FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NEGLECTED DIAPHYSEAL BOTH BONES FOREARM FRACTURES IN ADULT TREATED WITH PLATE OSTEOSYNTHESIS

A dissertation submitted to the Tamil Nadu Dr.M.G.R. Medical University

in partial fulfillment of the requirement for the award of M.S. Branch II

(Orthopaedic Surgery) degree March 2007-2009

CERTIFICATE

This is to certify that this dissertation titled "FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NEGLECTED BOTH BONES FOREARM FRACTURES TREATED WITH PLATE OSTEOSYNTHESIS" is a bonafide work done by Dr. KIRAN SASI. P, in the Department of Orthopaedic Surgery, Christian Medical College and Hospital, Vellore in partial fulfillment of the rules and regulations of the Tamil Nadu Dr. M.G.R. Medical University for the award of M.S. Degree (Branch-II) Orthopaedic Surgery under the supervision and guidance of Prof. SAMUEL CHITTARANJAN during the period of his post-graduate study from March 2007 to February 2009.

This consolidated report presented herein is based on bonafide cases, studied by the candidate himself.

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INTRODUCTION

Forearm consists of the radius, the ulna, the proximal radioulnar joint, the distal radioulnar joint and the interosseus ligament. For normal functioning of the forearm alignment of both radius and ulna in relation to each other , the proximal and distal radioulnar joints and the interosseus alignment and critical.

The forearm is a complex anatomic structure serving an integral role in upper extremity function. The dexterity of the upper limb is dependent on a combination of hand and wrist function and forearm rotation. The forearm bones can be considered struts linking two halves of a condylar joint formed by the proximal and distal radioulnar joints. Thus, any change in the geometry of the radius or ulna alters the congruency and range of motion of this condylar joint. It maintains a stable link between the elbow and the wrist, provides an origin for many of the muscles that insert on the hand, and allows rotation of the wrist to position the hand more effectively in space. Acute injuries can involve different components of the forearm unit simultaneously, thus necessitating integrated treatment of all of the injured structures for recovery of function (1).

It has been universally recognized that diaphyseal both bones forearm fractures in adult warrant operative fixation. The purpose of this study is to describe and elucidate a special group of cases which is unique to a certain geographical location in South India. Traditional healers have been an integral part of the society even in urban areas. Even though traditional healers have been incorporated into partaking in modern medical treatment of conditions like home deliveries (2) or management of Tuberculosis as a part of the DOTS program(3), their practices have been largely detrimental and even dangerous in Orthopaedic conditions. Even in the face of dangerous complications like traditional bone setters' gangrene (4), even educated people tend to use their services (5). This study attempts to describe diaphyseal both bones fracture in adults which have been mostly managed initially by traditional bone setters with native splint and manipulation and present late to modern Orthopaedic care.

AIMS AND OBJECTIVES

- The aims and objectives of the study are:
- To retrospectively analyze all cases of adult neglected forearm treated with open reduction and plate osteosynthesis from January 2000 to October 2007
- To assess the functional outcome of patients
- To assess the radiological union
- To assess the importance of maximal radial bowing and the location of the maximum radial bow postoperatively with forearm movements and function.

REVIEW OF LITERATURE

FUNCTIONAL ANATOMY

Normal function of the forearm requires intact skeletal structures; a normal interosseous membrane; stable proximal and distal radio-ulnar joints; and normal soft-tissue structures, including the muscles, nerves, and vessels that are in the forearm and that traverse it. In the distal aspect of the forearm, the radius is larger than the ulna and accounts for 80 per cent of the force transmitted from the wrist to the forearm (5). The relative amount of force transmitted to the forearm from the wrist is closely associated with the relative lengths of the radius and ulna. Normally, the two bones are of nearly equal lengths (6) (7**).** If they are not of equal lengths, ulnar variance results. Positive ulnar variance results when the ulna is longer than the radius distally, and negative ulnar variance occurs when the ulna is shorter than the radius distally. It was found that shortening of the radius by even a small amount dramatically increased the amount of force transmitted to the ulnar aspect of the wrist(8).

The ulna is a relatively straight bone that progressively enlarges proximally in the forearm. At the elbow, the ulna provides the site of attachment for both the medial and the lateral collateral ligament. At the level of the wrist, the ulna accepts a small proportion of the load transmitted to the forearm by the carpus. In the proximal aspect of the forearm, the ulna accepts proportionately more load because of the transference of load from the radius through the interosseous membrane and the addition of local muscle forces. At the elbow, the radius transmits 60 per cent of the transarticular load, depending on the position of the forearm when the measurement is made (9)(10). The radius has a gentle curve as it traverses the forearm. This curve, or bow, has been shown to be of crucial importance to the normal range of rotation of the forearm and to the strength generated by the muscles of the forearm, as reflected in grip strength (11).

The radial head is a circular structure that articulates with the capitellum. The radial head is concave in order to accommodate the convex capitellum. The head tapers to form the radial neck and, just distal to the neck, the attachment of the biceps tendon arises from the radial tuberosity. The proximal aspect of the ulna forms the sigmoid notch, which articulates with the trochlea. Articular cartilage covers approximately 240 degrees of the external surface of the radial head. The articular surface of the lesser sigmoid fossa forms a 60 to 80-degree arc. Accordingly, the range of allowable rotation of the proximal aspect of the radius is approximately 180degrees. The radial collateral ligament arises from the lateral epicondyle and inserts onto the annular ligament.

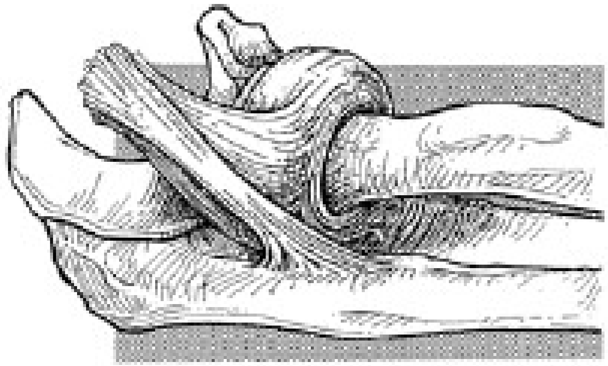
The annular ligament arises from the lesser sigmoid notch and encircles the radial head, holding it in contact with the ulna.

The articular surfaces of the distal radio-ulnar joint are trochoid. The concavity of the sigmoid notch is shallow, with dorsal and volar margins. The dorsal margin is more acutely angled than the volar margin. The head of ulna is semi cylindrical, with a 130-degree dorsal-to-volar arc. The contour of the ulnar head is similar to that of the radial head. The radius of the sigmoid notch is greater than that of the distal aspect of the ulna. In mid-rotation, the sigmoid notch can accept between60 and 80 degrees of the articular convexity of the distal aspect of the ulna. In the extreme positions of rotation, less than 10 per cent of the sigmoid notch may be in contact with the distal aspect of the ulna. Stability depends heavily on the soft tissue structures that surround the distal radio-ulnar joint. The distal articular surface of the ulna articulates with the triangular fibrocartilage.

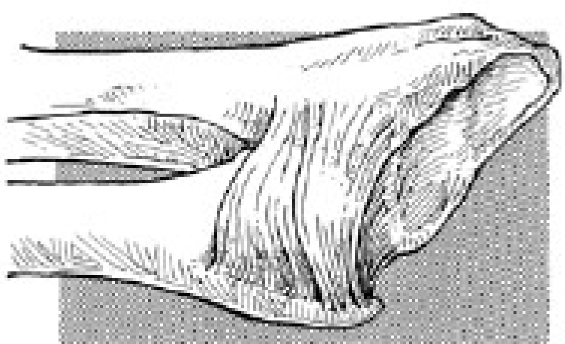
The triangular fibrocartilage originates from the distal aspect of the radius and inserts at the base of the ulnar styloid process.

The ulnar styloid process is the distal projection of the subcutaneous ridge of the ulnar shaft and extends between two and six millimeters toward the triquetrum.

