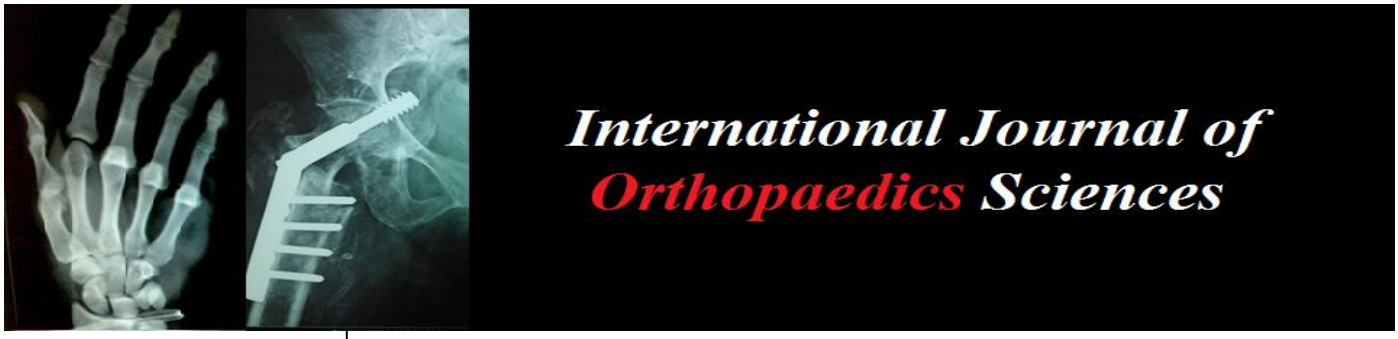

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(2): 745-749

www.orthopaper.com
Received: 23-02-2020
Accepted: 25-03-2020

Dr. Gaurav Kumar
Associate Professor, Department of Orthopaedics, Integral Institute of Medical Sciences and Research, Dasauli, Kursi Road, Lucknow, Uttar Pradesh, India

Dr. Varun Vijay
Assistant Professor, Department of Orthopaedics, Super Speciality Cancer Institute and Hospital, Sultanpur Road, Chak Gajaria, Lucknow, Uttar Pradesh, India

Corresponding Author:
Dr. Varun Vijay
Assistant Professor, Department of Orthopaedics, Super Speciality Cancer Institute and Hospital, Sultanpur Road, Chak Gajaria, Lucknow, Uttar Pradesh, India

Functional outcome of treatment of extra articular distal humerus fractures using pre contoured distal humerus locking compression plate: A retrospective study

Dr. Gaurav Kumar and Dr. Varun Vijay

DOI: https://doi.org/10.22271/ortho.2020.v6.i2l.2134

Abstract
Background: Extra-articular distal humerus fractures are difficult and challenging entities to manage owing to the complex anatomy of distal part of humerus as well as complicated fracture morphology. Functional cast bracing does not provide adequate stabilisation of these fractures apart from having other brace related complications. To overcome this problem, surgical intervention is the preferred method of treating these fractures with its share of complications like infection, non-union, implant failure and iatrogenic radial nerve palsy. Intra-medullary nailing and fixation with conventional plates is not a good option due to inadequate fixation in short distal fragment. The use of pre contoured, extra-articular distal humerus plates have emerged as a standard treatment in managing such fractures. This study was aimed to evaluate the clinical and functional outcome of managing such fractures using extra-articular distal humerus locking plates.
Methods: This retrospective study was carried out at Integral Institute of Medical Sciences And Research, Lucknow from September 2013 till August 2016. Out of the 47 patients records analysed, only 25 patients qualified for this study. All the patients were operated using the posterolateral triceps reflecting approach to the humerus. All the fractures were fixed using extra-articular distal humerus locking plates. All the patients were followed for 12-18 months with a mean of 16 months. The clinical and functional outcome was assessed using the Mayo Elbow Performance score (MEPS) for elbow and University of California Los Angeles (UCLA) rating scale for the shoulder function.
Results: At the final follow-up according to MEPS we had 18 patients showing excellent results (72%), 6 had Good results (24%) and 1 patient had Fair results (4%). According to UCLA, we had 22 patients (88%) Excellent results, while remaining 3 patients (12%) had Good results at final follow-up. No case of malunion or non-union was reported in our study. 1 patient developed superficial infection which was managed by daily dressing. 2 patients developed post-operative radial nerve palsy which recovered spontaneously. In 1 patient implant removal was warranted due to prominence of the hardware but that too after the fracture had united.
Conclusion: Stable fixation of these fracture and early mobilisation of the elbow joint are the key features to have an optimal outcome after the surgery. Using the pre contoured, extra-articular distal humerus locking plate with minimal soft tissue stripping has yielded good results with early return to normal function.

