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Prospective Study of Management of Closed Diaphyseal Fracture of Radius and Ulna with Dynamic Compression Plate

Medical Science

KEYWORDS : closed diaphyseal fractures, internal fixation, dynamic compression plate

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ABSTRACT

Objective- *To study the mechanism of injury of diaphyseal fractures of radius and ulna and study principles of dynamic compression plate and assess the rate of fracture union, its complication and to evaluate the post-operative function of the forearm following dynamic compression plating.*

Material and methods- *40 patients with forearm fracture who were treated with Open Reduction and Internal Fixation with Dynamic Compression Plating. The patients were evaluated based on "Anderson et al" scoringsystem. Elbow movements and wrist movements were noted and the union was assessed radiologically.*

Results- *In 40 patients mean age is 34.43.Out of 40 patients, for 23 (58%) patients, the time of union was less than 10 weeks, for 8 (20%) patients, the time of union was between 10-14 weeks, for 6 (15%) patients, the time of union was 14-18 weeks and for 3 (8%) patients, the time of union was more than 18 weeks.*

For all 40 patients included in study, the average time of union was 11.75 weeks (SD = 3.643 weeks) with minimum 8 weeks and maximum 20 weeks.Out of 40 patients included in study, 34 (85%) shown excellent wrist movement whereas 6 (15%) showed satisfactory wrist movement. 34 (85%) patients showed excellent pronation supination and 6 (15%) showed satisfactory pronation supination. Out of 40 patients, 34 (85%) showed excellent results whereas 6 (15%) showed satisfactory results.

Conclusion- *With rigid/anatomical internal fixation, dynamic compression plate is a good fixation for displaced diaphyseal fractures of the forearm bones.*

Introduction

The forearm, in combination with the proximal and distal radio - ulnar joints, allows pronation and supination movements that are important to all of us in the usual activities of daily living. The forearm serves an important role in upper extremity function, facilitating positioning the hand in space, thus helping to provide the upper extremity with its unique mobility.

It is essential to regain length, apposition, axial alignment and normal rotational alignment while treating diaphyseal fractures of the radius and the ulnato gain good range of pronation and supination. The chances for the occurrence of malunion and non-union are greater because of the difficulties in reducing and maintaining the reduction of two parallel bones in the presence of the pronating and supinating muscles, which have angulatory as well as rotatory influences.[1]

Forearm bone fractures are commonly encountered in today's industrial era. Various treatment modalities were introduced from time to time and each of them had some edge over the previous one. Continuing this process of revolution and based on many years of experience with compression plating and promising results obtained with so called internal fixation, an implant system has been developed which combines the two treatment modalities.

Open reduction and internal fixation with plating is generally accepted as the best method of treatment for displaced diaphyseal fractures of the forearm in the adult.[2]

The dynamic compression plate (DCP) first described by Bagby and Denham.[3] Compression techniques have a lower incidence of non-union and are found to hasten rehabilitation, with less joint stiffness.[4-9]

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. [10]

Gilfillen devised metallic plate for fixation of fratures of radius and ulna.[11]

The dynamic compression plate (DCP) 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.

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.[12]. Allgower recommended 3.5 DCP for forearm fractures.[13]

It is difficult to achieve a satisfactory closed reduction of displaced fractures of the forearm bones, and if achieved, it is hard to maintain, for this reason fractures of both bones or a displaced isolated fracture of the radius and ulna should be treated by open reduction, plate fixation, and cancellous bone grafting whenever there is bone loss. Sarmiento believed that plate fixation is the most satisfactory treatment for forearm fractures and can achieve good functional results [14]. Campbell says with compression plate

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fixation , early active motion is possible. This helps prevent muscle atrophy and joint stiffness. Talwalkar described treatment of simple fracture of radius and ulna with internal fixation without external support.[15]

Material and methods -
Our study includes 40 patients with forearm fracture who were treated with Open Reduction and Inernal Fixation with Dynamic Compression Plating.

All patients admitted with acute diaphyseal fractures of the radius and ulna, a careful history was elicited from the patient and/or attendants to reveal the mechanism of injury and the severity of trauma.

The patients were then assessed clinically to evaluate their general condition and the local injury. It was done in accordance to Acute Trauma Life Support protocol. Vital parametres were recorded. Methodical examination was done to rule out fractures at other sites. Local examination of injured forearm and hand such as 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, pallor and paraesthesia at finger tips.**Neurological examination**: Sensory system was examined for pain and touch sensation in the radial. ulnar and median nerve innervated arrears.Power including handgrip was tested in forearm and hand muscles.

