

A Prospective Evaluation on Functional and Radiological Outcome of Proximal Humerus Fracture in Adults Treated with Proximal Humeral Internal Locking Osteosynthesis System (PHILOS)

Kishore Babu Sattaru¹, Amarnadh Paidi², Sanjeev Kumar Kare³

¹Government Medical College and General Hospital, Srikakulam (affiliated to Dr.YSR University of Health Sciences, Vijaywada, Andhra Pradesh)

²Government Medical College and General Hospital, Srikakulam (affiliated to Dr.YSR University of Health Sciences, Vijaywada, Andhra Pradesh)

³Government Medical College and General Hospital, Srikakulam (affiliated to Dr.YSR University of Health Sciences, Vijaywada, Andhra Pradesh)

Received: 28-06-2023 / Revised: 25-07-2023 / Accepted: 29-08-2023

Corresponding author: Dr. Amarnadh Paidi

Conflict of interest: Nil

Abstract:

Background: To evaluate the clinical, radiological, and functional outcome of fractures involving the proximal part of the humerus treated operatively using proximal humeral internal locking osteosynthesis system (PHILOS).

Methods: At the Government General Hospital (GGH) in Srikakulam, a series of 30 patients with closed proximal humerus fractures (Neer's types), with a mean age of 51 years (range, 23-70 years), were surgically treated between October 2020 and November 2022. Using the Neer's functional scoring system, the functional outcome was evaluated; radiological outcomes are analyzed by serial periodical x-rays and complications were noted.

Results: All fractures have shown fracture union within an average period of twelve weeks. The average range of active Flexion, external rotation and abduction are 130.8°, 46.67° and 127° respectively. 17 (85%) of cases had normal muscle strength in the shoulder. Patients with 2-part fractures had better functional outcomes than 3-part and 4-part fractures. Skin necrosis, wound gaping and Deltoid atony was observed in one case each, post-operative joint stiffness in two cases; instability malunion and heterotrophic ossification was identified in one case each. Mean Neer's functional score is 87.1.

Conclusion: proximal humeral fractures when managed surgically using PHILOS plate particularly in poor quality bones and comminuted fractures, gives a better stability and early mobilization, and hence greater range of movements and lesser stiffness.

Keywords: Proximal Humerus, Neer's functional scoring system, PHILOS.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Fractures involving the proximal humerus are defined as "fractures that take place at and or proximal to the surgical neck of the humerus". In 2000, approximately 706,000 fractures involving proximal end of humerus had reported worldwide. It constitutes four percent of all fractures and nearly one-half of all humerus fractures. It is the 2nd most prevalent injury of the Omos girdle in adults & 2nd most frequent upper extremity fracture >65 years of age group, and third most among non-vertebral osteoporotic fractures after proximal femur and distal radius fractures, representing for 10% of fractures in these population group. It has a unimodal distribution in the adult group, peaking at 84 years of age for both genders [1]. Fractures

involving the proximal end of the humerus have become progressively more frequent over the past decades, and the yearly number of 275,000 fractures is expected to reach by 2030. The majority of proximal humerus fractures don't require surgery. Fracture repair is growing more often than prosthesis replacement, while surgical therapy is becoming more common. It has a significant regional variation in fracture incidence, ranging from 0.57 to 4.97 per 1,000. The rate of operatively managed fractures shows similar variability from less than ten percent to forty percent or more [1]. Most research concurs good denouement with non-operative management of un-displaced fractures; recent prospective studies suggest that signifi-

cant functional disability might occur, with over two-thirds of patients reporting chronic pain. Therefore, the impact of decreased quality of life in this patient population might be significant. However, aged and weaker individuals tend to have more complicated fractures. In an effect, up to one-third of patients with proximal humerus fractures may require hospital admission. Hence, surgical corrections are advised, and the patient no longer needs to be renounced with a sophisticated plating system to have good results. We intend to evaluate functional denouement of proximal humeral fractures treating by ORIF with PHILOS plating in perspective of a variety of movement and possible essential functions around the Omos girdle, radiological outcome, and subsequent distortions in the process and after completion of the healing.