Keywords: Extra-articular distal humerus fracture, pre contoured distal humerus locking plate, posterolateral plate, posterolateral approach humerus, MEPS, UCLA.

Introduction
Fracture shaft of humerus is a common injury where 7% of the fractures involves the distal third of the shaft [1].
Various modalities of treatment have been proposed in managing fractures involving the distal third of humerus shaft like treating conservatively by functional cast bracing as well as surgically by plate osteosynthesis or intra-medullary nailing [2, 3]. However, managing extra-articular distal humeral fractures has always been a challenging and difficult task [4]. These are due to change in anatomic region of the bone where humerus become round to flat as one goes from proximal to distal part of the bone, forces acting on the distal segment of the bone

Provided by action of various flexor and extensor muscle groups, shorter fractured segment of distal part with limited area for osteosynthesis.

Non-surgical management with hanging cast and functional cast bracing is not a feasible option because the distal fragment is small and difficult to control due to the rotational forces acting along the distal third of humerus which has a tendency to go into adduction [5, 6]. The association of metaphyseal comminution also adds further difficulties in non- surgical treatment [7]. Prolonged bracing or casting results in delay in return to work and also stiffness of the elbow joint [8].

The use of conventional plating system in this area is a challenging task due to the smaller distal fragment which engages lesser number of screws and also impingement by the plate upon the olecranon fossa [9]. Dual platting technique takes care of this problem at the risk of extensive soft tissue stripping of the bone leading to higher infection and non-union rates [10, 12].

The main goal of treatment is to achieve stable fixation of the construct along with correct alignment of the bony fragments and to allow early range of movement at elbow and shoulder joint to prevent stiffness of theses joints due to prolonged immobilisation [13, 14].

In the present retrospective study, we have used the single column, pre-contoured, extra articular distal humerus locking compression plate for treatment of extra articular distal humerus fractures. The aim of our study was to evaluate the clinical and functional results of treating such fractures using single column system.

Material and methods

This retrospective study was carried out at Integral Institute of Medical Sciences And Research, Lucknow from September 2013 till August 2016. A total of 47 patients records were analyzed in this study with fracture of lower third of humerus. Records of patients who were skeletally immature, Gustilo Aderson Grade II and Grade III open fractures, frank compartment syndrome at the time of presentation, patients with vascular injuries, pathological fractures, patients with follow up of less than 1 year, associated ipsilateral upper extremity fractures, intra-articular extension of distal humerus fractures and patients who had undergone any previous surgery of humerus or around elbow joint of the fractured extremity were excluded from the study. Thus only 25 patients qualified for the present study.

All the fractures were classified using AO/OTA classification. On admission, the following parameters like patient demographics, mode of injury, side involved, skin condition, status of the radial nerve, associated injuries, AO classification of fracture type, time interval between injury and surgery of all patients were recorded. X-rays, both antero-posterior and lateral radiographs of the involved extremity was done from shoulder to wrist joint.

After getting surgical clearance from the anaesthetist, patients were posted for surgery. The duration from the date of injury to date of operation ranged from 2-7 days (average 4 days). All the cases were performed under brachial block and we used the single column, pre-contoured, extra articular distal humerus locking compression plate in all the cases. The operating position for all the patients was lateral decubitus. Fracture site was approached using the midline posterior incision and triceps-reflecting approach. Radial nerve was identified and protected both at lateral intermuscular septum and at spiral groove. The fracture site was exposed by lifting the triceps from lateral inter muscular septum. Temporary stabilisation of the fracture fragments was done using K wires before final plate was used in its place.

Post operatively, only an arm pouch was given to all the patients and intermittent passive range of motion exercises at elbow joint was started as tolerated by the patients. Distal neuro-vascular status was evaluated and recorded. In 2 patients, radial nerve palsy was present post injury and during surgery the nerve was found to be contused but in continuity and in 2 patients radial nerve palsy developed post-surgery due to extensive stretching of the radial nerve, a cock-up splint was given in all these patients. All the 4 patients recovered spontaneously within 3 months. Stitches were removed between 12-16 days. All the patients were followed at every four weeks interval post-operatively for first 3 months, then at 6 months and then every 6 months. They were evaluated clinically and radiologically for alignment, union and complications. The fracture was said to be clinically united when local tenderness disappeared and radiological union when there was bridging of at least three out of four cortices on antero-posterior and lateral radiographs.