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

Imaging: The clinical signs and symptomsare usually obvious in shaft fractures of both bones of the forearm, so are the radiologic signs. The configuration of midshaft fractures of the radius and ulna varies depending on the mechanism of injury and the degree of violence involved. Low-energy fractures tend to be transverse or short71 oblique, whereas high-energy injuries are frequently extensively comminuted or segmented, often with extensive soft tissue injuries.

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

The determination of the correct rotational position in which to immobilize fractures of both bones of the forearm is of importance, in that any degree of error will be 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 EVANS. It is 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 importance, the only essential being the careful alignment of the elbow joint.

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

The limb was then immobilized in above elbow Plaster of Paris slab with sling. Proximal radius was approached by dorsal Thompson incision and volar Henry approach was used for middle and distal radius. A narrow 3.5mm DCP was used and a minimum of 6 cortices 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 ofradiographs. Adose of tetanus toxoid and antibiotic were given preoperatively.If evidence of compartment syndrome, surgery has to be done as soon aspossible.Part Prepared.

INSTRUMENTS AND IMPLANTS USED IN DYNAMIC COMPRESSION PLATING FOR FOREARM BONES:
• Drill and Drill Bit of 2.5mm and 3. 5mm. 3.5mm Drill sleeve system.3.5mm counter sink.3.5mm universal drill guide.Depthgauge.Tap for 3. 5mm cortex screw.3.5mm Cortex Screws.Plate Holding Clamp (Lowman's Clamp). Hexagonal Screwdriver73.Bending templates.Bending press/pliers,Narrow 3. 5mm stainless steel DCP of varying length,Generalinstruments like Bone Holding Forceps, PeriosteumElevator, Bone Lever, Bone Reduction Clamps

Operative procedure
Type of anaesthesia: General anaesthesia was used in 14 cases and brachial block in 16 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 pronation.Painting and draping of the part done.

Incision-Ulnar shaft: Parallel and slightly volar to the subcutaneous crest of the ulna.Radial shaft: Dorsal Thompson approach and Volar Henry's approach.

Procedure: Usually radius was fixed first, however the bone which was less comminuted and more74 stable was fixed first and later the other bone was fixed.After identifying the fracture ends, periosteum was not elevated and fractureends were cleaned.

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

A plate hole is left vacant for angled lag screw through the plate in case of oblique fractures. 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.In case of transverse and short oblique fractures plate hole adjacent to fracture is drilled first using neutral drill guide.

In case of oblique fractures, the first screw is applied to the fragment, which forms an obtuse 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.

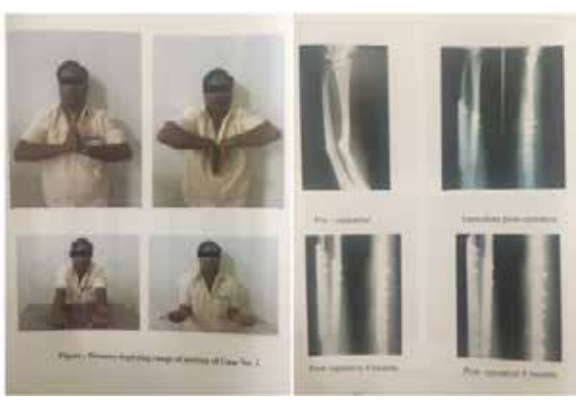
The arrow of the neutral drill guide points towards the fracture. 2.5mm drill bit is used for drilling a hole through both cortices and with depth gauge,appropriate 3.5mm screw length is determined.The tap of 3.5mm is used to cut the thread. The chosen 3.5 mm cortex screw is inserted, but not fully tightened.The plate is pulled towards the fracture to place first eccentric screw.

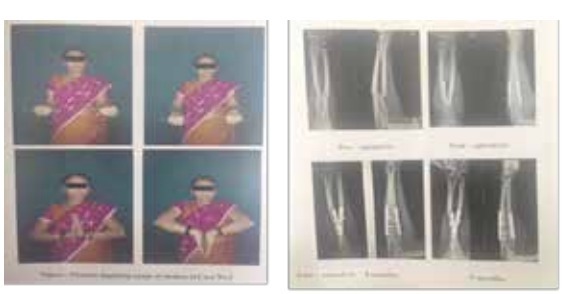
The second screw hole for axial compression is drilled in the fragment which forms an acute angle near the plate. The load guide (yellow) is used with the arrow pointing towards the fracture line to be compressed. At this position, a lag screw will be inserted.Tightening of the two screws produces axial compression.