Aims & Objectives

To evaluate the clinical, radiological, and functional outcome of fractures involving the proximal part of the humerus treated operatively using proximal humeral internal locking osteosynthesis system (PHILOS) plating at Government Medical College, Srikakulam; To evaluate fracture patterns; To assess the complication rates of the implant.

Materials & Methods

In this prospective research, which was conducted at the Government General Hospital & Government Medical College, Srikakulam from October 2020 to November 2022, thirty cases of surgically treated proximal humerus fractures employing PHILOS plates were evaluated for their functional and radiological outcomes.

Type of Study: Prospective intervention analysis

Source of Data

Adults (>18years) with proximal humerus fractures admitted to department of orthopaedics, GMC & GGH, Srikakulam.

Study Duration: From October 2020 to November 2022.

Sample Size: 30

Inclusion Criteria

- Patients with the fractures of proximal Humerus, who are skeletally matured and aged >18 years.
- Satisfy Neer's criteria for operative displacement, i.e., displacement between major fracture fragments >10mm or articular surface angulation >45°
- Neer's two, three, and four-part fractures.

Exclusion Criteria

- Patients with Open fractures.
- Pathological fractures (due to tumors).
- Associated neurovascular injury.
- Associated head injury.

Methodology

Preoperative

After the initial resuscitation, a complete clinical examination was carried out to rule out any other concomitant injuries, and a thorough history was recorded. Status of the distal neurovascular system was evaluated. Fractures were classified according to Neer's classification.

Operative Procedure

Type of Anesthesia

Twenty-four individuals had surgery with interscalene and supraclavicular block. The remaining six patients underwent combined general anaesthesia with an inter-scalene block in anticipation of a longer procedure due to difficulties with fracture fragments reduction.

Patient Positioning

To move the index side forward and open up the anterior half of the joint, all patients were placed supine on the operating table with a sandbag between the medial border of the scapula and the spine.

Approach: The traditional Deltopectoral technique was used to operate on all of the patients.

Operative Technique

After cutting the epidermis, subcutaneous tissue and fascia, blunt dissection of deltoid, and Pectoralis major muscle is done, then the conjoint tendon was identified and retracted medially. With the aid of 1.5mm, or 1.8mm, or 2mm K-wires, the fragments were indirectly reduced and momentarily stabilized under the guidance of image intensifier. After achieving acceptable reduction, The Biceps tendon's long head was recognized, kept intact and it was not compromised since the plate was then positioned 2 mm laterally to it. With the aid of a specially created screwdriver and locking head screws, the metaphyseal shaft and the portion of the humerus head were joined together. An image intensifier was used to verify the plate's ultimate location in several planes. The shoulder was examined for fixation stability, the lack of impingement, and range of motion. None of the subject in the present evaluation had need of bone grafting. The suction drain was left in place, and incision is closed in layers with 1/0 or 2/0 Vicryl sutures and 1/0 or 2/0 Ethilon sutures.

Fracture Dislocation

The coracoid process was pre-drilled, osteotomised, and retracted with the tendon in instances of irreducible fracture-dislocation. After passing a blunt hemostat between the subscapularis and capsule with the arm in external rotation, stay sutures were placed then one inch from its insertion, the subscapularis was split and retracted. To open the joint, the capsule was longitudinally incised, and the articular fragment was subsequently reduced.

Postoperative Protocol

In all the patients, the arm was placed in a cuff and a collar or an arm sling or a shoulder immobilizer. On day two following surgery, the drain was taken out. Ice packs were used to minimize the swelling. Passive elbow flexion and extension were initiated within 24-48hrs. Intravenous antibiotics are given till the 8th post-operative day. Sutures were removed on the 10th to 14th post-operative day. X-rays are taken in the immediate post-op period to document the fracture alignment, reduction, and fixation. After that, X-rays are taken at intervals of 6 weeks, 3 months, 6 months, 9 months and 12 months to check on the progression of fracture union and look for any implant loosening, deviation, screw penetration, screw back out, impingement, and failure.