Final functional evaluation of the elbow and shoulder was done using Mayo Elbow Performance score (MEPS) for elbow and University of California Los Angeles (UCLA) rating scale for the shoulder function. Range-of-motion of elbow and shoulder was measured using a goniometer.

The UCLA shoulder scale was graded into EXCELLENT (34-35 points), GOOD (29-33 points), FAIR (21-28 points) and POOR (0-20 points) [15, 16].

The MEPS was graded into EXCELLENT (90 points or more), GOOD (75-89 points), FAIR (60-74 points) and POOR (less than 60 points) [17].

The statistical analysis of the data was done using SPSS software version 17.0

Results

A total of 25 patients were included in this retrospective study. The mean age of the patients at the time of surgery was 36 years (range 24 to 70 years). There were 20 male patients (80%) and 5 female patients (20%). The most common mechanism of injury was road traffic accident which was seen in 20 patients (80%) followed by assault in 3 patients (12%) and trivial fall in remaining 2 patients (8%). Right side of the extremity was involved in 18 patients (72%) and left in 7 patients (28%). 5 patients (20%) had other associated injuries not involving the fractured extremity. 2 patients (8%) had associated radial nerve palsy at the time of presentation. These 2 patients had contusion of the radial nerve that was documented during surgery. These patients were given a cock-up splint in the post-operative period and these patients recovered spontaneously within 3 months after surgery as was evident clinically and on nerve conduction study. According to AO/OTA classification of fractures, the most common fracture pattern was type 12B2 seen in 5 patients (20%) followed by 12C1 and 12C2 seen in 4 patients each (16%). The least common fracture pattern was type 12A2 and 12B1 seen in only 1 patient each (4%). The interval between time of injury and surgery performed ranged from 2-8 days (mean of 4 days).

The average follow-up of patients ranged from 12-18 months with mean of 16 months. The time taken for radiological union of the fracture ranged from 12 to 20 weeks (mean of 17 weeks). 2 patients (8%) who developed radial nerve palsy post-operatively, recovered completely within 3 months. 1 patient (4%) developed superficial surgical site infection that

was managed by daily dressing. 1 patient (4%) who was thin built complaint of prominence of hardware at the postero-lateral aspect of the elbow and requested for implant removal. However, the plate was only removed after his radiographs showed union at the fracture site (18 months post-surgery). No case of malunion or non-union was reported in our study [Table 1].

At the final follow up, mean flexion at elbow was 120^0 (range from 90^0 to 140^0). 1 patient developed a fixed flexion deformity of 20^0 with range of motion from 20 to 90^0. All the remaining patients had flexion extension movement arc of more than 105^0. Mayo's Elbow Performance Score (MEPS) of the patients ranged from 60 points to 100 points at final follow up with an average score of 80 points. On the basis of MEPS, 18 patients had Excellent results (72%), 6 had Good results (24%) and 1 patient had Fair results (4%). [Table 2]

University of California Los Angeles (UCLA) rating scale for the shoulder function of the patients ranged from 30-35 points (average 34 points). 22 patients (88%) had Excellent results, while remaining 3 patients (12%) had Good results at final follow-up [Table 3]. 2 patients complained of occasional and slight pain in the shoulder (8%) while 1 patient (4%) complained of slight restriction of his shoulder movements but was able to do the work above shoulder level. Active shoulder forward flexion ranged from 130^0 to 180^0 with a mean of 155^0.