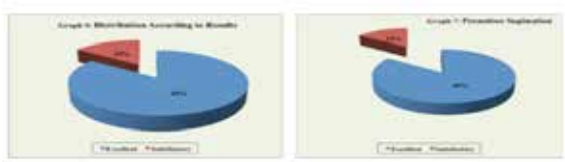
The position of the oblique lag screw through the plate is determined. The angulation of the screw should not exceed +/- 25 degrees longitudinally and +/- 7 degrees transeversely. The lag screw is applied by subsequently over drilling (3.5mm) the near cortex to create a gliding hole.If compression is 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.76Finally tightening of all the screws. hemostasis is maintained, the wound is closed in layers over a suction drain and sterile dressing is applied.

Results







Discussion-

This study was conducted with the aim to know the importance of rigid anatomical reduction and fixation of forearm diaphyseal fractures with 3.5 mm DCP. This in turn was reciprocated on the functional results obtained. Initially our study had patient number of 20, however as the availability of patients were plenty and to obtain a statistically significant result the number of patients was raised to 30.

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

Age distribution: In our study, the age of these patients ranged from 20-56 years and an averageage of 34.93 years. Our findings are comparable to the study made by, Michael W.Chapman et al, (1989) series which showed average age as 33years.

Sex distribution: Our series had male preponderance with (68 %) male patients and(33%) female patients which were comparable to previous studies.**Mode of injury:** In our series 52% of cases had road traffic accidents, 38% had fall,10% with history of assault.**Extremity affected:**

We had about 62.5% incidence of forearm fractures in right extremity, which is also comparable to the previous studies.**Fracture anatomy**

Group of fracture: Majority of our patients were with both bones forearm.16 (53.33%) were with both bones forearm, 9(30%) were isolated fracture of shaft radius and only 5(16.66%) were isolated fracture shaft ulna. Our study was comparable to Anderson and chapman series.

Type of fracture: As we had included diaphyseal fractures of both bones, isolated radius and isolated ulna in our study, in total we had total of 25 radius shaft fractures and 21 ulna fractures.Among 25 radius, 16(64%) were Transverse/short oblique type and 9(34%) were comminuted variety.

Among 21 ulna, 14(66.66%) were Transverse/short oblique type and 7(33.33%) were comminuted variety.

On an average we had 65.33% with Transverse/short oblique type and 33.66% were comminuted variety. Ours were not comparable to any of the studies available.**Level of fracture**:Our series had 40% of fractures in middle third, 30% in proximal third and 30% in lower third.**Time of union**:The present series had average union time of 11.75 weeks with a range of 8 to 20 weeks. Radius united in all cases we had Ulna union in 96.6% of cases.The results of our present studies are comparable to the previous studies **Functional results:**The range of motion was determined and Anderson et al, scoring system was used as a measure for the functional outcome.In our series we had 23 (76.66%) cases with excellent results, 5 (16.66%) satisfactory and 1 (3.33%) case of unsatisfactory result and 1 (3.33%) case of failure due to ulnar non union.

Our series had 85% of excellent and 15% satisfactory result and 3.33 (%) failures which is comparable to the previous studies.

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Unsatisfactory result was seen in a female patient with comminuted fracture. The patient was uncooperative where she didn't follow physiotherapy properly.**Complications**:In our series we had 2 cases of superficial infection. The wound was debrided, pus sent for culture. They resolved with appropriate antibiotics. **Duration of Follow Up**:We had a follow up which ranged from 6 months to 22 months with an average mean of 12 months, which is comparable to Chapman series but other series had longer follow up.

Conclusion-

Based on our experience and results we conclude-

Diaphysealfracture of forearm are seen most commonly in middle aged subjects. Males show hign incidence of fracture as they are often engaged in motor vehicle driving accident, agriculture and industrial work. The cause of fracture is mostly due to road traffic accident or fall on an outstretched hand .Magority of the fractures were in middle third of forearm.

With the use of 3.5 mm DCP for acute diaphyseal fractures of forearm, rigid and anatomical fixation can be achieved. With use of DCP , distraction forces leading to separation fracture fragments like seen in interlocking nail for upper limb is not possible. Radial bowing is very important for supination and pronation.This can be maintained very well with compression plate. A minimum of 6 cortices should be engaged in each fracture fragment. It is better to use longer plates like a bridge plate in case of comminuted oblique fractures.radius and ulna are approached separately to avoid extensive soft tissue dissection and resulting complications.

Post operatively with DCP fixation additional supportive measures may not be required after soft tissue healing and shoulder elbow and wrist movements can be started early. This helps prevent muscle atrophy and joint stiffness. It is very much possible in intelligent and cooperative patients. However all patients should be curtailed from lifting heavy weights till union of fracture.

All fractures in our study united by 4-6 months.

The AO principle of internal fixation namely-Anatomical reduction,Preservation of vascularity,Mechanically stable fixation Rapid mobilization of joints in proximity can be achieved with compression plating system.

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