"SURGICAL MANAGEMENT OF DIAPHYSEAL FRACTURES OF BOTH BONES OF FOREARM IN ADULTS WITH DYNAMIC COMPRESSION PLATE"

By Dr. RAGHAVENDER.G



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IN

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Under the Guidance of Dr. B.SHAIK NAZEER M.S.(Ortho) Professor



DEPARTMENT OF ORTHOPAEDICS, SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101 OCT 2015

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

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Dr. RAGHAVENDER .G.

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION, TAMAKA, KOLAR, KARNATAKA

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Place: Kolar

Signature of the Guide

Dr. B.SHAIK NAZEER,

Professor, Hospital KOL

Department of Orthopaedics,

Sri Devaraj Urs Medical College,

& Research Center, Tamaka, Kolar.

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTER, TAMAKA, KOLAR, KARNATAKA

ENDORSEMENT BY THE HOD, PRINCIPAL / HEAD OF THE INSTITUTION

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Dr. ARUN F. S. Orthopeadics Professor & HODES Medical College KOLAR-563 101

Department of Orthopaedics,

Sn Devaraj Urs Medical College,

& Research Center, Tamaka, Kolar

Dr. M. B. SANIKOP

Principal,

Sri Devaraj Urs Medical College

& Research Center, Tamaka, Kolar Principat

Devaraj Urs Medical Comago Pamaka, KOLAR-583 180

Date:

15/6/4

Place: Kolar

Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTER, TAMAKA, KOLAR, KARNATAKA

ETHICAL COMMITTEE CERTIFICATE

This is to certify that the Ethical committee of Sri Devaraj Urs Medical College & Research Center, Tamaka, Kolar has unanimously approved

Dr. RAGHAVENDER.G

Post-Graduate student in the subject of ORTHOPAEDICS

at Sri Devaraj Urs Medical College, Kolar to take up the Dissertation work entitled

"SURGICAL MANAGEMENT OF DIAPHYSEAL FRACTURES OF BOTH BONES OF FOREARM IN ADULTS WITH DYNAMIC COMPRESSION PLATE"

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Date: 15/6/15

Place: Kolar

Member Secretary

Sri Devaraj Urs Medical College,

& Research Center,

Tamaka, Kolar-563101

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ABSTRACT

Background:

In the present era of industrialization and mechanization and even in the rural set up, the fracture of both bone forearm are more common and more than any another diaphyseal fracture in the body. The forearm serves as a important role in the functioning of the hand. To achieve a satisfactory functional outcome, good anatomical reduction and internal fixation is a must. Though there are various modalities of treatment present for fracture both bones of forearm. Anatomical reduction, rigid internal fixation, early mobilization has excellent functional outcome with dynamic compression plate. The aim of the treatment is to reestablish the normal anatomy and good functional outcome of forearm. Rehabilitation is started immediately post operatively, which prevents disability to a large extent.

Therefore, the study of diaphyseal fracture of both bones forearm and fixation with dynamic compression plate becomes significant in present days and study has been under taken to evaluate its management in the clinical practice of the patients in our rural set up.

Objectives:

- To study the intraoperative and postoperative complications of the surgery.
- To assess the functional outcome of forearm after open reduction and internal fixation with DYNAMIC COMPRESSION PLATE.

MATERIALS AND METHODS:

This study is a hospital based prospective study centered in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from Nov 2012 to May 2014 in which 30 patients with diaphyseal fractures of both bone forearm treated with DYNAMIC COMPRESSION PLATE.

Results:

In our series of 30 cases, majority of the patients were males, middle aged, with road traffic accidents being the commonest mode of injury, involving middle third. Transverse or short oblique fractures were most common. The fractures united in all 30 patients. Full range of mobility of elbow, forearm and wrist joints were present in 26 patients (87%), 4(13%) patients having good range of movements.

Interpretation & Conclusion:

With rigid/anatomical internal fixation, dynamic compression plate is a good fixation for displaced diaphyseal fractures of both bones forearm. Adherence to AO principles, strict asepsis, proper post operative rehabilitation and patient education are more important to obtain excellent results.

Key Words: Forearm; Fracture; Diaphyses; Internal fixation; Dynamic compression plate; Transverse; Short oblique; Delayed union.

LIST OF ABBREVIATIONS

AO - Arbeitsgemeinschaft für Osteosynthesefragen

ASIF - Association for the study of internal fixation

BP - Blood Pressure

BT/CT - Bleeding Time / Clotting Time

DCP - Dynamic Compression Plate

Deg - Degree

K wire - Kirschner wire

ECG - Electrocardiography

FBS/PPBS - Fasting Blood Sugar / Postprandial Blood Sugar

Hb - Haemoglobin

HbsAg - Hepatitis B Virus Surface Antigen

HIV - Human Immunodeficiency Virus

SFS DCP - Small fragment set Dynamic Compression Plate

LC-DCP - Limited Contact Dynamic Compression Plate

Lat - Lateral

PC-FIX - Point contact fixator

AP - Anterior posterior

ORIF - Open Reduction and Internal Fixation

OTA - Orthopaedic Trauma Association

RR - Respiratory Rate

RTA - Road Traffic Accident

- Fracture

LCP - Locking compression plate

No. of patients - Number of patients

POP - Plaster of paris

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Introduction

INTRODUCTION

The forearm, being a component of upper limb serves important movements that are important in activities of daily living. The forearm, in combination with the proximal and distal radioulnar joints, allows pronation and supination which in turn helps hand, to perform multi axial movements.

The incidence of forearm fractures are increasing faster than the predicted rate due to increase in population, increasing number of vehicles, rapid industrialization, increased incidence of violence and various sports activities have contributed to the increased incidence of fracture shaft of both bones forearm.

Fracture of the forearm both bones may result in severe loss of function unless adequately treated. Hence good anatomical reduction and internal fixation of these fractures is necessary to restore function.¹

Closed reduction which was employed in earlier days yielded unsatisfactory results from either non-union or loss of motion. Also there are complex forces acting on the forearm bone that makes reduction and its maintenance of displaced fracture fragments difficult.²

Union may be achieved with any of the methods available however severe loss of function may be the end result unless adequately treated with proper technique and implants.

With the development of compression plate osteosynthesis which provides a good treatment option and predictable outcome, there is an important change in the treatment of forearm fractures ³. This method helps in perfect reduction of fracture fragments in anatomical position by rigid fixation and early mobilization, the normal functions of the hand can be reachieved at the earliest

Bagby and Denham were the first describe dynamic compression plate and more recently developed by the AO school has an intrinsic compression device making extensive dissection unnecessary. The plate depends upon the obliquity of cylindrical screw holes for compression which is produced as the screws are driven home. The most effective method of producing rigid internal fixation is by the use of compression plates developed by the AO School in Switzerland.⁴

AO (Arbeitsgemeinschaft fur Osteosynthesefragen) / Association for the Study of internal fixation (ASIF), dynamic compression plate provides more secure fixation without cast protection. It produces sufficiently rigid fixation, impaction and compression of the fracture site. It can be inserted through a smaller incision than the standard plate because no external compression device is required.

The authors concluded that the use of ASIF compression plates for diaphyseal fractures of both bone forearm is a very successful method of obtaining union and restoring optimum functional use of the extremity. The recently developed ASIF compression plating apparatus seemed to satisfy the basic objectives of internal fixation; namely

(1) Anatomical reduction, (2) Preservation of vascularity, (3) Mechanically stable fixation, and (4) Rapid mobilization of the joints in proximity.

The functional outcome was certified using "Anderson et al, scoring system".

The variables taken into consideration were

- L Union of the fracture,
- Range of elbow and wrist movements.5
- Extent of functional capacity reached

To conclude, satisfactory reduction of displaced fractures of the forearm bones is difficult to achieve by closed methods and if achieved, it is hard to maintain.

So with open reduction and internal fixation using dynamic compression plate, it is possible to achieve perfect fracture reduction, rigid fixation, better bone healing and mobilization. Cancellous bone grafting can be used whenever there is a need.

Objectives

OBJECTIVES

- To study the intraoperative and postoperative complications of the surgery.
- To assess the functional outcome of forearm after open reduction and internal fixation with DYNAMIC COMPRESSION PLATE.

REVIEW OF LITERATURE

Fractures are known to occur since evolution of mankind. However Prehistoric man must have had his troubles with broken bones. According to Sudhoff, the bones of Neolithic man showed traces of attempts at corrections of deformities. Apparently enough specimens of fractured bones from that age have been found to justify statistical statements.⁶

Fractures have been recognized and treated as long as recorded history.

History of fracture and its knowledge dates back to Egyptians Mummies of 2700

BC.⁷

Recorded descriptions of the methods of fracture treatment days back to Egyptian times, which has been clearly mentioned in **Edwin Smith Surgical Papyrus.** Egyptians used palm bark and linen bandages for management of fractures. Clay and lime mixed with egg white were used, but the material most commonly used has been, the wood.⁸

From the nubian excavations, came several specimens of forearm fractures which are now in the museum of the Royal College of Surgeons in London. It is a model of neat splinting with wood from the stems of palm leaves, the padding being of coarsely woven cloth such as we today would call homespun. The splints are applied without any attempts at control of the fragments. There is good approximation, but no union.⁶

So in those days, surgeons merely used to fix two bone fragments in an approximate alignment which resulted in mechanical failures either loss of function or pon-union.

Then came the era Plaster of Paris. described by Matthysen, a Dutch surgeon in 1852. It is made from gypsum, a naturally occurring mineral.prepared from ordinary cotton bandage role smeared with POP powder. When this material is dipped into water, the powdery plaster of paris is transformed into a solid crystalline form of gypsum, and heat is given off.

Principles. Three points of force are produced by the operator, who moulds the cast firmly against the proximal and distal portions of the extremity (two of the points) and locates the third point directly opposite the apex of the cast. Periosteal or other soft tissue attachments usually are required on the convex side of the cast to provide stability.

So there is always a chance for cast slippage if not properly applied. This may result in malunion or non-union if there is motion at the fracture site.

In recent years, fibreglass cast materials are trying to replace plaster of paris.

Most of these are a fiberglass fabric impregnated with polyurethane resin.

- Merits:-These materials are strong, lightweight, and resist breakdown in water.
- Demerits:-They are harder to contour than plaster of paris, and the polyurethane may irritate the skin. Fiberglass is harder to apply, although the newer bias stretch material is an improvement.

In 1770, the first attempt at internal fixation took place in Toulouse, France. It was Lapejode and Sicre, two surgeons who used brass wire for cerclage of long bone fractures.⁸

In 1843, Malgaigne performed fracture stabilization using griffe.8

Albin Lambotte of Belgium, in 1894 designed a diamond shaped plate for the treatment of diaphyseal fractures. However, metal reaction led to frequent failures until modern metals were introduced in 1937. He also coined the term "Osteosynthesis", by which he meant stable, bone fixation. He is generally regarded as the "Father of Internal fixation".

In 1912, Beckman advocated plate fixation of diaphyseal fractures. A year later Nicholaysen described intramedullary nailing.⁹

The concept of intramedullary nailing was developed by **George Schore** in 1913. He used silver rods for both radius and ulna. 10

Later Gilfillen developed a method of fixation of radius and ulna using metallic plates.¹⁰

Robert Danis a surgeon in Brussels, published two books on osteosynthesis in 1932 and 1940. The second of these works recorded fascinating observations on the use of rigid fixation devices his aim was to stabilize the fracture firmly so that securing recovery of soft tissue injury, joint mobility, and muscle function, i.e. immediate functional rehabilitation. To achieve this end he devised a compression plate and, after anatomically reducing the fracture, he compressed the bone ends together to increase the rigidity of fixation.⁸

Carrel (1938), studied the causes of poor results and pointed out the reasons as inadequate immobilization, imperfect reduction and early removal of splints. He claimed that proper traction gave satisfactory results. Fracture of the forearm bones may result in severe loss of function, unless adequately treated.

Diaphyseal fractures of radius and ulna present specific problems in addition to problems common to all fractures of shaft of long bones. Retaining length, apposition,

axial alignment and achieving normal rotational alignment is necessary if a good range of pronation and supination are to be restored. Mal-union and non-union occur more frequently because of the difficulty in reducing and maintaining the reduction of two parallel bones in the presence of the pronating and supinating muscles that have angulating and rotational influences. Because of these factors open reduction and internal fixation for diaphyseal fractures in the adults are generally accepted as best method of treatment ^{2,11}.

Evans Major E. Mervyn (1945), described methods to determine rotational displacement by special radiography technique (tuberosity view) and their correction. He demonstrated that rotational position of fractures which involve upper and lower third are well seen on supination instead of midpronation. 12

Patrick (1946), pointed out that when fractures of both bones of the forearm were perfectly aligned in both anteroposterior and lateral radiological views, the degree of rotation were full. He also considered that the restriction of motion in these fractures was due to callus or fibrous tissue in the interosseous space, especially from ulnar side resulting in shortening and fixation of the interosseous membrane.¹³

Knight and Purvis (1949), in their paper on diaphyseal fractures of both bones forearm describe about the difficulty of closed treatment and the high failure rate in closed reduction and cast application.⁹

A Swiss Surgeon Maurice E. Muller, was inspired by Robert Danis books, put these ideas into practice to investigate this new healing phenomenon. He along group of surgeons on historical weekend in 1958 formed the AO group

Arbeitsgemeinschaft fur osteosynthesefragen), later on to be known in

Significant speaking countries as the Association for the study of internal fixation

ASIF). This group dedicated itself to research into osteosynthesis, the design of

propriate instrumentation for fracture surgery and the documentation.⁸

They found that the more accurately a fracture is aligned, the less demand will be for callus. Four principles were accepted as "Working hypothesis".

- Anatomical reduction
- Rigid internal fixation
- Atraumatic technique on soft tissue as well as on the bone.
- Early pain free active mobilization.

According to AO "Life is movement and movement is life" should be the guiding principle of fracture care. A satisfactory internal fixation is achieved only when external splinting is superfluous and when full active pain free mobilization of muscles and joints is possible. This is the AO's main objective and is best achieved by a stable internal fixation which will last for the whole duration of bone healing.

Smith (1959), showed that certain long oblique fractures could be fixed with two screws. Also satisfactory intramedullary fixation could be achieved by using prebent Diamond shaped nails.¹⁴

Anderson et al at the Campbell Clinic from 1960 to 1970, revived experience of 244 patients (216 with closed and twenty-eight with open fractures) with 330 acute diaphyseal fractures of the radius and ulna which were treated with ASIF compression plates and followed for from 4 months to 9 years. 112 patients had fractures of both bones of the forearm, 50 single fractures of the ulna, and 82 single fractures of the

radius. In all, 193 fractures of the radius and 137 fractures of the ulna were treated by compression plating .63 (25.9 per cent) with severely comminuted fractures also had iliac-bone grafts. The over-all rate of union for the radius was 97.9 per cent and for the ulna, 96.3 percent. He achieved excellent functional results in acute diaphyseal fractures of forearm and advised minimal stripping .ASIF compression plates, therefore, provided a successful method for obtaining union and restoring optimum function.⁵

Brunwell & Charnely (1964), in their series of 102 cases (130 fractures), compared patient who were treated early i.e. within 1 week and after 1 week and concluded that by delaying surgery, non union chances are more. They also said that the fixity of plate depends upon the obliquity of cylindrical screw holes for compression which is produced as the screws are driven home. The most effective method of producing rigid internal fixation is by the use of compression plates developed by the AO School in Switzerland.¹⁵

Sarmiento et al, (1975), in their study of treatment of forearm fractures in adults fractures and can achieve good functional results with avoidable complications. ¹⁶

But both bones fracture conservatively treated with the k wire had unsatisfactory results as they were unable to prevent side to side angular and rotatory movements. Intramedullary nails with bone graft improved the results but closed methods alone using these devices produced unsatisfactory results.

