Studying a lateral approach of plating of the lower 2/3rd diaphyseal fractures of the radius

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DOI: https://doi.org/10.22271/ortho.2020.v6.i4f.2363

Abstract

Introduction: Present study was conducting for evaluation of lateral approach for plating of the lower 2/3rd diaphyseal fractures of the Radius in terms of surgical exposure, Intra-operative problems and Radiological and functional outcome.

Methodology: The study included 25 cases of lower 2/3rd diaphyseal fractures of the Radius with or without fracture of the Ulna. Cases were selected randomly.

Inclusion Criteria: All adult patients of either sex; Fractures involving lower 2/3rd diaphysis of the Radius with or without fracture Ulna; Transverse/oblique/spiral/comminuted (<50% diameter) fracture pattern.

Exclusion Criteria: Open fractures, Damaged or infected skin or soft tissue around the fracture, Pre-existing deformity of forearm due to any disease, Proximal diaphyseal fractures, Pathological fractures, Fractures with comminution >50% of diameter, and Fracture with neurovascular injury.

Results: Present study was conducted on 25 patients were followed Majority of patients were < 55 years of age. Most common mode of injury in this study was RTA, having 12 patients, which was 48% of total followed by assault (28%). In majority of cases (72%) lateral cutaneous nerve of forearm was not encountered during surgical dissection. In maximum number of cases Small DCP was used in 88% for fracture fixation.

Conclusion: The lateral approach is recommended as an alternative for lateral plating of fractures of the lower two thirds of the radius. It is safe, follows biological principles, has a low risk and is easy to do.

Keywords: Radial, diaphyseal, lateral

Introduction

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.

The radial bow should be restored for the good functional outcome. It is important to regain the length of the bones, good opposition and alignment without any malrotation.

The reasons for higher rate of non-union and malunion as well as poor functional outcome, are due to complex anatomical structure with a coordination between muscles, tendon, bones and joints which is responsible for the multi-fold functions of the arm and hand including pronation and supination where the radius rotates around the ulna because the radius has a lateral curvature called bow.

The current standard treatment for the forearm bone fractures in adults is open reduction and internal fixation with plating in compression mode [1]. Various types of plates are available for fixation. Small dynamic compression plates and 1/3rd tubular plates are generally preferred for the distal 2/3rd radial diaphyseal fractures, as they suit the profile of the bone. The plates are applied usually anteriorly on the radius, sometimes posteriorly.

Anterior or posterior plate placement besides losing a mechanical advantage (as per the tensile principal) also have certain disadvantages.
1. Definite stripping of bone soft tissue is required in both, compromising bone viability.
2. Impingment by plate presence on one aspect and screw projection in the opposite is seen and may cause painful obstruction to tendons crossing over.
There are two standard approaches to expose the distal radius [2], namely,

a) Anterior approach (Henry)
b) Posterior approach (Thompson)

Each of the above approaches has its own advantages and disadvantages. Advantages of the volar approach include potential for extensive exposure of the entire radius and decompression of the volar forearm fascia. One important disadvantage of this approach is a possible mechanical limitation of pronation [3]. When using the anterior approach, care has to be taken to protect the superficial branch of the radial nerve and also the radial artery which is directly exposed through this approach and sometime may cause dangerous bleeding [4]. In the “Henry approach”, neurovascular structures need to be dissected, isolated and retracted, viz. the Radial nerve cutaneous branch in the upper part and the radial artery all along, especially in the lower fourth; the Median nerve has to be kept free from retractor pressure all through.

The A.O. group describes a dorsolateral approach [5], where the incision is lateral but deeper dissection posterior as per the “Thompson approach”.

Advantages of the dorsal approach are few and limited to cases which require exploration of the posterior interosseus nerve.

The chief purpose of exposing the lateral cortex of the radius is to enable application of a contoured plate on the lateral surface to maintain natural bowing of the radius. The radius is a curved bone and its concavity faces the ulna. When the radius fracture is reduced, the arc on ulnar side must be maintained because any deviation in changes of length of bone involves the interosseus membrane, affects the distal radioulnar joint, and produces restriction of pronation and supination [6].

It is for this reason that the lateral approach was being used for some time at our department, with certain advantages both during surgery and in applying a plate on the lateral convex surface which is the tensile side and therefore mechanically logical.

