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MANAGEMENT OF FRACTURES OF BOTH BONES FOREARM USING INTRAMEDULLARY 'L'RODS: A CLINICAL STUDY

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ABSTRACT: INTRODUCTION: According to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) documentation center, forearm fractures accounts for 10-14% of all fractures. Various treatment modalities are available depending upon the fracture type. In this study 20 patients with diaphyseal fractures of both bones forearm were studied and treated with Intramedullary L-rods by closed technique. All these cases were treated at our institution from July 2012 to Jun 2013. The minimum duration of follow up was 6 months. **AIMS & OBJECTIVES:** 1) to find the effectiveness of intramedullary L rods over other alternative methods 2) to evaluate functional and anatomical outcome based on clinical and radiological follow up. 3) To evaluate the difficulties associated with this technique and suggestions to overcome it. **MATERIALS & METHODS:** Through assessment of the patient including clinical examination of the injury, systemic examination, ruling out other injuries and radiological assessment was done before deciding on the surgical procedure. **Sample size:** 20 patients satisfying the following criterion. **Inclusion criteria** 1) Age>17yr 2) Diaphyseal fractures of radius and ulna. 3) Closed fractures and Gustilo Anderson type 1 and 2 fractures **Exclusion criteria** 1) Fractures >4 weeks old. 2) Pathological fractures, Gustilo Anderson type 3 open fractures and associated epiphyseal radius and ulna injury. **STATISTICAL ANALYSIS:** The final results were based on Clinical and radiological assessments i.e. entry point wound status and migration of nail, pain and tenderness at the fracture site, range of movement of elbow and wrist, limb length disparity, three cortices union, callus formation with reference to time, Implant status and varus/ valgus angulation. Functional outcome was assessed using Grace and Eversman scoring system. **RESULTS & CONCLUSIONS:** CLOSED REDUCTION AND INTERNAL FIXATION WITH INTRAMEDULLARY L -RODS is an easy and fast method for treating forearm fractures with minimal blood loss and scar. Full range of movements was achieved without any significant complication.

KEYWORDS: Intradmeduallry L Rods, forearm fractures, Closed Technique.

INTRODUCTION: In the present mechanization active life and industrial development whether in field, on the road or in the factory, fractures of forearm bones are not only one of the commonest injuries but also on increasing frequencies.¹ According to the AO (Arbeitsgemeinschaft für Osteosynthesefragen [Association for Osteosynthesis] documentation center, forearm fractures accounted for 10-14% of all fractures². The most common cause of forearm fracture is direct blow. Fall on out-stretched hand is the second most common cause².

Forearm fractures can be regarded as articular fractures as slight deviations in the spatial orientation of the radius and ulna will significantly decrease the forearm's rotational amplitude and thereby impair the positioning and function of the hand. Thus, the management of these fractures and their associated injuries deserve special attention as their treatment is not the same as the treatment

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of other diaphyseal fractures. Imperfect treatment of fractures of the radius and ulna diaphyses leads to a loss of motion as well as muscle imbalance and poor hand function.³

There are a number of important principles that should be followed to achieve the ideal goal of fracture healing without deformity or dysfunction. There has been variety of treatment options for the management of both bone forearm fractures. The basic principle is to accurately align the fracture fragments and to maintain this position until the fracture is united.

Historically, it has been the standard to treat most of these fractures by closed reduction and immobilization in cast. Moreover, results after prolonged immobilization is not acceptable in adults.⁴ Because of these factors, surgical management for displaced diaphyseal fractures in the adult are generally accepted as the best method of treatment, even though closed reduction may be achieved.

Malunion and nonunion occur more frequently because of difficulty in reducing and maintaining the reduction of the two parallel bones in the presence of pronating and supinating muscles. For displaced forearm fractures in adults to achieve and maintain reduction in cast has been challenging for the surgeon as well as for the patients to get good functional outcome⁴. Alternatives include pins and plasters, closed or mini-open reduction with intramedullary rods and nails, open reduction and internal fixation with plates and screws.⁵

In the present situation of nuclear families, prolonged hospitalization or cast application of patients at home causes social, psychological and financial impacts on the patients and his/her family hence the role of alternative procedures came into practice in the past few decades. They include ORIF with plates and screws, or intramedullary nailing with k- wires, rush rods or flexible nails like square nails and titanium (Nancy) nails with percutaneous fixation⁶.

