ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 01 | January - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

OUTCOMES OF EXTERNAL FIXATION VERSUS VOLAR PLATING FOR COMMINUTED DISTAL RADIUS FRACTURES IN ADULTS: A PROSPECTIVE STUDY

Orthopaedics

Dr. S. P. Prasanth Assistant Professor, Department of Orthopaedics, BIRRD Trust Hospital, Tirumala Tirupathi Devasthanam, Tirupati, Andhra Pradesh, India.

Dr Avinash Bajjuri Assistant Professor, Department of Orthopaedics, BIRRD Trust Hospital, Tirumala Tirupathi Devasthanam, Tirupati, Andhra Pradesh, India.

Dr Batthina Sri Prabhav Assistant Professor, Department of Orthopaedics, BIRRD Trust Hospital, Tirumala Tirupathi Devasthanam, Tirupati, Andhra Pradesh, India.

Dr Anna Mohan Yadav Assistant Professor, Department of Orthopaedics, BIRRD Trust Hospital, Tirumala Tirupathi Devasthanam, Tirupati, Andhra Pradesh, India.

ABSTRACT

Introduction: Several treatment alternatives are accessible for individuals with an intraarticular distal radius fracture; however, in instances of comminuted fractures, the choices typically converge to either a volar locking plate, an external fixator, or a combination of the two. A study was undertaken to investigate fracture healing and functional outcomes in distal radius fractures treated with external fixation and plating. **Methods:** In this prospective study adult patients aged between 20- and 60-years with comminuted fracture wrist were recruited for the study. After preoperative by clinical and roentgenographic examination, they were randomly selected for external fixator or plating. Postoperatively, participants were evaluated for the clinical outcomes according to modified clinical system of Green and O'Brien 1978 and DASH score. Standard care was provided for both the groups. **Results:** The follow-up ranged from 3 to 24 months. Functional outcome results was mostly excellent (20%) to good (46.7%). Both the groups showed a similar outcome ($p>0.05$). However, the mean DASH score was significantly lower in the volar plate group than the external fixation group (mean difference 9.0, 95% CI: 4.5 to 13.6, $p<0.001$). The mean healing duration was 5.8 weeks (SD 1.3 weeks) for external fixation and 5.5 weeks (SD 1.2 weeks) for ORIF, with a non-significant difference (mean difference 0.3; 95% CI: -1.2 to 0.6). **Conclusion:** External fixation versus volar plating in the treatment of comminuted fracture of wrist indicates that volar plating emerges as a superior method, demonstrating lower DASH scores, and decreased infection rates.

KEYWORDS

DASH Score, External Fixators, Green and O'Brien Scoring System, Intra-Articular Fractures, Wrist Injuries

INTRODUCTION

Over the past three decades, distal radial fracture management has evolved from cast applications to operative methods such as closed reduction with external fixation or open reduction with locking plates [1]. Risk factors, including decreased bone mineral density, sex, age group, ethnicity, family history, and early menopause, contribute to distal radius fractures [2]. Intraarticular fractures result from high-energy trauma, presenting challenges such as pain, swelling, weakness, limited movement, joint arthritis, and instability when anatomical reduction is not achieved [3]. Unfavourable outcomes, including malunion and wrist joint stiffness, increase the need for surgical correction [4]. While conservative methods are preferred for stable fractures, surgical interventions are necessary for unstable fractures with intraarticular displacement [2]. Precise restoration of the distal radius articular surface is crucial, correlating strongly with osteoarthritis and residual articular congruity [5]. External fixation offers advantages in fracture reduction under fluoroscopy, ligamentotaxis, and preservation until healing, with easy application and minimal operative exposure [1]. Internal fixation, although reducing surgical complications and pin track infections, demands longer surgical time and greater trauma, providing better stability and shorter rehabilitation time [6]. Volar locking plates show superior functional outcomes compared to external fixators, favoured for severe fractures [7]. Despite numerous studies comparing internal and external fixation, evidence on the best outcome in elderly patients remains insufficient [4]. In this background, a study was conducted to study fracture healing and functional outcome in distal radius fracture following external fixation and plating. The study also compared the efficacy of bridging external fixator with volar plating in comminuted fracture of distal end of radius in adults in terms of: hospital stay, healing duration, and regaining normal range of movement.

Methods

Study Design: Prospective study

Study Setting: The study was conducted in the Orthopaedic department of a tertiary care centre in Birrd Trust Hospital,Tirupati.