Rehabilitation

Phase I: exercises consisting of pendulum exercises, was started in the first week. Gentle passive forward flexion internal and external rotation exercises were initiated by the third week.

Phase II: exercises consisting of active range of motion exercises and resistive exercises were started by 4-6 weeks of the post-operative period.

Phase III: exercises comprising advanced stretching and strengthening exercises were initiated in the third month. Lifting of light weight objects was started after three months

Follow Up: Every two weeks for the first three months, and then every month after that, the patients were visited on at regular intervals. The minimum and maximum follow-up intervals were 6 months and 12 months, respectively. Neer's scoring system [2] was adopted to evaluate the functional outcome of present study cases. The following parameters were taken into account while evaluating the findings during follow-up: Pain; Function- Strength, Reaching, and Stability; Range of movements; Anatomic resto-

ration; Radiological recording of fracture union progression. Post-op radiological outcome was analyzed by periodical x-rays by assessing the fracture union, neck-shaft angle (NSA) [$>120^\circ$ - normal; $\leq 120^\circ$ - abnormal], greater tuberosity (G.T.) to articular surface (AS) distance [Ideal: 5-8mm], medial hinge reduction, and presence (or absence) of calcar screw.

Observations

Male cases (70%) were predominated. The majority of patients were in their 6th decade (30%). The most common mode of injury is free fall at ground level (50%). None of the cases with bilateral fractures were reported. All the cases are right-handed dominant persons and the right arm is involved 19 (67.3%).

Within the five days of injury, 16 (53.3%) cases were reported to the hospital. 20% of cases (6 out of 30) had undergone previous native management either in splinting, massage or attempted reduction and splinting. Nine (09) cases, i.e., 30% of cases, had associated fractures. All the cases had closed injuries. Neer's 2-part fracture is the most common type, with 56.7% of patients.

In 2-part fractures, Greater tuberosity fracture is the predominant type of fracture. The 4-part fractures accounted for only 3.3% of patients. Fracture dislocations were present in 10% of patients (3 cases). One patient needed post-operative immobilization with Plaster of Paris. Cases were taken up for surgery on an average of 5.23 days after admission. 60% of patients did not have any complaint of pain during follow-up.

The average range of active Flexion was 130.8° . The average range of active external rotation is 46.67° . The average range of abduction is 127° . 17(85%) cases had normal muscle strength in the shoulder. Patients with 2-part fractures had better functional outcomes than 3-part and 4-part fractures. All fractures have shown fracture union within an average period of twelve weeks. None of the cases encountered implant loosening or failure.

Results

Functional outcome was analyzed with the ability to perform day-to-day activities by assessing Strength, Reaching, and Stability. Of the 30 patients 18 (60%) patients had excellent result, 8 (26.7%) satisfactory, 3 (10%) unsatisfactory and 1(3%) failure. [Table-1].

Table 1:

S. No.	Neer's scoring system Rating	No. of cases	Percentage
1	Excellent (90-100 points)	18	60%
2	Satisfactory (80-89 points)	8	26.7%
3	Unsatisfactory (70-79 points)	3	10%
4	Failure (<70 points)	1	3.3%