The complications associated with ORIF techniques, such as infections, overgrowth and re-fracture has encouraged surgeons to develop flexible rods inserted in a percutaneous fashion for stable intramedullary fixation.^{7,8}

Closed reduction and internal fixation with Intramedullary L RODS is an easy and fast method for treating forearm fractures with minimal blood loss and scar. Full range of movements was achieved without any significant complication. As the cost of implant is very less and hospital stay is reduced to an average of 4 days, with less operative time, less chance of infection, early union and no need for reoperation for implant removal Intramedullary L rod fixation for radius and ulna is an effective method of treating these fractures.⁸

It is hence the need for the hour to evaluate the results of intramedullary nailing with flexible L -rods in forearm fractures and help the affected in returning to active life by early mobilization and decrease the social, psychological and financial burden on their family.

MATERIALS AND METHODS: In this study 20 patients with diaphyseal fractures of both bones of forearm were studied. All these cases were treated our Institution between July 2012 to Jun 20103 at and followed for a minimum of 6 months. All fracture in this series were post traumatic. No pathological fractures were included in this study.

Sample Size: Cases satisfying the inclusion criteria admitted in KIMS, Hubli during the study period of November 2009 to September 2011 will be included.

Inclusion criteria:

1. Age>17yr
2. Diaphyseal fractures of radius and ulna.
3. Closed fractures and Gustilo Anderson type 1 and 2 fractures

Exclusion criteria

1. Fractures >4 weeks old.
2. Patients with underlying neuromuscular disease, metabolic bone disorder, pathological fractures, Gustilo Anderson type 3 open fractures and associated epiphyseal radius and ulna injury.

The following protocol was observed for patients with diaphyseal fractures of forearm on arrival.

1. General and systemic examination as well as local examination of the patient.
2. Thorough assessment of the patient to rule out head/ chest/ abdominal/spinal or pelvic injury.
3. Evaluation of the patient in terms of;
 - A - Age
 - B - Sex
 - C - Mode of injury
 - D - Period between injury and arrival
4. Musculoskeletal examination of the patient to rule out associated fracture
5. Stabilization of patient with intravenous fluids, oxygen and blood transfusion as and when required.
6. Careful assessment of injured limb as regards to neurovascular status.
7. Primary immobilization of involved limb in above elbow slab with an arm sling and transport of the patient to the department of radiodiagnosis in the same.
8. Radiological assessment: anteroposterior views and lateral views of injured limb including the wrist and elbow joint.
9. Thorough irrigation and lavage of compound fractures with hydrogen peroxide and normal saline followed by povidone iodine padded dressings.
10. Injection ATS 1500 IU, broad spectrum antibiotics and analgesics were administered for open fractures.

IMPLANT USED

- L (Lambrinudi) rods- manufactured from 316L alloy
 L rods are available in different sizes of length and diameter.

ADVANTAGES OF L -RODS:

1. Benefits of Closed technique
 - A. Reduced surgical exposure & decreased periosteal stripping.
 - B. Avoids big skin incision and subsequent scar with less cosmetic concerns.
 - C. Decreased chances of infection.
 - D. Early union.
 - E. Useful in patients with poor skin conditions & in compound fractures.

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2. Better anatomical- axial reduction and dynamic stabilization
3. Decreased incidence of synostosis, less then as compared to after plating.
4. Less refracture after nail removal compared to after plate removal.
5. Decreased incidence of non-union.
6. Cost is cheaper.
7. Possibility to use in children with small diameter nails by making an entry point without crossing open growth plates.
8. Useful in fractures near radial head as Plates placed high on dorsal surface of radius may trap posterior interosseous nerve underneath & also lack of space for application of plates

OPERATIVE PROCEDURE: Patients were taken for surgery within 24 to 72 hours after pre-anesthetic check-up and valid informed written consent. Under general or regional anesthesia the procedure was done.

Position: Patient was placed supine on the table with a side arm board. An optimal closed fracture reduction was achieved under biplanar fluoroscopic control, prior to preparation and draping.

Procedure: Standard aseptic precaution and draping was used.

ENTRY POINT:

Approach to Ulna: Since ulna is subcutaneous, easily manipulated, and relatively straight, it is usually reduced and fixed first.