Study Period: The study was conducted between October 2021 and October 2023.

Study Populations: All adult patients aged between 20- and 60-years with comminuted fracture wrist were eligible to take part in the study. Patients with associated Distal radius fracture, open fracture, Pathological Fracture, Distal radius Fracture associated with neurovascular complications were excluded from the study.

Sample Size: Fifteen participants in both the groups were recruited for the study.

Surgical Methods and Data Collection

All eligible patients were evaluated preoperatively by clinical and roentgenographic examination. Preoperatively patients were immobilized with POP or splints. Patients were informed about the operative procedure and consent taken and pre-operative investigations were done. Patients were randomly selected for external fixator or plating.

The Joshi type of External fixator was used in our study. This fixator consists of distractor bar attachment with the schanz pins (screws). We have used two 3mm schanz screws for radius and two 2.5 mm schanz screws for the second metacarpal and 4 mm connecting rods. We used the following instruments for external fixator: External fixator set, Spanner No 7&8, Drill-bits, Electric drill & hand drill, T handle, Scalpel blade, Image intensifier. Under regional block Anesthesia (Brachial block) or GA depending upon anesthesiologist preference, patient was placed supine on the operating table. The forearm and hand were scrubbed with betadine and saline. The tourniquet was applied over the arm. The forearm and hand were painted with betadine and draped. The operating forearm was placed on a radiolucent arm-board. Closed reduction was done under C-arm. In this technique, 5mm incision for 4 schanz pins, 2 in the middle third of the radius on the dorso lateral aspect about 10-12cm from distal end and 2-3cm apart. We have done soft tissue dissection using a hemostat, care taken to avoid injury to radial nerve. Another 2 incision over the base of the second metacarpal on dorso lateral aspect about 1-2cm apart were done, 3mm schanz pin were inserted in the radius, and 2.5mm schanz pins was introduced in second metacarpal, then with fixator pins securely in place, clamps and external fixator rod were mounted to schanz pin. The clamps were loosened and longitudinal traction was given with manual molding of the fracture fragments back into a more normal alignment and gentle flexion and ulnar deviation was maintained. The reduction was confirmed through image intensifier and then external fixation device was locked into place. The tension across the wrist generated by the external fixator device which provides enough ligamentotaxis was confirmed by image intensifier

wherein, radiocarpal articulation was seen to be 1 mm wider than the mid-carpal joint in A-P projection.

For plating, the following instruments were used: Ellis Buttress plate or locking compression plate of varying length 2.5mm drill bit and 3.5mm drill sleeve system, 3.5mm LCP drill bit and sleeve system. Hand drill and power drill, tap for 3.5mm cortical screws and 3.5mm depth gauge, Hexagonal screw driver for 3.5mm cortical screws and locking screw driver, Other instrument like retractors, periosteal elevator, reduction clamps, bone lever. Pneumatic tourniquet.

The volar radial approach which uses the interval between the flexor Carpi radialis and the radial artery was used. An incision was made just radial to the FCR tendon, and careful dissection precedes the radial artery, which was retracted with brachio-radialis. The FCR and other flexor tendon were retracted ulnarly and the Pronator quadrates were elevated cut from the radial surface of the distal radius. The exposure was extended distally by releasing the FCR from its attachment to the trapezium allowing visualization of the radial styloid and volar rim of the distal radius. Caution was expressed with regard to retraction of the soft tissue and median nerve.

Fracture fragments were reduced, reduction was obtained by cortical inter digitations of the metaphyseal portion of the fracture and observing the effect of the reduction with image intensification. The volar buttress (ELLIS) plate or LCP was applied with the center portion of the plate elevated 1to 2 mm off the underlying cortex. In case of locking compression plate a standard cortical screw was applied to the most distal oval hole of the vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allows concomitant proximal and distal plate adjustment. After fixing the distal fragment with subchondral locking screws, radial length was gained, when necessary by pushing the plate distally. The final position of the plate is confirmed using fluoroscopy. After the closure, anterior below elbow slab was applied.

Postoperative Care and Rehabilitation

The check X-rays were taken in both A-P and Lateral views. The reduction of the fracture was confirmed and amount of distraction was also studied by radio carpal joint space in A-P view, which should be 1 mm wider than the mid-carpal joint space. Active exercises of fingers, thumb, elbow, forearm and shoulder were commenced from the day 1 of operation. On the third post-operative day the dressing was removed. The pins were cleaned in external fixator and small dressing done applied in plating case. Patient was discharged after the third day with an advice to clean the pins alternate days and was reviewed after 1 week followed by fortnightly. The patient was followed up at 2,4,6,8 12 weeks, post-operatively.