Methodology

This study was conducted in the Department of Orthopedics at S.P. Medical College & Associated group of Hospitals, Bikaner. The study included 25 cases of lower 2/3rd diaphyseal fractures of the Radius with or without fracture of the Ulna. Cases were selected randomly.

Inclusion criteria: All adult patients of either sex; Fractures involving lower 2/3rd diaphysis of the Radius with or without fracture Ulna; Transverse /oblique/ spiral / comminuted (<50% diameter) fracture pattern.

Exclusion criteria: Open fractures, Damaged or infected skin or soft tissue around the fracture, Pre-existing deformity of forearm due to any disease, Proximal diaphyseal fractures, Pathological fractures, Fractures with comminution >50% of diameter, and Fracture with neurovascular injury

Pre-operative assessment

Cases were selected and posted for surgery as per inclusion criteria. Routine preoperative investigations were done for all patients for pre-anesthetic check-up. Patients with associated medical problems (hypertension, asthma, diabetes, anemia, COPD etc.) were evaluated and necessary treatment given before surgery. The patients were prepared neck to toe including perineum before being sent to the operation theatre. Prophylactic intravenous injection ceftriaxone 1gm was given to every case an hour before the surgery.

Surgical procedure

All surgeries were performed on an elective basis under standard aseptic precautions. Surgery was performed under regional or general anesthesia under tourniquet control.

Position of the patient

Standard position was supine with the affected limb supported on a hand table. A tourniquet was applied after elevating the limb for about a minute.

Approach

Lateral approach

Incision and exposure

Keeping the elbow flexed 90 degrees and the forearm in supination, a direct lateral incision was given on a line from the tip of the lateral epicondyle to the radial styloid.

The optimal level of the incision was determined by evaluating the pre-operative radiographs and level of the fracture and the skin incision was centered over the fracture site. Skin and subcutaneous tissue was dissected properly. The lateral cutaneous nerve of forearm and superficial branch of radial nerve, were preserved and retracted as and when encountered. The Brachioradialis and Extensor Carpi Radialis were identified and further plane of dissection was between these two (Fig. 12). The fracture site was exposed and fracture ends cleared of soft tissue. Dissection was musculo-periosteal. No periosteal stripping was done and the plate was placed spanning the fracture site. Reduction was usually achieved indirectly or if needed, with help of bone holders. Plate length was selected as per fracture type and site. The plate was contoured with the help of plate benders and then put over the lateral aspect of the radius across the fracture site, maintaining the contour of the Radius laterally. Degree of contouring required was assessed, by placing the plate repeatedly over the reduced fracture fragment and step wise bending was done in small increments guided by using malleable aluminium templates. The plate was fixed with cortical screws of required length. For the lower 1/4th fractures, a 1/3 tubular plate was used, since they have the advantage of a thinner profile and mouldability, which allows for spontaneous contouring with tightening of screws. These features are needed for the lower 1/4th fractures to avoid friction with the overlying Brachioradialis tendon and to enable/ accommodate...
contouring for the distal flaring of the bone. The distal most screw was cancellous. Cases with fracture ulna were also fixed with an appropriate plate through subcutaneous approach between Flexor Carpi Ulnaris and Extensor Carpi Ulnaris.

**Closure**
After removal of tourniquet, haemostasis was achieved and wound was closed in layers except the deep fascia. Care was taken to preserve the nerves and avoid inadvertent entrapment. Sterile dressing was done. An above elbow slab was applied after checking for the radial pulse and nail bed circulation.

**Intraoperative Problems**
Intraoperative problems regarding superficial radial nerve and lateral cutaneous nerve of forearm, surgical dissection plane, plate contouring and wound closure were noted.

**Postoperative Management**
On evening ward round, the patients were assessed for pain, sensory loss and soakage. Post-op analgesic was given SOS. Active finger movement was encouraged.

**Check X ray**
Postoperative radiographs were taken in AP and Lateral views of both sides in similar position on 2nd post-operative day and they were assessed for:
1. Restoration of the curvature of the radius: by comparing with the normal side.
2. Accuracy of reduction, adequacy of screw size and plate length.

**Post-operative dressing**
A standard aseptic dressing of the suture site was done on the 5th day. Local skin and stitch line margins were noted for any erythema and signs of necrosis. If any collection or discharge was found from the suture site, a culture was taken and appropriate antibiotics were started.

