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ORIGINAL RESEARCH

A Prospective Study In Functional Outcome Of Surgical Management Of Volar Barton Fracture (AO Type B3) With Volar Locking Compression Plate

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ABSTRACT

Background: Distal radius fracture is one of the frequent problem encountered of the shoulder in the daily practice of orthopedic surgeons. These injuries account for one sixth of all fractures seen and treated in emergency rooms[2]. Conservative treatment is usually unsuccessful and it is fraught with complications, such as early osteoarthrosis, deformity, subluxation, and instability. **Objective:** To Study in functional outcome of surgical management of volar Barton Fracture (AO Type B3) with volar Locking Compression Plate. **Methods:** This is a prospective observational study conducted in St Martha's Hospital, Bangalore, during the period extending from December 1st 2018 to November 30th 2019. 20 Patients were treated with open reduction and internal fixation with locking compression plate. We used 3 types of LCP including Conventional LCP, Multi-locking LCP and Variable angled multi-locking LCP through a modified Henry's approach and reviewed post operatively, one month and three months, clinically and with x-rays. **Result:** The study comprised of 15 male and 5 female patients aged from 18 to 72 years with the mean age of 42.2 years. The average duration from the date of injury to date of surgery was 3.5 days. The follow up ranged for 3 months. Using the Modified Cooney, Green and O'Brien functional score for wrist we had 50% excellent, 30% good, 15% fair and 5% poor results.

Conclusion: Fixation of Volar Barton fracture with a locking compression plate has satisfactory outcome for both the patients and surgeon. Locking plates give satisfactory results in the treatment of this type of fracture with better and faster recovery of functions and range of movements.

Keywords: Volar Barton fracture; distal radius fracture; locking compression plate; open reduction and internal fixation.

INTRODUCTION

The distal end of the radius is subject to many different types of fracture, depending on factor such as age, transfer of energy, mechanism of injury and bone quality i.e. Colles' fracture[1], Smith's fracture, volar and dorsal Barton's fracture.[1]

Fractures of the distal radius continue to be one of the most common skeletal injuries treated by orthopedic or trauma surgeons. These injuries account for one sixth of all fractures seen and treated in emergency rooms[2]. Conservative treatment is usually unsuccessful and it is fraught with complications, such as early osteoarthrosis, deformity, subluxation, and instability.[3]

Barton's fracture, named after the American surgeon John Rhea Barton[4], is a fracture of the distalend of the radius that involves the dorsal or volar rim and extends into the intra-articular region. There are two types of Barton's Fracture Volar and Dorsal among them Volar Barton is being the common one. The Barton's fracture is caused by a high-velocity trauma in which the wrist is extended and pronated.

Volar Barton's fractures are uncommon and unstable fracture. The Goal of treatment here is goodreduction and immediate stability to achieve anatomic fracture union, which will help to get the early mobilization of wrist and to avoid the complications of fracture[5,6]. Fracture healing depends on following factors: gap, stability and blood supply[7]. The locking plate decreases the compressive forces exerted on the bone

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to achieve stability, which prevent associated impairment of blood supply[8] and periosteal compression and which is favored for fracture healing. Various surgical techniques have been reported in the literature[9,10] percutaneous pinning, external fixators and internal fixation with Volar locking compression plate among which open reduction and internal fixation using a volar buttress plate system is currently advocated for the treatment of volar Barton's fractures, resulting in good reduction and providing immediate stability.[3, 11,12]. Improper fracture reduction by closed techniques, internal fixation can restore anatomy and improve functional outcomes[13].

With locking compression plate, the locking screw supports subchondral bone and resists axial forces. Compression of locking compression plate to bone is unnecessary and preserves periosteal blood supply[14] Volar locking compression plates are an effective treatment for unstable extra articular distal endradius fractures allowing early post-operative rehabilitation.[15]

Primary stability achieved with locking screw in a plate prevents secondary displacement irrespective of the bone enabling good result in osteoporotic bones and young patients.[16]

The purpose of this study was to evaluate functional outcome and assess the complications of patients with volar Barton fractures treated with a locking compression plate.