On demonstration of the radiological union, the external fixator was removed after 5-7 weeks (average 6 weeks) and physiotherapy of the wrist was commenced. A removable splint for forearm was applied during night and was removed during day time for physiotherapy for another 2 weeks and wrist and finger exercises were taught to continue at home. During the follow up, all the patients were observed for any possible complication. Each patient was evaluated for functional recovery at the end of three months and at the latest follow up visit up by clinical and radiological examination. The assessment of functional outcome was made according to modified clinical system of Green and O'Brien 1978 and Brad way et al 1989.

Statistical Analysis

Data was collected in clinical data abstraction form and entered in Microsoft Excel. The data was analyzed in Stata version 14.0. Descriptive analysis like frequency with percentage and mean and standard deviation (SD) was used to describe the participants' clinical characteristics. To differentiate between the two groups, Chi-square test and t-tests were applied based on the types of variables. The difference between the two groups were estimated by mean difference with 95% confidence interval (CI). A p-value <0.05 was considered as statistically significant.

Human subject protection: Ethics committee approval was taken for the participants. Written informed consent was taken for all the participants.

RESULTS

We recruited a total number of 30 patients, 15 each in both the groups. Majority of the participants (n=23, 76.7%) were young adults (21 to 30 years age), and males (n=17, 56.7%). Road traffic accidents (RTA) (n=18, 60%) was the major reason for fracture, right side was affected most (n=22, 73.3%), A3 (n=8, 26.7%) was the commonest type of the fracture. The average duration from the date of injury to the date of operation was 4 days ranging from 1st to14thday.

Table 1: Clinical Characteristics Of The Patients With Comminuted Fracture

Variables	Frequency (%)		p-value
	External fixator	Plating	
Age			
21-30	13 (86.7%)	10 (66.7)	0.07
31-40	1 (6.7)	4 (26.6)	
41-50	1 (6.7)	1 (6.7)	
Gender			
Male	9 (60)	8 (53.3)	0.32
Female	6 (40)	7 (46.7)	
Mode of injury			
RTA	11 (73.2)	7 (46.7)	0.03*
Fall	2 (13.4)	5 (33.3%)	
Fall from height	2 (13.4)	3 (20.0)	
Side affected			
Right	9 (60.0)	13 (86.7)	0.06
Left	6 (40.0)	2 (13.3)	
AO classification			
A2	1 (6.7)	4 (26.7)	0.16
A3	5 (33.3)	3 (20.0)	
B2	3 (20.0)	2 (13.4)	
B3	0 (0)	0 (0)	
C2	3 (20.0)	4 (26.7)	
C3	3 (20.0)	2 (13.4)	

Clinical Outcome

The follow up period was ranging from minimum 3 months to a maximum of 24 month (Average 9 months). The assessment of functional outcome was made according to modified clinical system of Green and O'Brien 1978 and Brad way et al 1989. This modified score includes independent scores for motion, strength, pain, and activity level. Overall results were graded as acceptable (excellent (90-100%) and good (80-100%)), fair (65-79%) or poor (>65%). In our study, six patients (20%) had full range of movements, no pain, returned to previous job and had 100% strength to that of normal side and the results were considered as excellent. (Figure 1-4) Another three patients (10%) had full range of movements as compared to that of opposite side with mild pain not affecting the function of wrist. They also scored more than 90% and the results were considered as excellent. There were 9 cases (30%) of Excellent, 14 cases (46.7%) of Good, 5 cases (16.7%) of Fair and 2 cases (6.7%) showed poor Result. However, the difference between the two groups were not statistically significant (p>0.05).

Table 2: Functional Outcome Of The Patients

Variables	Frequency (%)		p-value
	External fixator (n=15)	Plating (n=15)	
Excellent	4 (26.7)	5 (33.3)	0.31
Good	7 (46.7)	7 (46.7)	
Fair	3 (20)	2 (13.3)	
Poor	1 (6.7)	1 (6.7)	

The mean DASH score of the volar plate group was 9 (SD 5) compared to 23 (SD 7) for the external fixation group and the (p=0.015). The mean difference in DASH score was 9.0 (95% CI 4.5 to 13.6, p<0.001). The mean duration of healing was 5.8 weeks (SD 1.3 weeks) for the external fixation group, whereas it was 5.5 weeks (SD 1.2 weeks) in the ORIF group. However, the difference was not statistically significant (Mean difference 0.3; 95% CI: -1.2 to 0.6).