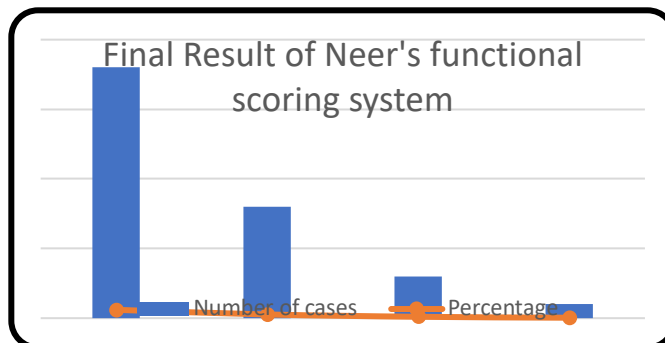


Figure 1: Final result of Neer's functional scoring system

Radiological Outcome

Fracture alignment, Quality of reduction, restoration of articular congruity, fracture union, screw penetration, back-out, PHILOS plate deviation, implant loosening, and failure were evaluated radiologically during the follow-up. All fractures had shown union, and the average time taken for the fracture union was approximately twelve weeks. One patient with a 3-part fracture developed mal-union. No cases had encountered with implant deviation, screw back out, screw penetration, impingement, and failure. Neck-Shaft angle (NSA) was normal in 28 (93.3%) cases, and 2 (6.7%) cases had abnormal. All the cases had ideal greater tuberosity (G.T.) to articular surface (AS) distance, medial hinge reduction, and presence of calcar screw.

Complications

Early complications were encountered in three (10%) patients. One case with type 2 diabetes mellitus developed a wound gaping due to infection requiring secondary suturing after Glycemic control. One case with a 3-part fracture had skin necrosis which resolved with intravenous antibiotics. One case had a Deltoid atony after surgery which was alleviated with the sling and strengthening exercises.

Late complications were experienced in 5 (25%) of patients. One patient with a 4-part fracture had a mal-union of the Greater tuberosity, limiting the abduction above 90°. The patient who had the Deltoid atony initially, after the operation, is debilitating. Two cases had joint stiffness. Both patients later had a manipulation under general anesthesia. One patient had developed Heterotropic ossification with

a 3-part fracture, probably because the patient had exerted native treatment in the form of many massages, attempted reduction, and splinting.

Discussion

In this prospective interventional study, we have evaluated thirty cases of fractures involving proximal humerus in adults managed surgically using PHILOS plates in Government General Hospital, Srikakulam. There was preponderance of men 21(70%) in the present study proportionate to the results of the study conducted by AA Martinez [3] involving 31 cases, Srikanth et al [4] involving sixteen cases and Nitin sharma et al [5] involving twentyfive cases of proximal humeral fractures. In the current evaluation, the mean age of the patients was 51 years which was equivalent to the results of Hawkins, Bell and Gurr [6], Chintan Doshi [7], Flatow & Co. [8] and Micheal Plecko et al. [9] showing fractures mostly involving in the 6th decade of life. In the present evaluation, the most common mode and mechanism of injury was self-slip & fall at ground level and fall on an outstretched hand were more related to the results of Flatow & Co. [8] as fall on the outstretched arm was the prime mechanism of injury and mean age of the cases are 53 years in their study. The average age is a little lower since our folks lack good bone stock quality and women reach menopause sooner in life. Neer's Classification is the widely used system for the fractures involving Proximal Humeral. It has gained universal clinical acceptance by Orthopaedic surgeons and radiologists and is considered to have significant implications for both treatment options and outcomes. Although various publications have noted a poor degree of inter-observer authenticity, the

current study also adhered to Neer's four-part classification. Sidor & Co. [10] reported a reliability coefficient of 0.48 for one viewing, 0.52 for eleven viewings.