Table 1: Demographic parameters, clinical details and complications

Variable	Value
Age	Mean 36 years (range 24 to 70 years)
Gender	
Male	20 patients (80%)
Female	5 patients (20%)
Mode of Injury	
RTA	20 patients (80%)
Assault	3 patients (12%)
Trivial fall	2 patients (8%)
Side Involved	
Right	18 patients (72%)
Left	7 patients (28%)
Pre-operative radial nerve palsy	2 patients (8%)
Associated injuries	5 patients (20%)
Interval between injury to surgery	2-8 days (mean 4 days)
AO/OTA fracture classification	
12A1	2 patients (8%)
12A2	1 patient (4%)
12A3	3 patients (12%)
12B1	1patient (4%)
12B2	5 patients (20%)
12B3	3 patients (12%)
12C1	4 patients (16%)
12C2	4 patients (16%)
12C3	2 patients (8%)
Follow up	12-18 months (mean of 16 months)
Time for radiological union	12 to 20 weeks (mean of 17 weeks)
ROM at elbow at final follow up	90^0-140^0 (mean of 120^0)
ROM at shoulder at final follow up	130^0-180^0 (mean of 155^0)
Complications	
Radial nerve palsy	2 patients (8%)
Superficial infection	1 patient (4%)
Hardware related issue	1 patient (4%)

Table 2: Mayo Elbow Performance Score (MEPS)

S. No.	Score	MEPS	No. of Cases	Percentage
1	90 or more points	Excellent	18	72%
2	75-89	Good	6	24%
3	60-74	Fair	1	4%
4	< 60	Poor	0	0%

Table 3: University of California Los Angeles (UCLA) rating scale for shoulder

S. No	Score	UCLA	No. of Cases	Percentage
1	34-35 Points	Excellent	22	88%
2	29-33	Good	3	12%
3	21-28	Fair	0	0%
4	20 or less	Poor	0	0%

Discussion

Management of fractures of distal third humerus had been proposed either by conservative ways or by surgical intervention. Conservative method in the form of Functional Cast Bracing is a demanding procedure with various limitations like skin problems, malalignment of the fracture fragments and high incidence of non-union rates ranging from 5% to 24% [18, 19].

Management by surgical intervention have become an accepted treatment modality in treating such fractures considering the drawbacks of conservative management [11, 20]. But few complications like infection, radial nerve palsy, non-union and hardware related problems have also been reported with the use of surgical fixation [11]. The various modalities of surgical intervention include fixation of the fracture either by intra-medullary nailing or by plate osteosynthesis using either single column plating or dual column plating. Biomechanical studies have shown that plate and screw vs intramedullary devices for fixing distal third fracture humerus, the use of plate and screw have superior bending properties. Also, the narrow medullary canal in the distal third of the humerus makes it difficult to perform intramedullary nailing for such fractures [21]. To enhance the distal fixation, Moran proposed the use of conventional plate that he used at 5 to 8 degree angle off center from the long axis of humerus, but the obliquity of the plate limited proximal fixation.[22] To overcome this difficulty, various modifications in the plate design have been suggested by many authors from time to time. Levy et al used the proximal tibial buttress plate with few modifications of the ipsilateral side to treat such fractures [23]. They used this method in 15 patients with good clinical and radiological outcome. Saragaglia et al. proposed the use of a "Lambda Plate" which can easily be bend to fit the distal humerus anatomy according to the fracture pattern [24]. But since this was a compression plate and not a locking plate, this plate was fraught with the risk of inadequate fixation particularly in cases of osteoporotic bones and in presence of comminution.

Use of Dual plating, though biomechanically superior than single column plating does so at the expense of extensive soft tissue dissection which is an essential part of fracture healing.[25] An in vitro study by Scolaro et al. have shown the favourable biomechanical properties of single, per contoured, postero-lateral extra articular locking compression plate.[26] Meloy et al. did a comparative study using the single column pre contoured posterolateral locking plate with dual column plating for extra articular fractures [27]. The results were comparable in terms of union rate and alignment but with significantly lesser complications and better range of motion of elbow joint in the single column plating group. Yang *et al.*

suggested that extensive soft tissue dissection done for dual plating may be responsible for increased incidences of infection, non-union and iatrogenic radial nerve palsy reported in some series [28]. To overcome this issue, single column plating for treating such fractures have now become a standard treatment protocol.

In our series we have used the posterolateral approach of Gerwin which has advantages like improved post-operative triceps function and extension of the incision both proximally and distally to elevate the triceps off humerus and also to mobilise the radial nerve than the traditional triceps splitting approach [29].

Fawi et al. and Capo et al. have reports an average time of union of 15.7 weeks and 7.3 months respectively with the use of extra articular distal humerus plate [30, 31]. In our series, the average time of union was 17 weeks.

Incidence of pre-operative radial nerve palsy ranged from 4.35 to 23.3% in different studies [10, 32]. In our series it was 8%.

The incidence of post-operative redial nerve palsy ranged from 0% to 8.3% in different studies [10, 32]. In our series it was 8%.

