	4	1	
Other	1	2	0.326
Scottish Index of Multiple Deprivation			
(most deprived) 1	5	11	
2	11	12	
3	7	11	
4	12	9	
(least deprived) 5	31	19	0.173
Mean number of medical comorbidities (range, SD, 95% CI)	0.9 (0-6, 1.2, 0.6-1.2)	1.4 (0-6, 1.6, 1-1.8)	0.037
Psychiatric history			
Anxiety	15	7	0.080
Depression	12	6	0.156
Posttraumatic stress disorder	0	0	
Obsessive-compulsive disorder	0	0	
Preinjury medication use			
Opiates	9	10	0.720
Neuropathic analgesia	2	1	0.587
Injury characteristics			
Mechanism of injury			

Table 2. continued

Demographics	Psychologic intervention workbook group (n = 66)	Information-only workbook group (n = 63)	p value
Fall < 2 m	47	42	
Fall > 2 m	8	8	
Sport	10	11	
Bicycle	1	2	0.898
Injured side			
Right	28	26	
Left	38	37	0.894
Dominant side affected	32	25	0.314
Nerve injury	0	2	0.145
AO-OTA classification			
A	35	34	
B	16	9	
C	15	20	0.270
Radiographic details of injury			
Radiocarpal alignment maintained	38	37	0.894
Dorsal angulation (degrees) Mean (range, SD, 95% CI)	6 (-22 to 77, 18, 1-10)	7 (-26 to 57, 17, 3-11)	0.341
Ulnar variance Mean mm (range, SD, 95% CI)	1 (-9 to 11, 3, 1-2)	2 (-4 to 13, 3, 1-2)	0.976
Treatment			
Surgical	18	12	
Nonoperative	48	51	0.269
ORIF	18	12	
Cast	36	33	
Manipulation and cast	12	18	0.292
Followup mean (range, SD, 95% CI)			
Days to presentation	13 (3-21, 5, 12-14)	12 (5-21, 5, 11-14)	0.298
Weeks to T2	6 (4-14, 1, 6-7)	7 (4-16, 2, 6-7)	0.471
Weeks to T3	27 (21-36, 3, 26-27)	26 (23-32, 2, 26-27)	0.318

CI = confidence interval; ORIF = open reduction and internal fixation.

personal control, IPQR emotion, and RLOC); and workbook assignment. In bivariate analysis, outcomes were compared using median scores and Mann-Whitney U tests for nonparametric data and mean scores and independent-sample t-tests for parametric data. Missing data were completed with mean imputation. Spearman correlations, Mann-Whitney U tests, and Kruskal-Wallis tests were used for nonparametric data and Pearson correlations, t-tests, and analysis of variance for parametric data. Factors with $p < 0.1$ in bivariate analysis were entered into multivariable linear regression models to determine factors independently associated with each response variable. Where there was a correlation of > 0.7 between factors, the least clinically relevant was dropped from the model. We created three subgroups of patients based on recognized threshold scores on the enrollment psychologic scores (GSES < cohort median – 1 interquartile range, PCS > 16, HADS depression ≥ 8).

Results

Six weeks after distal radius fracture, use of a psychological workbook was not associated with improved DASH (psychological workbook DASH: 38 [range, 21-48]; control DASH: 35 [range, 21-53]; difference of medians: 3; $p = 0.949$) nor NRS pain score (psychological workbook NRS pain score: 3 [range, 1-5]; control NRS pain score: 2 [range, 1-4]; difference of medians: 1; $p = 0.128$) when compared with the information-only workbook (Table 4). However, improved DASH scores were associated with less radial

Table 3. Enrollment psychologic scores with comparison to normal population and chronic pain cohorts