Accurate radiographic examination is crucial for the effective use of this classification [11]. In assessing these fractures, it was found that Neer's three view trauma series was the most useful. The importance of these series has been shown by Richard J, Hawkins S and R. L. Angel [12]. Computed tomographic scans were done to determine the direction of dislocation in circumstances with ambiguous findings. Flatow & Co. [8] believed that sole reliance on standard AP radiograph may lead to underestimation of the amount of displacement of fragments. The majority of fractures in the current research (56.7%) were two-part fractures, with greater tuberosity fractures being the most frequent kind. In 10% of the cases, associated dislocations were detected. If the tuberosity fragment in the Glenohumeral Dislocation Reduction remained more than 1 cm dislocated or more than 45 degrees angulated, Open Reduction & Internal Fixation was done. The muscles of the rotator cuff are repaired and reattached to enable dynamic stability restoration in such individuals [8]. In a group of 12 patients who had surgical ORIF with PHILOS plates treatment for a two-part greater tuberosity fracture, Flatow & Co. [8] reported 50% outstanding results and 50% good performances. Three-part fractures that get closed therapy are frequently accompanied by significant discomfort, limited range of motion, and impairment. According to a study by Hawkins et al. [6], surgical intervention for healthy, active people who suffer 3-part proximal humerus fractures is advised since it is linked with good to excellent outcomes in >80% of patients. When using the screw tension band approach to repair 3-part fractures, Cornell and Levine [13] observed positive outcomes. Prosthetic replacement has been utilized for 3-part fracture by various authors. Less than 10% of patients treated with open reduction and internal fixation for four component fractures and fracture dislocations had satisfactory or outstanding outcomes [14, 15]. Several isolated instances of revascularization of the humeral head after open reduction and internal fixation shown good recovery. In several cases described in the literature, there was no solitary articular fragment with 4-part fracture, and the follow-up was insufficient to rule out long-term osteonecrosis. Hugg and Lundberg found 74% AVN for similar fractures when ORIF was used. According to reports, the prevalence of avascular necrosis can reach ninety percent in 4-part fractures and 3-25% in 3-part fractures [16, 17]. All authors agree that replacing a prosthesis has provided pain relief in excess of 90%

of cases, although there have been varying degrees of success in terms of strength, function, and range of motion. With a modified procedure that uses the long Deltpectoral approach and superior rehabilitation, Neer and McIlveen have identified 90% outstanding outcomes. Although, many author reports that hemiarthroplasty outcomes in 3- and 4-part fractures are better than locking plate technique in aspects of avascular necrosis, implant failure and rate of reoperation, recent meta-analysis denied the same [18]. According to the results of the current study, the majority of patients (86.7%) reported no pain, only little discomfort rarely, or no activity impairment. This finding is consistent with findings of Hawkins & Co.[6,19] and Flatow & Co. [8]. The mean active abduction in the 2-part fractures of present study was 132.6° and mean external rotation was 48.2° which is approximately similar to the study done by Flatow & Co. [8] in study of 12 cases of 2-part fractures of proximal humerus managed surgically. The average abduction in the 3-part fracture of was 121.3° and external rotation was 44.58°, proportionate to the findings of Hawkins & Co. [6] in 15 cases of 3-part fracture of proximal Humerus managed surgically. All Cases of 3- and 4-part fractures had regained at least 100° abduction and about 92% of these individuals exhibited healthy and normal muscular strength, which was equivalent to the research work of Hawkins & Co. [6] and Flatow & Co [8]. In the present study few complications were seen but all fractures shown the radiological union and similar to Moonot P et al [20] & Gardner M J et al [21] the average time required for fracture union was about 12 ± 2 weeks. Mal-union occurred in one patient with a three-part fracture. There were no reports of implant deviance, screw penetration, screw back out, impingement, or failure.

Additionally, our study has limitations. First, there were insufficient controls for outcome comparison and a small number of patients, mostly of Neer's type 2 were included. Second, the follow-up time was only short to medium term, which was insufficient due COVID-19 pandemic. The fractures involving proximal part of Humerus may be immensely challenging. There are so many drawbacks for the incautious patient and surgeon to nullify, over the course of the therapy. The need of thorough and accurate diagnosis, as well as the development of simple, safe procedures for restoring anatomical stability, fracture union, and cuff integrity, adequate muscle strength and range of movements.

