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FRACTURE OF THE SHAFT OF RADIUS TREATED WITH LATERAL PLATING: AN OUTCOME STUDY

Orthopaedics

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ABSTRACT

Purpose: Fixation by plate is the gold standard for the treatment of forearm fractures that are displaced in adults. Conventionally radial shaft fractures will be either plated on the dorsal surface or on the volar surface depending on the approach. The lateral surface of the radius provides a uniformly curved and even area for plate placement. It has the advantage of easy assessing and restoring the radial bow post surgery. A prospective study was designed to observe the outcome of lateral plating of fractures of shaft of radius.

Methods: Fifteen patients were included in this study which was performed in at Sree Balaji Medical College &Hosipital,Chromepet,Chennai India. Of them, 11 had fractures of both the forearm bones and 4 had isolated fracture of radial shaft. Fixation was done within 36 h of injury in all using 3.5 mm limited contact dynamic compression plate or locking compression plate applied to the lateral surface of the radius. Ulna was fixed in routine manner.

Results: Union was achieved in 15 out of 15 patients, after a mean time of 17.8 weeks. According to Anderson et al.'s criteria, 11 patients had excellent results, 3 had satisfactory and 1 had unsatisfactory result.

Conclusion: The outcomes including rate of union were comparable to those in the existing literature. Plating the radial shaft on the lateral surface is a viable alternative to volar or dorsal plating of the radius. Larger studies with randomized data are needed to assess whether it has any superiority over other existing techniques.

KEYWORDS

Radial shaft fractures, Lateral surface plating, Volar plating, Dorsal plating

INTRODUCTION:

Fractures of the forearm are one of the most common orthopaedic injuries accounting for 1 percent of total fractures in adults(1,2). Conventionally, plating of the radius is done either on the volar or on the dorsal surface, using the Henry and Thompson approaches respectively(10,11,12,13).

The radius rotates around a comparatively immobile ulna during the course of rotation.The rotational movement occurs properly as the radius has a marked curve directed laterally and slightly posteriorly and the ulna has a comparatively straight form(14). In 1959, Sage made an argument that the curves of the radius , especially the lateral bow are of great value(15). Schemitsch and Richards confirmed this argument later and inferred that the return of the location and amount of the lateral bow back to normal was related to a good functional outcome(16).

It is observed that in the conventional method of plating on the volar or dorsal surface, some part of the plate has to remain off the bone in order to maintain the bow of the radius. This is a direct consequence of using a straight plate on a curved surface (Fig. 1A). Also, the dorsal and volar surfaces have significant muscle cover and are not completely uniform.

Fig. 1. An example shows seating a straight plate on the dorsal and lateral radius. A: Plate placed on dorsal aspect of radius will remain off the bone at one end because of the lateral bow. On the right is a plate placed on the volar surface, which again has a gentle dorsal curve, and the plate will remain off not only at one end, but also in the middle. B: The lateral surface is uniformly convex and the plate can easily be moulded.

The lateral surface is uniformly convex, unlike the variable contour of the volar and dorsal surfaces in addition to their curvature in the coronal plane (Fig. 1B).We also observed that in the enthusiasm to seat the plate on the bone all along, some malreduction and consequently distortion of the radial bow is possible (Fig. 2). We think that such subtle distortions may escape intraoperative detection, being concealed by the plate, and then again on postoperative anteroposterior (AP) radiographs due to superimposition of the plate on the fracture site.

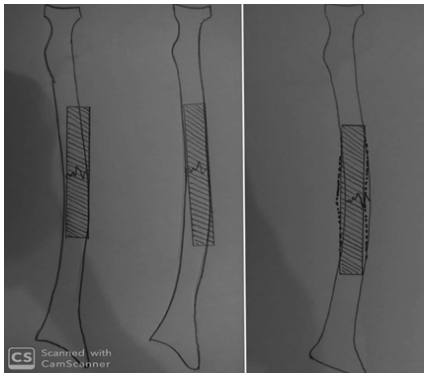

Fig. 2. Seating the plate on the dorsal or volar surface can leave the plate off proximally or distally, especially in smaller radii. In an effort to bring both fragments under the plate, sometimes the anatomy is distorted as marked in the figure on the right.

There is also evidence that injury to the nutrient artery, which enters the radius anteriorly, leads to delay or failure of fracture healing(17). Hence there may be some merit to avoid the volar surface for plate application. Furthermore, several texts and published manuscripts described volar and dorsal plating of the radius, but illustrative examples showed that the plate was placed on the lateral surface. Thus, lateral surface plating seems to be done every once in a while but is not reported. The idea for this study was thus conceived.