As a result of this, more rigid fixation by means of plate and screws was introduced. But normal plates did not produce compression at the fracture site. When DCP were used the overall union was increased to 90 to 97% with 90 to 97%

satisfactory results. Thus compression plating is good method of achieving early osteosynthesis and good function in forearm fractures.^{5,17}

The dynamic compression plate (DCP) was developed in 1979 by Perren and used successfully in humans by Allgower et al in the same year. Its spherical geometry not only allowed self compression but also enabled the maintenance of a congruent fit between the screw and the plate hole at different angles of inclination. Thus, the plate was more adaptable to different situations of internal fixation and could fulfill all the different plate functions, also they published a wonderful series of cast bracing. They avoided below and above joint immobilization and still documented excellent

functional results.18

In a study by Parren SM (1979), they proposed the use of biodegradable polymeric materials, avoiding a second operation for removal of implant. No such material has yet made available for use with conventional techniques of internal fixation, which combines adequate strength, ductility, maintenance of compression and degradability without marked tissue reaction. Tissue tolerance and local effects on infection are still unsolved problems.¹⁹

Allgower M (1977 to 1980), analysed 1903 radial shaft fractures, 666 ulnar shaft fractures, for 97% cases narrow DCP was used. They noted that there were 3.2% non-union and rest of them had good functional outcome. They recommended 3.5mm DCP for fixation of forearm fractures.²⁰

Grace JG and Eversmann W(1980), analysed 64 patients with fracture of adius and ulna fixed with AO compression plates. The purpose of their study was to be determine the effect of early post operative mobilization after rigid fixation.²¹

Uhthoff HK and co-workers (1981), have compared stainless steel and transium plates in the healing of osteotomies in beagles and found that radiologic bone loss was 19% for stainless steel and only 3% for the titanium plates. While histological measurements showed a total bone loss of 3.7 per cent under titanium alloy and of 11 percent under stainless steel plates.²²

Rai PK (1981), analysed 37 patients of forearm fractures treated by compression plateing and followed for more than one year. Excellent and good results were obtained in 89.2 % cases. Most of the cases showed union by 10 weeks.²³

Garland DE (1982), analysed with 47 forearm fractures in 661 head injured adults. They found no non-union and one delayed union. In 20% traumatic heterotrophic ossification developed at the elbow. 24% demonstrated calcification in the interosseous membrane with myositis in 18%. High rate of union was accounted to delayed surgery. Their review failed to demonstrate the association of head injury, increasing the rate of union. Authors recommended some type of internal fixation and early motion as the treatment of choice. They corroborated interosseous membrane and collateral ligaments of the elbow ossification, to their inherent capacity to ossify after direct trauma.²⁴

Watson-Jones (1982), said "Internal fixation is nothing more than a bone suture" stressing the importance of immobilization after internal fixation. Finger and shoulder exercises should be encouraged right from the start. He condemned the idea "Internal fixation of the fractures of the forearm with metal can allow unrestricted activities", mobilization can be achieved with plates but full activity requires radiological union.²⁵

Hadden WA (1983), conducted study on the animals to know the effect of compression on bone with the help of measuring device that measured compression as bone healing progressed, they noted that there was loss of compression as the fracture beals and some amount of compression persisted even after bony union. The fall in compression was due to the haversian remodeling. They concluded that compression and absolute rigidity of fracture ends that results from the force applied is highly favorable for fracture healing.²⁶

Stern PJ, Drury WJ (1983), Outlined the complication of forearm fractures and apply seal radius/ulna fractures. Major complications occurred in 28% of cases, hence non-union occurred in 93% of cases, treated with only 4 screws.

They concluded that

- Plating with 4 screws may be inadequate fixation for forearm fractures and at least 5 screws must be used to affix the plate to either radius / ulna.
- The ulna remains the most difficult bone to achieve primary healing. This may be due torsional stresses that increase during pronation and supination.
- Synostosis appears to be more common in patients who sustain concomitant head many and hence heterotrophic ossification.²⁷

Chazi RM, Haves M (1986), reported entrapment of flexor digitorum profundus in the ulnar cortical defect (in fracture both bones of forearm). The authors opined that complication can be avoided by achieving anatomical reduction of the both bones time of manipulation and by careful examination for active and passive range of motion of all digital joints with wrist in extension.²⁸

Moed BR (1986), conducted study open fractures of the diaphysis of the means, they demonstrated immediate stable plate fixation is a beneficial method of

treatment of open fractures of forearm and achieved excellent or good functional results in 85% of the series.²⁹

A study by **Tscherne H** (1986), was conducted measuring the magnitude of prestressing with transverse fractures. Data from their work are presented.

Prestressing of a compression plate applied to the tension side of a bone produces an enhanced dynamic tension band effect. 30

Shah (1988), in his study of 134 patients compared semi tubular plate with 3.5 mm DCP used for the treatment of forearm diaphyseal fractures. They concluded that 3.5 mm DCP fixation gives excellent fixation and limb can be mobilized immediately.³¹

Peter A. Deluca et al (1988), conducted study regarding refracture following removal of a plate that has been used to treat a fracture of the forearm.

They identified following risk factors for refracture,

- The nature of the original fracture (a disproportionate number of refractures occur in patients in whom the initial fracture was due to high-energy trauma or a crush injury, was open, or was associated with other fractures in the extremity).
- Failure to achieve adequate initial compression or reduction in a comminuted fracture.
- Radiographic determination that the site of the original fracture has remained

A retrospective study by Chapman et al (1989), was done of eighty-seven matter who had 129 diaphyseal fractures of either the radius or the ulna, or both, and were treated with fixation using an AO dynamic compression plate. Open matter were internally fixed primarily, and both comminuted and open fractures matterly had bone-grafting. 98% of the fractures united, and 92% of the patients were an excellent or satisfactory functional result, the rate of infection was 2.3 per

Plate in 2 patients, but no refractures after removal of a 3.5 millimeter plate. The authors concluded that the 3.5-millimeter-plate system gave excellent results in patients who had a fracture of the forearm, and it minimized the risk of refracture. Immediate plate fixation of an open fracture of the forearm, with a low rate of complications, is possible.¹⁷

In the study conducted by Wang JP et al (1991-2003), data from 25 patients showed that early meticulous debridement, good open reduction and internal fixation a small DCP proved very effective in the management of type I and II open sectures of both the radial and ulnar diaphyses.³³

schemitsch (1992), conducted regarding effect of malunion on functional outcome plate fixation of fractures of both bones of forearm in adults. The authors cancluded that restoration of normal radial bow was necessary to achieve good functional outcome.³⁴

D. Iversen, Marc F. Seinotkowski (1994), in their Manual of orthopaedic beapeutics have listed following observations and recommendations

- In adults it is difficult to achieve a satisfactory closed reduction of displaced fracture forearm bones, and if achieved, it is hard to maintain.
- by open reduction and plate fixation.
- minimum, there must be screws engaging six cortices above and below the site. The use of 3.5 mm plate systems has nearly eliminated the problem of after plate removal. Eight hole plates are used most often.

- Cancellous bone grafting to these fractures, in addition to plate fixation, should be considered, as the union rate using this method of treatment has been nearly 100%.
- The arm is immobilized in a long arm plaster cast until there is roentgenographic evidence of union. Reliable patients may be place in a removable splint and early motion started as soon as wound healing is complete.³⁵

Campbell's Operative Orthopaedics says "with compression plate fixation, early active motion is possible. This helps prevent muscle atrophy and joint stiffness, which often are responsible for unsatisfactory results." 36

Miclau T (1995), performed mechanical comparison of DCP, LC-DCP and Point contact fixator (PC-fix) in cadaveric sheep tibiae and concluded that the DCP has torsion and bending properties comparable with LC-DCP and PC-Fix in fixation of simple transverse diaphyseal fractures.³⁷

Study conducted by Sharad Goyal (1997), on 50 patients each with narrow DCP and SFS DCP, fractures were middle 1/3 rd of forearm. Thought both provided good matomical alignment in both the groups, observed that SFS DCP fixation functional results were excellent in 86% as compared to 80% after narrow DCP. Average time for union after narrow DCP 13.6 weeks and SFS DCP 12.8 weeks.³⁸

study by Mihovil Ivica, et al (2000), stated stable internal fixation with plate reduces and allows for early soft tissue rehabilitation without the use of external splints or Restoration of forearm and hand function is ensured by use of DCP. 39

comminution may be quite marked and closed reduction is often difficult or mossible to achieve. The best treatment for displaced fractures of the forearm bones the fit adult is open reduction and internal fixation, usually by placing both bones mough separate incision. 3.5 mm AO dynamic compression plates are commonly with the radial plate contoured to fit the curve of the shaft. The screws should referably engage 6 cortices above and below the fracture. The aim is to achieve a modify of fixation which will permit early mobilization.

Goldfarb CA, W.M. Ricci, et al (2005), aim was correlated the health status with objective and radiological outcomes in patients treated by open reduction and internal fixation for both bones forearm, they assessed 23 patients. over all the functional outcomes showed that operative stabilization by plate and screws led to reliable finctional outcomes.⁴¹

Droll KP (2007), showed that Internal fixation of diaphyseal forearm fractures has seen associated with high union rates and satisfactory forearm motion. The purpose of study was to investigate patient-based functional outcomes and to objectively strength following plate fixation of fractures of both bones of the forearm. 42

arjan GJ. Bot et al (2011), conducted study on long term outcomes of fractures of both bones forearm, the results were similar to the results reported in the short-term and mid-long term follow up studies, most reduction in grip strength and range of nation, and limited arm - specific disability. As compared with the sketetal mature

cohart, patients in the skeletally immature cohart had slightly but significantly better motion, on the average, but no difference in the grip strength or disability. 43

Ibrahim Azboy et al (2013), Forty-two patients with diaphyseal forearm fractures were retrospectively analyzed. Of those, 22 had been treated with the LCP (LCP group) and 20 had been treated with the DCP (DCP group). Patients were assessed using the Grace-Eversmann criteria and the Disabilities of the Arm and Shoulder and Hand questionnaire during the final follow-up. Locking compression plates and DCPs have similar functional and radiological results in the treatment of adult diaphyseal forearm fractures. Therefore, the authors believe that the correct surgical technique is more important than the plate type in such fractures.

EVOLUTION OF PLATE

According to Mears, plating of fractures is traceable into the last century, when Hansmann described a percutaneously removable plate in 1886. Later, Lane, Lmbotte, and Sherman developed implants and techniques of plate osteosynthesis.

Pauwels defined tension-band techniques in 1935.

Peterson defined basic principles of bone plating in 1950.

- Careful implant handling
- Correct plate contour
- Proper screw head orientation
- Screw hole measurement with depth gauge
- Final tightening of all screws

It was Danis in 1950's pioneered techniques of compression osteosynthesis and primary union biologically. He was the first to report use of inter fragmentary expression by applying plates under tension along longitudinal axis of the bone.

- A bone plate has two mechanical functions: 45
- Transmits force from one end of a bone to the other, bypassing & thus protecting the
- Bolds the fracture ends together while maintaining proper alignment.

Regardless of their length, thickness, geometry, configuration/type of holes, all are classified into four groups. 45

- Neutralization plate: It acts as a bridge. It transmits various forces from one end of the bone to the other, bypassing the area of fracture. Its main function is to act as a mechanical link. A plate used in combination with a lag screw is also a neutralization plate counteracting the torsional, bending and shearing forces.
- Compression plate: The plate produces a locking force across a fracture site to which is applied. The effect occurs according to Newton's third law. The bone under compression will have superior stability, improved milieu for bone healing and early mobilization. The direction of compression force is parallel to the plate

ROLE OF COMPRESSION

- Compaction of the fracture to force together the inter digitating spicules of bone and increase the stability of the construct.
- Reduction of the space between the bone fragments to decrease the gap to be midged by the new bone.
- material and the blood supply through enhanced fracture stability
- Resists the tendency of the fragments to slide under torsion or shear.

Methods of achieving compression are by:

- Self compression plate with eccentric placement of screw.
- Tension device
 - 3. Buttress plate: The mechanical function of this plate is to strengthen (buttress) a weakened area of cortex. The plate prevents the bone from collapsing during the healing process. It has a large surface area which facilitates wider distribution of load. A buttress plate applies a force to the bone which is perpendicular to the flat surface of the plate.
 - 4. Condylar plate: this is mainly used in intraarticular distal femoral fractures. It maintains the reduction of the major intra articular fragments, hence restoring the anatomy of the joint surface. It also rigidly fixes the metaphyseal components to the diaphyseal shaft, permitting early movement of the extremity. Special instrumentation is required for application. Its use is diminishing with the advent of condylar screw.

Plate fixation techniques, as mainly practiced, necessitate exposure of the fracture site, evacuation of the haematoma, and violation of the periosteal circulation of the bone in proportion to the degree of soft tissue release performed by the surgeon. Whether the fracture haematoma is a source of cellular elements contributing to fracture healing, but preservation of the haematoma may be of value.

DYNAMIC COMPRESSION PLATE

Bagby and Denhan (1956) first described the dynamic compression plate (DCP).

The studies of Eggers and associates, of the effect of compression on the bealing of experimental fractures in animals were the first attempts to demonstrate at a compression force applied to healing bone fragments could influence the rate of

healing. However, Eggers' slotted Plate did not represent a clinical application of the

Perhaps the first surgeon to use a true compression plate in the treatment of acute fractures was Danis, in 1949. Danis had less experience and less encouraging with fractures of the humerus, tibia, and femur, and he wrote about his coapteurs' in 1956.

Later it was introduced in 1965 by AO School which follows the basic design of Danis but has a much more sophisticated compressing mechanism which is applied temporarily at one end of the plate. Because the screw of this compression device has a hexagonal head and the screws and holes in the plate are of special design, a kit which includes the necessary screws, screwdrivers, and wrenches must be used, as well as a long incision and an extra screw-hole in the bone to secure the compressing mechanism.

DCP is now the workhouse of AO system. When introduced in 1965 it was made of Titanium, but it is now fabricated from 316 stainless steel (Zimmer) and of Witallium (Howmedica).⁴

The DCP of AO/ASIF consists of a plate with obliquity of cylindrical screw holes compression which is produced as the screws are driven home. Due to this mechanism, use of a tension device is not required. This has made the plate more adaptable to different situation of internal fixation and can be used as a static compression plate, a buttress plate, a neutralization plate or as DCP. 46

As the name indicates DCP has the ability to cause the fragments to approximate to one another, resulting in self compression at the fracture site. It also achieves a congruent fit between screw head and plate hole at different angles of acclination.

By applying DCP on the tension side of the bone, the implant absorbs all the stress while all the compressive stress is taken up by the bone. Plate have on the undersurface for the hook of the tension device. 46

Compression Plate using external tension device:

Fracture is reduced; plate is applied and held in place with a bone clamp. The is fixed to the shorter fragment by inserting a screw near the fracture site.

Tension device is fixed to the other fragment temporarily with a screw beyond the and hook of the tension device is engaged in end hole of the plate. Screw of the ension device is tightened to pull on plate and compress fracture. Once it is fully tened the fracture is under maximal axial compression and the remaining screws are inserted. 45,46

Advantages:

- Provides rigid fixation and also prevents rotational strain
- There is no interference with medullary blood supply and there is no external callus formation, therefore there is no encroachment upon the interosseous space.

Disadvantages

- The use of external tension device will require longer exposure.
- More periosteal stripping, would delay fracture union.

Dynamics of DCP

Screw hole of DCP can be compared with a ball confined to an inclined cylindrical path, where it slides down and horizontally. The screw hole resembles two balf cylinders placed at an angle. The spherical gliding principle is implemented at both ends of the plate hole, which enables compression in either direction along its

geometry and eccentric placement of the screw in the screw hole. The under surface of the screw resembles the ball, and sloping wall of the screw hole is analogous to the inclined path. The screw descends as it is inserted by twisting the slope of the screw hole causes the plate to move at right angles to the direction of the descend the horizontal cylinder (path) facilitates this movement. The aim is to position the screw head at the inter section of the inclined and downward cylinder. At the end point the screw head has a spherical contact in this screw hole which results in maximum stability without completely blocking the horizontal movement of the screw. Side ways movements of the screw head are impossible.

The strength of bone plate assembly will be influenced by the character of the fracture. Transverse fractures are under stronger compression than oblique fractures.

Communition, inadequate reduction and missing fragments all contribute to the weakness of the assembly.

The interplay between

the spherical screw head and
the geometry of screw hole
permit the angulations of the
screws in all directions.

Maximum 25° longitudinally
and 7° side ways. It also
facilitates the insertion of an
oblique lag screw across the plate.

