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Outcome Analysis of Proximal Humerus Internal Locking Osteosynthesis System (PHILOS) In Management of Proximal Humerus Fractures

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Abstract: *Proximal humeral fractures are the third most common fracture in the elderly. Numerous authors have suggested that non operative treatment can be acceptable for two, three and four part fractures of proximal humerus in elderly patients but pain, stiffness, loss of function and muscle power have been described in more percentage of patients following this conservative approach.Fractures of Proximal Humerus have gained more attention recently. With more standard use of Neer's 4-part classification system for fracture and fracture dislocation, a protocol for management and comparison of long term outcome of similar injuries has been made possible. The elderly people no longer need to be denied effective surgical treatment, especially at time in life, when the shoulders are often needed for ambulation with canes and crutches. Maintenance of good shoulder function will surely make a good difference to their independent life style. In this study we have analysed the functional and radiological outcome of twenty (20) cases of proximal humeral fractures treated surgically using PHILOS plates. (Proximal Humerus Internal Locking Osteosynthesis System)*

Keywords:*Proximal Humerus fractures, PHILOS, Elderly fractures*

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I. Introduction

Proximal humeral fractures account for about 4 to 5% of all fractures [1,2,3,4,5,6]. It accounts for up to 45% of all humeral fractures [7]. It is the third most common fracture after hip fracture and colles fracture in elderly patients [8]. It is important to recognize these fractures early. Numerous authors have suggested that non operative treatment [9,10,11] can be acceptable for two, three and four part fractures of proximal humerus in elderly patients but pain, stiffness, loss of function and muscle power have been described in more percentage of patients following this conservative approachFractures of Proximal Humerus have gained more attention recently. Diagnosis has been facilitated with adaptation of 3-right angled trauma series X-rays [2,12,13,14] supplemented with CT or MRI. With more standard use of Neer's 4-part Classification system for fracture and fracture dislocation, a protocol for management and comparison of long term outcome of similar injuries has been made possible [15, 16, 17].Emphasis is placed on complete and accurate diagnosis and formulation of safe and simple standard techniques for fracture realignment, restoration ofanatomic stability, fracture healing, cuff integrity, regaining movementand function.[18] There have been improvements in fixation techniques and in the understanding of the role of prosthetic replacement [19,20,21,22] to maximise anatomic restoration and minimising immobilisation time, during which period stiffness develops.The elderly people no longer need to be denied effective surgical treatment, especially at a time in life, when the shoulders are often needed for ambulation with canes and crutches. Maintenance of good shoulder function will surely make a good difference to their independent life style.[23]In this study we have analysed the functional and radiological outcome of twenty (20) cases of proximal humeral fractures treated surgically using PHILOS plates. (Proximal Humerus Internal Locking Osteosynthesis System)

II. Review of Literature

During the early 20th century, various methods of closed reduction, traction and abduction splints were developed to achieve and maintain alignment of these fractures with inconsistent results.In 1973, the original Neer I prosthesis was revised by Neer, as Neer II prosthesis, to improve the results.[24] Newer prosthesis like Grammont reverse shoulder prosthesis has been designed for even better function. Percutaneous pinning and minimal fixation have now become the order of the day with principles of biological fixation.Recently, a new

concept has evolved in treating osteoporotic fractures. Fixed angle stable locking plates have been developed which lock screws to the plate and hence forms fixed angle construct. Controversies still exist whether to do conservative or operative management. The recent trend is to surgically treat the patients with locking compression plates. Various studies have been done on this.In a retrospective study by Jan -Magnus Bjorkenheim on fracture of the proximal humerus treatedsurgically with PHILOS plates, they made a final interpretation that the PHILOS method was safe and can be advised for the treatment of these fractures in patients with reduced mineral density of bone[25].C.P. Charalambous et al in 2007 analysed a total of 25 cases of fractures of Proximalhumerus treated with PHILOS plates and concluded that PHILOS plate is effective for giving fracture stabilization but knowledge of potential hardware complication is essential[26].Kenmal A. Egol[27] (2008) conducted aretrospective analysis of 51 patients with fracture of proximal humerus managed with PHILOS plates reported a success rate of 76%.MA Fazal, FS Haddad (2009) conducted aprospective study of 27 individuals with displaced proximal humerus fractures managed with PHILOS plate fixation and concluded that fixation with PHILOS plate provided stable fixation, less hardware problem and helped to attain early range of motion[28].