A stab incision is made over the olecranon process, and dissection is carried down through the subcutaneous tissue and triceps insertion to the bone. The entry point should be on the radial side of the olecranon tip about 5mm from lateral cortex in line with the longitudinal axis of the ulnar shaft because it bows laterally in proximal third. Avoid dissection medial to olecranon in region of ulnar nerve. A small owl is used to create an entry hole for insertion of intramedullary nail. After fracture reduction, the nail was passed in an antegrade fashion through the medullary canal under C-arm guidance and across the fracture site, short of 1 to 2 cm from distal articular surface. After intramedullary fixation of the ulna [least comminuted fracture between radius and ulna is fixed first], the radial fracture is reduced.

Approach to Radius:

Lister Tubercle Approach: Make 2.5 to 3 cm longitudinal incision over distal radius on radial side of Lister's tubercle starting at the level of wrist joint. Bluntly dissect subcutaneous tissues to avoid injury to superficial radial nerve branches. Open the of the second extensor compartment through longitudinal incision on of the extensor retinaculum radial to Lister's tubercle leaving proximal third intact. Retract extensor carpi radialis longus and brevis tendon to radial side. Entry point should be 5 mm to 1 cm proximal to articular surface.

Dissection is carried out between the second and third extensor compartments to cortical bone. Under C-arm confirmation that the approach has been made from proximal to distal, a small fine tip awl is used on the dorsal surface directing the drill bit slightly proximal and volar allows easier passage of the intramedullary rod through the radius The extensor pollicis tendon must be protected during drilling and nail passage. Awl is advanced into the medullary canal at a low angle (30 degree) to prevent engaging the palmar cortex. Flexion of wrist over a stack of towel helps in

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preventing penetration of volar cortex. After the nail has been passed across the fracture site and reduction has been confirmed with C-arm in both planes, the distal tip is bent and cut under the skin. The extremity is then placed in well-padded long arm slab.

Postoperative management: In the postoperative period, immobilization with long arm slab was given. Elbow and finger mobilization was done early according to general condition and co-operation of the patient. Suture removal was done at 7 to 10 days after surgery, following which slab was removed and immobilization was done with above elbow cast for additional 4 to 6 weeks. Patients were followed up at regular intervals of 6 weeks, 12 weeks and 6 months.

Fig. 1: LISTER TUBERCLE APPROACH (RADIUS)

Fig. 2: ULNAR ENTRY POINT THROUGH THE OLECRANON

Fig. 3: RADIAL ENTRY POINT

Fig. 4: REDUCTION UNDER C - ARM

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OBSERVATIONS & RESULTS: In our study 20 fractures of diaphyseal fractures of both bone forearm. All cases were fresh fractures, 14 patients were males and 6 patients were females. The median age was 36 years ranging from 18 to 65 years. 10 of the fractures were caused by direct blow, 5 were by fall on outstretched hand and 5 were due to road traffic accidents. 8 patients had fractures on right side and 12 on left side.

Of the 20 diaphyseal fractures of forearm, 13 were OTA A3.2, 2 each were A 3.3 and B3.1, 1 each were cases of OTA A3.1, B 3.2 AND C2.2 type of fractures

In our study 6 patients had associated injuries. Of them, 2 patients had metacarpal fractures, 2 patients had ipsilateral tibial fractures, 1 patient had lateral condyle humerus fracture and 1 case of patella fracture.

All patients were operated within 3 days. Average duration of surgery was 45 minutes.

The size of rod was selected based on the type of fracture of the 20 patients, 16 patients showed radiological union within 16 weeks. One patient went for delayed union

We encountered 2 superficial infection,. They were treated with local debridement and antibiotics as warranted by culture report. However fractures went on to heal uneventfully 70% of patients had excellent results with good range of supination and pronation. There were no cases of malunion and nonunion in our study. The duration of follow up ranged from 6months to 24 months.

Important observations and results are summarized in charts and tables below.

Union (Weeks)	No. Of cases	Percentage
< 12 wks.	4	20
12 – 16 wks.	12	60
16 – 20 wks.	3	15
Delayed union	1	5
Nonunion	0	0.00

TABLE 1: RADIOLOGICAL UNION

Figure 5

Fig. 5: Radiological union was defined as presence of bridging callus across three cortex of 20 patients, 16 patients (80%) showed radiological union within 16 weeks.

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PERCENTAGE LOSS OF PRONATION/SUPINATION	No. of CASES
<25 %	14
25- 50%	5
>50 %	1

TABLE 2: RANGE OF PRONATION/ SUPINATION

Figure 6

GRADE	No OF CASES	PERCENTAGE
EXCELLENT	14	70%
GOOD	4	20%
ACCEPTABLE	2	10%
UNACCEPTABLE	0	0.00%

TABLE 3: FUNCTIONAL RESULTS

Figure 7

Fig 7: Functional outcome was assessed using standard Grace and Eversman scoring system.