Figure -1: Mechanism of dynamization of DCP

advantages of DCP. 45,46

- Table of two load screw in main fragment for axial compression at fracture.
- Congruent fit between screw head and plate hole
- deg horizontally, 7 deg sideways.
- **Exement** of a screw in neutral position without danger of distraction of fragments.
- **Exercise** of a load screw into hole positioned most favorably for a given fracture.
- screws permit compression.
- Compression of several fragments individually in comminuted fractures.
- Application as a buttress plate in articular areas by inserting the screws in the buttress
- **Early** mobilization is possible.
- inclined surface allows using lag screw in spiral or oblique fractures.

Disadvantages of DCP: 47

Inclination of Screw Hole:

The geometry of the DCP hole is such that in the long axis, a screw cannot be more than 25°. This has led to difficulties to lag short oblique fractures through the plate.

Flat undersurface:

The flat undersurface of bone leads to major interference with periosteal blood to plate induced osteoporosis. The potential danger of necrosis, formation of a sequestrum from underneath the plate with the interference in the steal blood supply immediately below the plate, this area heals more slowly. At the time of plate removal from the tension side of the bone, there is a notch in the which behaves as a stress riser and may induce or facilitate a refracture. So it is necessary to protect bone till it consolidates after plate removal.

Distribution of Plate Holes:

When a plate bridges a defect in the bone diaphysis, a fatigue fracture can because of stress, due to cyclic weight bearing, flexural and or torsional loads, becomes concentrated at the exposed plate holes.

Asymmetry of plate holes:

To be best suited for the more common multi fragmentary and complex facture, a plate must have symmetric plate holes, allowing compression in both fractions. The plate hole of the DCP is asymmetric: the self-compressing part of the hole is located at the end of the plate hole away from the fracture.

Fragile lining:

Plates with a rectangular cross section provoke the formation of a magnetively thin bony wall along the length of the plate. If the ridges so formed are they are easily nicked at the time of the plate removal. This not only renders the less strong, but may also act as a stress riser and contribute to failure.

Important dimensions 46

Name	Thickness	Width	Hole spacing	Hole length	Uses
45mm Broad	4.5 mm	16 mm	16&25mm	8.5 mm	Humerus and
DCP	63				femur
4.5 mm narrow	3.6 mm	12 mm	16&25mm	8.5 mm	forearm, tibia & pelvis
3.5mm DCP	3.0 mm	10 mm	12&16mm	6.5mm	radius and ulna
27mmDCP					mandibular surgeries

The number in the beginning indicates the size of cortical screw used.

The Drill guides for DCP 46

- The neutral drill guide
- The load drill guide

The Neutral drill guide (Green color):

Used when drilling for a screw in neutral position, at the intersection of the cylinders. A minimal movement of 0.1 mm in fact occurs when the screws are tightened even in neutral position resulting in slight degree of axial compression.

The load drill guide (Gold color):

This allows eccentric drilling, placing the screw in a load position. The little arrow on the top must point towards the fracture because when the screw is driven home, it is is placed 1.0 mm horizontally. When screw is tightened its head slides downwards the inclined path plane resulting in axial compression of the bone and tension in the plate. Insertion of one screw in load position results in axial compression of 50-80. This is used only to achieve axial compression once the fracture has been materially reduced and fixed with at least one screw in the opposite fragment.

DCP as a Buttress plate:

Generally buttressing of metaphysis is best carried out with the special T plate,

L plate and condylar plates. In many situations however, the buttressing effect of the

DCP is enough. If used as such it can be used to fix the fracture line and the screw

about be angled obliquely into the diaphysis.

Contouring of plates

Special contouring devices permit accurate and controlled shaping of the The new shape is the result of plastic deformation and is permanent. With rectice, the plates can be twisted at the time they are bent. This is accomplished by inserting the plate at an angle into the bending pliers or press. Shaping of normal mucht plates such as the DCP is extremely difficult. Normal plates can be twisted and bent in the direction of their long axis, but they resist strongly any attempt to bend mem in the direction of their short axis or width. The contouring of any plates has further facilitated by the design of the malleable templates. They come in Efferent sizes to correspond to the different plates, and in different lengths. They been colour coded for easy identification. Once reduction is carried out, the malleable template is laid on the bone and then gently shaped to correspond exactly to the underlying bone. The template is then removed and taken to the contouring device where the plate is shaped until it corresponds to the template. At the end, the contouring of the plate is checked against the bone and adjusted to make it perfect. In contouring a plate, care should be taken not to bend it back and forth because this weakens the plate.

Anatomy

ANATOMY OF FOREARM

The forearm fulfills an important role in the integrated function of the upper memity. It maintains a stable link between elbow and wrist, provides an origin for muscles that insert on the hand, and allows rotation of the wrist to position hand more effectively in space.⁴⁸

Acute injuries can involve different components of the forearm unit multaneously, thus necessitating the understanding of forearm anatomy for planned multaneously and surgical management.

EMBRYOLOGY 49

Development of the limb buds.

- The forelimb bud appears about the 26th day (end of 4th week) and hind limb bud about the 28th day. The limbs become paddle-shaped after about 4 days (5th week).
- coopers between the future digits (digital rays) can be seen by the 36th day (6th
- by the 50th day or so (8th week) the elbows and shoulder are established, and the fingers are free.
- Retation of limbs occurs during the 7th week.
- contilaginous models of bones start forming in the 6th week, and primary centers of self-cation are seen in many bones in the 8th week. They are present in all long by the 12th week.
- limb bud is covered by the surface ectoderm and contains a mesodermal core which is derived from the somatopleuric layer of the plate under the inductive mesoder of the adjacent somites. The core mesoderm of the lateral plate differentiates

the bones, ligaments, joints and vasculature of the limbs, whereas the limb musculature is derived from the mesodermal somites that migrate into the developing bud.

minal nerves; C5 to T1 for the upper limb.

SELETAL ANATOMY:

Normal function of the forearm requires intact skeletal structures formed by and ulna, interosseous membrane, radioulnar joints and normal soft tissue

INSTEOLOGY OF THE FOREARM:

IIIIma

The ulna is the medial bone of the forearm and in homologous with fibula of lower limb. It has a upper end, a shaft and lower end (head). It's size diminishes upper to lower end. Upper end is strong, expanded and has hook like rection called trochlear notch which articulates with trochlea of humerus. It has processes olecranon and coronoid processes and two articular notches, trochlear radial notches. Lower end is smaller and has small rounded head. Styloid projects downwards from the posteromedial aspect of the head and gives ment to ulnar collateral ligament of the wrist.

The shaft of the ulna has interosseous, anterior and posterior borders. The measurement border continues above with the supinator crest, which gives attachment borders begins at the posterior aspect of olecranon subcutaneous throughout its length. Anterior border is thick and rounded.

of styloid process. Ulna has three surfaces, anterior, medial and posterior which for muscle attachments.⁵⁰

Radius:

Radius is the lateral bone of forearm and in homologous with the tibia of limb. It has upper end, a shaft and lower end.

Radius has a characteristic bow which has demonstrated to be important for irrearm rotation and must be accurately restored when this bone is fractured. It has been curvature in both antero posterior and lateral planes. It has three borders, increaseous, anterior and posterior. Three surfaces, anterior, posterior and lateral. It is lower half is practically subcutaneous on its lateral and dorsal aspect. It is increaseous border in its lower three fourth gives increase to interosseous membrane. So

Lower end of the radius is the widest part of the radius and is four sided on sverse section. It has projection laterally called styloid process. It has carpal cular surface. Posteriorly, it has a dorsal tubercle, called Lister tubercle, which is below by a smooth ridge to which the base of articular disc of inferior cultural joint is attached.⁵⁰

The maximum radial bow can be measured by standard lateral radiographs forearm in neutral rotation. A reference line is drawn from the tip of the bicipital berosity to the ulnar most aspect of the distal radius. The maximum radial bow is measured as the number of millimeters along a perpendicular line to the reference line primarily. It is measured as the percentage distance from the tip of bicipital berosity to the point of the apex of maximum radial bow along the length of

line²¹ (i.e., x/y x 100). Failure to restore the parameters within ately 4% of the opposite was associated with a loss of 20% or more of rotation.⁵¹

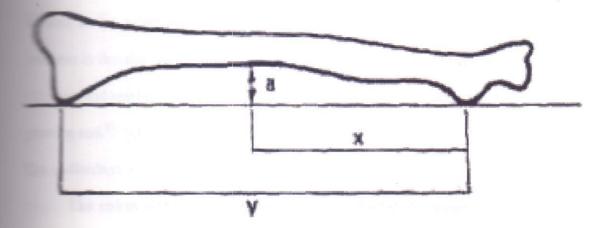


Fig-2 Measurement Of Radial Bow

Upper end of radius has head, neck and bicipital tuberosity. Head articulates

and all notch of the ulna. The upper surface of the head is hollowed out to form a

cup for articulation with the capitellum. Below the head is neck and

The rough posterior part of the tuberosity gives insertion to biceps brachii

smooth anterior part is separated from the tendon by a bursa. 50

ISSIFICATION:

Wina:

It ossifies in cartilage from one primary center for the shaft and secondary one for distal end and two for olecranon. Primary center for the shaft appears week of intrauterine life. Secondary center for upper end (growing end) appears years in females and 8-10 years in males and unites with the shaft at 14th year ales and 17th year in males. Secondary center for lower end appears in 5th year ale and 6th year in males, fuses with shaft at 17th year in female and 18th year

Whyfires:

Ossifies in cartilage from one primary center and two secondary centers.

center appears at 8th week for the shaft. Secondary center for upper end

at 3-4 years in females and 4-5 years in males, unites with the shaft at

in females and 17th year in males. Secondary center of lower end appears at

and unites with shaft at 17th year in females and 19th year in males. It is the

end.⁵⁰

me radioulnar articulations:

The radius and ulna are joined to each other at the superior and inferior points. The two bones are also connected by the interosseous membrane; sometimes said to constitute a middle radioulnar joint.

Superior radioulnar joint:

The essential structure is the annular ligament which holds the head of radius

The annular ligament is attached to the anterior and posterior margins of

anoth of ulna and has no attachment to radius. Superiorly it blends with the

another at the lower margin of the cylindrical articular surface.

The a privot type of synovial joint.

Management-pronation and supination of forearm

merior radioulnar joint:

It is closed distally by a triangular fibrocartilage which is attached to its base where the state of the sta

Separation and supination of forearm

Interosseous membrane:

mobilique angle and are supposed to have an effect in transmitting thrust from the wrist to the elbow via lower end of radius to upper end of ulna and to the humerus. It movides attachment to many muscles of forearm. Interosseous membrane is relaxed momplete pronation and supination, becomes taut while hand is midway between



RADIUS: ANTERIOR AND POSTERIOR VIEW



ULNA: ANTERIOR AND POSTERIOR VIEW

Fig 3: Anatomy of Forearm bones

Right Radius and Ulna in Supination Right Radius and Ulna in Pronation Anterior View Anterior View Olecranon Trochlear notch Coronoid process Head of radius Coronoid process-Radial notch of ulna Oblique cord Neck of radius -Ulnar tuberositu -Ulnar tuberosity Radial tuberosity Oblique cord Anterior surface of ulna Lateral surface of radius Amerior surface of radius Posterior border of radius-Anterior border of ulna Posterior surface of radius mior border of radius Interosseous membrane us border of radius -interosseous border of ulna Groove for extensor pollicis longus muscle Dorsal tubercle of radius Groove for extensor carpi radialis longus and brevis muscles Area for extensor pollicis brevis and abductor pollicis longus muscles Ulnar styloid process Groove for extensor digitorum and extensor indicis muscles Styloid process of ulna Styloid process of radius lai styloid process

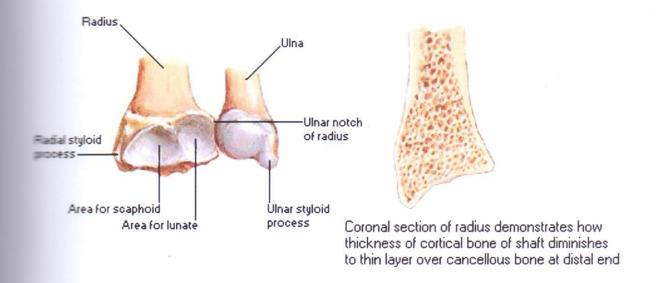


Figure -4 Osteology of forearm.

Anterior Fascial Compartment⁵¹

Superficial compartment

Time of	Origin	Insertion	Nerve	NI	A 4*
Thorse	Origin	Insertion	Supply	Nerve Root	Action
head head	Medial epicondyle of humerus. Medial border of coronoid process of ulna.	Lateral aspect of shaft of radius	Median nerve	C6, C7	Pronation and flexion of forearm
radialis	Medial epicondyle of humerus.	Base of second and third metacarpal bones	Median nerve	C6, C7	Flexes and abducts hand at wrist joint.
lingus	Medial epicondyle of humerus	Flexor retinaculam and palmar aponeuosis	Median nerve	C7, C8	Flexes hand
bead.	Medial epicondyle of humerus. Medial aspect of olecranon process and posterior border of ulna.	Pisiform bone, hook of the hammate, Base of fifth metacarpal bone	Ulnar nerve	C8, T1	Flexes and abducts hand at wrist joint.
Egiturium East	Medial epicondyle of humerus Medial border of coronoid process of ulna. Oblique line on anterior surface of shaft of radius.	Middle phalanx of medial four fingers	Median nerve	C7, C8, T1	Flexes middle phalanx of fingers and assists in flexing proximal phalanx and hand.

Deep compartment

State .	Origin	Insertion	Nerve Supply	Nerve Root	Action
Tellorium	Anteromedial surface of shaft of ulna.	Distal phalanx of medial four fingers	Ulnar (medial half) and median (lateral half) nerves	C8, T1	Flexes middle phalanx of fingers and assists in flexing proximal phalanx and hand.
_air atus	Anterior surface of shaft of ulna.	Anterior surface of shaft of radius.	Anterior interosseous branch of median nerve	C8, T1	Pronates forearm
margines.	Anterior surface of shaft of radius.	Distal phalanx of thumb	Anterior interosseous branch of median nerve	C8, T1	Flexes distal phalanx of thumb.

Muscles of Forearm [Superficial Layer]

Anterior View

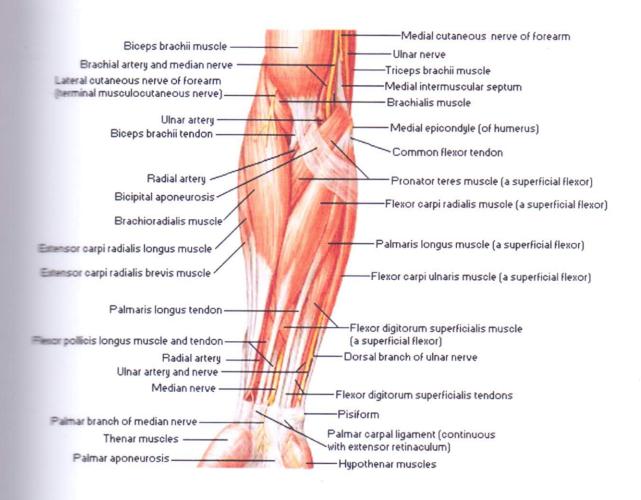


Fig -5 Muscles of the anterior facial compartment (superficial layer).

Muscles of Forearm [Intermediate Layer]

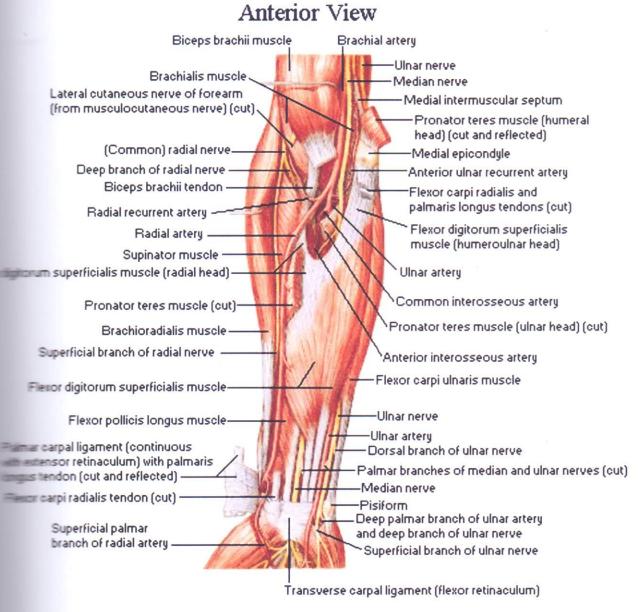


Fig-6 Muscles of the anterior facial compartment (intermediate layer).

