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The Impact of Non Weight Bearing: A prospective cohort study.

Title Page

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The Impact of Non Weight Bearing: A prospective cohort study.

ABSTRACT

Background

Patients with lower limb injuries are commonly advised to non weight bear (NWB) on their injured limb as part of treatment. Occasionally, patients complain that offloading one limb, associated with the use of crutches or other mobility aids, may lead to pain on one of the other supporting limbs. This has led to compensation claims (1) but has never been the subject of formal research.

Methods

A prospective cohort trial was undertaken to address this question. Patients were recruited from two Metropolitan Hospital Orthopaedic Fracture Clinics and Orthopaedic Wards. A survey was administered at two time points; the first at the point of definitive orthopaedic treatment and commencement of the NWB phase. The second after the NWB phase was completed. The surveys included a pain Visual Analogue Scale (VAS), Short Form (SF)12, a pain body chart and a health questionnaire.

Results

A total of 55 patients were enrolled in the study. Seven patients developed new joint pain after a period NWB. These patients scored significantly lower on the follow up SF12 when compared to those who did not develop new pain ($p=0.045$). Follow up phone calls at least 6 months following completion of the second survey revealed that all initial and new pain areas in these participants had resolved. The main limitation of this study was the limited numbers.

Conclusion

This study supports the idea that crutches, prescribed in the short term to allow a limb to be NWB, achieve this aim with minimal impact. Their use may be associated with new other joint pain however it can be anticipated this will resolve after cessation of crutch use.

Keywords: trauma, non weight bearing, recovery, pain

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Introduction

The use of an aid to mobilise is often a necessary part of Orthopaedic management. Following surgery or acute fracture, a period of NWB is often recommended to facilitate healing. The prescribed duration of NWB varies, but prescriptions of between 6 and 12 weeks are most commonly noted in the hospitals of this study for lower limb bone and joint injuries. Shorter or longer episodes of NWB can be prescribed in varying clinical scenarios

Mobilising with the use of an aid necessitates a change in gait pattern and limb loading. It introduces a weight bearing load to the upper limbs. The type of aid chosen will reflect the weight bearing status required and the ability of the user to tolerate and accommodate its use. In most cases crutches, either Axillary or Canadian, are prescribed. Axillary crutches rest against the lateral chest wall with the handles situated directly underneath. Canadian crutches, also known as elbow crutches, use the elbow and the wrist to weight bear

Anecdotally, there is a suggestion that the use of crutches leads to increased loading on the opposite lower limb, in addition to the weight bearing load on both upper limbs and may lead to damage and/or pain. There have been compensation claims made (1) by patients claiming that the use of crutches led to new joint pain. Biomechanical literature has suggested that there is an increase in both vertical and horizontal ground reaction forces (GRF) going through the knee joint with crutch assisted walking (2). This may be offset however by a reduction in the speed of walking and the overall amount of walking undertaken when using crutches (3).

The purpose of this study was to quantify the impact that a period of NWB has on the musculoskeletal system.

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Methods

This study was undertaken at two acute hospitals that treat a large amount of Orthopaedic Trauma. Patients were recruited from Outpatients clinic, at the first appointment after definitive management, or on the ward after operative management. Ethics approval was sought and granted by both hospitals Human Resource Ethics Committee's. Patients were eligible to be enrolled in the study if they met the inclusion criteria. These were: being over 16 years of age, having sustained a recent single traumatic lower limb injury requiring a period of at least six weeks of NWB, being able to read and write English sufficiently to complete the questionnaire and provide informed consent. Exclusion criteria were: any other injury sustained.

The questionnaire consisted of questions relating to the injury and its immediate management, a body chart on which to colour in the areas of current pain, a Visual Analogue Scale (VAS), to give a numerical value between 0-10 to their pain and a mental and physical health score, the SF12. The VAS was administered with the use of a faces scale. The SF 12 (4) is a questionnaire designed to determine the impact a health issue has on physical and mental health. It gives a physical composite score (PCS) and a mental health composite score (MCS) both of which range from 0-100 where 0 indicates lower possible level of health and 100 the highest. It only takes 2 minutes to complete and has been validated in this population (5). Questions were also included to determine whether the participant had any other medical problems and to determine their medications. It was specifically asked whether they took corticosteroids, were anti-coagulated, had diabetes or smoked. It was also recorded whether physiotherapist assistance was given in the provision and use of crutches.