Sutures were removed on the 10th - 14th day subject to suture line condition. If infection was not found to be resolving then thorough irrigation of the wound after opening the whole stitch line was done, all collection and necrotic tissue removed and wound was closed again in layers over a suction drain. Any sensory problems were recorded.

**Follow up**

**At 2 weeks:** The patient was asked to come for first follow up at 2 weeks to evaluate the suture line and sutures were removed if wound found healed. Sensory impairment if any was noted and documented. Above-elbow slab was removed and a removable splint was given to the patient with instructions to perform finger, elbow and shoulder exercises according to their level of comfort. A slab was reapplied in patients with comminuted fractures, old patients with poor bone stock and in those patients where fixation was not rigid due to any reason. These patients were asked to come again at 4 weeks follow-up for change of slab.

**At 6 weeks:** Follow-up X-ray was taken and the status of union was assessed based on obliteration of fracture line, bridging callus and extension of trabeculae across the fracture graded as (-) for unobliterted fracture line, (+) for less than 1/3 rd obliteration of fracture line, (+++) for >1/3rd but not complete union and (++++) for complete union. Patient was advised to continue physiotherapy as part of rehabilitation protocol. Any sensory impairment, if present previously in any patient, was evaluated and documented for any recovery or persistence.

Any implant related problems like pain on supination/pronation due to irritation by screw or plate were also noted. In patients with good bone stock and secure fixation, the detachable splint was discarded, and active limb exercises commenced. A sling was advised till the next follow up. Load bearing and strenous work was not allowed. For insecure fixations (comminution, old age and porosis) the above elbow slab was discontinued but detachable splints put to use, with controlled exercises.

**At 12 weeks:** X-rays were again taken to assess union and document the final result. Functional outcome was noted and documented in the form of flexion-extension at the wrist and supination-pronation at forearm. Progression/ regression of sensory impairment was noted. Implant loosening was noted if any.

Final results were evaluated on the basis of “Anderson et al. criteria for assessment of functional outcome of operative treatment of fractures of Radius and Ulna”.

**Table 1:** For assessment of functional outcome

| Result | Union     | Flexion and extension at wrist joint | Supination and pronation |
|--------|-----------|-------------------------------------|--------------------------|
| Excellent | Present          | <10° Loss                          | < 25% Loss |
| Good    | Present          | <20° Loss                          | < 50% Loss |
| Fair    | Present          | >30° Loss                          | >50% Loss  |
| Poor    | Nonunion with or without function loss |                     |                                      |

**Observations**
Present study was conducted on 25 patients were followed. Majority of patients were < 55 years of age. Maximum cases were recorded in the age group of 16-25 yrs (32%) and least were in age group 66-75 (4%).
Youngest patient was 18-year-old and oldest was 70-year-old. The mean age was 38.2 years. Mostly patients were males (76%) and females were 24%. Male to female ratio was 3.2:1. Mostly cases operated within 15 days.
Most common mode of injury in this study was RTA, having 12 patients, which was 48% of total followed by assault (28%) (Fig: 1).

*Fig 1: Distribution of cases according to mode of injury.*
In this study, injuries on the left side were higher when compared to right. The reported data was 68% vs 32% favouring left side. Maximum number of cases had fractures in middle one third of radial shaft (72%). Transverse fracture was the most common pattern of fracture (48%) followed by oblique (24%), comminuted (16%) and spiral (12%). During the surgical dissection, superficial radial nerve was not encountered in majority of cases (80%).

Table 2: comparison on the basis of level of fracture, pattern of fracture and radial nerve injury

| Distribution of cases according to side of injury | Number | Percentage |
|-----------------------------------------------|--------|------------|
| Affected limb                                  |        |            |
| Right                                         | 08     | 32         |
| Left                                          | 17     | 68         |
| Level of Fracture                              |        |            |
| Middle Third                                  | 18     | 72         |
| Lower Third                                   | 07     | 28         |
| Pattern of Fracture                           |        |            |
| Transverse                                    | 12     | 48         |
| Oblique                                       | 06     | 24         |
| Comminuted (<50%)                             | 4      | 16         |
| Spiral                                        | 3      | 12         |
| Superficial Radial nerve interference          |        |            |
| Yes                                           | 05     | 20         |
| No                                            | 20     | 80         |