Excellent rating meant there was union of fracture with at least 90% of normal rotation arc of the forearm.

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CASE NO- 17: R####/21 YRS/MALE

Fig. 8

Fig. 9: PRONATION/SUPINATION PRONATION/SUPINATION

DISCUSSION: Our study comprised of 20 patients with diaphyseal fractures of both bone forearm who were treated by L- rods. Overall final outcome was assessed by Grace and Eversman scoring system.

Reviewing the literature of standard studies, J Moerman, A Lenaert, DE Coninck, 1996⁹- presented a retrospective of acute fractures of diaphysis of ulna and radius an adults treated with intramedullary nailing.

A modification of rush pin was used 70 diaphyseal fractures in 38 patients were treated by intramedullary fixation.

The mean age of the patients was 31.5years.

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Union occurred in 66 fractures (94%). The average union time was 73 days. There were no delayed unions. Non-union was seen in 4 cases (6%) The average time in the cast was 7.9 weeks. No postoperative infection was noted. The overall success rate was 83%. No failure of fixation or material breakage was seen in the study.

They concluded that closed nailing does have many advantages, including early union, low incidence of infection, small scars, less blood loss and short operating time with minimal surgical trauma.

Ufuk OZKAYA, Ayhan KILIC, Umit OZDOGAN, Kubilay BENG¹⁰: evaluated the results of two different surgical methods (locked intramedullary nailing and plate osteosynthesis) for the treatment of adult diaphyseal fractures of both forearm bones. Forty-two adult patients with forearm fractures were retrospectively evaluated.

Of these, 22 patients (7 women, 15 men; mean age 32 years; range 18 to 69 years) underwent open reduction and plate-screw fixation, and 20 patients (6 women, 14 men; mean age 33 years; range 18 to 70 years) underwent closed reduction and locked intramedullary nail fixation. The fractures were classified according to the AO/OTA system. The patients were assessed using the Grace-Eversmann criteria and the DASH (Disability of the Arm, Shoulder and Hand) questionnaire.

The mean operation time was 65 minutes (range 40 to 97 min) with plate-screw fixation, and 61 minutes (range 35 to 90 min) with intramedullary nailing ($p>0.05$). The mean time to union was significantly shorter with intramedullary nailing (10 weeks vs. 14 weeks; $p<0.05$). According to the Grace-Eversmann criteria, the results were excellent or good in 18 patients (81.8%) and acceptable in four patients (18.2%) treated with plate-screw fixation, compared to 18 patients (90%) and two patients (10%), respectively, treated with intramedullary nailing.

The mean DASH scores were 15 (range 4 to 30) and 13 (range 3 to 25), respectively. The two groups did not differ significantly with respect to functional results and DASH scores ($p>0.05$). Postoperative complications were seen in three patients (13.6%) and two patients (10%) with plate-screw fixation and intramedullary nailing, respectively.

They concluded that two fixation methods yield similar results in terms of functional healing and patient satisfaction in the management of adult forearm fractures. Haider Mohammed, Fareed Salloom et al, 2009¹¹ - conducted a retrospective Study Between May 2004 and April 2006, twenty one pediatric patients with displaced forearm fractures were treated with flexible intramedullary nails at SMC. The study group included 19 boys and 2 girls aged 6 and 14 years (mean 9.3). Closed reduction and percutaneous introduction of nails was tried in all patients.

Closed reduction and percutaneous introduction of the nails was possible in 9 patients. In 8 patients, a mini incision was needed for either the radius or the ulna. In 4 patients, both the radius and ulna needed exposure through mini incision. The patients were followed- up for a period between 6.7 to 35.7 weeks (mean 18.7 weeks). All fractures were united in acceptable alignment and nails were removed at a mean interval of 18.7 the two complications occurred were delayed union and mild limitation of forearm motion. However, the functional outcome was excellent.

CONCLUSION: CLOSED REDUCTION AND INTERNAL FIXATION WITH INTRAMEDULLARY L - RODS is an easy and fast method for treating forearm fractures with minimal blood loss and scar. Full range of movements was achieved without any significant complication. As the cost of implant is very less

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and hospital stay is reduced to an average of 4 days, Intramedullary L rod fixation for radius and ulna is an effective method of treating these fractures.

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