The survey was administered on two occasions; the first after definitive management of the fracture had been undertaken, the second after the period of NWB had been completed. The second survey was shorter than the first. A follow up phone call was also made to those participants who had increased pain on the VAS at the time of the second survey.

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Statistical analysis was conducted using IBM SPSS version 22 with a significance level set at $p=0.05$. Differences between the participants who developed new pain areas after a period of non-weight bearing and those who did not were compared using a Pearson's chi square test (or a Fisher's exact test) for categorical variables and a Mann Whitney U test for continuous variables. Comparison over time between SF12 MCS, SF12 PCS and VAS pain scores were analysed using Wilcoxon signed ranks test.

Results

A total of 55 patients were recruited, and 50 completed the follow up study, giving a 90% response rate. The patients lost to follow up were unable to be contacted for the second survey. Demographic data (Table 1) for these patients shows no difference between those who completed the study and those lost to follow up. Of the patients included in the study the age range was 18-80 (IQR 28) with a median of 45, and 60% were male. The median time patients were NWB for was 6 weeks with a range of 6-12 (IQR 2.0). The median BMI of participants was 25.10 with a range of 19.1-37 (IQR 5.50). 50% of patients required surgical intervention. All patients had sustained a traumatic lower limb injury requiring a minimum period of six weeks NWB, as outlined by their treating orthopaedic surgeon. There were a variety of injuries. No patients who received operative management of their trauma suffered post operative complications.

Outcomes measured were pain score on the VAS, number of body areas affected by pain, physical component score (PCS) on the SF12 and mental health component score (MCS) on the SF12. Seven patients experienced new, other joint, pain at the time of the second survey. Four of these seven patients had had physiotherapy input in the initial prescription of the aid. As a group, 26 of the 50 patients who completed the follow up survey had physiotherapy input. Four of the seven participants with new pain experienced pain on the opposite side and three on the same side. The new areas of pain were experienced in the upper limb, lower limb and spine (Table 2).

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The SF 12 results showed that there was a significant difference in the follow up SF12 MCS scores, with patients who developed a new pain area scoring significantly lower compared to the cohort ($p=0.045$) (Table 3). In addition, these seven patients had no significant change in their VAS ($p=0.832$), SF12 PCS ($p=0.128$) or SF12 MCS ($p=0.735$) between the first and second surveys. At a follow up phone call, made to each of these participants six months after the second survey was completed, they all declared they no longer had any pain areas relating to the original trauma or the prescribed period of non weight bearing. The VAS was thought to be a valid measure, even administered over the phone, as the participants were visually familiar with score, having completed it twice previously.

Discussion

The results of this study indicate that the majority of patients improve in pain and function following treatment that includes a period of NWB for simple lower limb trauma. The heterogeneity of injuries sustained in our population adds to the generalisability of the results. Despite this, this study also found there is a chance that new joint pain may develop elsewhere in the body. In our population, there was complete resolution of this pain within six months. This is in contrast to much of the literature on simple orthopaedic trauma (6-9), which describes chronic pain and dysfunction to be common. Those patients that did suffer from the development of a new area of pain had an associated significant reduction in the mental component score of the SF12 and failure to improve on their VAS from initial survey to follow up.

The existing literature suggests that there is a correlation between a higher initial degree of pain experienced and poorer functional outcome (8) but no studies have prospectively analysed a change in VAS. It is of interest in this population that the VAS did not change in the new pain group, however the VAS was said to be 0 when patients were contacted six months post injury resolution.

The SF12, measured in this study, is designed to quantify the patient's physical and mental health. It has been reported that patient satisfaction following an

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injury is more strongly correlated with mental health than physical (10). This study found that it was the MHC score of the SF12 that was significantly reduced in the new pain group. The SF12 was not repeated at the follow up phone call so we cannot make conclusions as to ongoing mental health in this population. It is possible that simply following the patients up with a survey and then a phone call positively influenced their outcomes. Similar outcomes have been reported in the literature (11).

To investigate why new pain might develop in other joints in association with a period of NWB, the biomechanics behind a crutch-based gait needs to be reviewed. It has been well established that walking with crutches is metabolically expensive (12-14). There is an average increase in energy expenditure of 2.6 times compared to normal gait (14). This varies significantly with speed; as the speed of gait increases, there is a disproportionate increase in energy expenditure. Part of this increase in energy cost is the use of the upper limb muscles, not developed for a weight bearing role. Another contributor is the rigidity of the crutches. In normal gait, the lower limb soft tissues undergo alternating stretch and shortening cycles. The stretch stores elastic energy, which is then returned as the soft tissues shorten. With a crutch based gait this does not occur (14).