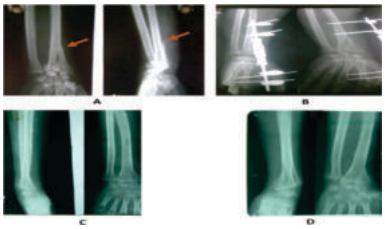

Figure 1: X Ray For External Fixator (a) Pre-op, (b) Immediate

Post Op, (c) Post Op 6 Weeks, And (d) Post Op 3 Months

Figure 2: Clinical Outcome For External Fixator (a) Extension, (b) Flexion, (c) Radial Deviation, (d) Ulnar Deviation, (e) Supination And (f) Pronation

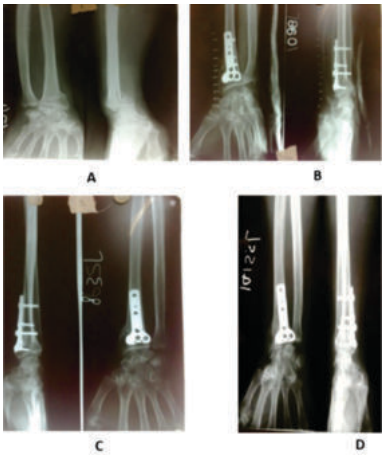

Figure 3: X Ray For Plating (a) Pre-op, (b) Immediate Post Op, (c) Post Op 6 Weeks, And (d) Post Op 3 Months

Figure 4: Clinical Outcome For External Fixator (a) Extension, (b) Flexion, (c) Ulnar Deviation, (d) Supination, (e) Pronation And (f) Radial Deviation,

DISCUSSION

Orthopaedic management of distal end radius fractures presents challenges from reduction to post-fracture mobility. Failure in treatment leads to permanent disability, emphasizing the need for optimal solutions. GREEN and O'BRIEN assert that successful outcomes hinge on identifying unstable fractures through displacement, comminution severity, and joint involvement. Surgical management gains favor among orthopaedicians over conventional methods. This study compares external fixation and plating in treating 30 distal radius fractures, with 57% males and 43% females, aged 20-60. Notably, males, often involved in high-energy traumas, predominate. Two diabetic patients, one asthmatic, and one post-delivery female were included. Systemic complications were absent, and fractures healed in 6-8 weeks. Pin tract infections occurred, leading to early removal of the external fixator. Malunion, wrist stiffness, and reflex sympathetic dystrophy were observed, but no non-unions or neurological deficits. Radiological and functional assessments favoured plating over external fixation, contributing valuable insights for further discussions and comparisons with similar studies.

In the past century, the prevailing approach to distal radius fractures involved conservative treatment. However, numerous studies have revealed inconsistent and debatable outcomes regarding the effectiveness of this conservative approach. While controversies persist about the necessity of anatomical reduction in distal radial fractures, there is unanimity regarding the challenge of maintaining satisfactory reduction through a simple plaster cast. Trumble et al. emphasized the strong correlation between surgical intervention and enhanced outcomes, particularly in improving articular step-off, reducing fragment gapping, and addressing radial shortening [8]. Presently, diverse surgical strategies, including external fixations, percutaneous pinning, and open reduction with internal fixation, are available to address these fractures.

Fracture fixation through open reduction and internal fixation (ORIF) typically involves a volar, and occasionally dorsal or combined, approach. This method demands technical expertise and is favoured by surgeons possessing adequate skill sets. In contrast, external fixation has been in use for approximately 80 years, offering various configurations tailored to injury patterns and surgeon experience. External fixation often necessitates additional measures like K wires, bone grafting, or stabilization of the radioulnar joint to support and sustain reduction in complex fractures [9]. The introduction of arthroscopic-assisted reduction during external fixation enhances the capacity for satisfactory reduction by providing direct visualization of the joint surface and simultaneous evaluation of wrist ligaments. Recent advancements, including lower-profile polyaxial locking screw implants, have simplified the management of fractures with extensive fragmentation, variations in normal anatomy, and dorsal metaphyseal instability, contributing to the growing preference for ORIF among surgeons [10-11].