The incidence of non-union reported ranged from 0% to 7.7% in different studies [10, 32]. In our series no case of non-union was reported.

Mean elbow flexion ranged from 122.9^0 to 141.2^0 in different studies [10, 32]. In our series it was 120^0.

Trikha V et al. and Jain D et al. had a mean MEPS score of 90.8 and 96.15 respectively at the final follow-up in their series [7, 32]. Our series had a mean MEPS score of 80.

All the patients in our study were satisfied with their shoulder function. All 25 patients had excellent to good UCLA scores with mean active forward flexion of 155^0. This is consistent with other studies [20, 30, 31].

Conclusion

Managing the extra-articular distal third humerus fractures is relatively difficult compared to the midshaft fractures due to short distal fragment and difficulty in positioning the conventional implants. To overcome this problem, the extra-articular distal humerus locking plate system has been developed. This provides greater screw hole density in the distal plate by using the 3.5mm screws instead of 4.5mm screws used in conventional plating system thereby increasing the rigidity of the construct which allows early rehabilitation at elbow joint. Using the Bi-columnar system definitely provides increased stability but at the cost of increased soft tissue dissection. Posterolateral approach for treating distal humerus fractures has an increased advantage of adequate exposure of the fracture fragments and also visualisation and mobilisation of the radial nerve while fixing the fracture.

Acknowledgement: NIL

Declarations

Funding: Self

Conflict of Interest: Nil

Ethical Approval: As it is a retrospective study, waiver of consent had been approved by the institute's ethical committee.

References

1. Rockwood CA, Green DP, Bucholz RW. Rockwood and Green's Fractures in Adults, 8th ed., Lippincott-Raven Publishers, Philadelphia. 2015; 1:1230.
2. Sarmiento A, Zagorski JB, Zych GA, Latta LL, Capps CA. Functional bracing for the treatment of fractures of the humeral diaphysis. J Bone Joint Surg Am. 2000; 82(4):478-486.
3. Wali MG, Baba AN, Latoo IA, Bhat NA, Baba OK, Sharma S. Internal fixation of shaft humerus fractures by dynamic compression plate or interlocking intramedullary nail: a prospective, randomized study. Strategies Trauma Limb Reconstr. 2014; 9(3):133-140.
4. Horne G. Supracondylar fractures of the humerus in adults. J Trauma. 1980; 20(1):71-74.
5. Prasarn ML, Ahn J, Paul O, Morris EM, Kalandiak SP, Helfet DL, *et al.* Dual plating for fracture of the distal third of the humeral shaft. J Orthop Trauma. 2011; 25(1):57-63.
6. Browner BD, Jupiter JB, Levine AM. Skeletal Trauma. 3rd ed. Philadelphia: Saunders, 2003, 1436-511.
7. Trikha V, Agrawal P, Das S, Gaba S, Kumar A. Functional outcome of extra-articular distal humerus fracture fixation using a single locking plate: A retrospective study. J Orthop Surg (Hong Kong) 2017; 25(3):1-6.
8. Ayoub MS, Tarkin IS. Best care paradigm to optimize functionality after extra-articular distal humeral fractures in the young patient. J ClinOrthop Trauma. 2018; 9(Suppl 1):S116-S122.
9. Shimamura Y, Nishida K, Imatani J *et al.* Biomechanical evaluation of the fixation methods for transcondylar fracture of the humerus: ONI plate versus conventional plates and screws. Acta Med Okayama. 2010; 64(2):115-120.
10. Kharbanda Y, Tanwar YS, Srivastava V, Birla V, Rajput A, Pandit R. Retrospective analysis of extra-articular distal humerus shaft fractures treated with the use of pre-contoured lateral column metaphyseal LCP by triceps-sparing posterolateral approach. Strategies in Trauma and Limb Reconstruction. 2017; 12(1):1-9.
11. Jawa A, McCarty P, Doornberg J, Harris M, Ring D. Extra-articular distal-third diaphyseal fracture of the humerus. A comparison of functional bracing and plate fixation. J Bone Joint Surg Am 88(11):2343-2347.
12. Paris H, Tropiano P, ClouetD'orval B, Chaudet H, Pointout DG. Fracture of the shaft of the humerus: Systematic plate fixation. Anatomic and functional results in 156 cases and a review of the literature. Rev Chir Orthop Reparatrice Appar Mot 86(4):346-359.
13. Self J, Viegas SF, Buford WL Jr, *et al.* A comparison of double-plate fixation methods for complex distal humerus fractures. J Shoulder Elbow Surg 1995; 4(1 Pt 1):10-16.
14. Waddell JP, Hatch J and Richards R. Supracondylar fractures of the humerus-results of surgical treatment. J Trauma. 1988; 28(12):1615-1621.
15. Amstutz HC, Sew Hoy Al, Clark IC. UCLA anatomic total shoulder arthroplasty. Clin Orthop Relat Res. 1981; (155):7-20.
16. Nutton RW, McBirnie JM, Phillips C. Treatment of chronic rotator-cuff impingement by arthroscopic subacromial decompression. J Bone Joint Surg Br. 1997; 79(1):73-76.
17. Dawson J, Fitzpartic R, Carr A, Murray D. Questionnaire on the perceptions of patients about total hip replacement. J Bone Joint Surg Br. March. 1996; 78(2):185-190.
18. Ali E, Griffiths D, Obi N, Tytherleigh-Strong G, Van Rensburg L. Non operative treatment of humerus shaft