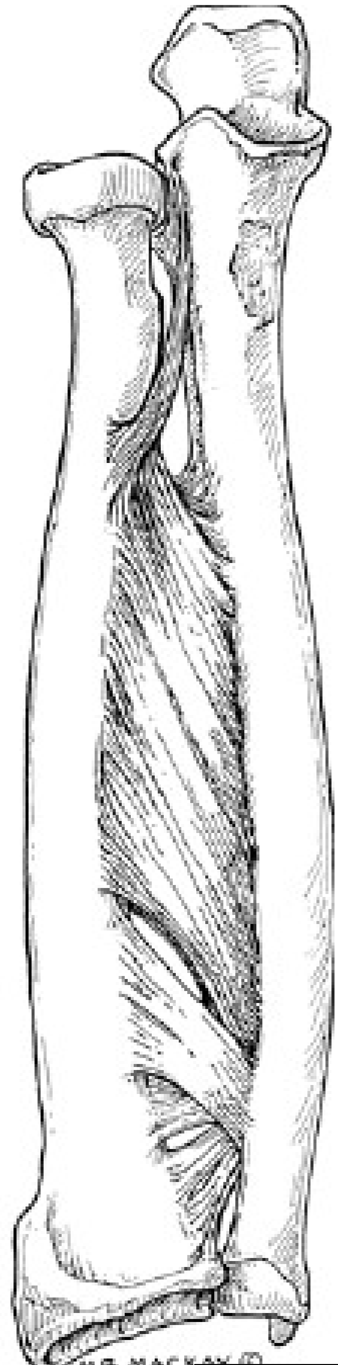
The interosseous membrane is of critical importance to normal function of the forearm and is considered as a separate joint. It is thin and translucent, with minimal intrinsic strength. A central band of ligamentous tissue, approximately twice the thickness of the interosseous membrane on either side, is a consistent anatomical pattern in the forearm. Cadaveric studies have demonstrated that the central band contributed about 71 per cent of the longitudinal stiffness of the interosseous membrane. The central band arose from the radius proximally and from the ulna distally. The mean thickness of the central band was 0.94 millimeter, and the mean width was 3.5centimeters. (12).



PROXIMAL RADIOULNAR JOINT



DISTAL RADIOULNAR JOINT



INTEROSSEUS MEMBRANE

Fig 1-RADIOULNAR ARTICUALTION WITH SUPPORTING LIGAMENTS

BIOMECHANICS OF THE FOREARM

Transfer of load from the wrist, through the radius and the ulna, to the elbow is a complex event that depends on the position of the forearm, anatomy of the wrist, and soft-tissue linkages between the radius and the ulna. Varus-valgus alignment of the elbow influences the basic mechanism of force transmission through the forearm. Most normal activities of daily living can be accomplished with an arc of 100 degrees of rotation, with equal amounts of pronation and supination (13).

Biomechanics of forearm movement

The rotation axis of the radius about the ulna during supination and pronation coincides with the line drawn from the ulnar head to the radial head about which the radius moves in an arc of a circle. At one-fourth the length of the forearm from the distal end, the axis coincides with the edge of the interosseous border of the ulna. The most prominent fibers of the interosseous membrane are those being attached to this part of the ulna. The tension of these most prominent fibers is constant. (14)

Biomechanics of the interosseous membrane

Cadaveric biomechanical studies have aided in the calculation of radioulnar load-sharing at the wrist and the elbow and also the calculation of the amount of force that is transferred from the radius to the ulna through the interosseous membrane. With the elbow in valgus alignment when there is contact between the radial head and the capitellum, the main pathway for load transmission through the forearm is direct axial loading of the radius and is unaffected by the angle of elbow flexion. When the forearm is in neutral rotation, the mean force in the distal end of the ulna is about 2.8 per cent of the load applied to the wrist and the mean force in the proximal end of the ulna is about 11.8 per cent; this indicates that only a small amount of tension is developed in the interosseous membrane. With the elbow in varus alignment when there is no contact between the radial head and the capitellum, load is transmitted through the forearm by a transfer of force from the radius to the ulna through the interosseous membrane. When the forearm is in neutral rotation, the force in the distal end of the ulna is about 7.0 per cent of the load applied to the wrist and the force in the proximal end of the ulna was about 93.0 per cent; the force through the interosseous membrane decreases with supination of the forearm.

Testing with the elbow in valgus alignment and shortening of the distal end of the radius in two-millimeter increments produces a corresponding increase in force in the distal end of the ulna and decrease in force in the radial head. The forces through the interosseous membrane remain low after each amount of radial shortening.

Varus-valgus alignment of the elbow influences the basic mechanism of force transmission through the forearm. The interosseous membrane plays a minimum role in load transmission with the elbow in valgus alignment. Dynamic gripping activities that include varus stress to the elbow would be expected to develop force in the interosseous membrane. (15).

The ‘forearm complex’

The concept of ‘forearm complex’ is a result of several such cadaveric and in vivo studies. The ‘forearm complex’ is comprised of the proximal radioulnar joint, middle radioulnar joint/interosseous membrane and the distal radioulnar joint. These three areas function in a coordinated manner to rotate the hand in space and allow performance of functional tasks. The aim of surgical intervention is to restore the anatomical alignment of the ‘forearm complex’ thereby restoring function. (16).

FRACTURE OF BOTH BONES FOREARM

EPIDEMIOLOGY

Hand/forearm fractures, accounting for 1.5% of all emergency department cases. Radius and/or ulna fractures comprised the largest proportion of fractures (44%). (17).

Diaphyseal forearm fractures account for about 5% of all upper limb fractures.

The incidence of forearm fractures as per various published literature is highest in children averaging 14-16/10,000. The incidence drops to around 1.5/10,000 after 20 years of age increases to 2/10,000 after 60 years of age. (18)(19).

Certain studies have described upto 17.5% nonunion in open forearm fractures. (20).

MECHANISMS OF INJURY

The common mechanisms of forearm injury can be divided into direct trauma and indirect axial or twisting trauma. Road traffic accidents are responsible for a fair share of forearm fractures especially those with complex fracture patterns.

Occupational injuries especially agricultural injuries are common among the rural population. Fall from height is been recorded as a common mechanism. (21).Industrial accidents and trivial fall in osteoporotic women are also among the common mechanisms of forearm fractures. (18).

FRACTURE CLASSIFICATION

AO/OTA classification is widely used and applicably classification system that can be used for forearm fractures.