Psychologic scores	Psychologic workbook group at enrollment Median (IQR)	Information-only workbook group at enrollment Median (IQR)	Reference normative population scores	Reference chronic pain population scores
PCS	5 (0-8) (n = 61)	4 (0-7) (n = 55)	12 (0-52, 9.1)*	20.9 (0-50, 12.5)‡
HADS depression	2 (1-4) (n = 61)	2 (1-4) (n = 57)	Female 4.1 (3.8)§ Male 3.8 (3.7)§	8.1†
HADS anxiety	5 (2-7) (n = 62)	4 (2-5) (n = 59)	Female 6.8 (4.2)§ Male 5.5 (4)§	9.3†
PTSD	21 (18-24) (n = 62)	20 (18-24) (n = 59)	Gunshot wound 30 (22-48)‖ Assault 30 (23-53)‖ Fall 21 (18-28)‖	35 (13)¶
TSK	35 (32-39) (n = 60)	37 (34-39) (n = 56)	N/A	41.2 (9.4)*
GSES	31 (28-35) (n = 62)	32 (30-35) (n = 59)	N/A	29 (6)**
RLOC	39 (35-42) (n = 62)	37 (34-40) (n = 59)	N/A	N/A
IPQR identity	4 (3-5) (n = 62)	3 (2-5) (n = 58)	N/A	N/A
IPQR timeline acute chronic	11 (9-14) (n = 62)	12 (9-14) (n = 60)	N/A	N/A
IPQR timeline cyclical	10 (8-13) (n = 62)	9 (8-11) (n = 59)	N/A	N/A
IPQR consequence	14 (12-18) (n = 62)	14 (11-16) (n = 60)	N/A	N/A
IPQR personal control	23 (22-26) (n = 62)	23 (21-24) (n = 60)	N/A	N/A
IPQR treatment control	20 (19-23) (n = 62)	20 (18-21) (n = 59)	N/A	N/A
IPQR coherence	24 (20-25) (n = 62)	23 (20-24) (n = 59)	N/A	N/A
IPQR emotion	14 (9-19) (n = 62)	14 (11-17) (n = 60)	N/A	N/A

*[40].
†[43].
‡[52].
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IQR = interquartile range; PCS = Pain Catastrophising Scale; HADS = Hospital Anxiety and Depression Scale; PTSD = posttraumatic stress disorder; TSK = Tampa Scale for Kinesiophobia; GSES = General Self-efficacy Scale; RLOC = Recovery Locus of Control; IPQR = Illness Perception Questionnaire–Revised; N/A = not available.

shortening (β = 0.2, p = 0.009), less dorsal tilt (β = 0.2, p = 0.035), and nonoperative treatment (β = 0.2, p = 0.027) and improved NRS pain score was associated with nonoperative treatment (β = 0.2, p = 0.021) and lower enrollment PTSD score (β = 0.2, p = 0.046) (Table 5).

At 6 months, use of a psychological workbook was not associated with improved DASH (psychological workbook DASH score: 11 [range, 5-28]; control DASH score: 11 [range, 3-20]; difference of medians: 0; p = 0.367) nor NRS (psychological workbook NRS pain score: 1 [range, 0-2]; control NRS pain score: 1 [range, 0-2]; difference of medians: 0; p = 0.704) when compared with the information-only workbook (Table 4). However, improved DASH score was associated with having fewer medical comorbidities (β = 0.3, p < 0.001) and lower enrollment PTSD (β = 0.3, p = 0.011) and improved NRS pain score was associated with having fewer medical comorbidities (β = 0.2, p = 0.045), lower enrollment PTSD score (β = 0.3, p = 0.008), and lower enrollment TSK score (β = 0.2, p = 0.042) (Table 6).

GSES did not differ between treatment groups at any time point (Table 7). As a result of the small number of cases in each subgroup, this could not be statistically analyzed.

Discussion

Self-efficacy is associated with recovery after acute orthopaedic trauma [4, 5, 11]. Psychologic interventions to teach effective coping strategies and change perceptions are associated with increased self-efficacy [33, 54] and reduced disability in musculoskeletal conditions [33]. This study

Table 4. Outcomes compared between treatment groups (Mann-Whitney U tests to compare medians; independent-samples t-test to compare means; chi-square test for nominal data)