fractures revisited. J Shoulder Elbow Surg. 2015; 24:201-204.
19. Papasoulis E, Drosog GI, Ververidis AN, Verettas DA. Functional bracing of humeral shaft fractures. A review of clinical studies. Injury. 2010; 41:21-27.
20. Scolero JA, Voleti P, Makani A, Namdari S, Mirza A, Mahta S. Surgical fixation of extra-articular distal humerus fractures with a posterolateral plate through a triceps-reflecting technique. J Shoulder Elbow Sur 23(2):251-257.
21. Zimmermac MC, Waite AM, Deehan M, Tovey J, Oppenheim W. A biomechanical analysis of four humeral fracture fixation systems. J Orthop Trauma 8(3):233-239.
22. Moran MC. Modified lateral approach to the distal humerus for internal fixation. Clin Orthop Relat Resp 1997; 340:190-197.
23. Levy JC, Kalandiak SP, Hutson JJ, *et al.* An alternative method of osteosynthesis for distal humeral shaft fractures. J Orthop Trauma 2005; 19(1):43-47.
24. Saragaglia D, Rouchy RC and Mercier N. Fractures of the distal humerus operated on using the Lambda® plate: report Trikha et al. 5 of 75 cases at 9.5 years follow-up. Orthop Traumatol Surg Res. 2013; 99(6):707-712.
25. Tejwani NC, Murthy A, Park J, McLaurin TM, Egol KA, Kummer FJ. Fixation of extra-articular distal humerus fractures using one locking plate versus two reconstruction plates: a laboratory study. J Trauma 66(3):795-799.
26. Scolero AJ, Hus JE, Svach DJ *et al.* Plate selection for fixation of extra-articular distal humerus fractures: comparison of three different implants. Injury 2014; 45(12):2040-2044.
27. Meloy GM, Mormino MA, Siska PA, *et al.* A paradigm shift in the surgical reconstruction of extra-articular distal humeral fractures: single-column plating. Injury 2013; 44(11):1620-1624.
28. Yang Q, Wang F, Wang Q, Gao W, Huang J, Wu X, *et al.* Surgical treatment of adult extraarticular distal humeral diaphyseal fractures using an oblique metaphyseal locking compression plate via a posterior approach. Med PrincPract. 2012; 21(1):40-45.
29. Gerwin M, Hotchkiss RN, Weiland AJ. Alternative operative exposures of the posterior aspect of the humeral diaphysis with reference to the radial nerve. J Bone Joint Surg Am 78(11):1690-1695.
30. Fawi H, Lewis J, Rao P, Parfitt D, Mohanty K, Ghandour A. Distal third humeri fractures treated using the Synthes^{TM} 3.5-mm extra-articular distal humeral locking compression plate: clinical, radiographic and patient outcome scores. Shoulder Elbow. 2015; 7(2):104-109.
31. Capo JT, Debkowska MP, Liporace F, Beutel BG, Melamed E. Outcomes of distal humerus diaphyseal injuries fixed with a single-column anatomic plate. IntOrthop. 2014; 38(5):1037-1043.
32. Jain D, Goyal GS, Garg R, Mahindra P, Yamin M, Selhi HS. Outcome of anatomic locking plate in extraarticular distal humeral shaft fractures. Indian J Orthop. 2017; 51(1):86-92.