Table: 3 shows the union sub-component of Anderson criteria at 6 and 12 weeks respectively.Incomplete obliteration was seen in 23 (92%) cases and complete obliteration was seen in 2 (8%) cases at 6 weeks. However, at 12 weeks there was complete obliteration of the fracture line was observed in 24 (96%) cases whereas incomplete obliteration was observed in only 1 (4%) case. Table also shows loss of flexion and extension movement at wrist (Degree) at 6 and 12 weeks. Less than 10° loss of movement was observed in 4 cases, greater than 10° loss was observed in 21 cases at 6 weeks. At 12 weeks, 19 cases had less than 10° loss of movement whereas 6 cases had greater than 10° loss of movement. At 6 and 12 weeks, less than 25% loss was seen in 4 and 19 cases, greater than 25% but less than 50% loss was seen in 16 and 4 cases and greater than 50% loss was seen in 5 and 2 cases respectively (Table: 4).

Table 4: Evaluation of fracture union and ROM at 6 and 12 weeks

| Union status | At 6 weeks | At 12 weeks |
|--------------|------------|-------------|
| <1/3rd fracture obliterated (+)          | 6 (24%)    | 1 (4%)      |
| <2/3rd fracture obliterated(++)          | 17 (68%)   | 0 (0%)      |
| Complete obliteration (+++)              | 2 (8%)     | 24 (96%)    |

| Degrees of F/E loss                      | At 6 weeks | At 12 weeks |
|------------------------------------------|------------|-------------|
| <10                                      | 4          | 19          |
| <20                                      | 15         | 4           |
| <30                                      | 3          | 0           |
| >30                                      | 3          | 2           |

| Loss of supination and pronation         | At 6 weeks | At 12 weeks |
|------------------------------------------|------------|-------------|
| <25%                                     | 4          | 19          |
| >25% - <50%                               | 16         | 4           |
| >50%                                     | 5          | 2           |

Fig 2: shows outcome at 12 week follow-up in accordance with Andersons criteria. The results are as follows: excellent in 19 cases, good in 4, fair and poor in 1 case respectively.

Discussion
In any surgical operation, the approach is the route through which a desired body structure is made visible for the procedure. The approach is chosen considering various factors; firstly it should provide a good view of the structures, in a convenient position for both patient and surgeon and in the process, minimal damage be caused to other adjacent structures, while keeping away from critical structures [7].

In fracture of the radius, for plating the current preferred approach is the “Henry approach” for all levels, and is anterior. The second traditional approach is posterior by “Thompson”, in which the incision basically is applied over the dorsal aspect of the forearm and plane of dissection is between ECRB and ED. Radial nerve motor branches have to be taken care of in the proximal third and cutaneous branch in the lower third.

The A.O. group describes a dorsolateral approach, where the incision is lateral but deeper dissection posterior as per the “Thompson approach”. In all these incisions, a certain amount of muscle stripping is necessary to expose the bone. In the “Henry approach”,...
In our study maximum patients were in age group 16-25 years. Mean age of patients were 38.2 years.
due to the fact that this is the earning age group and maximum mobility of population is observed during the age of 22-50 years. We observed that maximum patients were males in (76%) This is because in our society male are responsible for earning for the family and females are generally stay at home. Chapman et al. [12] et al. found mean age of 33 years with male predominance.

We observed that most of patients were operated within 15 days of injury because these patients presented to us early. Two patients previously refused for surgery and other presented late. The cause may be previous treatment elsewhere or other comorbid condition were present that may took time for pre-anaesthetic fitness.

In our study the most common mode of injury was road traffic accident (12 patients) followed by almost equal number of cases due to fall and assaults. Due to rapid industrialization and increase in the mean of transportation, the incidence of road traffic accident has been on the rise. Same findings were found in the study done by C.A. Gold Farb et al. [13] (13 patients out of 20).

In our study maximum number of cases had injury on left side (68%). Similar findings were study done by C.A. Gold Farb [13] (56.52).

We observed that maximum cases had fracture of middle 3rd of the radius (72%) and rest of patients were having fracture lower 3rd of radius. As our study included only the fracture of the lower 2/3rd diaphysis of the radius, these findings correlated with our patients selection criteria. Similar observation were made in the study done by Chapman et al. [12] (61%).

In our study maximum patients were having transverse fracture pattern [12 patients (48%)] followed by oblique in 6 patients and almost equal number of spiral and comminuted. This finding may be due to random selection of cases and the criteria that comminuted fractures involved more than 50% diameter of shaft were not included.