Conclusions

As PHILOS has choice for more number of screws for humeral head than the conventional locking plate,

it provides more stable fixation and early mobilization of the patients. As PHILOS plate has options of multidirectional screws, it will aid in better stability. Earlier the intervention better the results can be achieved. Functional results from isolated fractures are superior to those from fracture dislocations. The effectiveness of surgery will be determined by an in-depth knowledge of morphology and bio-mechanical principles, as well as the careful selection of patients. The positive accuracy come from surgical techniques that produce stable fixations that permit passive movement early on. The functional prognosis of PHILOS treated 2-part fractures is superior to that of 3- and 4-part fractures. Radiological outcome evaluated by mean quality of reduction and union of fracture in 2 & 3-part fractures is better than in 4-

part fractures. Finally, within the limitations of the present study it concluded that proximal humeral fractures when managed surgically using PHILOS plate particularly in poor quality bones and comminuted fractures, gives a better stability and early mobilization, and hence greater range of movements and lesser stiffness.

Illustrative Cases

Case 1:

A 49-year-old male patient, after h/o of RTA, came with pain & swelling in the Left shoulder and was diagnosed as Neer's three-part fracture and managed with 5 holed PHILOS plating.



Figure 2: (above to down) Pre OP Xray; Immediate Post OP Xray; IntraOP pictures; 6th month & 12th month follow up Xray; clinical pictures at 12th month

Case 2:

A 57 years old male patient, h/o of RTA, came with pain & swelling in the right shoulder and was diagnosed as Neer's three-part fracture and managed with 5 holed PHILOS plating

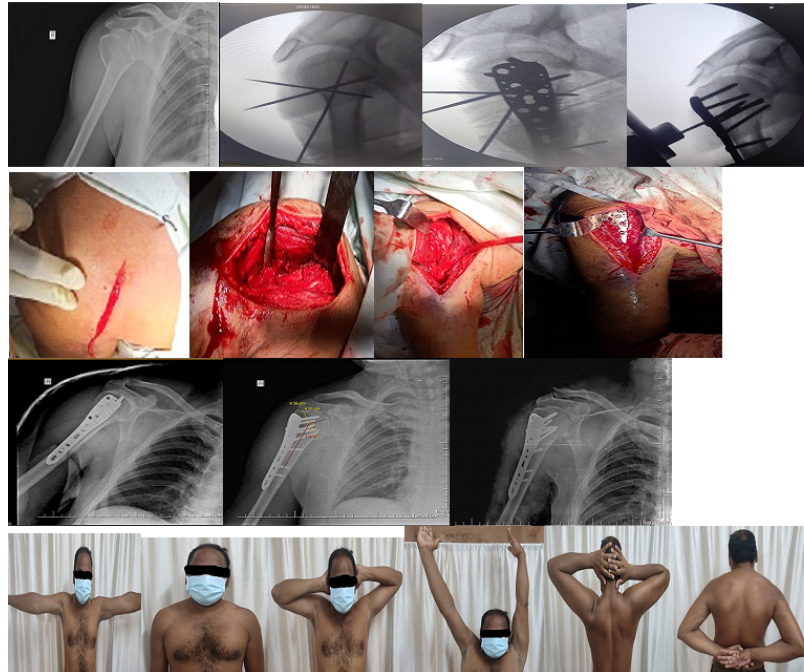


Figure 3: (above to down) Pre OP Xray and C Arm pictures; Intra OP pictures; Immediate Post OP Xray & 6th month follow up Xray; clinical pictures at 12th month

Case 3:

A 45year female patient, after h/o of RTA, came with pain swelling in the right shoulder and was diagnosed as Neer's three-part fracture, treated with 4 holed PHILOS.



Figure 4: (above to down) Pre OP Xray & IntraOP pictures; Immediate Post OP Xray; 6th month & 12th month follow-up Xray; clinical pictures at 12th month

Funding: Nil

Ethical statement: This study was conducted with authorization from the departmental review board and the ethical committee.