Outcome measure	Psychologic intervention workbook group	Information-only workbook group	Difference of medians/means (95% CI)	p value
6-week functional outcomes	Median (IQR)	Median (IQR)		
DASH	38 (21-48)	35 (21-53)	3	0.949
SF-12 mental component (mental)	53 (44-58)	54 (51-59)	1	0.099
SF-12 physical component (physical)	46 (35-51)	42 (35-52)	4	0.559
NRS pain score	3 (1-5)	2 (1-4)	1	0.128
GSES	31 (29-35)	31 (29-36)	0	0.780
6-week radiographic outcomes				
Dorsal angulation at 6 weeks (degrees) Mean (range, SD, 95% CI)	0 (-26 to 27, 11, -3 to 3)	-2 (-18 to 26, 10, -4 to 1)	1.4 (-2.3 to 5.1)	0.871
Ulnar variance at 6 weeks Mean (mm; range, SD, 95% CI)	1 (-4 to 5, 2, 1-2)	2 (-5 to 9, 2, 1-2)	0.4 (-1.1 to 0.4)	0.994
Radiocarpal alignment maintained at 6 weeks number (%)	51 (n = 65)	49 (n = 62)		0.937
6-month functional outcomes	Median (IQR)	Median (IQR)		
DASH	11 (5-28)	11 (3-20)	0	0.367
SF-12 mental component (MCS)	54 (48-58)	55 (53-58)	1	0.120
SF-12 physical component (PCS)	54 (45-56)	48 (42-55)	6	0.076
NRS pain score	1 (0-2)	1 (0-2)	0	0.704
Finger stiffness (fingertip to palm distance; mm)	0 (0-6)	0 (0-6)	0	0.114
Grip strength	82 (67-91)	81 (66-96)	1	0.996
GSES	31 (29-36)	33 (30-38)	2	0.096

CI = confidence interval; IQR = interquartile range; DASH = Disabilities of the Arm, Shoulder and Hand; NRS = Numerical Rating Scale; GSES = General Self-efficacy Scale.

represents an attempt to improve outcomes after fracture of the distal radius by bolstering self-efficacy using a LEARN approach [15]. We found that the use of a psychological workbook in addition to routine treatment of distal radius fracture did not reduce disability or symptom intensity compared with an information-only workbook in an inclusive cohort of patients with distal radius fracture whose baseline level of psychological distress was generally low.

This study had a number of limitations. First, patients were only followed up for 6 months. Patients can continue to improve for a year after injury, but we focused on early recovery because level of disability is most varied in this time period. Second, for unclear reasons, the psychologic workbook group had more patients from higher socioeconomic quintiles (less social deprivation) and more patients with a preinjury diagnosis of anxiety and depression. Stratified randomization was used to evenly distribute treatment type, age, and gender between the two treatment groups. Third, results should be extrapolated to other trauma populations with caution. The association among fracture site, injury severity, and psychological response to injury is unclear [3, 49, 56]. Psychological response may vary between patient groups with different fractures and severity of injury; thus, the utility of a psychological intervention may differ in these patient groups. Finally, we did not quantify engagement (how much time patients spent using workbooks); this was because this was an effectiveness rather than efficacy trial (the aim was to assess the intervention in a "real" fracture clinic setting rather than under "ideal" test conditions).

The use of a psychological workbook did not reduce short-term (6-week) disability or symptom intensity after distal radius fracture. The enrollment factors associated with outcome at this time point were radial shortening and dorsal tilt at 6 weeks and nonoperative management and level of psychological distress at enrollment. The limited associations between psychological factors and function and absence of improvement with the psychological workbook were unexpected in the context of other work. Prior studies found correlations of magnitude of limitations and symptom intensity with psychologic factors among patients recovering from distal radius fracture [30, 47]. There is work demonstrating that psychologic response to acute injury can be modified [28] and that goal-setting

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Table 5. Multivariable linear regression analysis for predictors of DASH and NRS pain scores at 6 weeks after distal radius fracture