AIMS AND OBJECTIVES:

To observe the outcome of lateral plating in radial shaft fractures.

MATERIALS AND METHODS:

The study was a prospective case series conducted between September

2017 and March 2019, in the orthopaedic department of at Sree Balaji Medical College and Hosipital, Chromepet, Chennai. Prior approval was obtained from the Institutional Ethics Committee. Subjects were chosen from adult patients with forearm fractures attending the emergency department, after consenting them for the procedure. Patients below 18 years of age, open grade 3 fractures, and fractures with preoperative neurovascular deficits, compartment syndrome or other major ipsilateral upper limb injuries were excluded. Fifteen patients fulfilled the inclusion criteria, of whom 12 were males and 3 females. The mean age of the patients was 35.5 years (18–62 years). Detailed data of patients are shown in Table 1.

Table 1. General data of patients.

Variables	
Male/Female	12/3
Age (years)	35.5 (18–61)
Injury	
Fractures of both the forearm bones	11
Isolated radial shaft fracture	4
Fracture type	
Closed	14
Open	1
Mode of trauma	
Motor vehicle accident	6
Fall on the hand	8
Assault	1
Affected level of radial shaft	
Upper third	1
Middle third	14

All the patients were operated upon within 36 h of injury. The radius was approached first in most cases. In the first 2 cases, radius was approached from the volar side (Henry, 1 case) or dorsally (Thompson, 1 case). In proximal fractures, care was exercised to protect the posterior interosseus nerve by elevating the supinator. Fixation was done using a 3.5 mm limited contact dynamic compression plate(LC-DCP) or locking compression plate (LCP), depending on the mode of plating. After reduction of the radius, a template was used to assess the lateral bow, and the plate was contoured accordingly before being placed on the lateral surface. Thereafter fixation was done in routine manner with 3 bicortical screws on both sides of the fracture. In patients with comminuted radius, the ulna was fixed first. Closure was done in routine manner.

No postoperative immobilization was used and active hand, wrist and elbow exercises were encouraged from the first postoperative day. Antibiotics were given for two days, and periodic dressings were done. Stitches were removed at 2 weeks. Activity was gradually increased depending on patient comfort, and the patients were followed up clinicoradiologically at 4 week intervals for the first three months and at 6 week intervals thereafter till union. Final follow-up was done at an averaged 6 months following surgery and the scoring done at this time.

Union was assessed by gradual disappearance of the fracture line and/or development of bridging callus at the fracture site. Functional outcome was determined using Anderson et al.'s(6) criteria.

Table 2. Anderson et al. criteria for assessment of functional outcome.

Result	**Union**	**Flexion/ extension at wrist**	**Supination/ pronation**
Excellent	Present	<10° loss	<25% loss
Satisfactory	Present	<20° loss	<50% loss
Unsatisfactory	Present	<30° loss	>50% loss
Failure	Non union with or without loss of motion		

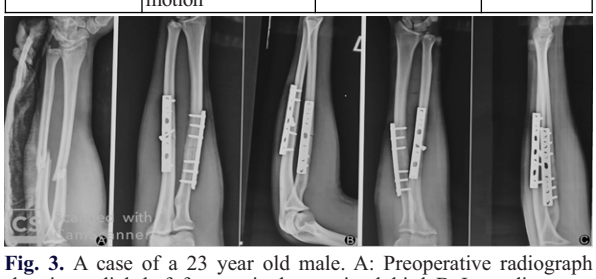

Fig. 3. A case of a 23 year old male. A: Preoperative radiograph showing radial shaft fracture in the proximal third. B: Immediate post operative AP and lateral radiographs after compression plating of the radius on the lateral surface. The approach used here was a direct lateral. C: Follow up radiographs showing union by primary fracture healing(no callus).

RESULTS:

Fixation was done within 36 h of injury in all the cases. LC-DCP (3.5 mm) was used for compression/neutralization plating of the radius in 16 cases, and 3.5 mm LCP used for bridge plating in 3 radii. Primary bone grafting was done in 1 patient with severe comminution of the radius.

There was no case of ulnar nonunion. The mean time to union of both bones was 17.8 weeks (10–28 weeks). The mean arc of elbow flexion was 136.9° (127°–142°), and that of the wrist was 140.3° (130°–145°). The mean arc of rotation of the forearm was 129.8° (64°–152°). There were no nerve or vessel injuries, and no infections in this series.

According to Anderson et al's(6) criteria, 11 patients had excellent results, 3 had satisfactory and 1 unsatisfactory result.