References

1. Rockwood and Green's Fractures in adults tenth edition chapter 35 page 1865-1867.
2. The Journal of Bone and Joint Surgery, Inc. Neer CS. Displaced proximal humeral fractures. Part-I. Classification and evaluation. J Bone Joint Surg Am. 1970; 52:1077-1089.
3. AA Martinez, Janenca A. Herrera, (Philos plate fixation for the proximal humerus, Journal of Orth. Surg. 2009;17(1) Pages 4-10.
4. Srikanth S et al. -study of proximal humerus fractures treated by PHILOS plating in a tertiary care hospital International Journal of Research in Orthopaedics Int J Res Orthop. 2019 Sep; 5(5): 838-842.
5. Nitin Sharma, Mohit Dhingra, Deepak Sharma - Philos Plating in Displaced Surgical Neck of Humerus Fracture, Annals of International Medical and Dental Research, Mar 2017;3(3): 11-17
6. R J Hawkins, R H Bell, and K Gurr The three-part fracture of the proximal part of the humerus. Operative treatment. J. Bone Joint Surg. Am., Dec 1986; 68: 1410 -1414.
7. Chintan Doshi, Gaurav Mahesh Sharma, Lokesh Gudda Naik, Krishna Sudhakar Badgire, Faisal Qureshi - Treatment of Proximal Humerus Fractures using PHILOS Plate. JCDR Orthopaedics Section. 2017 Jul; 11(7): RC10-R13.
8. EL Flatow, F Cuomo, MG Maday, SR Miller, SJ McIlveen, and LV Bigliani Open reduction and internal fixation of two-part displaced fractures of the greater tuberosity of the proximal part of the humerus J. Bone Joint Surg. Am., Sep1991;73:1213-1218.
9. Michael Plecko, Aurel Kraus Internal fixation of proximal humerus fractures using the locking proximal humerus plate Oper Orthop Traumatol. 2005 Feb;17(1):25-50.
10. ML Sidor, JD Zuckerman, T Lyon, K Koval, F Cuomo, and N Schoenberg, The Neer classification system for proximal humeral fractures. An assessment o interobserver reliability and interobserver reproducibility. J. Bone Joint Surg. Am., Dec 1993;75:1745-1750.
11. Mc K Laughlin HL Posterior dislocation of the shoulder. JBJS; 1952;34A;584-590.
12. InstructionalCourseLecture.2006;54:357-62.
13. Cornell CN, Levine D, Pagnani MJ. Internal fixation of proximal humerus fractures using the screw-tension band technique. J Orthop Trauma.1994;8(1):23-7.
14. Scott E. Powell, Joseph D. Zuckermann, Frances Cuomo, Debra Newmann, Maureen Gallagher. 1 Part Proximal Humeral Fractures: A Prospective study of Functional Outcome: AAOS 1992; Annual Meeting; Scientific Program; Paper No. 1992;330; Feb, 241992.
15. Stephen K. Benirschke, Louis U. Bigliani, Christian Gerber, Clayton R. Perry, Timothy Weber Symposium Proximal Humeral Fracture - An Unsolved Fracture; Feb 8, 1992.
16. Neer CS I: Displaced PHF. Part I Classification, JBJS; 1970;52A: 1077-1089.
17. Neer CS II Displaced Proximal Humeral Fractures; Treatment of 3-part and 4-partfractures. J Bone Joint Surg Am. 1970; 52A;1090.
18. Dai J, Chai Y, Wang C, Wen G. Meta-analysis comparing locking plate fixation with hemiarthroplasty for complex humeral fractures. Eur J Orthop Surg Traumatol. 2014;24(3):305-1.
19. Fleiss JL: Statistical methods for Rates and Proportions Ed2, p217, New York, John Wiley and sons1981.
20. Moonot P, Ashwood N, Hamlet M. Early results for treatment of three- and four-part fractures of the proximal humerus using the PHILOS plate system. J Bone Joint Surg Br. 2007;89(9):1206-09
21. Gardner MJ, Weil Y, Barker JU, Kelly BT, Helfet DL, Lorich DG. The importance of medial support in locked plating of proximal humerus fractures. J Orthop Trauma. 2007;21(3):185-91.