The optimal treatment approach for distal radius fractures remains contentious, as prospective randomized studies have not decisively favored any particular method, despite some studies showing positive outcomes for various techniques. Chung KC et al. concluded that volar locking plates provide effective fixation for unstable distal radius fractures [12]. Chan BK et al. and McKenna J et al. demonstrated the efficacy of external fixation in managing unstable intraarticular fractures of the distal radius, although it may be insufficient to address articular incongruence [13,14]. Several authors have compared open reduction and plating with external fixation supplemented with K wiring. Cui Z et al.'s meta-analysis of 738 patients favored internal fixation, citing a lower incidence of postoperative complications, better clinical outcomes, and Disabilities of the Arm, Shoulder, and Hand (DASH) scores at six weeks, three months, and 12 months postoperatively [6]. Fu Q et al.'s meta-analysis of nine randomized controlled trials with 776 patients supported the use of volar plating over external fixation, indicating better clinical results even at 12 months follow-up [15].

Wei DH et al. and Karantana A et al. reported comparable outcomes for internal and external fixation. Wei DH et al.'s meta-analysis favoured internal fixation, noting better functional outcomes, anatomical restoration, and forearm supination, while external fixation showed advantages in grip strength and wrist flexion, presenting it as a viable surgical alternative [16,17]. Karantana A et al.'s Level 1 RCT found volar plating led to quicker early recovery of function and better anatomical reduction, but no lasting functional advantage beyond 12 weeks compared to external fixation. Shukla et al., Kreder et al., and Saving et al. favored external fixation over internal fixation [1,18,19]. Kreder et al.'s RCT for displaced intraarticular fractures highlighted a more rapid return to function with external fixation, provided articular deformities were minimized [18]. Shukla et al.'s Level 4 RCT for Cooney's Type 4 fractures showed superior outcomes with external fixation in wrist joint movements, grip power, and overall outcome one year postop [1]. Saving et al.'s RCT found comparable functional results but higher arthrosis and reoperation rates in volar locking plates [19]. Kapoor et al.'s RCT concluded that internal fixation minimizes articular complications, while severely comminuted fractures may benefit from external fixation, maintaining radial length through ligamentotaxis [20]. Rogachefsky et al. endorsed a combined approach for severely comminuted fractures, achieving satisfactory anatomy and function [21].

Our study revealed no statistically significant differences in pain score, functional score, and grip strength at the three-month follow-up between the internal fixation and external fixation groups. Even the

duration for healing was similar for both the groups. However, both groups showed a significant difference in DASH score which indicates that external fixator group. Hattori Y et al. and Germaine GQ et al. reported similar findings, with no statistically significant differences in Green & O'Brien scores between plating and fixator groups at various time points [22,23]. These results align with our finding in the present paper.

CONCLUSION

In conclusion, the comparative analysis of external fixation versus volar plating in the treatment of distal radius fractures indicates that volar plating emerges as a superior method, demonstrating lower DASH scores, and decreased infection rates. Notably, patients treated with volar plating exhibit reduced pain, enhanced range of motion in all directions, and improved functional scores, leading to better patient-reported outcomes in the initial three months postoperatively. Although external fixation remains a longstanding and minimally invasive technique, associated with slightly higher complication rates and increased radial shortening, its continued use is observed, especially in less experienced hands or by surgeons less familiar with newer plating systems. Nonetheless, the study advocates for the appropriateness of volar plating, particularly in cases requiring accelerated functional recovery, as it is associated with fewer complications and superior outcomes in the management of comminuted distal radius fractures.