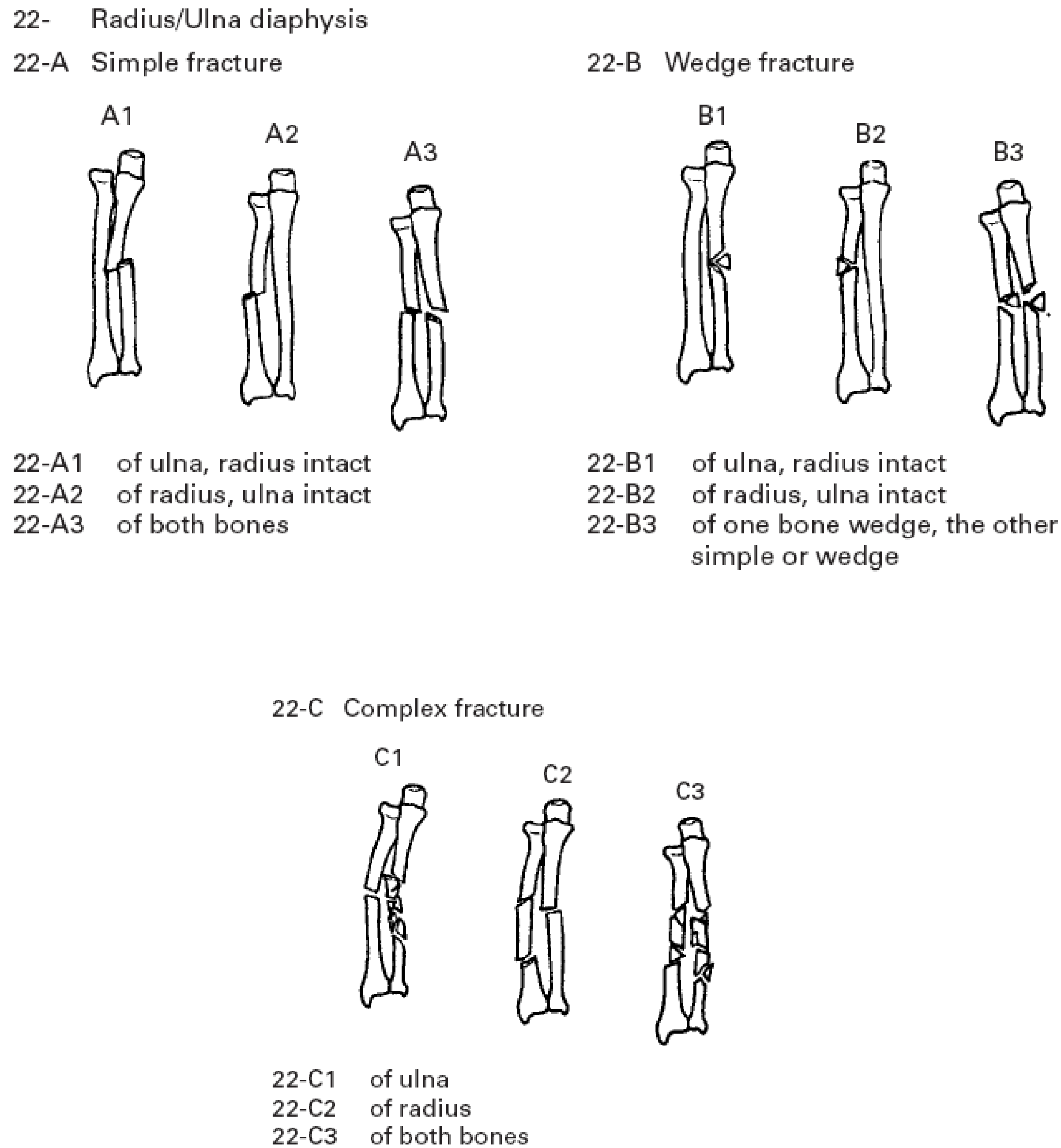


Fig 2(41)-THE AO/OTA CLASSIFICATION FOR FOREARM FRACTURES

HISTORY AND EVOLUTION OF MANAGEMENT

CLOSED TREATMENT

Till 1936 closed management was the only treatment option available. Early authors recommended closed reduction followed by lengthy plaster immobilization. Malunion and nonunion were frequent complications.

Bohler in 1936 recognized that to maintain skeletal length, continuous traction was often required. He recommended Kirschner wires inserted above and below the fracture and held by a plaster cast to achieve this goal (22). However the results were not significantly improved. Upto 92% unsatisfactory results were reported as early as 1957 (23).

OPEN TREATMENT

Open reduction without internal fixation - The main objection to this method is that a good initial reduction may not be maintained despite the use of a plaster cast**.** Upto 60% unsatisfactory results and 46% nonunion were reported with this method of management (24).

Open reduction with screw fixation - This method is only applicable to oblique fractures and has been found not to provide sound fixation (24) (23) (25) (26).

Open reduction with an encircling loop of wire - Only applicable to oblique or spiral fractures, this method is now rarely used because it is known that the viability of the bone may be impaired by compression of its blood supply, and cause non-union (27) (28).

Intramedullary fixation – even though closed intramedullary flexible nailing is preferred in paediatric forearm fracture (29) (30) (31), the evidence in adult forearm fractures have been largely controversial. Intramedullary fixation has been used for the treatment for both bones forearm fractures in the presence of severe soft-tissue injury as it helps in maintaining length and alignment with a minimal incidence of infection. In the treatment of solitary or segmental fractures of the ulna, it has been found to be an efficient, rapid, and simple procedure in some studies. In the treatment of radial fractures, however, the technique is not simple nor is it uniformly efficient. (32).But this finding has been contradicted by other studies which suggested that a prebent Rush pin inserted in or near Lister's tubercle and adequate immobilization is an acceptable treatment for fractures of the radius. They found that a Rush pin is inadequate fixation for fractures of the ulna, because of poor fixation for rotatory stress. (33) Invitro studies have shown that plate fixation was superior to nail stabilization in restoration of the normal radial architecture (11). The interlocking contoured intramedullary nail fixation has been recommended by some authors not as superior to plate fixation but as an alternative to that method for selected diaphyseal fractures of the forearm in adults. (34) The advantages of using an intramedullary device that are postulated are that periosteal stripping is unnecessary, the skin incisions are smaller, and there is less soft-tissue dissection, resulting in preservation of the osseous blood supply, which aids in fracture union. (35).

Intramedullary implants are stress-sharing devices rather than stress-shielding, which lead to a peripheral periosteal callus that may facilitate stronger fracture union. (36) In vivo canine experiments have shown that bone blood flow reached higher levels and remained elevated longer in fractures that were fixed with an intramedullary device than in those fixed with a plate. Rod-fixed fractures healed by periosteal callus, whereas plate-fixed fractures healed by endosteal callus. They also found that fracture gained mechanical strength more slowly in the rod-fixed group than in the plate-fixed group. Intramedullary fixation also necessitates external splinting till radiological evidence of callus formation is noted which can lead to stiffness and loss of function.

Open reduction and plate osteosynthesis – is largely accepted as the method of choice of treatment of both bones forearm fractures; even in cases of open injuries

Rigid plating is considered to be the most satisfactory treatment for both bones forearm fractures, with a low incidence of non-union. Bone grafting is recommended in severely comminuted fractures even during primary fixation. Other advantages are that immobilization of the limb after operation is not necessary and is undesirable if the fixation is rigid. Serious complications of the plating operation are few and avoidable**.** (37)

AO/ASIF TECHNIQUES

Techniques developed by AO/ASIF group were responsible for the major advancement in the management of these injuries. Danis is credited with initiating the era of compression plates (38). Strict adherence to AO principles and the use of AO implants have dramatically changed the management of these fractures. Stable internal fixation has eliminated the need for casting or splinting aiding faster rehabilitation and improved forearm movement and functionality. (39).

Surgical Approaches

Surgical Approaches to the Radius

Anterior approach (40)

This was first described by Henry(40). The skin incision is made along the 'mobile wad'. The internervous plane is between radial and median nerves. The intermuscular plane is between the brachioradialis and flexor carpi radialis.

Pronater quadrates and flexor pollicis longus musles need to be elevated and mobilized. This exposure can be used to visualize the entire radius. The structures which have to be protected are the posterior interosseus nerve proximally, the superficial branch of radial nerve, and radial artery distally.

Dorsolateral Approach (42)

This was first described by Thompson. (42).This is particularly suited for fractures in the middle third of the forearm (43). There are two internervous planes in the dorsal aspect of the forearm. The proximal internervous plane is between the 'mobile wad' supplied by radial nerve and extensor digitorum communis muscle supplied by posterior interosseus nerve. The second internervous plane is between extensor carpi ulnaris supplied by posterior interosseus nerve and anconeus supplied by a branch of radial nerve. The critical step in the approach is to identify and preserve the posterior interosseus nerve.

Surgical Approaches to the Ulna

The incision is along the subcutaneous border of the ulna and dissection is between flexor carpi ulnaris supplied by ulnar nerve and extensor carpi ulnaris supplied by posterior interosseus nerve.

Dynamic Compression Plating

A landmark discovery in the field of plate osteosynthesis was the evolution of compression osteogenesis. It was found that the contact compression factor which incorporates compression forces in physiological muscle balance stimulates osteogenesis and fracture union. Its absence fails to stimulate, but does not prevent osteogenesis. Even the presence of infection in the fracture site does not alter the tendency for osteogenesis. It has also been found that excessive pressure can causes necrosis of the compressed bone. (44)

Several large studies have reported excellent results with plate fixation. Compression plate fixation has been shown to have union rates as high as 97.9% for fractures of the radius and 96.3% for fracture of the ulna.(45)(46) (11).

Using 3.5mm dynamic compression plates was found to achieve union in an average duration of six months (47).and good functional outcome. (46),(48),(49) (50). The infection rates in closed both bones forearm fractures fixed with compression plates is as low as 0.7%(50).

If the normal radial bow is restored to its normal size and location good functional results are obtained with range of movement of more than 80% as compared to the opposite normal limb(11).

Implants Used in Plate Osteosynthesis of Both Bones Forearm Fractures

The most widely used implants for fixation of both bones forearm are the 3.5mm dynamic compression plate (DCP) and the 3.5mm limited contact- dynamic compression plate (LC-DCP). (45)(48) (49) (50)(51)(52) (53).