Muscles of Forearm [Deep Layer]

Anterior View

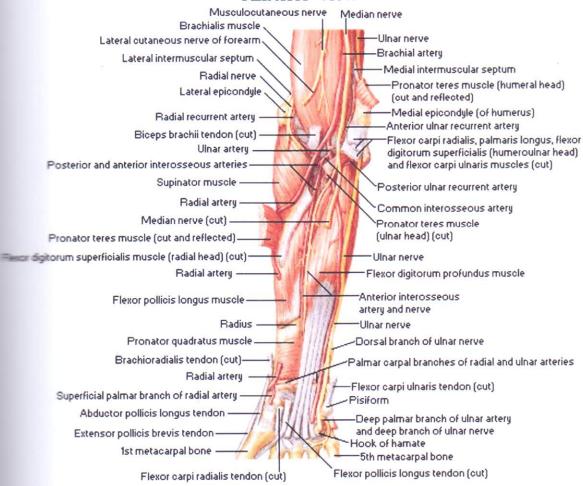


Fig-7 Muscles of the anterior facial compartment (deep layer).

MUSCLES OF POSTERIOR COMPARTMENT OF FOREARM 51

Name of Muscle	Origin	Insertion	Nerve Supply	Nerve Root	Action
oradialis	Lateral supracondylar ridge of humerus.	Base of styloid process of radius.	Radial nerve	C5, C6, C7	Flexes the forearm at the elbow joint; rotates forearm to the midprone position
Energy carpi	Lateral supracondylar ridge of humerus.	Posterior surface of base of second metacarpal bone.	Radial nerve	C6, C7	
Emersor carpi	Lateral epicondyle of humerus.	Posterior surface of base of third metacarpal bone	Deep branch of radial nerve	C7, C8	Extends and abducts hand at wrist joint
Entensor	Lateral epicondyle of humerus.	Middle and distal phalanges of medial four fingers	Deep branch of radial nerve	C7, C8	Extend fingers and hands
exessor digiti	Lateral epicondyle of humerus.	Extensor expansion little finger	Deep branch of radial nerve	C7, C8	Extends metacarpoph alangeal joint of little finger
Entersor carpi	Lateral epicondyle of humerus.	Base of fifth metacarpal bone	Deep branch of radial nerve	C7, C8	Extends and abducts hand at wrist joint
Anomeus	Lateral epicondyle of humerus.	Lateral surface of olecranon	Radial nerve	C7, C8, T1	Extends elbow joint
Segunator	Lateral epicondyle of humerus, annular ligament of proximal radioulnar joint, and ulna	Neck and shaft of radius	Deep branch of radial nerve	C5, C6	Supination of forearm
policis	Posterior surface of shafts of radius and ulna.	Base of 1 st metacarpal bone	Deep branch of radial nerve	C7, C8,	Abducts and extends thumb

Extensor pollicis brevis	Posterior surface of shafts of radius.	Base of proximal phalanx of thumb	Deep branch of radial nerve	C7, C8	Extend metacarpoph alangeal joints of thumb.
Extensor pollicis longus	Posterior surface of shafts of ulna.	Base of distal phalanx of thumb	Deep branch of radial nerve	C7, C8	Extends distal phalanx of thumb
Extensor indicis	Posterior surface of shafts of ulna.	Extensor expansion of index finger.	Deep branch of radial nerve	C7, C8	Extends metacarpoph alangeal joint index finger.

Muscles of Forearm [Superficial Layer]

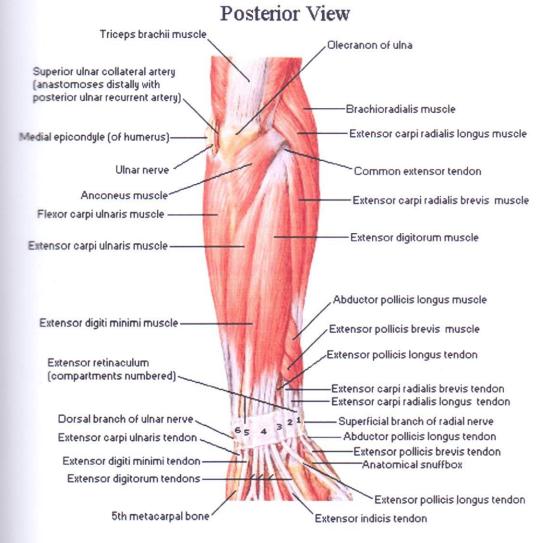


Fig-8 Muscles of the posterior facial compartment (superficial layer).

Muscles of Forearm [Deep Layer]

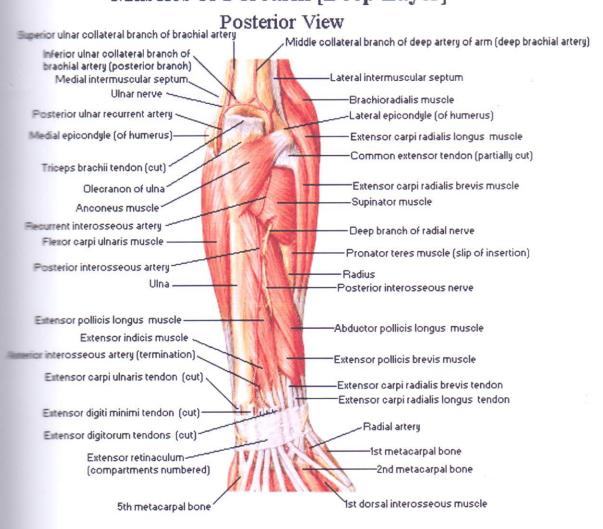


Fig-9 Muscles of the posterior facial compartment (deep layer).

ARTERIES OF FOREARM52

Radial Artery

Smaller terminal branch of brachial artery and begins in cubital fossa. Runs inferometally under cover of brachioradialis and distally, lateral to flexor carpi radials, and service winds around lateral aspect of radius and crosses floor of anatomical, snuff to pierce fascia, ends by forming deep palmar arch with deep branch of ulnar arch.

Branches in forearm:

- Radial recurrent artery
- Muscular branch
- Palmar carpal branch
- Dorsal carpal branch

Illiar Artery

It is a larger terminal branch of brachial artery and begins in cubital fossa, infero-medially and then directly deep to Pronator teres, Palmaris longus and digitorum superficialis to reach medial side of forearm; passes superficial to retinaculum at wrist and gives a deep arch and continue as superficial palmar

Branches in forearm

Anterior and posterior ulnar recurrent arteries

anterior ulnar recurrent artery passes superiorly and posteriorly and ulnar collateral passes posteriorly to anastomose with ulnar collateral and interosseous recurrent arteries.

Tommon interosseous artery

arises soon after the bifurcation of brachial artery and after a short course minates by diving into anterior and posterior interosseous arteries. The anterior and posterior interosseous arteries descend down on anterior and posterior sides of membrane respectively.

Branches

WERVES OF FLEXOR COMPARTMENT

Engageous Nerves of the forearm

The cutaneous continuation of the musculocutaneous nerve pierces the deep above the elbow lateral to the tendon of biceps and supplies the anterolateral of the forearm.

The medial cutaneous nerve of the forearm supplies front and back of the

The superficial terminal branch of the radial nerve, the cutaneous continuation

main nerve runs from the cubical fossa on the surface of supinator, pronator

and flexor digitorum superficialis on the lateral side of forearm under

brachioradialis. In the middle third of the forearm, it lies beside and laterals

artery. It then leaves the flexor compartment of the forearm by passing

mackwards deep to the tendon of brachioradialis and breaks into two or three maches.

Median Nerve

Leaves the cubital fossa between the two heads of pronator teres. It passes to the fibrous arch of flexor digitorium superficialis. Just above the wrist, the comes closer to the surface between the tendons of flexor carpi radialis and digitorum superficialis, lying behind the tendon of palmaris longus. Muscular teres, flexor carpi radialis, palmaris longus and flexor digitorium superficialis (lateral half), the nerve also supplies the elbow and proximal radioulnar

Deep to flexor digitorium superficialis, the median nerve gives off an anterior second branch, which runs down the artery of the same name and supplies flexor profundus (bellies which move the index and middle finger), flexor pollicis pronator quadratus, and the inferior radio-ulnar, wrist and carpal joints.

The Ulnar nerve

The ulnar nerve enters the forearm from the extensor compartment of arm by between the two heads of flexor carpi ulnaris. The nerve lies undercover of lattened aponeurosis of flexor carpi ulnaris with the ulnar artery to its radial side.

Nerve of Extensor Compartment

Posterior interosseous Nerve

The nerve appears in the extensor compartment after passing through the spinator muscle. It passes downwards over the abductor pollicis longus origin and to reach the interosseous membrane where it passes between the muscles as far as wrist joint. Here it ends in a small nodule from which branches supply the wrist. The nerve supplies the muscles, which arise from the common extensor origin, deep muscles of the extensor compartment. 52

BIOMECHANICS OF FOREARM

The longitudinal axis of rotation of the forearm passes through the articular confidence of the radial head, the interosseous membrane, and the articular surface of the at the distal radio-ulnar joint. 53

Ulna is relatively straight bone, but the radius is much more complex. The ulna is strut around which the radius rotates in pronation and supination.

Both the supinator and the biceps muscle supinate the forearm. The biceps is a supinator when the forearm is pronated and the elbow is flexed.

Supination strength is normally greater than pronation strength.

Pronation occurs by the action of the pronator quadratus and pronator teres

The normal range of rotation of the forearm is 75 degrees of pronation and 85 of supination.

Most normal activities of daily living can be accomplished with an arc of 100 of rotation, with equal amounts of pronation and supination.⁵⁴

MECHANISM OF INJURY

The mechanism of injury that causes fractures of radius and ulna are myriad.

For the most common is high-speed vehicular trauma.

Direct violence

Automobile and motorcycle accidents results in some type of direct blow to be forearm, other causes include fights in which one of the adversaries is struck on the forearm with a stick. Gunshot wounds can also cause fracture of both bones of

Interect violence

Fall on an outstretched hand results in most of these fractures. Most forearm

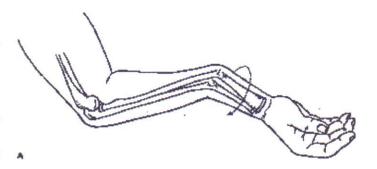


Fig. 10: Deformity in forced supination of forearm

Forced supination of the forearm produces a fracture pattern with apex volar in addition to dorsal displacement with supination of the distal fragment.¹³

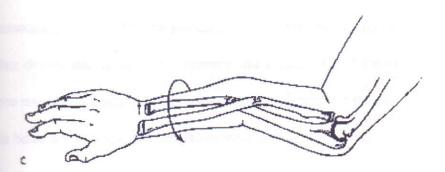


Fig. 11: Deformity in forced pronation of forearm

Forced pronation of the forearm can result in a fracture pattern with apex angulation, in addition to pronation and volar displacement of the distal

Applied Anatomy

As has been well described in the literature on the treatment of forearm, the surgical anatomy of the forearm creates problems in fracture treatment in the treatment of diaphyseal fractures of other long bones. The radius and faction as a unit but come into contact with each other only at the ends⁵¹. They have proximally by the capsule of the elbow joint and the annular ligament, and by the capsule of the wrist joint, the dorsal and volar radioulnar ligaments, fibrocartilaginous articular disc. As Palmer and Werner have shown, the stabilizer of the distal radioulnar joint is the triangular fibrocartilage. The proximal and distal joints are very complex in both function and and relate closely to the ulnohumeral, radiocapitellar, and radiocarpal joints.

The proximal radioulnar joint is stabilized by the annular ligament. The distal

associated joints complex, but the muscle groups acting across the forearm cause make deforming forces when fractures are present. The radius and ulna are joined three muscles the supinator, pronator teres, and pronator quadratus that take origin to bone and insert on the other. In addition to their named functions, when there fracture these muscles tend to approximate the radius and ulna and decrease the aspect of the forearm and insert on the radial side of the wrist or hand, such as the abductor pollicis longus and brevis and the extensor pollicis longus, have their origins on the ulna and interosseous membrane on the dorsal, side are inserted on the radial side of the wrist, tend to exert a pronating force.

In addition to the supinator muscle itself, the biceps brachii is a powerful of the radius. In fractures of the upper radius below the insertion of the and above the insertion of pronator teres, two strong muscles (the biceps supinator) exert an unopposed force that supinates the proximal radial. In fractures of the radius located distal to the pronator teres, the combined the biceps and supinator is somewhat neutralized. In these fractures the fragment of the radius is usually in a slightly supinated or neutral position.

closed treatment of forearm fractures, therefore, the location of the fracture radius helps to determine the degree of supination of the distal fragment correct rotational alignment.

If satisfactory functional results are to be achieved in the treatment of fractures of the forearm, it is not sufficient merely to maintain the length of each bone, axial and rotational alignment must be achieved as well, and the radial bow must be maintained.⁵⁵

With the complexity of the bones and joints involved, and the many and deforming muscle forces, it is extremely difficult to obtain union with efficient restoration of the anatomy to ensure good functional results by closed ment. 16

FRACTURE DISPLACEMENTS

Deforming forces

brachii and Supinator inserts into the proximal 1/3 of the radius, these muscle supinators of the forearm.⁵⁵

Teres, originating above the elbow medially, inserts into the middle third of medius, when fracture is distal to insertion of pronator teres, proximal fragment lies medial rotation, and the distal fragment is pronated.

Quadratus located on the anterior aspect of the lower forearm, inserts into

of forearm of forearm, bringing it from supine or prone position to neutral extensors and abductors of the thumb act with Brachioradialis muscle in

factures of the distal third of the radius and pull the distal fragment of the radius maximally.⁵⁵

Mexor muscles of the forearm

Tend to pull the distal fragments anteriorly and produce dorsal bowing of the and ulna during healing;

Emaimal Third Fractures

Above insertion of pronator teres, proximal fragment of radius is supinated because of unopposed action of biceps brachii and supinator, and the distal is pronated by the action of the pronator teres and pronator quadratus to obtain alignment of the fracture, the distal fragment should be supinated.

Third Fractures

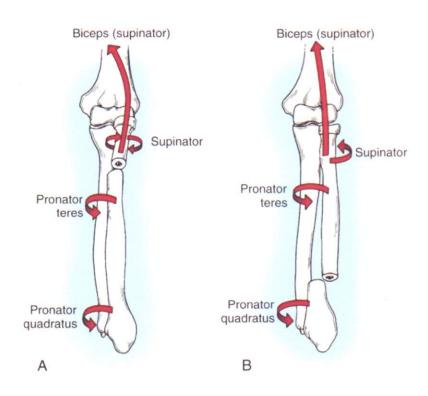
Below pronator teres, proximal fragment is held in neutral rotation, as action is countered by the pronator teres. Proximal fragment is drawn into by action of biceps, distal fragment is pronated and drawn toward ulna by quadratus to achieve anatomic reduction, distal fragment is brought into

of Forearm Fractures

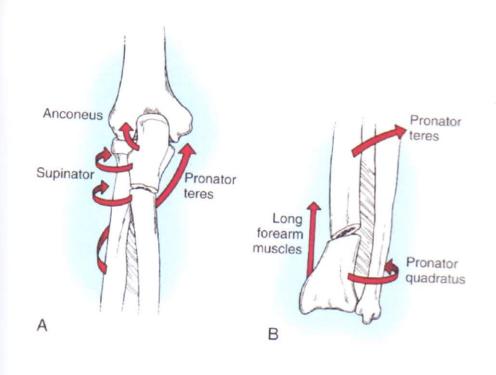
fragment of the pulled radius is pronated and pulled inward by pronator overriding and shortening are caused by obliquity of and pull of muscles.

Diagnosis and radiographic findings

In adults, usually the fragments are displaced. The patient complains of pain, according to the forearm and hand. Some degree of swelling is present. Abnormal mobility and crepitus are present. The physical mobility and include neurological evaluation of the motor and sensory fractions of radial, median and ulnar nerves. The vascularity should be checked and marked and partment syndrome should be ruled out. 55



- pronator teres. Proximal fragment lies in supination because of unopposed performing forces of fractures of radius above level of insertion of pull of supinator biceps.
- Below level of insertion of pronator teres, proximal fragment is in neutral mestion.