MATERIAL AND METHODS

20 patients with Volar Barton fracture were selected admitted at St Martha's Hospital, Bengaluru, during the period extending from December 1st 2018 to November 30th 2019. Patients were treated with open reduction and internal fixation with locking compression plate. We used 3 types of LCP including Conventional LCP, Multi-locking LCP and Variable angled multi-locking LCP through a modified Henry's approach and reviewed post operatively, one month and three months, clinically and with x-rays. This is a prospective study during the academic year from December 1st 2018 to November 30th 2019.

Inclusion criteria

1. Adults over **18 years,** both male and female with volar Barton fracture (AO Type B3) with or without other associated injuries.
2. Patients medically fit for surgery
3. Patients willing for surgical treatment and have given informed written consent.

Exclusion Criteria

1. Patients below 18 years of age.
2. Patients medically unfit for surgery.
3. Compound fracture associated with vascular injuries.
4. Patients not willing for surgery.

Sample size estimation:[n= [(1.96)2 x σ2] / E2.

Standard deviation of Modified Cooney, Green and O'Brien functional score for wrist being the primary outcome measure, we considered an outcome of 20 % better or worse to be clinically significant. Given α = 0.05, we calculated the sample size to be 20 to have an 80 % power to detect a difference in mean Modified Cooney, Green and O'Brien functional score for wrist ≥ 10.

OPERATIVE PROCEDURE

Image 1: Painting and Draping Of Distal Radius

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Image 1b: Modified Henry's Approach Distal Radius Incision

Image 1c: Soft tissue and Fracture fragment exposed

Image 1d: 3.5mm Conventional Plate Fixation

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Image 1e: 2.7mm Multi-locking Plate Fixation

Image 1f: Wash and Closure of the Operative Wound

STATISTICAL ANALYSIS

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp. will be used to perform statistical analyses. Descriptive Statistics: It includes expression explanatory variables on categorical data using number & percentage. The outcome variables like Modified Cooney, Green and O'Brien functional score for wrist areexpressed in terms of Mean & SD.

RESULTS

The present study consists of 20 cases of distal radius fractures admitted at St Martha's Hospital, Bangalore, during the period extending from December 1st 2018 to November 30th 2019. All 20 were closed fractures. All cases were followed-up periodically during the period 2018 to 2019. The following are the observations made to the available data analyzed as follows.

TABLE NO – 1: AGE INCIDENCE

Age in Years	No. of Cases	Percentage
< 20	2	10
21 – 30	2	10
31- 40	4	20
41 – 50	6	30
51 – 60	2	10
61 – 70	3	15
>70	1	5