REFERENCES

1. External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. Shukla R, Jain RK, Sharma NK, Kumar R. J Orthop Traumatol. 2014;15:265–270.
2. Risk factors for fractures of the distal forearm: a population-based case-control study. Mallmin H, Ljunghall S, Persson I, Bergström R. Osteoporos Int. 1994;4:298–304.
3. Bucholz M, Robert W, Heckman M, Court-Brown CM, Tornetta P. Wolters Kluwer. Pennsylvania, United States: Lippincott Williams & Wilkins; 2015. Rockwood and Green's Fractures in Adults.
4. External fixation is more suitable for intra-articular fractures of the distal radius in elderly patients. Ma C, Deng Q, Pu H, et al. Bone Res. 2016;4:16017.
5. A surgical protocol for combined internal and external fixation of complex intraarticular distal radius fractures using dorsal and volar approaches. Jebson PJ, Blair WF. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2378127/ Iowa Orthop J. 1996;16:35–38.
6. Internal versus external fixation for unstable distal radius fractures: an up-to-date meta-analysis. Cui Z, Pan J, Yu B, Zhang K, Xiong X. Int Orthop. 2011;35:1333–1341.
7. Are volar locking plates superior to percutaneous K-wires for distal radius fractures? A meta-analysis. Chaudhry H, Kleinlugtenbelt Y V., Mundi R, Ristevski B, Goslings JC, Bhandari M. Clin Orthop Relat Res. 2015;473:3017–3027.
8. Factors affecting functional outcome of displaced intra-articular distal radius fractures. Trumble TE, Schmitt SR, Vedder NB. J Hand Surg Am. 1994;19:325–340.
9. External fixation of the wrist. Pennig D, Gausepohl T. Injury. 1996;10:1–15.
10. A revolution in the management of fractures of the distal radius? Downing ND, Karantana A. J Bone Jt Surg Ser B. 2008;90:1271–1275.
11. Comparison of outcome of extra articular lower end radius fracture with percutaneous pinning and volar locking plate. Jagdev SS, Kedia R, Pathak SK, Salunke A. Int J Res Orthop. 2017;3
12. Treatment of unstable distal radial fractures with the volar locking plating system. Chung KC, Watt AJ, Kotsis S V, Margaliot Z, Haase SC, Kim HM. J Bone Joint Surg Am. 2006;88:2687–2694.
13. The use of the external fixator in the treatment of intra-articular fractures of the distal radius. Chan BK, Leong LCS, Low CO, See HF. https://www.ncbi.nlm.nih.gov/pubmed/10489512. Singapore Med J. 1999;40:420–424.
14. External fixation of distal radial fractures. McKenna J, Harte M, Lunn J, O'Bierne J. Injury. 2000;31:613–616.
15. Volar locking plate versus external fixation for distal radius fractures: a meta-analysis of randomized controlled trials. Fu Q, Zhu L, Yang P, Chen A. Indian J Orthop. 2018;52:602–610.
16. External fixation versus internal fixation for unstable distal radius fractures: a systematic review and meta-analysis of comparative clinical trials. Wei DH, Poolman RW, Bhandari M, Wolfe VM, Rosenwasser MP. J Orthop Trauma. 2012;26:386–394.
17. Surgical treatment of distal radial fractures with a volar locking plate versus conventional percutaneous methods: a randomized controlled trial. Karantana A, Downing ND, Forward DP, et al. J Bone Joint Surg Am. 2013;95:1737–1744.
18. Indirect reduction and percutaneous fixation versus open reduction and internal fixation for displaced intra-articular fractures of the distal radius. Kreder HJ, Hanel DP, Agel J, McKee M, Schemitsch EH, Trumble TE, Stephen D. J Bone Jt Surg Ser B. 2005;87:829–836.
19. External fixation versus volar plate fixation for unstable distal radial fractures—a 3-year follow-up of a randomized controlled trial. Saving J, Enocson A, Ponzer S, Mellstrand Navarro C. https://www.ncbi.nlm.nih.gov/pubmed/30420192 J Hand Surg Am. 2017;42:39–40. [Google Scholar]
20. Displaced intra-articular fractures of distal radius: a comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. Kapoor H, Agarwal A, Dhaon BK. Injury. 2000;31:75–79. [PubMed] [Google Scholar]
21. Treatment of severely comminuted intra-articular fractures of the distal end of the radius by open reduction and combined internal and external fixation. Rogachefsky RA, Lipson SR, Applegate B, Ouellette EA, Savenor AM, McAuliffe JA. J Bone Joint Surg Am. 2001;83:509–519. [PubMed] [Google Scholar]
22. Arthroscopically assisted reduction with volar plating or external fixation for displaced intra-articular fractures of the distal radius in the elderly patients. Yasunori H, Kazuteru D, Emmanuel PE, Guofen C. Hand Surg. 2007;12:1–12. [PubMed] [Google Scholar]
23. Prospective randomised study of intra-articular fractures of the distal radius: comparison between external fixation and plate fixation. Xu GGQ, Surg M, Edin M, Chan SP. Ann Acad Med Singapore. 2009;38:600–605.