- Isolated fractures of ulna in its proximal third are angulated toward radius and
- Fractures of distal radius are angulated toward ulna because of pull of long muscles and pronator quadratus.

Figure-12: Displacement of radius and ulna with various levels of fracture

Radiological Evaluation

The x-ray of the forearm including elbow and wrist are taken at least in two antero-posterior and lateral. It is important to know the level of fracture, the antiguration, degree of angulation, communication and displacements. The proximal distal radioulnar joints are evaluated. Associated injuries to these joints are apportant to be diagnosed, because it impacts heavily on prognosis and treatment.

The rotational alignment of the forearm is difficult to determine in the many anterior posterior and lateral x-ray. The "Bicipital tuberosity view" mended by Evans is helpful. 12 Because the surgeon has no hold on the proximal ment, the distal radial fragment has to be brought into correct relationship with the tuberosity view before reduction, gives some idea of how much pronation or tuberosity view before reduction, gives some idea of how much pronation or tuberosity view is made with x-ray tube-tilted 20° and the olecranon, with the subcutaneous border of ulna flat on the cassette. The can be composed with serial diagrams showing the prominence in supination. In this method full supination is referred to as 180° and mid 180° and full pronation as 0°.

Since the normal range of pronation is by the radius crossing over the ulna and messing the deep flexor muscle between the two bones, anything encroaching their space such as fibrous tissue, callus, edema or hemorrhage will alter to messibility of the flexor muscles and limit pronation. It is therefore expected that the fractures of mid third radius/ulna some loss of pronation will occur and will acconsiderable time after union has occurred.³⁴

Assessment of other factor limiting rotation is therefore based on measurement rather than pronation.¹³

CLASSIFICATION OF DIAPHYSEAL FRACTURES BOTH BONES FOREARM

The fractures are classified according to the level of fracture, configuration of factures, degree of displacement and degree of communication.

AO Classification

The AO classification has broadly classified into 3 types type A with simple factures, Type B are wedge fractures and Type C are complex fractures. The subtypes of these fractures are shown in the figure.

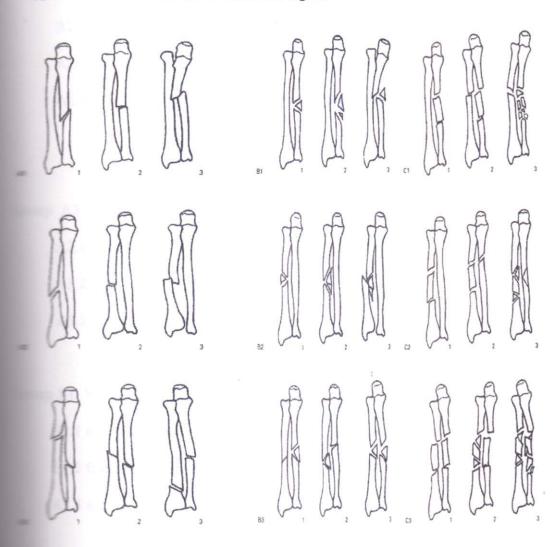


Fig-13: AO Classification of Fractures of the Both Bones Forearm

The AO classification of the fracture of the diaphysis of the radius and ulna

Group A1: Simple fracture of the ulna, radius intact

- A1.1 oblique
- A1.2 transverse
- A1.3 with dislocation of the radial head (Monteggia)

Group A2: Simple fracture of the radius, ulna intact

- A2.1 oblique
- A2.2 transverse
- A2.3 with dislocation of distal radio ulnar joint (Galeazzi)

A3: Simple fracture of both bones

- A3.1 radius proximal zone
- A3.2 radius middle zone
- A3.3 radius distal zone

B1: Wedge fracture of the ulna, radius intact

- B1.1 intact wedge
- B1.2 fragmented wedge
- B1.3 with dislocation of distal radio ulnar joint (Galeazzi)

Group B2: Wedge fracture of the radius, ulna intact

- B2.1 intact wedge
- B2.2 fragmented wedge
- B2.3 with dislocation of distal radio ulnar joint

Group B3: Wedge fracture of one bone, simple or wedge fracture fracture of

other

- B3.1 ulnar wedge, simple fracture of the radius
- B3.2 radial wedge, simple fracture of the ulna
- B3.3 radial and ulnar wedges

C1: Complex fracture of the ulna

- C1.1 bifocal ,radius intact
- C1.2 bifocal, radius fractured
- C1.3 irregular

C2: Complex fracture of the radius

- C2.1 bifocal, ulna intact
- C2.2 bifocal, radius fractured
- C2.3 irregular

C3: Complex fracture of both bones

- 3.1 bifocal
- 32 bifocal of one ,irregular of other
- 33 irregular

Orthopaedic trauma association (OTA) system for the fracture configuration

Type 1) Linear fractures:

Transverse

Oblique

Spiral

minuted fractures:

Comminuted – less than 50%

Comminuted - more than 50%

Butterfly - less than 50%

Butterfly - more than 50%

mental fractures:

Two levels

Three levels or more

Longitudinal split

Segmental comminuted fracture

with bone loss:

Bone loss less than 50%

Bone loss more than 50%

Complete bone loss.

BEATMENT

The orthopedic surgeon has varieties of options for treating the fractures of

both bones forearm. They are:

and cast immobilization.

fixators application.

menullary Nailing.

mediaction and Internal fixation with plate and screws.

(point contact fixators)

Conservative management of fracture both bones of forearm have met with functional outcome and frustration. The rate of non-union is very high in medullary nailing. Also it is difficult to maintain the radial bow in nailing. The maintain the radi

MADICATIONS FOR OPEN REDUCTION OF FRACTURES OF THE

- Esplaced fractures of radius and ulna in adults.
- isolated displaced fractures of the radius.
 - fractures of the ulna with angulations greater than 10°.
- Monteggia fractures.
- Galeazzi fractures
- associated with compartment syndrome regardless and the degree of
- fractures in same extremity.
- and logic fractures.

APPROACHES TO THE RADIUS 56

ANTERIOR APPROACH (Henry's)

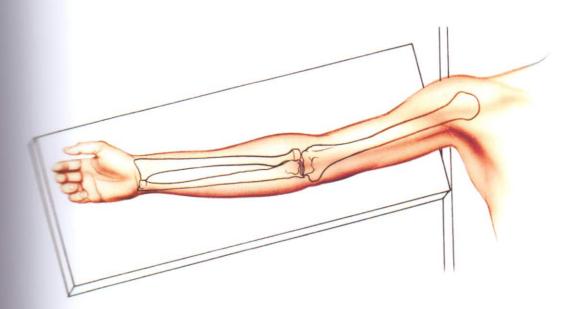
Position of the patient

Patient should be put in supine position with a side arm table. Usually a murniquet is applied to the arm and forearm should be supinated.

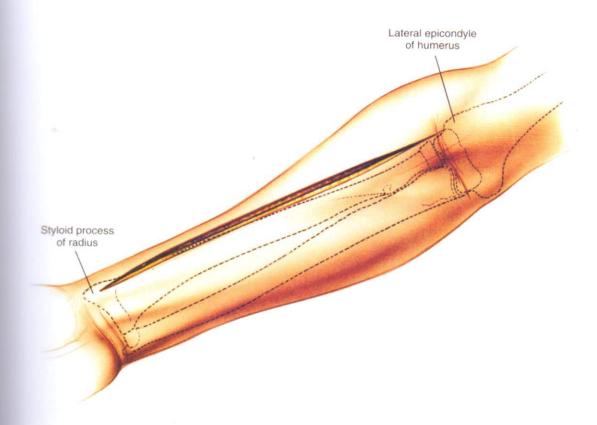
bone. The approach was first described by Henry and his name usually is associated with it.

Incision

Make a straight incision from the anterior flexor crease of the elbow just lateral to the biceps tendon down to styloid process of the radius. The length of incision depends on the amount of bone that needs to be exposed.



Position of the patient on the operating table for the anterior approach to the radius.



Straight incision on the anterior part of the forearm, from the flexor on the lateral side of the biceps down to the styloid process of the radius.

Internervous plane

Proximally: Brachioradialis muscle (radial nerve) and pronator teres (median **Distally**: Brachioradialis muscle (radial nerve) and flexor carpi radialis muscle (median nerve).

Superficial surgical dissection

After developing the plane, identify the superficial radial nerve running on the surface of the brachioradialis and moving with it. The radial artery lies beneath brachioradialis in the middle part of the forearm, the artery may have to be

sperficial radial nerve, which is sensory nerve, also runs under cover of the specifical radialis.

Deep surgical dissection

Proximal third: The proximal third of the radius is covered by the supinator muscle, through which the posterior interosseous nerve passes on its way to the muscle this approach. Hence, fully supinate the forearm and perform subperiosteal muscle.

Middle third: To reach anterior surface of the bone, covered by pronator teres

flexor digitorium superficialis, pronate the arm so that the insertion of pronator

onto the lateral aspect of the radius is exposed. Detach this insertion and strip

muscle off.

Distal third: To reach its bone partially supinate the forearm and incise the mosteum of the lateral aspect of the radius lateral to the pronator quadratus and pollicis longus. Continue the dissection subperiosteally lifting them off the

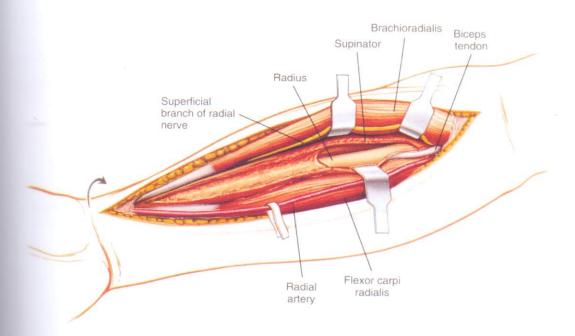


Fig-16: Exposure of the radius from proximal to distal end

Dangers

Nerves: The posterior interosseous nerve. The key to ensure its safety is to the insertion of supinator subperiosteally.

The superficial radial nerve.

Tessels

- The radial artery
- The recurrent radial artery

POSTERIOR APPROACH TO THE RADIUS 56 (Thompson's approach)

Position

Patient supine on operating table with arm on the arm board. Pronate the patient's forearm to expose the extensor compartment.

Incision

Make either straight or gently curved incision extending from a point anterior lateral epicondyle of the humerus to a point just distal to ulna side of the lister's lateral epicondyle at the wrist.

Internervous plane

Proximally

Extensor carpi radialis brevis (Radial nerve)

Extensor digitorium communis (Posterior interosseous nerve)

Distally

Extensor carpi radialis brevis (Radial nerve)

Extensor pollicis longus muscle (Post interosseous nerve)

Superficial surgical dissection

After developing the inter-nervous plane, incise the deep fascia, distally, the muscles longus and extensor pollicis brevis emerge between the two muscles, the dissection proximally, separating the two muscles to reveal the upper of the shaft of radius, which is covered by enveloping supinator.

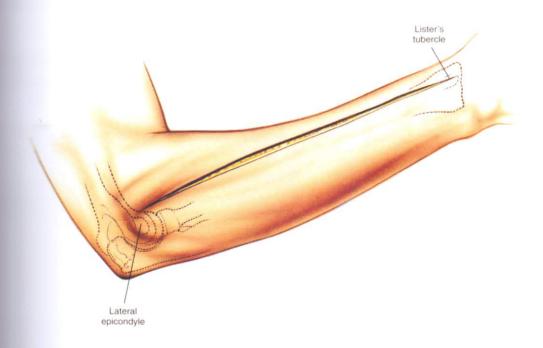


Fig.-17: Posterior Thompson's approach to the radius

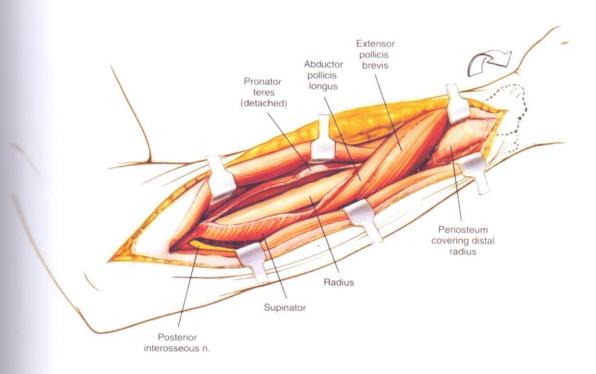


Fig-18: Exposure of the radius from posterior approach

Deep surgical dissection

Proximal third

The supinator muscle cloaks the dorsal aspect of the upper third of the radius, be posterior interosseous nerve runs within its substance between the superficial and heads. Care should be taken not to injure the posterior interosseous nerve. The posterior interosseous nerve and fully supinate the arm to bring the anterior surface of radius view. Detach the insertion of the supinator muscle from anterior aspect of the subperiosteally to expose the proximal third of the shaft of the radius.

Middle third

Two muscles, the abductor pollicis longus and extensor pollicis brevis, blanket approach as they cross the dorsal aspect of the radius before heading distally and across the middle third of the radius. Make an incision along their superior inferior borders, then retract them off the bone.

Issal third

Separating the extensor carpi radialis brevis from extensor pollicis longus has led directly onto the lateral border of the radius, subperiosteal dissection leads aspect of the bone.

Tampers

Posterior interosseous nerve identifying and preserving the nerve in the supinator is the only means of ensuring that it will not be trapped beneath the plate.

APPROACH TO ULNA56

Position

Place the patient in supine position on the operating table with the arm placed the chest to expose the subcutaneous border of the ulna.

Exposing the shaft of ulna is the simplest of all forearm approaches,

Incision

Linear, longitudinal incision over the subcutaneous border of the ulna.

mernervous plane

carpi ulnaris (posterior interosseous nerve)

Team carpi ulnaris (ulnar nerve).

dissection

Incise down the subcutaneous border of ulna. Even though the bone feels

the subcutaneous in its middle third, the fibers of extensor carpi ulnaris muscle nearly

have to be divided to reach the bone.

the periosteum over the ulna longitudinally and dissect around the bone in a second plane to reveal either the flexor or the extensor aspects of the bone as

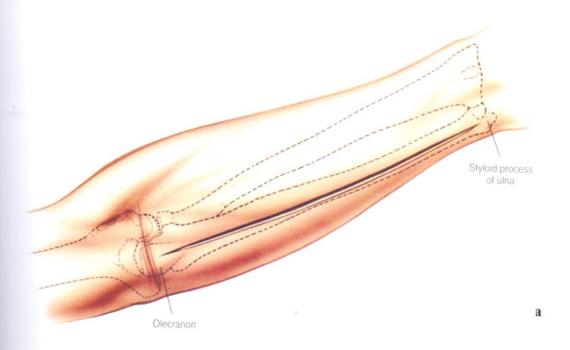


Fig-19: Incision for ulnar exposure over the subcutaneous border of the ulna

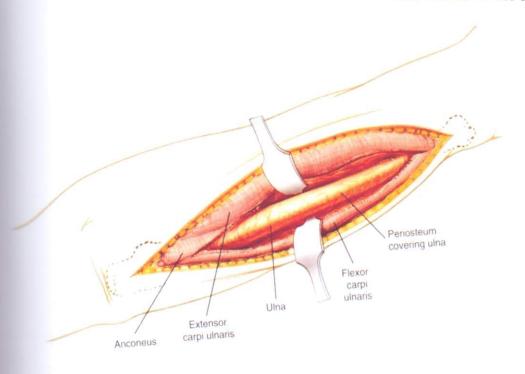


Fig-20: Exposure of the entire posterior length of the ulna

Dangers

Ulnar nerves which travels down the forearm under the flexor carpi ulnaris, on the flexor digitorum profundus. The nerve is safe as long as the flexor carpi ulnaris is stripped off the ulna subperiosteally. Nerve in most vulnerable in its moximal dissections.

Vessels

The ulnar artery travels down the forearm with the ulnar nerve, lying on its radial.