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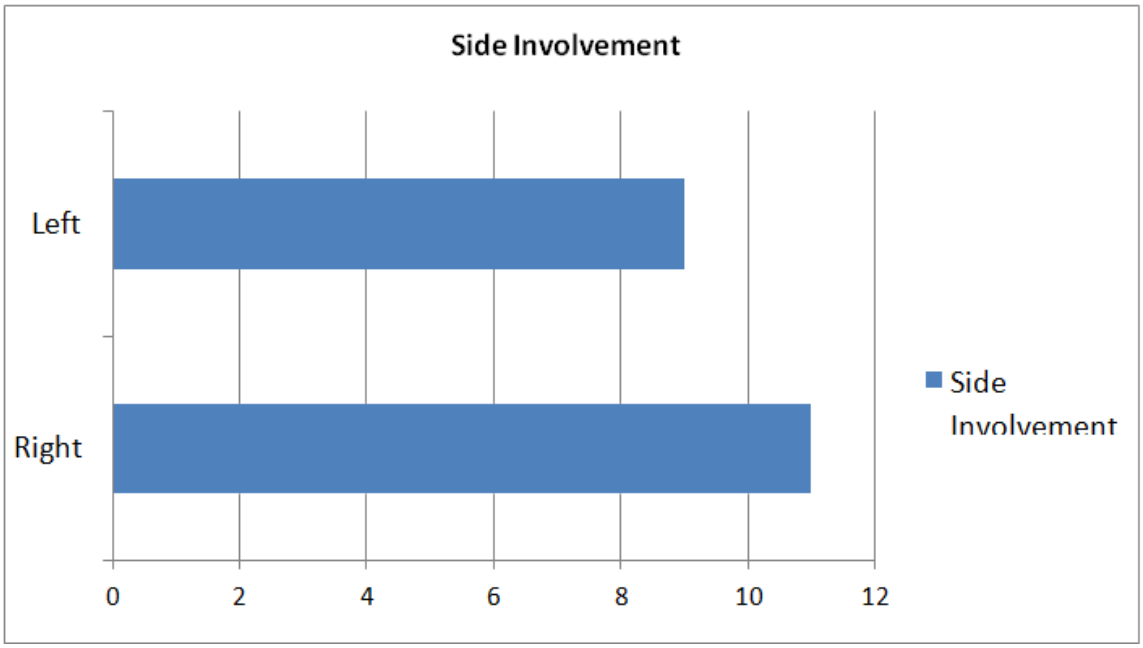
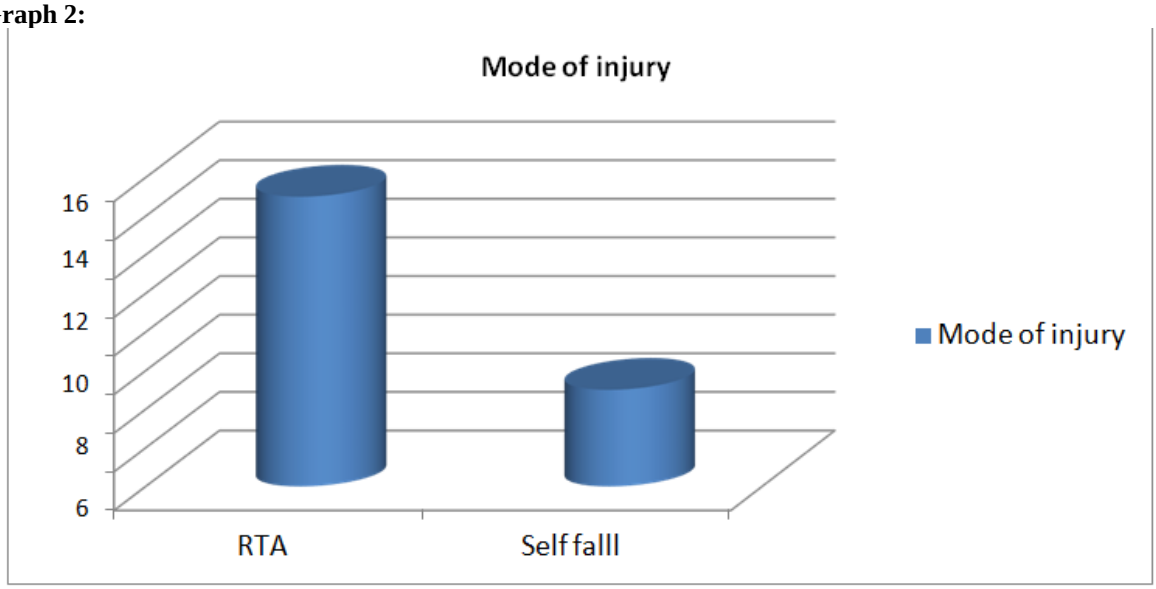
In this series 2 (10%) patients were between 18-20 years, 2 (10%) patients were between 21-30 years, 4 (20%) between 31-40 years, 6 (30%) between 41-50 years, 2 (10%) between 51-60 years and 3 (15%) patients between 61-70 years and 1 (5%) patient was >70 years of age.
The age of the patients ranged from 18-72 years with an average of 42.2 years. Out of 20 patients, 15 (75%) were males and 5 (25%) were females, showing a male preponderance withthe ratio being M: F - 3:1.
Right side (dominant wrist) was involved in 11 (55%) patients and the left side was involved in 9 (45%)patients.

Graph 1:



Graph 2:



In our study there were 15 (75%) patients with road traffic accidents and 5 (25%) patients fell on their outstretched hand.