The contact area between the bone and the plate is about 50% reduced in LC-DCP as compared to DCP.(54) (55) .This is presumed to improve the blood supply to the underlying bone cortex and lessen the risk of partial bone necrosis which can improve healing and decrease infection rate.(56)

The point contact-fixator (PC-Fix) was developed along the principles of limited contact between bone and the plate. In PC-Fix the contact between bone and the plate is reduced to two contact points every 16mm. (57) PC-Fix achieves fixation not by friction like other plates but by shear between the screws and the bone. The screws used in PC-Fix system have conical heads which lock into the plate giving angular stability. This has later evolved into the development of locked compression plates (LCP) where the screw heads have threads which lock into the plate. The PC-Fix system and the LCP system require only unicortical screw fixation.

The disadvantages of the PC-Fix system include the inability to achieve compression through the plate which warrants the use of additional compression devices. The structure of the screw hole does not allow for inclination of the screws making it impossible to apply lag screws. (58)

Although unicortical screws are considered more biological it required more number of screws to achieve stability. Even though PC-Fix principle is a step in the evolutionary process of improving biomechanical and biological properties of fracture fixation, it has not been found to have any advantage over LC-DCP with comparable union rates and functional outcome.(52).

Evaluation of the forearm

Evaluation of an acutely injured forearm will include evaluation of the bones, the soft tissue, neurological and vascular injury, the proximal and the distal limb and also ruling out systemic injury.

Evaluation of the forearm post-op or after chronic injury will include functional, clinical and radiological assessment.

Functional evaluation

The scoring system that has been validated and universally accepted for the subjective assessment of upper limb function is the **Disabilities of the Arm, Shoulder and Hand (DASH)** scoring system. The DASH is a 30-item questionnaire intended to assess the function and symptoms of persons with disorders of the upper limb. Patients rate their ability to perform 21 physical activities such as opening jars, turning doorknobs and similar activities. The remaining nine items relate to symptoms (six items) and self-image and social life (three items).

Each is scored on a five-point Likert scale. The raw score is converted to a global score ranging from 0to 100. A score of 0 indicates ‘no disability’, and 100 indicate ‘severe disability’. (59)(60)(61)(62)(63).

Clinical Assessment

The clinical assessment of the forearm involves assessment of the soft tissues, the bones of the forearm, the movements at the elbow, forearm and wrist, the assessment of stiffness and assessment of the neurovascular structures.

Assessment of the soft tissues will involve evaluating the skin condition, the functioning of the muscles and the soft tissue cover of the bones and the implants.

Assessment of the bones involve assessment of bony integrity, tenderness at the fracture site or about the implant, abnormal mobility or stress tenderness.

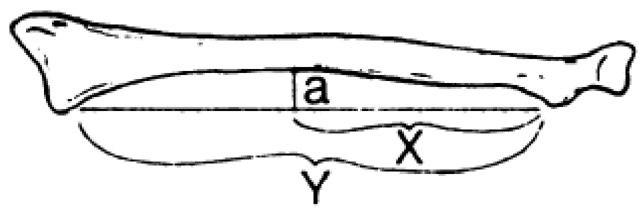
Range of movements have to be assessed for the elbow (flexion and extension), the forearm (supination and pronation), the wrist (dorsiflexion and palmar flexion) and fingers (digito-palmar distance). The standardized method of assessment of range of movement is using a standardized goniometer in anatomical position.

Assessment of neurovascular structures involves sensory and motor assessment of the radial, posterior interosseus, median and ulnar nerves and radial and ulnar pulses.

Radiological assessment

Radiographic examination of the forearm requires anteroposterior and lateral radiographs be taken with the forearm in neutral rotation (64)(65).These radiographs can most easily be taken by having the patient sit in a chair, with the shoulder abducted and the upper extremity placed on the radiographic table. This method of positioning ensures that the forearm is in neutral rotation and minimizes the effect of rotation when the relative lengths of the radius and ulna are assessed. A lateral radiograph with the forearm in neutral rotation should also be made. The location and amount of maximum radial bow can be determined with the method of Schemitsch and Richards(66). A line is drawn from the bicipital tuberosity to the most ulnar aspect of the radius at the wrist. A perpendicular is drawn from the point of maximum radial bow to this line. The height of the perpendicular (defined as maximum radial bow) is measured in millimeters. The distance from the bicipital tuberosity to the previously measured perpendicular at the point of maximum radial bow is then measured and is recorded as a percentage of the length of the entire bow (the distance from the midpoint of the bicipital tuberosity to the most ulnar aspect of the subchondral bone of the distal aspect of the radius). This measurement is termed the "location of maximum radial bow" (66). Radiographs of the contralateral forearm must be made in order to determine the variance from normal for individual patients.

Fig 3 – Calculation of the maximum radial bow



Maximum radial bow = a (mm)

Location of maximum radial bow = x/y x 100

MATERIALS AND METHODS

Research Design

This is a retrospective study. A total of 21 patients were recruited for this study.

Study setting

This study was conducted in the department of Orthopaedics, CMC Vellore between August 2007 and August 2008.The study was approved by the ethics committee of the hospital.

Inclusion Criteria

1. Patients after physeal closure
2. Patients who sustained diaphyseal fractures of both bones forearm.
3. Patients who presented for definitive intervention at least one month after the injury
4. Plate osteosynthesis was used as the treatment modality

Exclusion Criteria

1. Age – before physeal closure
2. Patients who underwent the definitive intervention earlier than one month post trauma
3. Patients for whom treatment modalities other than plating was used as the definitive intervention
4. Patients with a contralateral forearm injury

5. Patients with an ipsilateral elbow or wrist dislocation
6. Patients who refused to undergo radiographic or clinical reevaluation

Sample Size

Based on the operation theatre register and inpatient and outpatient records a total of 42 patients were identified for review. Correspondences were sent to their latest known addresses inviting them to participate in the study. Contact numbers were used when available. After repeated correspondences 21 patients presented for review and consented to enroll in the study.

Method

Informed consent was taken. One-to-one interviews were conducted for obtaining the relevant history and applying the DASH questionnaire. Clinical examination was done to assess the status of the soft tissue and bone; bony tenderness and vascular and neurological examination was done. MRC grading was used to assess the motor power. Standardized goniometer was used for the assessment of range of movement of the elbow, forearm and wrist. Digito-palmar distance was used to assess finger stiffness.

Neglected forearm fracture was defined as forearm fractures for which definitive intervention was undertaken at least one month after the event.

Standardized antero-posterior and lateral plain radiographs were obtained.

All radiological calculations were calculated using GE Centricity 1.0 Radiology Web software. Measurement of the maximum radial bow was calculated based on the formula described by Schemitsch and Richards (66) (Fig 3). The location of maximum radial bow also was calculated.

The plain radiographs of the affected forearm taken at the time of presentation were reviewed for evaluating the fracture configuration and classifying the fractures based on the AO/OTA system of classification for forearm fractures.

Inpatient records of the selected cases were obtained to ascertain the details of the surgical procedure and the details of the peroperative period and immediate postoperative period.

Statistical Analysis

Data Analyses:

All statistical analyses were performed using SPSS 11.0 for windows. Descriptive statistics such as mean and standard deviation is used to describe continuous variables and frequency and percentage is used to describe categorical variables. Associations between categorical variables are assessed using chi-square test with Yates continuity correction. Continuous variables were compared using Mann-Whitney and Kruskal Wallis tests. Relationships between continuous variables were assessed using Spearman's rank correlation. A p-value < 0.05 is considered statistically significant.

RESULTS

The total number of patients who underwent surgery as per the criteria were 36. The **total number** of patients who presented for review was 21. The frequency distribution of this group is shown below in Table 1.