Hence vulnerable while dissecting the flexor carpi ulnaris.⁵⁷

COMPLICATIONS 57

Sum union and Malunion

Nonunion of fractures is most often seen when infection is present, when fixation madequate. Accurate open reduction and rigid internal fixation will prevent these made plications. Fracture both bones forearm results in malunion if

Infection

Despite all attempts to prevent infection, some open fractures and closed treated by open reduction inevitably become infected. The incidence is in patients with extensive soft tissue injury. If infected, wound should be cally drained, copiously irrigated, debrided and appropriate antibiotics instituted.

Principle of the treatment is that union of the fracture must be obtained even in the companion of the infection.

Nerve injury

They are uncommon in closed fracture of forearm bones. They are more common in compound wounds with extensive soft tissue loss. Posterior interosseous nerve may be injured when fixing proximal third radius by posterior approach.

Vascular injury

Radial artery may be injured when radius is approached anteriorly. The viability of the forearm and hand will not be a problem if one of the radial or the ulnar artery is patent. It is rare to have both radial and ulnar artery getting lacerated except open fractures.

Compartment syndrome

This can occur either after trauma or after surgery on the forearm bones. They usually due to faulty hemostasis or closure of the deep fascia. They can usually be usually be releasing the tourniquet before wound closure to make sure hemostasis is usualte, by closing only the subcutaneous tissue and skin.

***-traumatic Radioulnar synostosis

Synostosis is relatively uncommon. Seen frequently in patients with either a string injury of forearm or a head injury. The highest risk for synostosis is in fractures treated through single incision. If synostosis develops and position is relatively functional, it is best to do nothing if rotational alignment of is poor, an osteotomy to position the hand in more functional position can be dered.

Excision of the synostosis, obliteration of the dead space with muscle, revention of hematoma formation and early mobilization have yielded good results.

Refracture

If the plate is removed early, minor trauma can cause refracture. It is best to plates for at least for 18 months to prevent refracture. Also after removal of protect the forearm at least for 6-8 wks.

Muscle and Tendon Entrapment and Adherence

belly of tendon gets trapped between ends of bone. Release of the muscle belly results in full activity.

Methodology

METHODOLOGY

The present study includes 30 cases of fracture both bones of forearm by open reduction and internal fixation with **DYNAMIC COMPRESSION PLATE &**SCREWS between Nov 2012 to May 2014 admitted to R L Jalappa Hospital attached

To Sri Devaraj Urs Medical College, Kolar. This is a prospective study with follow up period of 6 months.

NCLUSION CRITERIA:

- above 18 years
- Closed fractures.
- fractures-GUSTILO ANDERSON type I, type II, type III A.
- Won-union

EXCLUSION CRITERIA:

- ental fractures.
- Section of the sec
- shaft with intra articular extension.

All patients admitted with diaphyseal fractures of both bones forearm, a history was elicited from the patient and/or attendants to reveal the mechanism and the severity of trauma.

The patients were then assessed clinically to evaluate their general condition
the local injury. It was done in accordance to Acute Trauma Life Support
Vital parametres were recorded. Methodical examination was done to rule

attitude and position of the affected upper limb compared with normal counter part, any abnormal swelling and deformity, their level and direction.

Palpation to check any local rise of temperature, soft tissue tenderness, any palpable step, breach in continuity of bone, any revealed abnormal mobility, crepitus and shortening of the forearm.

Distal vascularity was assessed by radial artery pulsations, capillary filling, radio and paraesthesia at finger tips.

Neurological examination: Sensory system was examined for pain and touch sessation in the radial. ulnar and median nerve innervated arrears.

mer including handgrip was tested in forearm and hand muscles.

Movements: Flexion and extension of elbow. supination and pronation of Movements: Abduction and adduction and palmar flexion and dorsiflexion of the wrist performed and any restriction of motion and pain observed.

maging

The clinical signs and symptoms are usually obvious in shaft fractures of both of the forearm, so are the radiologic signs. The configuration of midshaft of the radius and ulna varies depending on the mechanism of injury and the of violence involved. Low-energy fractures tend to be transverse or short whereas high-energy injuries are frequently extensively comminuted or attend, often with extensive soft tissue injuries.

Radiographs of the radius and ulna i. e., anteroposterior and lateral views, betained. The elbow and wrist joints were included in each view.

The determination of the correct rotational position in which to immobilize of both bones of the forearm is of importance, in that any degree of error followed by a corresponding limitation of rotational movement.

To achieve standardization, a constant technique must be employed to demonstrate what may be termed "the tuberosity view" by EVANS¹². It is an anteroposterior view of the elbow joint taken with the tube at an angle of 20 degrees; the tip of the olecranon is placed one-third of the way along the plate, with the elbow joint flexed to 90 degrees, and care is taken that both condyles of the humerus are at the same level.

The rotational position of the hand when this view is taken is of no portance, the only essential being the careful alignment of the elbow joint.

The X-ray can be compared with serial diagrams showing the prominence supination. As an alternative, a film of the opposite elbow can be taken at a given of rotation for comparison. In this method full supination is referred to as 180° and mid position 90° and full pronation as 0°

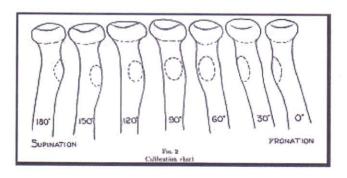


Figure -20: X-ray images of radial tuberosity at different levels of fracture

middle third radius was approached by dorsal Thompson incision and volar Henry was used for distal radius. A narrow 3.5mm DCP was used and a minimum contices were engaged with screw fixation in each fragment.

Preoperative planning:

- Consent of the patient or relative was taken prior to the surgery.
- Appropriate Length of the plate to be used was assessed with the help of radiographs.
- A dose of tetanus toxoid and antibiotic were given preoperatively.
- fevidence of compartment syndrome, surgery has to be done as soon as possible.
- Part Prepared.

ENSTRUMENTS AND IMPLANTS USED IN DYNAMIC COMPRESSION PLATING FOR FOREARM BONES:

- and Drill Bit of 2. 5mm and 3. 5mm
- Drill sleeve system
- 55mm counter sink
- universal drill guide
 - Tenth gauge
 - for 3. 5mm cortex screw
 - Cortex Screws
 - Clamp (Lowman's Clamp)
 - Screwdriver
 - ming templates
 - press/pliers
 - 3. 5mm stainless steel DCP of varying length
 - instruments like Bone Holding Forceps, Periosteum
 - Bone Lever, Bone Reduction Clamps.

Operative procedure

Type of anaesthesia: General anaesthesia was used in 21 cases and brachial block in 9 cases.

Position

Patient supine on the operating table

Henry's approach-the arm is placed on an arm board with elbow straight and forearm in supination.

Thompson approach-the arm is on the arm board, elbow flexed and forearm in mid monation.

Printing and draping of the part done.

Incision

That shaft: Parallel and slightly volar to the subcutaneous crest of the ulna.

shaft: Dorsal Thompson approach and Volar Henry's approach.

mcedure:

stable was fixed first, however the bone which was less comminuted and stable was fixed first and later the other bone was fixed.

After identifying the fracture ends, periosteum was not elevated and fracture were cleaned.

Fracture was reduced. The contoured plate is applied to the bone with middle placed over the fracture, and held with reduction forceps for short oblique or before fracture.

hole is left vacant for angled lag screw through the plate in case of oblique.

This hole is used for interfragmentary compression of a lag screw.

A plate of at least 6 holes was chosen and longer plates were used in spiral, segmental and comminuted fractures

For upper third radial fractures, the plate was fixed dorsally. For middle third, the plate was fixed dorsolateral and for distal radial fractures the plate was fixed on the volar aspect.

In ulnar fractures, plate was applied over the posterior surface of ulna. 39

In case of transverse and short oblique fractures plate hole adjacent to fracture drilled first using neutral drill guide.

in case of oblique fractures, the first screw is applied to the fragment, which forms

nobtuse angle with the fracture near the plate. The resulting space between the

fracture plane and plate under surface guides the opposite fragment towards the plate.

The arrow of the neutral drill guide points towards the fracture. 2.5mm drill bit used for drilling a hole through both cortices and with depth gauge, appropriate screw length is determined.

The tap of 3.5mm is used to cut the thread. The chosen 3.5 mm cortex screw is serted, but not fully tightened. The plate is pulled towards the fracture to place first screw.

The second screw hole for axial compression is drilled in the fragment which an acute angle near the plate.

load guide (yellow) is used with the arrow pointing towards the fracture line to be pressed. At this position, a lag screw will be inserted. Tightening of the two produces axial compression.

The position of the oblique lag screw through the plate is determined. The mulation of the screw should not exceed +/- 25 degrees longitudinally and +/- 7

degrees transeversely. The lag screw is applied by subsequently over drilling (3.5mm) the near cortex to create a gliding hole.

If compression is sufficient the remaining screws are applied one by one, alternating from one side to the other.

In case of porotic, comminuted and/or small bones, long screws and/or a longer plate were used.

Finally tightening of all the screws. hemostasis is maintained, the wound is dosed in layers over a suction drain and sterile dressing is applied.

Post operative treatment

Crepe bandage was applied over the affected forearm and either pre op posterior slab continued or arm pouch was given depending upon the requirement.

Limb is elevated and active movement of the fingers and elbow joint is encouraged.

Section drain was removed after 48 hours and Wound was inspected. Check X ray AP

and Lateral view was taken at that time.

Antibiotics and analgesics were continued till the time of suture removal which was on 10-14 postoperative day.

discharge patient was advised physiotherapy of shoulder, elbow, wrist and finger movements. They were told not to lift heavy weight or exert the affected forearm.

Follow-up

The patients were followed regularly at interval of first week, one month, three months, six months.

The patients were evaluated based on "Anderson et al 5" scoring system.

Elbow movements and wrist movements were noted and the union was assessed

adiologically.

The fracture is said to be united when there was presence of periosteal callus midging the fracture site and trabeculation extending across the fracture line.

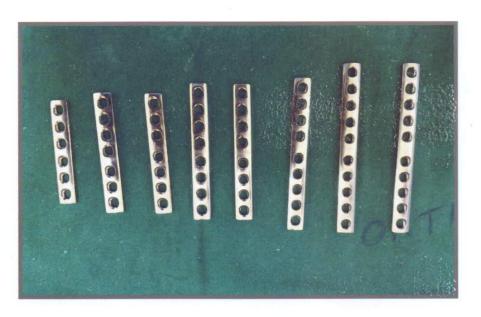
OPERATIVE PHOTOGRAPHS

INSTRUMENTS



- Bone tap with fixed T-handle
- Retractors
- Hexagonal screw driver
- 2.5 mm drill bit
- Osteotome
- Dynamic compression plates

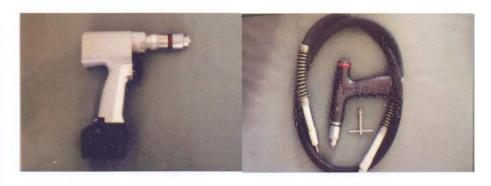
- Periosteum elevator
- Reduction forceps
- Reduction clamps
- Plate holding clamps
- Depth gauge
- Mallet



3.5mm DCP Plates



Pneumatic tourniquet



Power drill

SURGICAL PROCEDURE

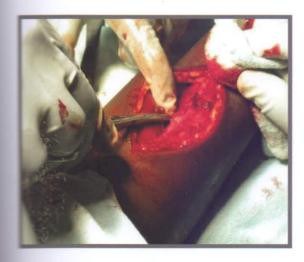
RADIUS FRACTURE FIXATION



Parts painted and draped



Incision



Soft tissue dissection



Exposure of fracture site



Reduction of fracture

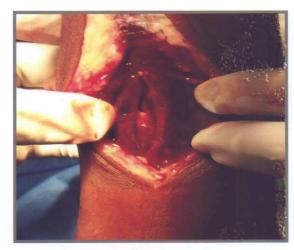


Fixation of Plate

ULNA FRACTURE FIXATION



Incision



Fracture site exposed



Fracture reduction

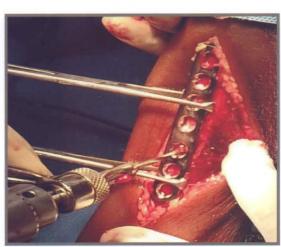
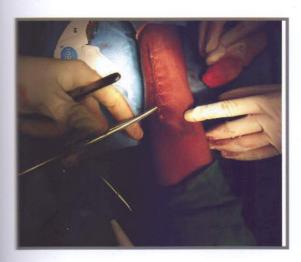


Plate fixation



Wound closure



Sterile dressing with slab application

Results

OBSERVATION AND RESULTS

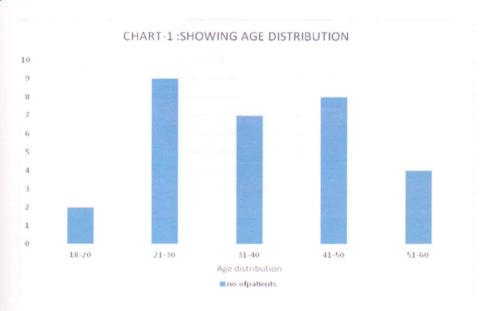
In our series 30 diaphyseal fracture of both bones forearm, treated surgically with Dynamic Compression Plate & screws at R.L Jalappa Hospital attached to Sri Deveraj Urs Medical College, Tamaka, Kolar during the period of November 2012 to May 2014 were studied. The patients were followed up regularly. Following are observations made and the available data analyse as follows.

D AGE DISTRIBUTION:

Table 1:

AGE	NO. OF. PATIENTS	PERCENTAGE
18-20	2	7 %
21-30	9	30%
31-40	7	23%
41-50	8	27%
51-60	4	13%
Total	30	100%

Graph 1:



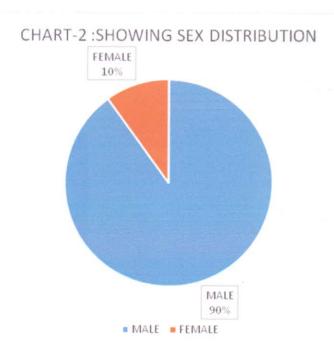
2) SEX DISTRIBUTION:

Out of 30 patients, 27 patients (90%) were males and 3 patients (10%) were females showing male preponderance because of working in factories, fields, travelling and sports.

Table 2:

SEX	NO.OF PATIENTS	PERCENTAGE
Male	27	90%
Female	3	10%
Total	30	100%

Graph 2:



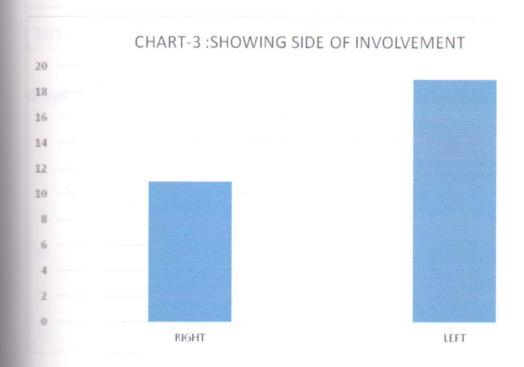
3) SIDE AFFECTED

In 19 (63%) patients with left forearm and 11 (37%) patients with right forearm were fractured.

Table 3:

Side involved	No.of patients	Percentage
Right forearm	11	37%
Left forearm	19	63%
TOTAL	30	100%

Graph 3:



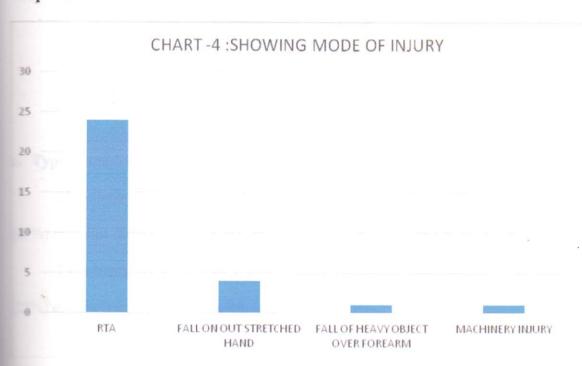
4) MODE OF INJURY

In our study, there were 24(80%) patients with road traffic accidents (RTA), 4 (13%) patients with fall, 1(3.5%) patients with machinery injury and 1(3.5%) patient with fall of heavy object over fore arm.