TABLE NO – 2: ASSOCIATED INJURIES

Associated Injuries	No. of Cases	Percentage
Multiple abrasions	5	25
Contusion head injury	1	5
Total	6	30

Out of 20 cases, 6 (30%) patients had associated injuries, with 25% having multiple abrasions and 5% with contusional head injuries

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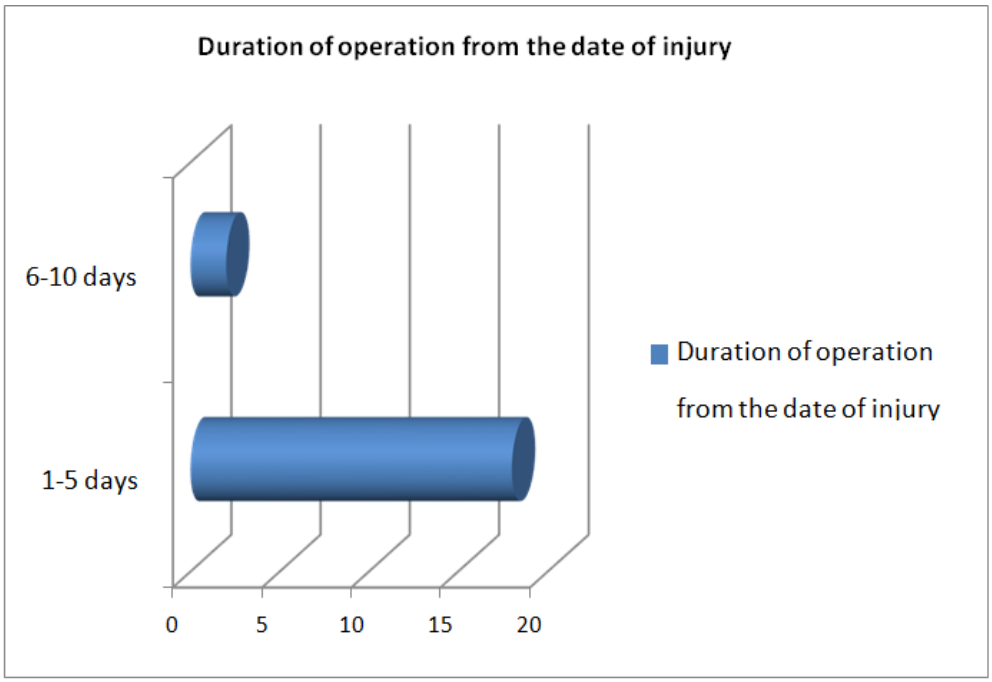
Graph 3:



Surgery was done between 1-5 days in 18 (90%) patients as an elective procedure. Surgery was delayedup-to the 7th day in 2 (10%).

TABLE NO -3: DURATION OF FRACTURE UNION

Time of Union	No. of Cases	Percentage
<2-3 months	17	85
>3 months	3	15

In the present study 17 (85%) patients had union in <2-3 months and 03 (15%) patients had unionin >3 months.

TABLE NO – 4: RANGE OF MOTION

Movement (within normal functional range)	No. of Cases	Percentage
Dorsiflexion (min. 45°)	20	100
Palmar flexion (min 30°)	20	100
Pronation (min 50°)	20	100
Supination (min 50°)	20	100
Radial deviation (min 15°)	18	90
Ulnar deviation (min 15°)	19	95
Pain in distal radioulnar joint	1	5
Grip strength (60% or less than on opposite side)	1	5

In our study 20 (100%) patients had dorsiflexion within the normal functional range (minimum 45°), 20 (100%) had palmar flexion within the normal functional range (minimum 30°), 20 (100%) had pronation within the normal functional range (minimum 50°), 20 (100%) had supination within the normalfunctional range (minimum 50°), 18 (90%) had radial deviation within the normal functional range (minimum 15°) and 19 (95%) patients had ulnar deviation within the normal functional range (minimum 15°). 19 (95%) patients had grip strength more than 60% compared to the opposite side.

1 (5%) had significant loss of grip strength (< 60% compared to the opposite side). 1 (5%) patienthad pain in the distal radioulnar joint.

TABLE NO – 5: COMPLICATIONS

Complications	No. of Cases	Percentage
Extensor pollicis longus tendon irritation	1	5
Stiffness	1	5
Infection	1	5
Total	3	15

1 (5%) patient had extensor pollicis longus tendon irritation because of long volar to dorsal screw.