Table 1. FREQUENCY DISTRIBUTAION

Parameter	Frequency (n)	Percentage (%)
Total number of patients	21	100
Male	16	76.2
Female	05	23.8
Present occupation Heavy labour	08	38.1
Moderate labour	10	47.6
Light labour	03	14.3
Occupation at the time of injury Heavy labour	07	33.3
Moderate labour	10	47.6
Light labour	04	19.0

Parameter		Frequency (n)	Percentage (%)
Dominant limb	Right	20	95.2
	Left	01	4.1
Injured limb	Right	05	23.8
	Left	16	76.2
Injury to the dominant limb	Yes	6	28.6
	No	15	71.4
Gustillo & Anderson classification			
	Open Fractures	10	47.6
	Closed Fractures	11	52.4
Mode of Injury			
	Road traffic accident	08	38.1
	Work place injury	07	33.3
	Domestic injury	06	28.6
AO/OTA classification	A3	05	23.8
	B3	12	57.2
	C2	04	19.0

Initial Management			
Native Splint		10	47.6
Cast/Slab		03	14.3
Surgical other than plating		08	38.1
Associated systemic injury-	Present	06	28.6
	Absent	15	71.4
Other injuries to the same limb	Present	03	14.3
	Absent	18	85.7
Past injury to the same limb	Present	03	14.3
	Absent	18	85.7
Smoking	Present	12	57.1
	Absent	09	42.9
Diabetes mellitus	Present	03	14.3
	Absent	18	85.7
Infection	Present	06	28.6
	Absent	15	71.4

Nerve injury at the time of trauma Present	04	19.0
Absent	17	81.0
Soft tissue complications Present	03	14.3
Absent	18	85.7
Bone grafting - Early	7	33.33
Late	2	9.52
No bone grafting	12	57.14
Radiological union Present	21	100
Absent	0	0

Out of the 21 patients there were 16 **males** (76.2%) and 5 **females** (23.8%).

The mean **age** was 37.67years (range = 16 – 69 years).

The mean duration after surgery at follow up was 36.76 months (range=12-72 months).

When the **present occupation** of the 21patients were recorded, there were 8 (38.1%) patients who were involved in heavy physical labour including agricultural labour and wood cutting; 10 (47.6%) patients were involved in moderated physical labour including painting and driving and 3 (14.3%) patients were involved light physical labour; mostly desk bound work. 3 (14.3%) patients had to change their occupation because of the forearm fracture.

For 20 patients (95.2%) right upper limb was the **dominant limb**; 1 patient (4.1%) was left hand dominant. 6(28.6%) patients had sustained injury to their dominant upper limbs and 15(71.4%) patients had sustained to their non dominant upper limbs.

When the **mode of injury** was checked, it was found that 8(38.1%) had road traffic accident. There were 7 (33.3%) patients who sustained injury at their work place. Domestic injury was responsible for 6 (28.6%) of the injuries.

The fractures were classified as per the **AO/OTA classification** system (Fig 2).

The injuries could be classified in to three groups.5 (23.8%) patients were classified as A3, 12(57.2%) were classified as B3 and 4(19.3%) were classified as C2 type injury.

The **initial management** which the patients underwent were divided into native splinting, non-operative splinting-cast/slab by a physician or surgical management other than plate osteosynthesis. 10(47.6%) had undergone native splinting. 3(14.3%) patients were treated initially with cast/slab. 8(38.1%) had undergone surgical management other than plate osteosynthesis.

Out of the 21 patients assessed 6(28.6%) had other **associated systemic injuries** at the time of trauma.

3(14.3%) of patients had associated **other injuries to the same limb** at the time of trauma.

On historical review 3(14.3%) patients also had **past injuries to the same limb** where as 18(85.7%) had not sustained any other injuries to the same limb before**.**

Cigarette smoking was found in 12(57.1) of patients whereas 9(42.9%) were non smokers.

Associated co morbid condition like **diabetes mellitus** was present in 3 (14.3) patients. 18(85.7%) did not have any co morbid condition.

Recorded history of wound **infection** was seen in 6(28.6%) patients. 15 (71.4%) of 21 patients had no evidence of infection.

At the time of assessment none of the patients had clinical or radiological evidence suggestive of **nonunion.**

17(81%) of the 21 patients reviewed complained of **pain** over the wrist or the elbow when 4(19%) were asymptomatic.

There was clinical recorded evidence of **nerve injury** in 4(19%) of patients where as 17(81%) did not have any evidence suggesting neurological injury. All these injuries were following trauma. There was no case of postoperative neurological injury.

Soft tissue complications were found in 3(14.3%) of patients and absent in 18 (85.7%).

Of the 21 patients reviewed, 7 (33.3%) had undergone **early bone grafting** and 2 (9.52%) patients had undergone delayed bone grafting. 12 (57.14%) patients had fracture union without bone grafting.

The clinical assessment data was analyzed and the details are presented in Table 2.

Table 2. Assessment data

Parameter	Mean	Standard deviation
DASH Score	39.9	15.67
Time from injury to definitive surgery (months)	2.43	3.46
Elbow flexion (degree)	126.19	8.05
Elbow extension (degree)	1.90	16.31
Supination (degree)	67.62	14.37
Pronation (degree)	47.38	20.29
Wrist dorsiflexion (degree)	70.48	18.57
Wrist palmar flexion (degree)	65.95	24.78

On interviewing the patients and assessing the **DASH score**, the mean score was found to 39.9 with a standard deviation of 15.67.

The mean delay in presentation for the definitive fixation was tabulated as **time from injury** and the mean delay was 2.43 months with a standard deviation of 3.46 months.

On clinical evaluation the **range of movement** was assessed.

The mean elbow flexion was 126.19° (SD – 8.05), mean elbow extension was 1.90° (SD 16.31). The mean forearm supination was 67.62° (SD14.37) and mean pronation was 47.38° (SD20.29). The mean wrist dorsiflexion was 70.48° (SD18.57) and mean wrist palmar flexion was 65.95° (SD 24.78).

Table 4: Correlation of the various parameters

	p values		
Parameter	Delay in treatment	DASH	AO classification
Elbow flexion	0.405 (NS)	0.922 (NS)	0.385 (NS)
Elbow extension	0.431 (NS)	0.664 (NS)	0.871 (NS)
Supination	0.228 (NS)	0.006*	0.220 (NS)
Pronation	0.960 (NS)	0.497 (NS)	0.579 (NS)
Wrist dorsiflexion	0.003*	0.058 (NS)	0.947 (NS)
Wrist palmar flexion	0.078 (NS)	0.016 (NS)	0.268 (NS)
Finger stiffness	0.122 (NS)	0.218 (NS)	0.203 (NS)
Finger grip weakness	0.039*	0.129 (NS)	0.811 (NS)
Nerve palsy	0.628 (NS)	0.035*	0.001*
Bone grafting	0.349 (NS)	0.521 (NS)	0.248 (NS)
Maximum radial bow	0.321 (NS)	0.045*	0.524 (NS)

* - statistically significant

NS – statistically not significant.

The above table demonstrates the statistical significance of the various parameters used in the assessment of outcome of plate osteosynthesis of neglected forearm fractures. The variables and the respective p values are given.

It is seen that there was statistically significant correlation between DASH scores and patients range of supination (p=0.006), wrist palmar flexion (p=0.016) and maximum radial bow (p=0.045).

There was statistically significant correlation between the time of operation from injury and wrist dorsiflexion (p=0.003).

There was strong statistically significant correlation between the AO classification of the fractures and nerve palsy (p=0.001).

There was significant correlation between DASH score and nerve palsy (p=0.035).

The study did not succeed in proving statistical significance between the other variables analyzed.

The p value on correlating wrist dorsiflexion and DASH score was 0.058 which indicate that there might have been significant correlation if the sample size was higher.

Table 5: Correlation of the various parameters

	p value	
Parameter	Soft tissue complication	Infection
Gustillo & Anderson classification (open fractures)	0.050*	0.269 (NS)
Diabetes mellitus	0.445 (NS)	0.844 (NS)
Smoking	0.368 (NS)	0.577 (NS)

* - statistically significant

NS – statistically not significant.

The above table demonstrates that the study has succeeding in proving statistically significant correlation between open fractures as per the Gustillo and Anderson score and soft tissue complication.

There was no demonstrable statistically significant correlation between diabetes mellitus or smoking and any of the parameters.