Table 4:

MODE OF INJURY	NUMBER OF PATIENTS	PERCENTAGE
RTA	24	80%
Fall on out stretched hand	4	13%
Fall of heavy object over forearm	1	3.5%
Machinery injury	1	3.5%
TOTAL	30	100%

Graph 4:



5) FRACTURE CHARACTERISTICS

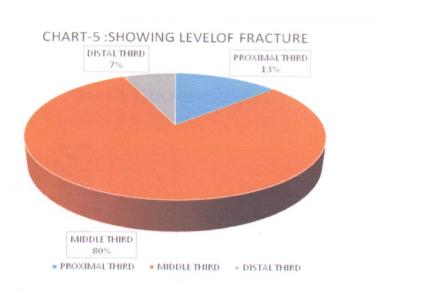
Clinical: 28 cases were closed injuries and 2 cases open injuries (both cases are Gustilo Anderson type 2).

b Level of fracture

Majority of the fractures were seen in the mid diaphysis of both bones of forearm.

24 (80%) patients had mid diaphysial fractures, 4(13%) had proximal third fractures and 2 (7%) patients had lower third fracture of both bones of forearm.

Graph 5:



E. Type of the fracture

21 patients (70%) of radius fractures were transverse/short oblique. 8 patients (27%) of radius fractures were comminuted and 1 patient (3%) had spiral fracture.

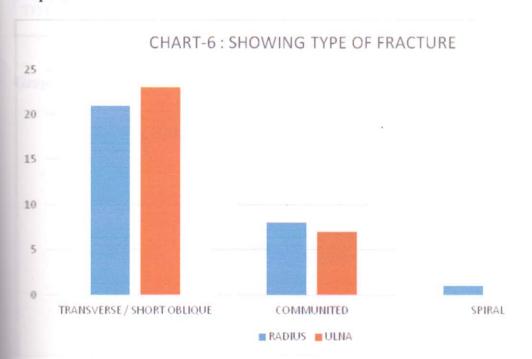
23 patients (77%) of ulna fractures were transverse/short oblique. 7 patients (23%) of ulna fractures were comminuted.

TYPE OF THE FRACTURE

Table 5:

TYPE OF FRACTURE	RADIUS	ULNA	PERCE	NTAGE
Transverse/short oblique	21	23	70%	77%
Comminuted	8	7	27%	23%
Spiral	1	0	3%	0%
Total	30	30	100%	100%

Graph 6:



6) Associated injuries:

9 (30%) of the patients had associated skeletal injuries.

Table 6:

ASSOCIATED INJURIES	NUMBER OF CASES	PERCENTAGE
Fibula fracture	2	7%
Fracture of the shaft of femur	2	7%
phalynx fractures fifth digit right foot	1	3%
Fracture tibia	2	7%
Traumatic head injury	1	3%
Superior inferior pubic rami fracture	1	3%
TOTAL	9	30%

Graph 7:

CHART-7: SHOWING ASSOCIATED INJURIES

FIBULA FRACTURE

FRACTURE SHAFT OF FEMUR ## PHALYNX FRACTURE

FRACTURE TIBIA

TRAUMATIC HEAD INJURY

PUBIC RAMII FRACTURE

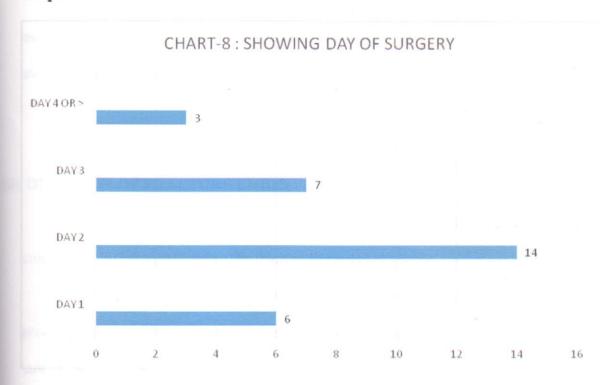
7) TIME INTERVAL BETWEEN INJURY AND INTERVENTION:

Most of the cases were operated between day 1 and day 3 (90 %).

Table 7:

DAY	DAY1	DAY 2	DAY 3	DAY 4
				OR MORE
NO OF CASES	6	14	7	3
PERCENTAGE	20	47	23	10

Graph 8:



8) STATISTICS OF SURGERY

21 of the 30 cases were operated under general anaesthesia and in other 9 patients brachial block was used.

Dorsal Thompson approach for proximal and middle third radius was used in 28 patients and Henrys approach for lower third radius was used in 2 patients.

Ulna was approached subcutaneously. Pneumatic tourniquet was used in all the cases.

9) DURATION OF SURGERY AND TOURNIQUET TIME

In our study, the duration of surgery ranged from 60 to 95 minutes, with average time of 80 minutes. The tourniquet time ranged from 40 to 60 minutes, with average time of 49 minutes.

DURATION OF FRACTURE UNION

The fracture was considered as united when there were no subjective complaints, radiologically when the fracture line was not visible.

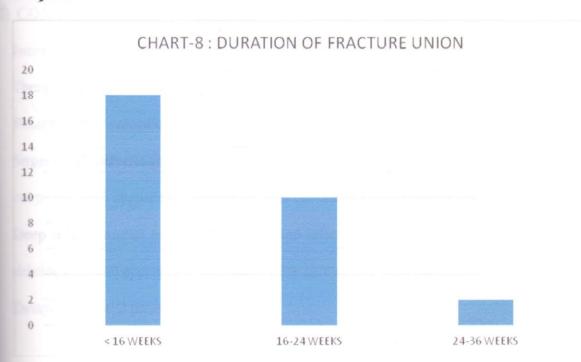
Those fractures, which healed after 6 months without an additional operative procedure was considered as delayed union. Fractures, which did not unite after six months or that needed an additional operative procedure to unite was considered as non-union.

Table 8:

TIME OF UNION	NO. OF	PERCENTAGE
	CASES	
< 4 months (16 weeks)	18	60%
4-6 months (16 – 24 weeks)	10	33%
6 months - 1 year (24-36 weeks)	2	7%
Total	30	100 %

28(93%) patients had sound union in less than 6 months, 2(7%) patients had delayed union.

Graph 8:



11) FOLLOW UP

Most of the cases were followed up for a minimum period of 6 months. Average duration of follow up was 37.04 weeks. Range of Movements achieved.

Table 9:

MOVEMENTS	AVERAGE MOVEMENTS	NORMAL
Elbow flexion	140.6 ⁰	130° to 145°
Elbow extension	00	00
Supination	76.5 ⁰	70° to 80°
Pronation	75.5 ⁰	75° to 85°
Dorsiflexion	82.6 ⁰	75° to 85°
Palmarflexion	82.5 ⁰	75° to 85°

(2) COMPLICATIONS

Intraoperative complications

There were no cases of intraoperative complications.

Postoperative complications

Superficial Infections: two patient developed superficial infection. Infection was controlled with appropriate antibiotics after culture and sensitivity report.

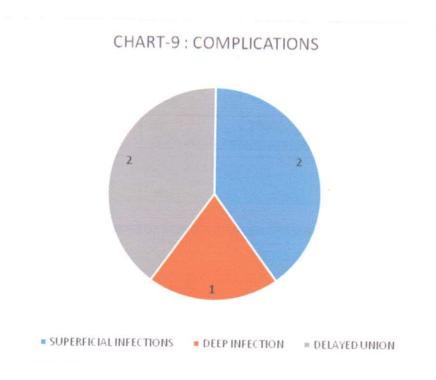
Deep infection: one patient developed deep infection. Infection was controlled with debridement and appropriate antibiotics after culture and sensivity report.

Delayed union: 2 patients

Table 10:

COMPLICATIONS	NO. OF	PERCENTAGE
Superficial infection	CASES	
Superiiciai infection	2	7%
Deep infection	1	3%
Delayed union	2	7%
Total	5	17%

Graph 10:



CRITERIA FOR EVALUATION OF RESULTS

"Anderson" et al scoring system (1975).5

Criteria for evaluation of Results

Table 11:

RESULTS	UNION	FLEXION / EXTENSION AT ELBOW JOINT	SUPINATION AND PRONATION
Excellent	Present	<10 ⁰ loss	<25% loss
Satisfactory	Present	<20° loss	<50% loss
Unsatisfactory	Present	>20 ⁰ loss	>50% loss

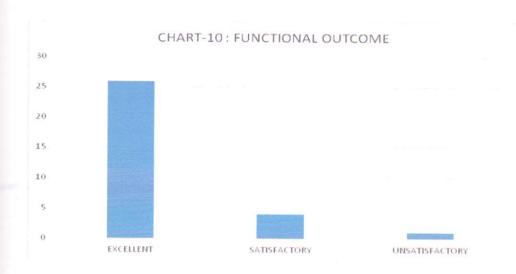
Using the Anderson et al scoring system we had 26(%) patients with excellent results,4(%) patients with satisfactory results.

13) FUNCTIONAL RESULTS:

Table 12:

Results	No. of cases	Percentage
Excellent	26	87%
Satisfactory	4	13%
Unsatisfactory	0	0%
Total	30	100%

Graph 12:



X-Ray & Clinical Photographs

CLINICAL AND RADIOLOGICAL PHOTOGRAPHS

CASE NO: 2



PRE OPERATIVE



3 MONTHS FOLLOW UP



POSTOPERATIVE



6 MONTHS FOLLOW UP



PRONATION



SUPINATION



ELBOW FLEXION



ELBOW EXTENSION



PALMAR FLEXION



DORSI FLEXION

Case No: 29



PRE-OPERATIVE



POST OPERATIVE



3 MONTHS FOLLOW UP



6 MONTHS FOLLOW UP



SUPINATION



PRONATION



ELBOW FLEXION



ELBOW EXTENSION



PALMAR FLEXION



DORSI FLEXION

Case No.17



PRE-OPERATIVE



POST OPERATIVE



6 MONTHS FOLLOW UP



SUPINATION



PRONATION



ELBOW FLEXION



ELBOW EXTENSION



PALMAR FLEXION



DORSI FLEXION

CASE NO.26:



PRE-OPERATIVE



3 MONTHS FOLLOW UP



POST OPERATIVE



6 MONTHS FOLLOW UP



SUPINATION



PRONATION



ELBOW FLEXION



ELBOW EXTENSION



DORSI FLEXION



PALMAR FLEXION

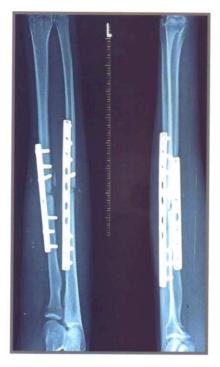
Case No.20



PRE OPERATIVE



3 MONTHS FOLLOW UP



POST OPERATIVE



6 MONTHS FOLLOW UP



SUPINATION



PRONATION



ELBOW FLEXION



ELBOW EXTENSION



PALMAR FLEXION



DORSI FLEXION

Case No.22



PRE-OPERATIVE



POST OPERATIVE



6 MONTHS FOLLOW UP



IMPLANT REMOVAL



SUPINATION



PRONATION



ELBOW EXTENSION



ELBOW FLEXION



DORSI FLEXION



PALMAR FLEXION

Discussion

DISCUSSION

The forearm, being a component of upper limb serves important movements that are important in activities of daily living. The forearm, allows pronation and supination which in turn helps hand, to perform multi axial movements.

Fractures of the forearm bones may result in severe loss of function unless adequately treated. Hence good anatomical reduction and internal fixation of these fractures is necessary to restore function.¹¹

This study was conducted on 30 patients at our hospital with the aim to know the importance of rigid anatomical reduction and fixation of diaphyseal fractures of both bones forearm with DCP. This in turn was reciprocated on the functional results obtained. All the patients were followed up with minimum period of 6 months follow up.

We evaluated our results and compared them with those obtained by various other studies. Our analysis is as follows.

1) AGE DISTRIBUTION:

In our study, fracture was commoner in the second and fourth decade, with average age of 36.5 years (18-55 years).

Our findings are comparable to the study made by Chapman et al in 1989 witnessed 70% of patients between third and fourth decade and an average of 33 years. 17

In 1964, Charnley series showed average age of 33 years (13-79). 15

In 1972, Herbert S. Dodge and Gerald W. Cady found 24 years as the average age in their series.²

In 1986 Berton R. Moed found the average age was 22 years. 29

In 1992, Schemitsch, Emil H., found 24 years as average.34

SERIES	MINIMUM	MAXIMUM	AVERAGE AGE
	(YEARS) AGE	(YEARS) AGE	(YEARS)
Herbert Dodge	13	59	24
Michael Chapman	13	79	33
Moed BR	14	65	22
Schemitsch et al	16	83	24
Present study	18	55	36.5

2) SEX DISTRIBUTION

In our study, male preponderance with 90% males and 10% female patients, which is comparable to previous studies.

Our serious is comparable to Herbert Dodge and Talwalker.

Herbert Dodge in his study, noted about 89% males and 11% females.²

Michael Chapman noted about 78% males and 22% females. 17

Talwalkar in his series had 80% males and 20% females.⁵⁹

¥	MALES (%)	FEMALES (%)
SERIES		
Herbert Dodge	89	11
Michael Chapman	78	22
Talwalkar	80	20
Present study	90	10

3. MODE OF INJURY:

In our series 80% of cases had road traffic accidents, 13% had fall on out stretched hand, 3.5% with fall of heavy object over forearm and 3.5% machinery injury.

Our series is comparable to Moed BR et al., and Hadden series.

Moed BR. et al. accounted 70% of his cases to road traffic accident, 14% due to fall, 12% due to direct blow and 4% due to gunshot injuries²⁹.

Smith noted about 45% of his cases, which were due to RTA, 36% were due to fall and 19% were due to industrial accidents.¹⁴

Hadden 1983 , accounted 75% of his cases to road traffic accident, 8% were due to fall, 2% machinery injuries. 26

SERIES	ACCIDENT (%)	FALL (%)	DIRECT	
			BLOW/MISCELLANEOUS (%)	
Mode	70	14	16	
Hadden	75	8	17	
Smith	45	36	19	
Present study	80	17	3	

4) EXTREMITY AFFECTED:

H.N. Burwell and A.D. Charnley reported about 50.67% incidence of fracture both bones in left forearm.¹⁵

M.W. Chapman reported about 55% incidence of fractures of both bones in right forearm.¹⁷

Schemitsch H, et al reported about 56.37% fractures of both bones in left forearm.³⁴
We accounted about 63% incidence of fracture both bones in left extremity.

SERIES	RIGHT (%)	LEFT (%)
H.N.Burwell	50	50
M.W.Chapman	55	45
Schemitsch et al	43.63	56.37
Present study	37	63

5) FRACTURE ANATOMY:

a) Type of fracture:

M.W. Chapman et al, series noted about 53% of fractures as comminuted and 47% were transverse/short oblique. 17

Our series accounted 73.5% of fractures as transverse/short oblique and 25% were comminuted. The results were not comparable to the previous studies, which can be attributed to low velocity trauma in our country.

SERIES	TRANSVERSE/SHORT OBLIQUE	COMMINUTED
Chapman	47%	53%
Present study	75%	25%

b) LEVEL OF FRACTURE:

A. Sarmiento et al, noted about 84.6% of fracture both bones were in middle third and 15.4% of cases had lower third fracture of both bones.¹⁶

H.S. Dodge and G.W. Cady documented 71.5% fracture both bones n middle third, 21.5% in distal third and 7% in proximal third.²

M.W. Chapman et al noted about 59% and 40% of fractures in middle third of Radius and ulna, 13% and 21% in proximal third of radius and ulna and 28% and 12% in lower third of radius and ulna respectively.¹⁷

Our series had 80% of fractures in middle third, 13% in proximal third and 7% in lower third, comparable to previous studies.

SERIES	PROXIMAL THIRD	MIDDLE THIRD	DISTAL THIRD
Sarmiento	-	84.6%	15.4%
Dodge	7%	71.5%	21.5%
Chapman et al	13%	59%	28%
Present study	13%	80%	7%

a) TIME FOR UNION

In most of the reported series, it is usually around 12 weeks except in the series of Anderson et al,⁵ where he reports a union time of 7.4 weeks (average). Time for union varies according to age, general condition, rigidity of fixation and presence of infection. Also inter observer variation is there, regarding time of union.

Absence of tenderness at the fracture site and disappearance of fracture line with callus formation is taken as union.