Variable	Unstandardized regression coefficient (95% confidence interval)	Standardized coefficient	95% confidence limits	p value
DASH				
Age	0.2 (0-0.4)	0.2	0–0.4	0.059
Number of medical comorbidities	1.5 (-0.8 to 3.8)	0.1	-0.8 to 3.8	0.202
AO classification	0.1 (-3.5 to 3.6)	0.0	-3.5 to 3.6	0.973
Maintenance of radiocarpal alignment at 6 weeks	0.1 (-7.8 to 8.0)	0.0	-7.8 to 8.0	0.988
Radial shortening at 6 weeks	2.0 (0.5-3.6)	0.2	0.5–3.6	0.009
Dorsal tilt at 6 weeks	0.3 (0-0.7)	0.2	0–0.7	0.035
Nonoperative management	8.5 (1.0-16.0)	0.2	1.0–16.0	0.027
Enrolment GSES	-0.5 (-1.3 to 0.2)	-0.1	-1.3 to 0.2	0.183
Enrollment PCS	0.4 (-0.1 to 0.8)	0.1	-0.1 to 0.8	0.151
Enrollment HADS depression	-0.4 (-2.0 to 1.2)	-0.1	-2.0 to 1.2	0.591
Enrollment HADS anxiety	0.4 (-1.0 to 1.7)	0.1	-1 to 1.7	0.595
Enrollment TSK	0.5 (-0.2 to 1.1)	0.1	-0.2 to 1.1	0.140
Enrollment PTSD	0.2 (-0.3 to 0.7)	0.1	-0.3 to 0.7	0.472
Enrollment IPQR personal control	-0.3 (-1.2 to 0.6)	0.0	-1.2 to 0.6	0.560
Enrollment IPQR emotional control	0.4 (-0.4 to 1.1)	0.1	-0.4 to 1.1	0.318
Enrollment RLOC	-0.3 (-1.1 to 0.5)	-0.1	-1.1 to 0.5	0.519
NRS pain score				
Age	0.0 (0.0-0.0)	0.1	0.0–0.0	0.210
Number of medical comorbidities	0.1 (-0.1 to 0.4)	0.1	-0.1 to 0.4	0.342
Radial shortening at 6 weeks (mm)	0.1 (-0.1 to 0.3)	0.2	-0.1 to 0.3	0.216
Surgical management	1.0 (0.2-1.9)	0.2	0.2–1.9	0.021
Enrollment PCS	0.0 (0.0-0.1)	0	0.0–0.1	0.667
Enrollment HADS anxiety	0.0 (-0.1 to 0.1)	0	-0.1 to 0.1	0.745
Enrollment PTSD	0.1 (0.0-0.1)	0.2	0.0–0.1	0.046
Enrollment IPQR personal control	0.0 (-0.1 to 0.1)	-0.1	-0.1 to 0.1	0.489
IPQR emotional response	0.0 (-0.1 to 0.1)	0.1	-0.1 to 0.1	0.497

DASH = Disabilities of the Arm, Shoulder and Hand; NRS = Numerical Rating Scale; GSES = General Self-efficacy Scale; PCS = Pain Catastrophising Scale; HADS = Hospital Anxiety and Depression Scale; TSK = Tampa Scale for Kinesiophobia; PTSD = posttraumatic stress disorder; IPQR = Illness Perception Questionnaire–Revised; RLOC = Recovery Locus of Control.

exercises can be effective [16]. A recent pilot randomized controlled trial in patients with acute musculoskeletal trauma demonstrated that disability, pain, and psychologic response to injury could be improved with psychological intervention [58]. This study differed from ours in a number of ways. The intervention in the pilot study was delivered face to face rather than in a workbook. However, there is evidence that interventions delivered remotely can be effective [8, 24]. Being a pilot study, it was underpowered; it also had a high attrition rate (50%) in the control group, which did not have a placebo intervention. Most importantly, the pilot study only included patients with high enrollment levels of depression and pain anxiety, whereas our study did not set inclusion criteria based on enrollment psychologic scores. Studies of psychological intervention in patients with back pain have shown that intervention is most effective in patients with poorer coping strategies [19, 25, 31]. Perhaps the psychological intervention would have been more effective if targeted to patients with relatively low self-efficacy or high levels of stress or distress. The association between surgical management and increased pain at 6 weeks is surprising because regardless of treatment method, the fracture should have united by this time and in the case of surgical management, the surgical wounds should have healed, creating a similar biomedical environment in both cases.