Table 5: Correlation of forearm movements with radiological parameters

	p value	
Parameter	Maximum radial bow	Location of the maximum radial bow
Forearm supination	0.375	0.332
Forearm pronation	<0.001	0.017

Strong statistical significance was found when maximum radial bow and the location of the maximum radial bow was correlated with forearm pronation signifying that loss of maximum radial bow and alteration in the location of the maximum radial bow results in loss of forearm pronation. (Table 5)

In order to assess the effect of the loss of maximum radial bow and the location of the maximum radial bow, the patients were divided into two groups [group A and B] based on the median value of maximum radial bow (7.58; range- 1.87-12.02) and into two separate groups [groups 1 and 2] based on the location of the maximum radial bow (43.17; range 17.15-51.55) and their correlation with forearm movements were analyzed. The results are given in Tables 6 and 7.

Table 6: Correlation between groups A and B with forearm movements

	Maximum radial bow		Supination (mean)	Pronation (mean)
	Median	Range		
Group A	6.70	1.87-7.58	70°	32°
Group B	10.12	7.72-12.02	65.45°	61.36°

Groups A and B are analyzed for correlation and it was found that there is strong statistical correlation between maximum radial bow and pronation between the groups (p=<0.001). It is also found that there group B with better restoration of the maximum radial bow has better forearm pronation.

Table 7: Correlation between groups 1 and 2 with forearm movements

	Location of the maximum radial bow		Supination	Pronation
	Median	Range		
Group 1	36.22	17.15-43.17	63.5°	35°
Group 2	46.62	44.94-51.55	71.36	58.64°

There is significant correlation between location of the maximum radial bow and forearm pronation between groups 1 and 2 ($p=0.010$). It is also found that there group 2 with better restoration of the location of maximum radial bow to near anatomical location has better forearm pronation.

DISCUSSION

Fractures of the diaphysis of both bones forearm are common injuries encountered in orthopedic practice. Open reduction and plate osteosynthesis is the commonest and currently the most favored treatment method of these injuries. (45)(46) (11) (46),(48),(49) (50).

Several authors have reported good functional outcome after plate osteosynthesis for fracture of the both bones forearm. In this study an attempt is being made to describe a special group of patients who sustain both bone forearm fractures but present late for definitive surgical management. Since such presentations are not common world over and are limited to certain locations, they have not been widely described or studied.

21 out of 36 patients (58.3%) who satisfied the inclusion criteria presented for review. Road traffic accident and work place injuries accounted for majority of the injuries. 71.4% of patients sustained injury to their non-dominant limb.

The mean DASH score was 39.9 ±15.67 points (range 10-75) which was higher than certain studies .[12 ± 10 (67); 18.6 ± 18.0 (68)] But the fact remains that these studies were done on acute forearm injuries and the mean delay in plate fixation of the forearm fracture in this study was 2.43 ± 3.46 months.

The mean range of forearm supination was 67.62 ± 14.37° whereas it was quite varied in some other studies [34 ± 21° (68); 85 ± 30° (67). The mean range of forearm pronation 47.38 ± 27.29° which was comparable to the results obtained by other studies [40 ± 27° (68); 75 ± 25° (67). 13 (61.9%) patients lost 20% or more of the arc of rotation of the forearm and 5 (23.8%) patients lost 40% or more of the arc of rotation of the forearm. There was strong statistical correlation between DASH scores and decreased forearm supination (p=0.006) which suggest that a decrease in forearm supination significantly affected the upper limb function. This is in agreement with other published literature even though some studies have found worsening function correlating significantly with forearm pronation (67).

The mean range of wrist dorsiflexion was 70.48 ± 18.57° and wrist palmar flexion was 65.95 ± 24.78° which was similar to the results obtained by several other authors following acute forearm palate osteosynthesis. Even though 10 (47.6%) patients had 20% or more loss of wrist arc of movement and 4(19.0%) patients had loss of more that 50% of wrist arc of movement, there was no significant correlation between DASH scores and wrist movements. This was echoed by several other studies. (67)(68)

Several other studies found significant correlation between functional outcome and finger grip strength. But this study result did not concord with this finding.

When the delay in presentation for definitive fixation was considered, there was strong correlation with wrist dorsiflexion (p=0.006) and also with finger grip weakness (p=0.039). This signifies that a delay in definitive fixation adversely affects the wrist movements and finger grip. The mean DASH score in this study (39.9 ± 15.67) was less than that found in some other studies [12 ± 10(41); 18.6 ± 18.0(62)].This is a significant outcome which proves adverse affection of the limb from neglecting the acute injury.

Several studies have proven the association between loss of maximum radial bow in the plain antero-posterior radiograph of the forearm and forearm function. (66) (68) (67). This study has proved strong correlation between alteration of maximum radial bow (p=<0.001) and the location of the maximum radial bow (p=0.017) with forearm pronation. There was significant correlation between loss of maximum radial bow and subjective loss of function as represented by the DASH score (p=0.045). When the entire sample was divided into two groups based on the median value, there was significant correlation between the radiological parameters between group A and B. This signifies that the range of pronation is significantly more when the maximum radial bow is restored to near normal and also as close to its anatomical location as possible. This reinforces the principle that anatomic reconstruction of the forearm with meticulous attention restoration of the radial bow is vital in restoring the limb function.

Proximalisation of the maximum radial bow resulted on loss of forearm pronation. The maximum radial bow has to be restored as close to the normal anatomical location possible for normal forearm function.

Another interesting outcome was the strong correlation which was proven between neurological complications and the severity of the fracture as denoted by the AO classification ($p=0.001$).

There were increased soft tissue complications in open fractures ($p=0.050$) as compared closed fractures.

Even though 17(81%) patients had significant pain in the affected forearm during follow up the study did not bring out any statistically significant association between pain and functional disability.

The delay in definitive fixation did not significantly affect union or soft tissue complications. The initial management of the forearm fracture, whether it was native splinting or other forms of management, did not significantly affect the outcome of plate osteosynthesis.

All the 21(100%) patients had achieved full clinical and radiological union at follow up irrespective of the delay in presentation or any other local or systemic factors.

CONCLUSION

Open reduction and plate osteosynthesis is seen to be a very good modality of treatment diaphyseal both bones forearm fractures in adult and as per this study and has resulted in 100% fracture union even in late presentation when reviewed at a mean follow up of 36.76 months. A delay in definitive fixation results in significant wrist and finger dysfunction. DASH is a widely accepted standardized scoring system to assess upper limb function and correlates strongly with forearm supination. Reconstruction of the maximum radial bow to near normal (8.08 ± 2.46) and the anatomic location of the restored maximum radial bow are vital in restoration of forearm function even in patients with delayed treatment.

LIMITATIONS OF THE STUDY

1. This study is it is a retrospective case series
2. The study involves a relatively small number of subjects treated by multiple surgeons.
3. A relatively high proportion of subjects were lost to follow-up.
4. The outcome assessment in this study is done on a small group of patients who responded to the invite and a significant number of patients were unreachable. This may have affected the results.

CLINICAL PICTURES – Follow Up (Operated Side – Left)

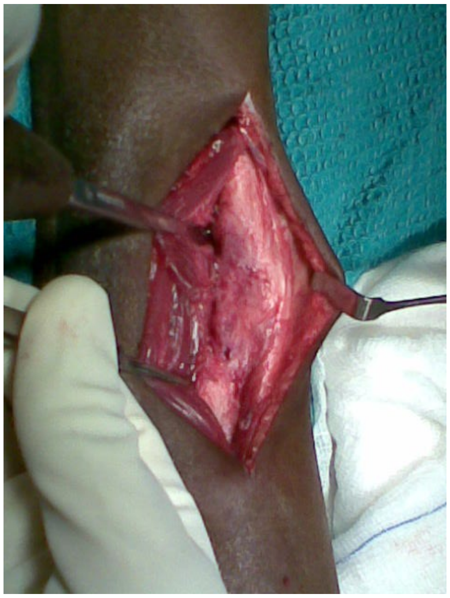
Pic 1- Elbow flexion – decreased on the left