Anderson's criteria for evaluation of union were taken into account. In our series, we had an average union time of 15 weeks, with the range of 9 to 35 weeks.

We had 100% union of both radius and ulna.

The results of our present study are comparable to the previous studies.

SERIES	UNION TIMES (WEEKS)	RANGE (WEEKS)	UNION (%)
Anderson	7.4	5 – 10	97
Chapman	12	6 – 14	98
Present study	15	9 – 35	100

6) FUNCTIONAL RESULTS

Fracture union and range of movements are the two factors, which affect the functional outcome. So early mobilization prevent soft tissue contracture, muscular tethering and improves the vascularity.

Anderson's et al scoring system was used as a measure for the functional outcome.⁵

Anderson et al reported about 54 (50.9%) cases as excellent, 37 (34.3%) satisfactory, 12 (11.3%) unsatisfactory and 2 (2.9%) as failure.⁵

Chapman et al reported about 36 (86%) cases as excellent, 3 (7%) satisfactory, 1 (2%) as unsatisfactory and 2 (5%) as failure.¹⁷

In present study, we had 26 (87%) with excellent results, 4 (13%) as satisfactory results.

FUNCTIONAL RESULTS

SERIES	EXCELLENT	SATISFACTORY(%)	UNSATISFACTORY	FAILURE
	(%)		(%)	(%)
Anderson	50.9	34.9	11.3	2.9
Chapman	86	7	12	5
Burwell	77	23.8	10.8	1.4
Present study	87	13	-	-

7) COMPLICATIONS

In our series we had 2 case of superficial infection which resolved with appropriate antibiotics and 1 case of deep infection which resolved with debridement and appropriate antibiotics and 2 cases of delayed union.

COMPLICATIONS	ANDERSON	CHAPMAN	GRACE- EVERSMANN	PRESENT STUDY
Superficial infection	2.9%	2.5%	2%	6.7%%
Deep infection		2.3%	3%	3.3%
Non-union	2.9%	2.3%	-	
Post-interosseous nerve injury	2%	1.5%	3%	-
Radio-ulnar synostosis	1.2%	2.3%	-	-
Delayes union		1.5%	1.5%	6.7%

Conclusion

CONCLUSION

The present study was conducted to assess the outcome of DCP plating in fractures of both bones forearm.

We conclude -

- Fractures of both bones of forearm in adults are commoner in second and fourth decade of life. Males predominant in the high incidence of fractures due to manual working and outdoor activities.
- Majority of the fractures were transverse/short oblique in the middle shafts of both bones forearm and were due to vehicle accidents
- With the use of AO/ASIF 3.5 mm DCP for diaphyseal fractures of both bones forearm, rigid and anatomical fixation can be achieved.
- Use of tourniquet, separate incisions for radius and ulna and preservation of the natural curves of radius will lesser the rate of complications.
- These fractures have to be fixed as early as possible and it is important to achieve anatomical reduction and stable internal fixation for excellent functional outcome.
- A minimum of 6 cortices has to be fixed on each fracture fragment.
- After DCP fixation, postoperative support, given in the form of arm pouch in most instances, can be discontinued after the soft tissues have healed and rapid return to full, painless motion can be anticipated.
- Most of the fracture united within 6 months.
- With rigid/anatomical fixation, Dynamic Compression Plate is a good fixation for displaced diaphyseal fractures of both bones forearm. Adherence to AO principles, strict asepsis, proper post-operative rehabilitation and patient education are more important to obtain excellent results. Also external immobilization was not necessary in intelligent and co-operative patients.

Summary

SUMMARY

This study has been taken to determine the functional outcome of diaphyseal fractures of both bones, forearm treated with DYNAMIC COMPRESSION PLATE at R L Jalappa Hospital attached to Sri Deveraj Urs Medical College, Tamaka, Kolar, from NOV 2012 to May 2014.

- 1. This is a time-bound prospective study.
- 2. Thirty cases of fractures of both bones forearm were treated by open reduction and internal fixation with 3.5 mm DCP.
- 3. The average age was 36.5 years with fracture being most common in second and fourth decade.
- 4. 27 male patients and 3 female patients.
- 5. The mechanism of injury was motor vehicle accident in 24, history of fall in 4 patients, fall of heavy objects on hand 1 patient, machinery injury 1 patient.
- 6. Side effected is left forearm 19 and right forearm 11.
- 7. Most of the fractures of both bones forearm were located in the middle third and the fracture pattern transverse/short oblique was commonest.
- 8. Minimum duration of follow up was 6 months.
- 9. 28 (93%) patients has sound union in less than 6 months, 2(7%) patients had delayed union.
- 10. The average time for fracture healing was 15 weeks.
- 11. Infection of wound was most common complication in our study.
- 12. The results were based on Anderson et al scoring system and in our study, there were 26 (87%) patients with excellent results and 4 (13%) with satisfactory.
- 13. Hence the study was satisfactory and DCP is the best mode of treatment for diaphyseal fractures of both bones forearm.

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Annexures

ANNEXURES 1

PROFORMA

	Case No.	:	Hospital	:
	Name	:	IP/OP No	:
	Age	:	D.O.A	:
	Sex	:	D.O.D	:
	Occupation	1:	Doctor:	
	Address	:	M.L.C	:
	Diagnosis	ad .		
	PRESENTING CO	OMPLAINTS :		
1.				
2.				
3.				
	HISTORY OF PRI	ESENTING COMPLAINTS:		
1.	Date of injury	;		
2.	Mode of injury	:		
a.	RTA :		1	
b.	Self-fall :			
c.	Others :			
3.	Associated injuries	*		

a.

b.

c.

PAST HISTORY

PERSONAL HISTORY

- a) Occupation:
- b) Diet-veg/non veg/mixed
- c) Habits -smoking/alcohol/both
- d) Sleep-impaired/not impaired
- e) Bowel and bladder habits

EXAMINATION

- 1. General physical examination
- a. Built and nutrition
- b. Pallor-present/absent
- c. Pulse
- d. BP
- e. Temperature
- f. Other significant findings
- 2. Systemic examination
- a. CVS
- b. RS
- c. PA
- d. CNS

Local examination : e. Inspection: Side-Left/Right Attitude of the limb Shortening Deformity Swelling Skin Wound f. Palpation: Tenderness Local rise temperature Bony irregularity Crepitus Abnormal mobility Peripheral pulses Neurological deficits-Present/Absent Associated injuries **MOVEMENTS:** Elbow: Flexion Extension Forearm: Supination Pronation

Radial deviation

Flexion

Extension

Wrist:

Grip of the hand

INVESTIGATIONS:		
Blood-Hb %		RBS
TC		Blood urea
DC		Serum Creatinine
HIV/HbsAg:		Grouping, Cross matching and FBS
X-ray forearm:	AP	
	Lateral	
ECG:		
Chest X-ray:		
Type		
Transverse/Ol	olique/Spiral/Bu	tterfly fragment/Comminuted
TREATMENT		
Preliminary treatment on a	admission : Dru	igs advised
Operative treatment :	Type of anesth	esia
	Tourniquet – a	pplied/not applied
	Approach-1	2-
Implant used :	:	
Bone grafting :		
Duration of operation	:	
Post operative orders	:	
Immobilization :A/E p	osterior slab app	blied fordays
Post operative antibiotics		Analgesics
Suture removal after	•••••	days
Wound healing/Gaping/Infec	ted	

ADVICE ON DISCHARGE

FOLLOW UP

Sl. No	Follow-up Date	Clinical-radiological	Functional Eva	luation
			Elbow Joint -	Flexion
1 st visit 1 st week			Forearm -	Extension Supination Pronation
			Wrist -	Flexion Extension
550			Elbow Joint -	Flexion Extension
2 nd visit 1 month			Forearm -	Supination Pronation
			Wrist -	Flexion Extension
			Elbow Joint -	Flexion Extension
3 rd visit 3 months			Forearm -	Supination Pronation
			Wrist -	Flexion Extension
			Elbow Joint -	Flexion Extension
4 th visit 6 months			Forearm -	Supination Pronation
1000 - 1000 000 000 000 000 000 000 000			Wrist -	Flexion Extension

Results:

Excellent: Loss of flexion and extensions at the wrist or elbow less 10⁰

Loss of supination and pronation less than 25%

Satisfactory: Loss of flexion and extensions at the wrist or elbow less than 20^o

Loss of supination and pronation less than 50%

Unsatisfactory:Loss of flexion and extensions at the wrist or elbow more than 20°

Loss of supination and pronation more than 50%

Failure: Non-union, un resolved chronic osteomyelitis

COMPLICATIONS:

Infection-	Superficial	Deep
Non-union		
Shortening		
Mal union		
Loss of movements		

Others

ANNEXURE – II

CONSENT FORM FOR OPERATION/ANAESTHESIA

I Hosp. No in my full senses hereby give my
complete consent for or any other procedure deemed fit which is a
diagnostic procedure / biopsy / transfusion / operation to be performed on me /
my son / my daughter / my ward age under any anaesthesia deemed fit. The
nature and risks involved in the procedure have been explained to me to my
satisfaction. For academic and scientific purpose the operation/procedure may be
televised or photographed.
Date:
Signature/Thumb Impression of Patient/Guardian
Name:
Designation:
Guardian Relationship:
Full address:

KEY TO MASTER CHART

Sl. No

Serial Number

Ip. No.

Inpatient Number

MOI

Mode of injury

ROM

Range of movements

M

Male

F

Female

RTA

Road Traffic Accidents

Rt

Right

Lt

Left

THOM

Thomson's

SUB

Subcutaneous

TRANS

Transverse

COMM

Comminuted

#

Fracture

BB

Both bones

SIGHT MIDTHIRD TRANS TRANS SHORT OBL. THOM SUB 12 FULL NILL 80 50 MINECTION OF SUB-FIELD MIDTHIRD TRANS TRANS THOM SUB 12 FULL NILL 80 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS TRANS THOM SUB 12 FULL NILL 80 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS TRANS THOM SUB 12 FULL NILL 80 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS TRANS THOM SUB 12 FULL NILL 80 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS THANS THOM SUB 12 FULL NILL 80 60 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS THANS THOM SUB 12 FULL NILL 80 60 60 60 60 MINECTION OF SUB-FIELD MIDTHIRD TRANS THANS THOM SUB 12 FULL NILL 80 60 60 60 60 60 60 60 60 60 60 60 60 60															
STATEMENT STAT		RESULTS	EXCELLENT	SATISFACTORY	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT
SUBGENERAL 19 M SOCIETA FIRST MID THIRD TRANS TRANS THOM SUB 12 FULL MILE SUBFRICAL MILE MI			20	09	55	40	20	09	45	20	45	55	20	40	40
TYPE OF FRACTURE ASSOCIATED TOTAL TOTA			80	96	75	06	80	80	85	75	70	80	95	80	80
BASSAMMA	SNOITA	COMPLIC	NIL	DEEP	NIL	SUPERFICIAL	NIL	NIL	NIL	NIL	SUPERFICIAL	NIL	NI	NIL	Ī
BASSAMMA	NOITON 3	RANGE O	FULL	G009	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	111111111111111111111111111111111111111
SURGERANNA	ONION IN MEEKS	TIME OF	12	24	6	20	14	10	∞	12	23	18	22	12	-
BASSAGANDA	CAL	ULNA	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	2
EASAMMA	SURGI	RADIUS	THOM	THOM	THOM	THOM	THOM	HENRY	THOM	THOM	THOM	THOM		THOM	
EASAMMA		ASSOCIATED INJURY				PROXIMAL PHALYNX # OF 5 TH DIGIT R FOOT							R SUPERIOR AND INFERIOR PUBIC RAMI #	R FEMUR SHAFT # MID THIRD	
BASAMIMA	RACTURE	ULNA	TRANS	SHORT OBL	TRANS	COMM.	TRANS	SHORT OBL	TRANS	COMM	TRANS	COMM	COMM	TRANS	
EASAMMA	TYPE OF F	RADIUS	TRANS	TRANS	TRANS	COMM.	SHORT OBL.	TRANS	COMM	TRANS	TRANS	COMM	COMM	COMM	
BASAMMA	3TI			MAL		MAL		S S						MID THIRD	
BASAMMA	10	SIDE					RIGHT	LEFT				LEFT	RIGHT	LEFT	
BASAMMA	98	IOM	RTA	RTA	RTA	RTA	RTA	RTA	RTA	FALL	FALL	RTA	FALL	RTA	
AMMA 2 KUMAR 2 KUMAR 3 YALLAPPA 4 VINOD KUMAR 5 SUBBA RAJU 6 NARAYANA SWAMY 7 SHIVA KUMAR 7 SHIVA KUMAR 8 VEERANNA 9 JAYARAM 19 N 10 SURESH 11 SUKANANDAR PATEL 23 N		ON.91	725347	824239	861778	862556	896075	900432	901837	902324	902458	903659	904284	916646	
E BASAMMA I BASAMMA I KUMAR I VINOD KUMAR I SUBBA RAJU S S S S S S S S S S S S S S S S S S S			7 F	Σ	Σ	Σ	Σ	Σ	Σ	Σ	≥	Z	Z 2	2	
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		ON'TS	1 BASAM	2 KUMAR	3 YALLAP	4 VINOD	S SIIRBA	6 NARAY	7 SHIVA	8 VEFRA	9 JAYARA	10 CHREST	11 SUKAN	12 UDAY I	

MASTER CHART

EXCELLENT	SATISFACTORY	EXCELLENT	SATISFACTORY	EXCELLENT	SATISFACTORY	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	
45 E	50	40	50	50 E	50 8	55	40	50 E	9 09	50 E	50 E	40 E	40 E	9 09	50 E	
75	95	09	75	70	80	06	06	80	70	06	80	80	70	06	80	
NIL	DELAYED	NIL	NIL	NIL	DELAYED	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	
9 FULL	33 GOOD	14 FULL	24 GOOD	20 FULL	35 GOOD	18 FULL	10 FULL	12 FULL	18 FULL	9 FULL	10 FULL	16 FULL	12 FULL	20 FULL	12 FULL	
SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	SUB	
THOM	THOM	THOM	THOM	THOM	THOM	THOM	THOM	THOM	THOM	THOM	THOM	ТНОМ	THOM	HENRY	THOM	
		R TIBIA MID SHAFT #				R TIBIA # MID SHAFT PROXIMAL THIRD R FIBULA					TRAUMATIC HEAD INJURY		PROXIMAL THIRD L FEMUR #			
TRANS	TRANS	TRANS	TRANS	SHORT OBL	SHORT OBL	TRANS	TRANS	SHORT OBL	COMM	TRANS	COMM	SHORT OBL	TRANS	COMM	SHORT OBL	
SHORT OBL	TRANS	SPIRAL	TRANS	SHORT OBL	TRANS	СОММ	TRANS	TRANS	TRANS	SHORT OBL	COMM	COMM	TRANS	FRANS	TRANS	
MID THIRD	MID THIRD	MID THIRD	MID THIRD	MID THIRD	MID THIRD	MID THIRD	MID THIRD	PROXIMAL THIRD	MID THIRD	PROXIMAL	MID THIRD (MID THIRD	MID THIRD	DISTAL THIRD TRA	MID THIRD	
LEFT	LEFT	RIGHT	LEFT	LEFT	LEFT	LEFT	LEFT	LEFT	LEFT	LEFT	LEFT	RIGHT	LEFT	RIGHT	RIGHT	
923432 RTA	928551 RTA	932164 RTA	934027 FALL	942124 RTA	942458 RTA	952136 RTA	955066 RTA	962421 RTA	970803 RTA	975916 RTA	976847 RTA	1003466 FALL	1010612 RTA	MACHIN ERY 1011394 INJURY	1011438 RTA	
23 M	55 M	43 M	34 M	25 M	32 M	50 M	25 F	39 M	42 M	55 M	25 M	33 M	S5 M	25 M	45 M	
14 ESHWAR	15 THIPANNA	16 MANJUNATH	17 RAMESH BABU	18 SYED	19 KANTHARAJ	20 VENKATA CHALAPATTI	21 RAMYA	22 SHARAT KUMAR	23 SIDAPPA	24 VALLAPPA	25 CHANDRA	26 PALABABU	27 VENKATA REDDY	28 KAPIL DEV	29 MUBARAK	