1 (5%) patient had developed post-surgical stiffness of the wrist joint after immobilization due non adherence to

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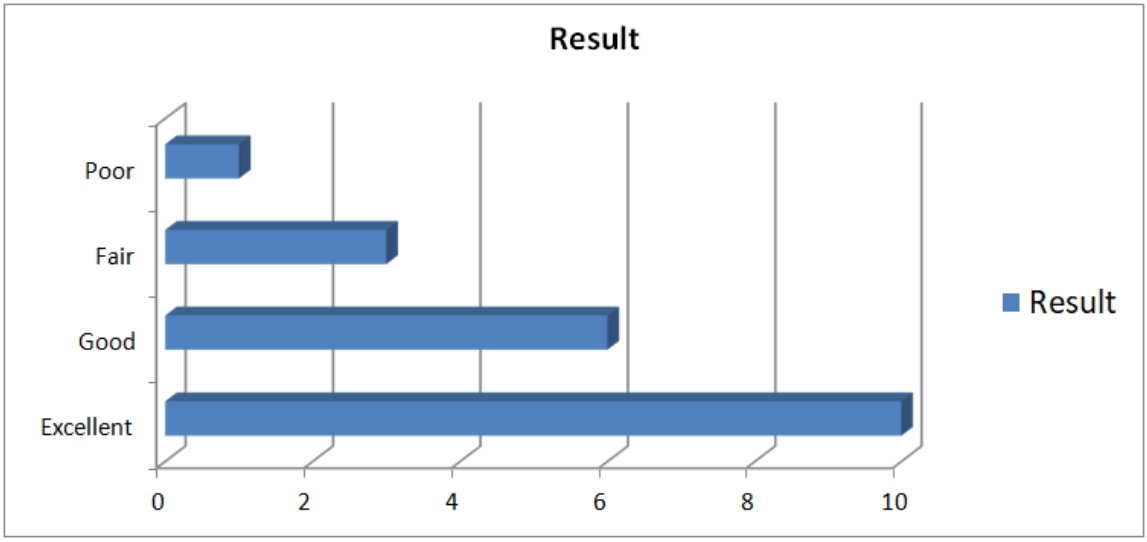
physiotherapy and 1 (5%) patient had developed superficial skin infection which was treatedwith antibiotics and it recovered. None of the patient had median nerve complication. There were no intra operative complications.
The assessment of results were made using the demerit score system of Modified Cooney, Green and O'Brien functional [84] score for wrist based on objective and subjective criteria, residual deformity andcomplications

Graph 4:



Using score system **of Modified Cooney, Green and O'Brien functional score[84]** for wrist, wehad 10 (50%) Excellent result, 6 (30%) Good result, 3 (15%) Fair result and 1 (5%) had poor result.