The manner in which crutches are fitted and used can alter the forces imparted on the user (15, 16), as well as minimise energy expenditure and the risk of falls (18). They should be fitted so as to minimise vertical motion of the body. Axillary crutches should be measured to create 30 degrees of elbow flexion with the crutches resting against the lateral chest wall, distal to the axilla. Our study did not appear to support the initial fitting of crutches by a physiotherapist changing the outcomes for patients developing new pain. It is possible however that a review of crutch use by a physiotherapist during the period of NWB may be beneficial in relieving any pain that may develop.

In a crutch based gait, the upper limbs have to work to elevate and accelerate the body's centre of mass and one study found that elbow crutch use was associated

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with more than 100% of body weight going through the glenohumeral joint (13). This supports the indication from this study that it is possible to develop upper limb pain from crutch use.

The type of gait pattern adopted also influences forces. With crutches, a step to gait achieved by placing the crutches first and then stepping the weight bearing limb to the crutches is associated with reduced loading in the weight bearing limb. A swing through gait advances the weight bearing limb beyond the base of support provided by the crutches, increasing the load on the limb (15).

Harrington et al (3) found that the magnitude of force going through the knee joint depends on body weight, stride length and walking speed.

It is possible that some of these factors influenced the experience of new joint pain in patients in this study. It is reassuring that these pains resolved with cessation of crutch use. Future research should investigate whether accurate prescription of an aid with an additional review of its use would reduce the incidence of new joint pain.

Conclusion

Mobilising with the use of an aid to allow NWB of an injured limb after isolated lower limb orthopaedic trauma is commonly recognised as an important part of the healing process. It has been shown that the majority of patients improve in pain and function after this period. It has also been shown that there are a small number of people that may suffer other joint pain during this period, which resolves after cessation of crutch use. Biomechanical studies indicate that the way a person uses their crutches influences the loading on both upper limb and lower limb joints. Thus it is possible that ideal crutch use may change the incidence of joint pain.

Conflict of Interest Statement

There are no conflicts of interest to declare.

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TABLE 1: Demographics of patients lost to follow up

TABLE 1 Demographics of patients lost to follow up compared to study participants			
	Cohort (n = 50)	Lost to follow up (n = 5)	P value
Gender	30M; 20F	5M; 0F	0.147†
Age (median years)	45	47	0.328*
Injury Type	12 Ligamentous 37 Bony	2 Ligamentous 3 Bony	0.592†
Management of injury	25 Operative 22 Non-operative	2 Operative 3 Non-operative	0.662†

†Pearson's chi square test; *Mann Whitney U test

TABLE 2

Distribution of new pain and pre and post NWB pain scores

TABLE 2 Distribution of new pain and pre and post NWB pain scores					
T1 VAS	T2 VAS	T1 Pain Areas	T2 Pain Areas	Region	Same side
6	2	1	2	Hand	No
4	2	1	2	Foot	No
3	5	4	3	Shoulder, hand	Yes
3	7	1	3	Foot	No
2	6	3	4	Knee, wrist	No
2	2	1	1	Knee	Yes
9	4	2	2	Spine, shoulder	yes

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TABLE 3 Comparison of patients who did and did not develop new pain areas

TABLE 3 Comparison of demographics of patients who developed new pain areas			
	No New Pain (n = 43)	New pain (n = 7)	p value
Gender	27M; 16F	3M; 4F	0.416†
Age (median years)	44	56	0.188*
BMI (median)	25.4	22	0.086*
Injury Type	11 Ligamentous 32 Bony	1 Ligamentous 6 Bony	1.000†
Management of Injury	21 Operative 20 Non-operative	4 Operative 2 Non-operative	0.670†
Initial VAS (median)	4	3	0.692*
Physiotherapy Input	19 Yes 24 No	4 Yes 3 No	0.689†
Follow up VAS (median)	2	4	0.076*
Duration of NWB status (median weeks)	6	6	0.332*
Initial SF12 PCS (median)	40.16	36.84	0.493*
Initial SF12 MCS (median)	48.00	42.92	0.253*
Follow up SF12 PCS (median)	49.13	41.37	0.531*
Follow up SF12 MCS (median)	52.60	46.59	0.045*

†Pearson's chi square test; *Mann Whitney U test