DISCUSSION:

The surface to plate the radius on is almost always decided by the choice of surgical approach. Thus surgeons favouring the dorsal approach carry out plate fixation on the dorsal surface, and those favouring the volar approach on the volar surface of the radius. By far, the debate has always been over the preferred approach(22,23,24) and the choice of surface been deemed obvious (dorsal or volar). It was felt that there is an equally accessible third surface which is unexplored and not routinely plated on.

The volar surface of the radius is convex in the proximal part, with an average apex anterior curvature of 13.1° and concave in the distal part with curvature of 6.4°(15). This corresponds to similar opposite curvatures of the dorsal surface. When the natural radial bow of the radius is added to this, we are faced with the situation of having to address two plane curvatures with a single straight plate (Fig. 1A), which creates potential for error and malreduction. Furthermore the assessment of the radial bow is frequently obscured by the plate in the post-operative anteroposterior radiographs.

As against this, the lateral surface is uniformly curved (representing the lateral bow), and relatively more even than the dorsal and volar surfaces. It thus becomes easier to recreate the radial bow when plating on the lateral surface. The cross section of the radius is triangular in most of its length, except in the proximal-most part. Screws placed through a lateral plate get far cortex purchase in the interosseus border which is thick and strong. This screw orientation also avoids potential irritation of tendons from dorsally protruding screw tips.

There are also concerns about biceps tendons impingement from a high volar plate and Mekhail et al.(25) suggested lateral plating through a volar approach. Another point of interest is the potential injury to the nutrient artery of the radius while plating on the volar surface. The nutrient vessel enters the radius in the second proximal quarter of the diaphysis from anterior to medial(26). It has been argued by several authors that although the periosteal and metaphyseal vessels maintain blood flow to the bone after injury to the nutrient artery, it is not enough to avoid disturbances in fracture healing(27,28,29). According to Giebel et al.(17),the dorsolateral surface of the radius is always free of the nutrient foramen, and thus plating here is advantageous. They stated that lesions of the supplying vessels of the bone are not recognized for weeks or months after surgery and when fracture healing fails, other circumstances are often blamed.

We compared our results with the existing literature or dorsal and volar plating and found that they were largely comparable. The rate of union in our series was 100% (15 out of 15 cases). Chapman et al.(30) reported a union rate of 90% in their series; Anderson et al.(6)reported 98% and Hadden et al.(31) 97%. The mean time for union in our patients was 17.8 weeks, while Leung and Chow(8) stated 20 weeks and Saikia et al.(18) 16.2 weeks. The elbow and wrist arcs of flexion/ extension were 136.9° and 140.3° respectively; the average arc of forearm rotation was 129.8°. These figures compare favorably with those of Goldfarb et al. (32)whose wrist arc 140.1° and rotation 150°.. We did not encounter any case of nerve injury or infection in our series.1 patient had an unsatisfactory result due to restricted distal forearm movements. Chapman et al. reported infection in 2.3% of his

patients. Hadden et al. reported nonunion in 3%, infection in 5.4%, and nerve injury in 6.3% of his 111 operated forearms.

In our search through the literature, we did come across a paper describing lateral surface plating by Eglseder et al.(33) Theirs was however, an ex-vivo biomechanical study, and they concluded that a significant biomechanical difference did not exist between anterior and lateral plating of the distal radial shaft. And although they expressed their preference for volar plates because of "ease of application", we are of the opinion that lateral plating is as much or even more convenient as volar plating, particularly when using the lateral approach that we have described.

Despite the utility of this technique, our study has some weaknesses. The possible effect of lateral plating on the subtle posterior curve of the radius has not been studied. Our follow-up period is short, and we did not operate on any patient for removal of the plate, thus the course after removal of a lateral plate is not known. In a few patients the radial plate was felt palpable in its distal part; however none of the patients complained of symptoms. The theoretical possibility of late hardware symptoms exists. Our sample size is also small and therefore, the clinical utility of this technique needs to be further established by larger and preferably randomized studies. Ours can be considered as an initial report on the results of plating the radial shaft laterally.

To summarize, lateral plating of the radius is a viable alternative to the conventional techniques. Further long term studies with larger patient numbers and parameters of study are needed to confirm our results, and establish its proposed advantages.

CONCLUSION:

The outcomes including rate of union were comparable to those in the existing literature. Plating the radial shaft on the lateral surface is a viable alternative to volar or dorsal plating of the radius. Larger studies with randomized data are needed to assess whether it has any superiority over other existing techniques.

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