DISCUSSION

In our study, distal radial fracture was more common in the 3rd to 5th decade with an average of 42.2 years. Mode of injury in young individuals is due to high-energy trauma such as road traffic accident and fall from tree. The average age in our study is comparable to the studies of Ayhan Kilic[17] et al, and Kevin et al[18] who had an average age of 45 years and 48.9 years.
Our study had a male preponderance with 15 male patients and 5 female patients. Increased incidence in males is probably due to their involvement in outdoor activities, riding vehicles andheavy manual labor.
In our study, right side was involved in 11 patients while 9 patients had their left wristinvolved.
All the above series had increased involvement of the right wrist in their series, which was also the case in our series.
In our study, 15 patients got Volar Barton fracture because of Road traffic accidentswhile 5 patients had self-fall at or around home. Kevin [18] and Arora[19] reported fall on the outstretched hand as the most common mode of injury. We reported road traffic accident as the more common mode of injury. Ayhan[17], Anakwe et al[20] reported similar findings in their series.
In our study, out of 20 cases, 6 (30%) patients had associated injuries, with 25% having multiple abrasions and 5% with contusional head injuries
Aggarwal[21] noted associated injuries were found in 10 patients, consisted of head injury, fracture dislocation of the hip fracture of the femoral shaft and fracture of the proximal humerus.
In the present study 17 (85%) patients had union in <2-3 months and 03 (15%) patients had union in >3 months. Aggarwal[21], Fractures healed in 7 to 10 weeks (mean, 8.8 weeks) postoperatively
In our study 100% patients had average dorsiflexion of 45°, palmar flexion 30°, pronation of 50°, supination of 50°. 18 (90%) had average radial deviation of 15° and 19 (95%) patients had average ulnar deviation 15°. 19 (95%) patients had grip strength more than 60% compared to the opposite side. 1 (5%) had significant loss of grip strength (< 60% compared to the opposite side). 1 (5%) patient had pain in the distal radioulnar joint.
In a study Arora[19] reported mean wrist extension measured 58°, wrist flexion 41°, pronation 83°, and supination 84°. Roshan[22] At the final follow-up, the mean range of wrist motion was as follows: 58° of extension, 52° of flexion, 78° of pronation, 72° of supination. The average grip strength was 82% (range 60% to 100%) compared with the patient's unaffected wrist.
1 (5%) patient had extensor pollicis longus tendon irritation because of long volar to dorsal screw. 1 (5%) patient had developed post-surgical stiffness of the wrist joint after immobilization due non adherence to physiotherapy and 1 (5%) patient had developed superficial skin infection which was treated with antibiotics and it recovered. None of the patient had median nerve complication. There were no intra operative complications.
Arora et al[19]. The overall complication rate was 27%. The most frequent problems were flexor and extensor tendon irritation. Carpal tunnel syndrome was observed in 3 patients, and CRPS occurred in 5

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patients. In 2 cases, loosening of a single screw was seen.

Delayed fracture union occurred in 3 patients, and intraoperative intra-articular screw displacement was observed in 1 patient

Evaluation of results

In our study, using score system **of Modified Cooney, Green and O'Brien functional score**[23]for wrist, we had 10 (50%) excellent result, 6 (30%) good result, 3 (15%) fair result and 1 (5%) had poor result.

- 10 cases showed Excellent result (50%)
- 6 patients got Good result (30%)
- 3 patients showed Fair result (15%)
- 1 patient had poor result (5%)

Patients, who obtained **Excellent results**, had no residual deformities or pain. Range of motion was within the normal functional range. They had no post-surgical stiffness or other complications. They were operatedwithin 4 days after injury. Radial length, volar tilt and articular step-off were within acceptable limits. Theywere co-operative to physiotherapy.

Patients with **Good results** had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with **Fair results**, 1 patient had superficial infection post-surgery, which healed in 2 weeks throughregular dressings and antibiotics. 1 patient had residual deformity, limitation of movements which on regular active physiotherapy showed improvement in 10 weeks post-surgery.

Patient with **Poor result** was uncooperative to physiotherapy and in spite of good fixation had post-surgical stiffness in the wrist. She had Extensor pollicis tendon irritation. Range of movements were restricted andwas unable to carry out day-to-day work. Aggarwal[21] reported excellent in 9 (56%) cases, good in 5 (31%), and fair in 2 (12.5%). Excellent results were obtained for 9 of the 16 patients; results were good for 5 patients and fair in the remaining 2.

Ayhan Kilic et al.[17], the results were excellent in 12 patients (44.4%), good in 12 patients and fair in three patients (11.1%).

CONCLUSION

In the subjects of our study, a successful anatomic alignment was acquired with modified volar Henry approach. The patients, who were young adults in majority, went back to their daily activities with 90% recovery. We encountered some complications (15%) in our study. One is extensor tendon irritation, which was because of long screws projecting dorsally. Other one complication was post-surgical stiffness in one patient, which was because of non-cooperative to physiotherapy. One patient developed superficial skin infection of operative wound, which was treated with antibiotics and recovered in 2 weeks. These complications can be prevented once the surgeon gets adapted to the procedure. Use of locked compression plates in Volar Barton fractures provide good to excellent results and are effective in the correction and maintenance of distal radius anatomy. By using these plates, joint motionsand daily functioning is recovered in a shorter time and patient is able to go for his routine work and job in much shorter period of time comparative to other methods of fixation with almost complete normal functions of wrist

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