The use of a psychological workbook did not reduce longer term (6-month) disability or symptom intensity

Table 6. Multivariable linear regression analysis for predictors of DASH and NRS pain scores at 6 months after distal radius fracture

Variable	Unstandardized regression coefficient (95% confidence interval)	Standardized coefficient	95% confidence limits	p value
DASH				
Age	0.1 (-0.1 to 0.3)	0.1	-0.1 to 0.3	0.264
Number of medical comorbidities	3.6 (1.7-5.5)	0.3	1.7–5.5	< 0.001
Radial shortening at 6 weeks	1.0 (-0.3 to 2.2)	0.1	-0.3 to 2.2	0.122
Nonoperative management	5.8 (-0.1 to 11.8)	0.2	-0.1 to 11.8	0.055
Enrollment GSES	0.0 (-0.6 to 0.6)	0	-0.6 to 0.6	0.937
Enrollment PCS	-0.2 (-0.6 to 0.2)	-0.1	-0.6 to 0.2	0.326
Enrollment HADS depression	0.3 (-1.6 to 1.0)	0	-1.6 to 1.0	0.679
Enrollment HADS anxiety	0.2 (-1.0 to 1.3)	0	-1.0 to 1.3	0.771
Enrollment TSK	0.4 (-0.1 to 0.9)	0.1	-0.1 to 0.9	0.130
Enrollment PTSD	0.6 (0.1-1.0)	0.3	0.1–1.0	0.011
Enrollment IPQR personal control	0.1 (-0.7 to 0.8)	0	-0.7 to 0.8	0.883
Enrollment IPQR emotional control	0.5 (-0.1 to 1.0)	0.1	-0.1 to 1.0	0.124
NRS pain score				
Number of medical comorbidities	0.2 (0.0-0.5)	0.2	0.0–0.5	0.045
SIMD quintile	-0.1 (-0.4 to 0.1)	-0.1	-0.4 to 0.1	0.236
Enrollment PCS	0.0 (-0.1 to 0.1)	0.0	-0.1 to 0.1	0.975
Enrollment HADS anxiety	-0.1 (-0.2 to 0.0)	-0.1	-0.2 to 0.0	0.251
Enrollment TSK	0.1 (0.0-0.1)	0.2	0.0–0.1	0.042
Enrollment PTSD	0.1 (0.0-0.1)	0.3	0.0–0.1	0.008
Enrollment IPQR personal control	-0.1 (-0.2 to 0.0)	-0.1	-0.2 to 0.0	0.180
Enrollment IPQR emotional	0.0 (-0.1 to 0.1)	0.1	-0.1 to 0.1	0.487

DASH = Disabilities of the Arm, Shoulder and Hand; GSES = General Self-efficacy Scale; PCS = Pain Catastrophising Scale; HADS = Hospital Anxiety and Depression Scale; TSK = Tampa Scale for Kinesiophobia; PTSD = posttraumatic stress disorder; IPQR = Illness Perception Questionnaire–Revised; NRS = Numerical Rating Scale.

after distal radius fracture. The only enrollment factors associated with level of disability at this time were psychological distress and number of underlying medical comorbidities and the only factors associated with symptom intensity were kinesophobia, psychological distress, and number of underlying medical comorbidities. In a study of a mixed trauma population, high catastrophic thinking rather than psychologic distress was associated with higher disability at this time [57]. In other cohorts of patients who have undergone orthopaedic trauma, associations between psychologic distress and pain have been demonstrated [12], but fear and anxiety constructs (TSK) have been associated with disability rather than pain [57]. These results suggest that as time from injury increases, the influence of unrelated medical problems and psychosocial factors increases. It also highlights the difficulty identifying one single psychological scoring system that can reproducibly be associated with outcome that could be used to screen for patients with a negative response to injury.

Our study demonstrates that there is no benefit from the untargeted use of a psychological workbook based on the

Table 7. GSES compared between treatment groups (Mann-Whitney U-tests)

Measurement	Psychologic intervention workbook group, median (IQR)	Information-only workbook group, median (IQR)	Difference in medians	p value
GSES at enrollment	31 (28-35)	32 (30-35)	1	0.483
GSES at 6 weeks	31 (29-35)	31 (29-36)	0	0.780
GSES at 6 months	31 (29-36)	33 (30-38)	2	0.096

GSES = General Self-efficacy Scale; IQR = interquartile range.

LEARN approach and goal-setting strategies in patients with distal radius fracture. Future research should investigate if there is a subgroup of patients with a negative psychological response to injury that benefit from psychological intervention and, if so, how best to identify these patients and intervene.

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