Pic 2- Elbow extension

Pic 3 - supination

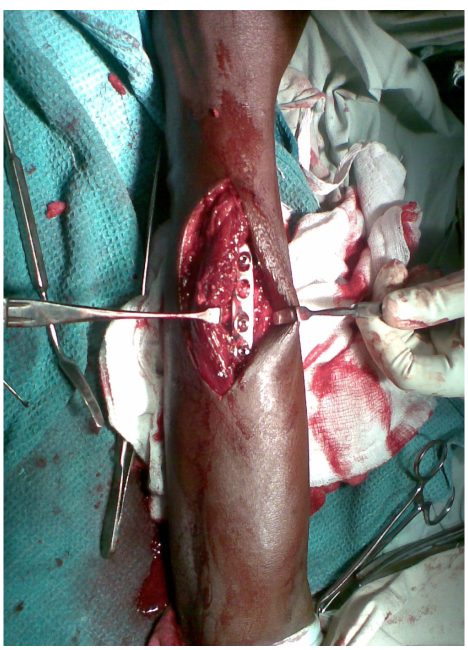
Pic 4 – Pronation – decreased on the left

INTRA OPERATIVE PICTURES

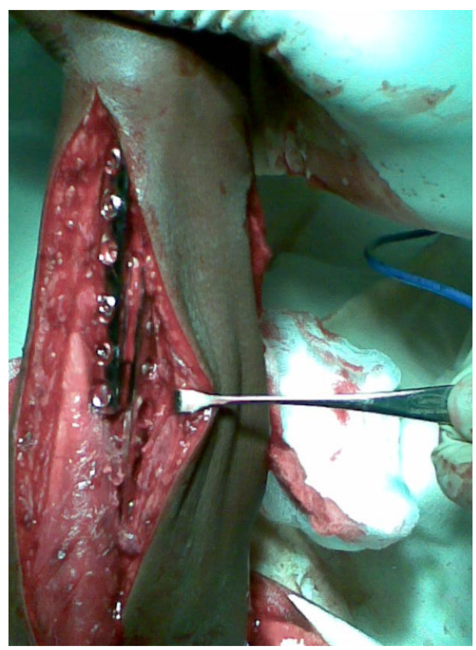


Pic 5 – Ununited fracture radius

Pic 6 - Ununited fracture ulna



Pic 7- Radius plating through dorsal approach



Pic 8 – Ulna plating through subcutaneous approach

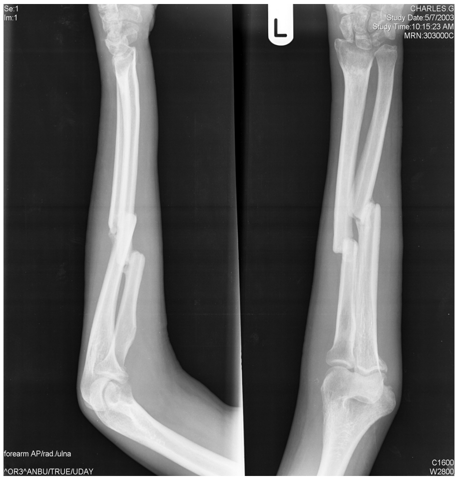
RADIOGRAPHS – Case 1

Xray 1 – Neglected forearm fracture; midshaft

Xray 2- Post operative radiograph – radial bow reconstructed

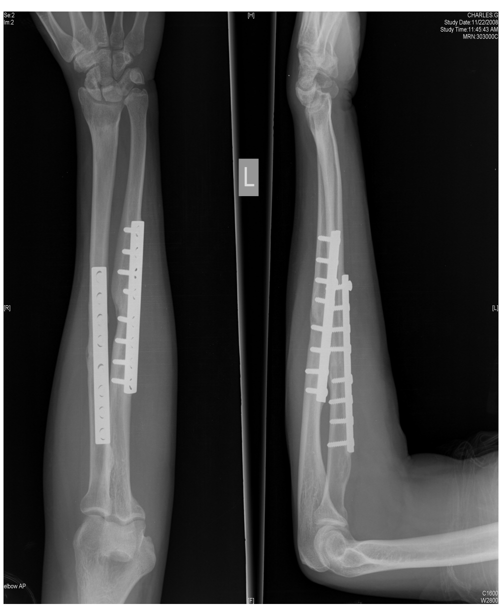
Xray 3- Follow up radiograph – fracture has united and radial bow is restored

RADIOGRAPH – Case 2



Xray 4- Neglected proximal forearm fracture

Xray 5- Post operative radiograph



Xray 6- Follow up radiograph – fracture has united

RADIOGRAPH – Case 3

Xray 7- Comminuted fracture forearm

Xray 8- Post operative radiograph – radial bow not restored

Xray 9 – Follow up radiograph – loss of radial bow

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Master sheet

AG CDT D I TI M G I SYS LM PST D SMOKI DA IN N PA PA SF B BG- ELB- EL SU PR W- W- FN P W FN X- V TI BO L

NAME E SEX PO OATI Tr L L M OI & AO M INJ B INJ M NG SH FN U IN LS T G- DL FLX B- PN O DF PF G W RI GRU E M W O

PUSHPAM	68	2	2	2	0	1	2	33	3	1	B.3.3	1	0	0	0	1	0	75	0	0	1	0	0	0	1	130	0	60	50	80	80	1	5	5	1	1	2	1	1.9	34
VINAYAGAM	27	1	2	2	0	1	2	36	1	1	B.3.1	3	1	0	1	0	1	50	0	0	1	0	0	1	0	130	#	70	50	45	50	0	5	5	1	1	1	3	4.5	43
GIRIJAVATHY	48	2	3	3	0	1	2	26	3	2	B.3.2	2	0	0	0	1	0	44	1	0	1	0	0		0	130	0	80	20	45	30	0	5	4	1	1	2	1	5.7	18
DEVENDIRAN	39	1	2	2	0	1	2	60	1	2	A.3.2	3	0	0	0	0	1	40	0	0	0	0	0	1	0	130	0	70	10	30	45	1	5	4	1	0	1	#	5.9	52
CHARLES	28	1	2	1	1	1	2	30	1	2	A.3.2	1	0	1	1	0	0	26	0	0	1	0	0	1	0	120	0	80	10	90	90	1	5	5	0	1	1	1	6.4	39
SIVA KUMAR	24	1	1	1	0	1	2	27	2	1	B.3.2	2	0	0	0	0	1	39	0	0	1	0	0	0	0	110	0	80	20	80	80	0	5	5	0	1	1	1	7	40
SANKAR	36	1	1	1	0	1	1	35	2	2	C.2.3	1	0	0	0	0	1	46	0	0	0	1	0	1	0	130	0	60	50	70	70	1	5	5	1	1	2	1	7.1	43
DHANANCHEZIA	33	1	1	1	1	1	2	54	2	1	C.2.3	3	1	0	0	0	0	57	1	1	1	1	1	0	0	130	0	70	20	50	30	1	5	5	1	1	1	2	7.4	34
KANAGABOOSH																																								
ANAM	69	2	2	2	0	1	1	38	3	2	A.3.2	1	0	0	1	1	0	10	0	0	1	0	0	0	0	130	0	70	50	75	90	0	5	5	1	1	2	2	7.4	45
MOHAMMED	21	1	3	3	0	2	2	12	3	2	B.3.1	1	0	0	0	0	0	29	0	0	1	0	0	0	0	130	0	60	40	45	20	0	5	5	1	1	1	2	7.6	38
VENKATESH	16	1	3	3	0	1	2	72	3	1	C.2.3	3	0	0	0	0	0	50	0	0	1	1	0	0	1	130	0	45	45	80	30	0	5	5	0	1	2	1	7.7	17
VINAYAGA	26	1	2	2	0	1	2	31	1	1	B.3.1	2	1	1	0	0	1	51	0	0	1	0	0	1	0	100	#	30	45	60	60	1	5	4	1	1	1	2	8.1	30
VIJAYAKUMAR	66	1	2	2	0	1	2	42	2	2	B.3.3	1	0	0	0	0	1	19	0	0	0	0	0	1	0	130	0	80	55	90	90	0	5	5	0	1	2	1	8.8	45
SUMATHY	27	2	1	1	0	1	1	34	2	2	A.3.1	1	0	0	0	0	0	47	1	0	1	0	0	1	0	130	0	40	60	70	60	0	5	5	1	1	2	5	9.5	48
JEYARAMA	48	1	1	1	0	1	2	33	2	1	C.2.2	3	1	0	0	0	1	58	1	0	1	1	1	0	0	130	0	65	60	80	80	1	5	4	1	1	2	2	10	48
SEKAR	36	1	1	2	0	1	2	38	1	1	B.3.3	1	1	1	0	0	1	51	1	0	1	0	1	0	0	120	#	70	60	70	80	1	4	4	1	1	1	2	10	49
CHANDRAPPA	35	1	1	2	1	1	2	60	1	1	B.3.3	3	1	0	0	0	1	30	0	0	1	0	0	0	0	130	0	70	70	90	90	0	5	5	0	1	1	1	10	44
PRABAKARAN	26	1	2	2	0	1	1	24	2	2	B.3.2	1	0	0	0	0	0	41	0	0	1	0	0	0	0	130	0	80	70	60	40	0	5	5	1	1	1	3	10	47
UMA ALICE	47	2	2	2	2	1	1	30	3	1	B.3.1	3	0	0	0	0	0	21	1	0	1	0	0	0	0	120	0	80	70	90	90	0	5	5	1	1	2	1	11	44
KESAVAMOORT	26	1	2	3	0	1	2	26	1	2	B.3.2	3	0	0	0	0	0	23	0	0	1	0	0	0	0	130	0	80	70	90	90	0	5	5	1	1	2	1	11	46
DEVARAJ	45	1	1	1	0	1	2	31	1	2	A.3.2	1	0	0	0	0	0	31	0	0	0	0	0	0	0	130	0	80	70	90	90	0	5	5	0	1	2	2	12	48