During the majority of cases we did not directly encounter the superficial radial nerve at the time of dissection [20 patients (80%)]. This may be due to the fact that maximum fractures were middle 3rd level. This nerve was encountered only in a single case of middle 3rd fracture level. Which was spiral pattern and required long exposure during surgical dissection. Out of the seven fractures of the lower 3rd level, this nerve was exposed in 4 patients and not in 3, this may be due to variable course. This parameter was not mentioned in any other study reviewed.

In our study, in the majority of cases we did not encounter the Lateral cutaneous nerve of the forearm [17 patients (68%)]. As per the anatomy of this nerve, it lies superficial to the BR and the surgical dissection generally does not involve dissection between skin flap and BR. Most of the cases in which this nerve was exposed during surgery were spiral and oblique fractures, requiring long exposure.

This parameter was not mentioned in any other study that we reviewed and in the description given in the A.O. manual also the nerve has been not mentioned.

In our study small DCP used in maximum patients [22 patients (88%)]. Only in three cases we used 1/3rd tuber plate. This parameter generally depends on the discretion of the operating surgeon. 1/3rd tubular plate were used in lower 4th fracture level, due to the fact that, this plate has a thin profile and is thought to be nonirritant to the gliding tendons during supination pronation movement of the forearm.

At the time of follow up we observed that at 6 weeks maximum patients had 1/3rd to 2/3rd obliteration of fracture line [18 patient (72%)]. At 12 weeks all but one (Case no-7), patients went into complete union. The single patient was still in the process of union was 70 years old male with poor bone stock, comminution at fracture site, and also, this patient presented late. Overall union rate was 96% in our study. Similar findings were observed in Schemitsch et al. [9] (98%), Chapman et al. [12] (98%), Anderson et al. [14] (97%), Hadden [15] et al. (97%) and Hartel et al. [16] (96%) in our study when patients were followed at 6 weeks maximum patients had >10° but <20° loss of flexion Extension movement at wrist. At 12 weeks maximum patient had <10° flexion extension loss. So there was a constant improvement in range of motion because of the early start of active physiotherapy protocol. This could be achieved because of secure fixation of the fractures. Similar were the finding observed in the study done by Anderson et al. (<20° loss in 85% patients), Chapman et al. [12] (93%) and Gold Farb et al. [13] (80% with <20° loss).

In our study when patient were followed at 6 weeks, maximum patients (60%) had supination pronation loss between 25-50%. At 12 week maximum patients (76%) had <25% loss of supination pronation and only 2 patients had loss >50%. (Case no- 7 and 8). The probable reason for restriction these two patients were that they presented late and consecutively pre-existing stiffness. However they followed beyond 12 weeks and movement recovered. No complain related to friction between brachioradialis and underlying plating. Similar findings were observed by Chapman et al. [12] (93% with <50% loss), Anderson et al. [14] (90% cases had <50% loss).

**Final Outcome:** (Based on Anderson’s criteria) At 12 weeks, in our study, 19 patients had excellent (76%), 4 patients (16%) had good, one patient had fair and one had poor result. These findings comparable to study done by Chapman et al. [92% had excellent and satisfactory results], Schemitsch et al. [9] (69% had excellent and good results), Anderson et al. [14] (89.6% had excellent and good results)

**Conclusion**

The lateral approach to the radius for fracture of the lower two third diaphysis is a logical approach to enable lateral plating which in turn is a rational concept in terms of biomechanical principles of plating on a curved bone, where-in planes are to be applied on the tensile convex aspect of such bones. Additionally, the lateral plating after contouring the plate enables easy restoration of the radial bowing which is critical to preserving supination pronation movements. In the commonly popular anterior plating, the radial bowing can be difficult to maintain and end up with significant function loss. The lateral approach has a major biological advantage of not requiring stripping of muscle cover that is essential to preserve bone vascularity. It also obviates the need to mobilize the radial artery and its branches. The neurological structures encountered pose no more interference or risk than the conventional Henry or Thomson’s approach, compared to which the difference being only the location of incision and deeper plane between BR and ECR. Thus the lateral approach is recommended as an alternative for lateral plating of fractures of the lower two thirds of the radius. It is safe, follows biological principles, has a low risk and is easy to do.

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