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NEGLECTED DIAPHYSEAL BOTH BONES FOREARM FRACTURES IN ADULT TREATED WITH PLATE OSTEOSYNTHESIS

ABSTRACT

AIMS AND OBJECTIVES

The aims and objectives of the study are:

- To retrospectively analyze all cases of adult neglected forearm treated with open reduction and plate osteosynthesis from January 2000 to October 2007
- To assess the functional outcome of patients
- To assess the clinical outcome the affected forearm and compared to the opposite normal limb
- To assess the radiological union
- To assess the maximal radial bowing and the location of the maximum radial bow and the relationship with forearm function.

STUDY DESIGN

This is a cross sectional study with retrospective case selection. A total of 21 patients were recruited for this study between August 2007 and August 2008.

METHODS

One-to-one interviews were conducted for obtaining the relevant history and applying the DASH questionnaire. Clinical examination was. MRC grading was used to assess the motor power. Standardized goniometer was used for the assessment of range of movement of the elbow, forearm and wrist. Neglected forearm fracture was defined as forearm fractures for which definitive surgical intervention was undertaken at least one month after the event. Standardized antero-posterior and lateral plain radiographs were obtained. Measurement of the maximum radial bow was calculated based on the formula described by Schemitsch and Richards. The location of maximum radial bow also was calculated. The plain radiographs of the affected forearm taken at the time of presentation were reviewed for evaluating the fracture configuration and classifying the fractures based on the AO/OTA system of classification for forearm fractures.

Inpatient records of the selected cases were obtained to ascertain the details of the surgical procedure and the details of the peroperative period and immediate postoperative period

RESULTS

There was statistically significant correlation between DASH scores and patients range of supination (p=0.006), wrist palmar flexion (p=0.016) and maximum radial bow (p=0.045). There was statistically significant correlation between the time of operation from injury and wrist dorsiflexion (p=0.003).There was strong statistically significant correlation between the AO classification of the fractures and nerve palsy (p=0.001). There was significant correlation between DASH score and nerve palsy (p=0.035). Strong statistical significance was found when maximum radial bow
(p= <0.001) and the location of the maximum radial bow (p= 0.017) was correlated with forearm pronation signifying that loss of maximum radial bow and alteration in the location of the maximum radial bow results in loss of forearm pronation.

All the 21(100%) patients had achieved full clinical and radiological union at follow up irrespective of the delay in presentation or any other local or systemic factors.

CONCLUSION

Open reduction and plate osteosynthesis is seen to be a very good modality of treatment diaphyseal both bones forearm fractures in adult and as per this study and has resulted in 100% fracture union even in late presentation when reviewed at a mean follow up of 36.76 months. A delay in definitive fixation results in significant wrist and finger dysfunction. DASH is a widely accepted standardized scoring system to assess upper limb function and correlates strongly with forearm supination. Reconstruction of the maximum radial bow to near normal (8.08 ± 2.46) and the anatomic location of the restored maximum radial bow are vital in restoration of forearm function even in patients with delayed treatment.

PROFORMA

NAME

AGE

SEX

1.male

2.female

PRESENT OCCUPATION

1.heavy labour

2.moderate labour

3.light labour

OCCUPATION AT TIME OF INJURY

1.heavy labour

2.moderate labour

3.light labour

WHETHER CHANGE IN OCCUPATION IS DUE TO INJURY

0 no

1 yes

DOMINANT HAND

1 right hand

2 left hand

INJURED HAND

1 right hand

2 left hand

DELAY IN DEFINITIVE MANAGEMENT

TIME FROM OPERATION (MONTHS)

MODE OF INJURY

1 road traffic accident

2 work place injury

3 domestic injury

FRACTURE CLASSIFICATION AO

GUYSTILLO ANDERSON

1open

2closed

INITIAL MANAGEMENT

1 native splint

2cast/slab

3surgery other than plating

SYSTEMIC INJURY

0 no

1 yes

OTHER INJURIES TO THE SAME LIMB

0 no

1 yes

PREVIOUS INJURY TO THE SAME LIMB

0 no

1 yes

DIABETES

0 no

1 yes

SMOKING

0 no

1yes

DASH

COMPLICATIONS

INFECTION

0 no

1 yes

NONUNION

0 no

1 yes

PAIN

0 no

1yes

NERVE PALSY

0 no

1 yes

SOFT TISSUE INJURY ☐

0 no

1 yes

BONE GRAFTING

EARLY

0 no

1 yes

LATE

0 no

1 yes

RANGE OF MOVEMENT

ELBOW

FLEXION(degrees)

EXTENSION(degrees)

SUPINATION

PRONATION

WRIST DORSIFLEXION

WRIST PALMARFLEXION

FINGER STIFFNESS

0 no

1 yes

MOTOR POWER (MRC GRADE)

ELBOW

WRIST

FINGERGRIP

RADIOLOGICAL UNIO

0 no

1 yes

MAXIMUM RADIAL BOW

DASH – **D**ISABILITIES OF THE **A**RM, **S**HOULDER AND **H**AND

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Write.	1	2	3	4	5
3. Turn a key.	1	2	3	4	5
4. Prepare a meal.	1	2	3	4	5
5. Push open a heavy door.	1	2	3	4	5
6. Place an object on a shelf above your head.	1	2	3	4	5
7. Do heavy household chores (e.g., wash walls, wash floors).	1	2	3	4	5
8. Garden or do yard work.	1	2	3	4	5
9. Make a bed.	1	2	3	4	5
10. Carry a shopping bag or briefcase.	1	2	3	4	5
11. Carry a heavy object (over 10 lbs).	1	2	3	4	5
12. Change a lightbulb overhead.	1	2	3	4	5
13. Wash or blow dry your hair.	1	2	3	4	5
14. Wash your back.	1	2	3	4	5
15. Put on a pullover sweater.	1	2	3	4	5
16. Use a knife to cut food.	1	2	3	4	5
17. Recreational activities which require little effort (e.g., cardplaying, knitting, etc.).	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.).	1	2	3	4	5
20. Manage transportation needs (getting from one place to another).	1	2	3	4	5
21. Sexual activities.	1	2	3	4	5

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
22. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups? *(circle number)*	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? *(circle number)*	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. *(circle number)*

	NONE	MILD	MODERATE	SEVERE	EXTREME
24. Arm, shoulder or hand pain.	1	2	3	4	5
25. Arm, shoulder or hand pain when you performed any specific activity.	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5
27. Weakness in your arm, shoulder or hand.	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? *(circle number)*	1	2	3	4	5

	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. *(circle number)*	1	2	3	4	5

DASH DISABILITY/SYMPTOM SCORE = $\left[\left(\frac{\text{sum of n responses}}{n}\right) - 1\right] \times 25$, where n is equal to the number of completed responses.

A DASH score may not be calculated if there are greater than 3 missing items.