AA Martinez (2009), conducted a retrospective study of 58 patients (31 males & 27 females) in the age group 36 to 73 (average 61) years with fractures of proximal humerus treated with PHILOS plates with a follow up of 1 to 1 1/2 years and concluded that PHILOS plate fixation was an appropriate treatment for Proximal humerus fractures[29]Agarwal et al, 2010 conducted a prospective study of 56 cases having an acute fracture of proximal humerus treated with PHILOS plates with follow up for 2 years, concluded that PHILOS plates produced good functional outcome. Results were better than non-locking plates in osteoporotic fractures of the geriatric age group[30].Rose et al (2007) evaluated the use of PHILOS plates in 16 patients aged around 51 years. The study group consisted of 5 two part, 9 three part and 2 four part fractures. Out of the fractures that healed, good functional outcome was made out (average elevation 132 degrees, average external rotation 43 degrees) within an average follow up of one year[31].In 2008, Andrew H. Crenshaw Jr, Edward A.Perez in their study concluded that in young patients, internal fixation with PHILOS plates are successful if damage to humeral head blood supply is avoided by keeping soft tissue stripping to a minimum. In young, active patients with four part proximal humeral fractures, fixation with PHILOS plates is the management of choice[32].

III. Materials & Methods

This prospective & retrospective study is an analysis of functional outcome of 20 cases of surgically managed fractures of proximal humerus using PHILOS plates. Of the 20 patients, 12(60%) were females and 8(40%) were males. The age of the patients ranged from 22-70 years. The mean age of the patients was 51 years.After initial resuscitation a detailed history was taken and thorough clinical examination done to rule out any other associated injuries. Distal neurovascular status was assessed. Routine investigations were done. Radiographs of the affected shoulder were taken in AP, Lateral and Axillary views and fractures were classified according to Neer' s classification. CT pictures were taken in selected patients with complex fracture patterns to know the articular involvement.

3.1 Inclusion Criteria

1. Patients with proximal humerus fractures, who,
2. Are skeletally mature and age more than 18 years
3. Satisfy Neer' s criteria for operative displacement i.e. displacement of >1 cm between the major fracture fragments or angulation of the articular surface of >45 degrees.
4. Neer' s two, three and four part fractures.

3.2 Exclusion Criteria

1.Patients with

1. Open fractures
2. Pathological fractures (due to tumours)
3. Associated neurovascular injury
4. Associated head injury

Twelve patients were operated under supra clavicular and interscalene block. Combined general anaesthesia with inter scalene block was used in remaining eight patients in view of anticipatory increase in duration of surgery due to difficulty in fracture reduction.All patients were positioned supine on the table with a sand bag between the spine and medial border of the scapula in order to push the affected side forward and to open up the front of the joint.

Sixteen patients were operated using standard deltopectoral approach. Four patients were operated using deltoid splitting approach.Post op functional outcome was assessed by using Constant and Murley Score.Post op radiological outcome was evaluated by taking serial X rays at follow up documenting on quality of reduction, fracture alignment, restoration ofarticular congruity, fracture union, PHILOS plate deviation, screw penetration, back out, implant loosening and failure.In all patients the arm was placed in an arm sling, cuff and collar or shoulder immobilizer. Passive elbow flexion and extension were started by 24-48 hrs. Sutures were removed by 12th post op day.Phase I exercises consisting of pendulum exercises were started from the first week. Gentle passive forward flexion, internal and external rotation exercises were initiated by third week. Phase II exercises consisting of active range of motion exercises and resistive exercises were started by 4-6 weeks. Phase III exercises consisting of advanced stretching and strengthening exercises were started by3 months. Lifting of light weight objects were started after 3 months.

IV. Results

Majority of injured patients were females (60%). Highest numbers of patients were in their 5th decade (35%). Free fall at ground level was the most common mode of injury (50%). Post-epileptic fall caused fracture of Proximal Humerus in one patient. No case with bilateral fractures was reported. All were right handed persons and the dominant arm was involved in 15 (75%) patients. Post-menopausal osteoporotic females accounted for 50% of patients. 16 (80%) patients reported to hospital within five days of injury. 25% of patients had undergone previous native treatment either in form of massage, splinting or attempted reduction and splinting. 8 patients had associated fractures. All the patients had closed injuries. Neer's 2-part fracture is the most common type in 60% patients. Greater Tuberosity fractures were the predominant type in 2-part fracture. 4 part fractures accounted for only 5% of patients. Fracture dislocation were present in 2(10%) of patients. None of our patients required post op immobilization with POP. Patients were taken up for surgery on an average of 6 days after admission. 60% patients did not have any pain during follow-up. The average range of active elevation was 126.25 degrees. The average range of active external rotation 47 degrees. The average range of abduction 123.25 degrees. 17(85%) of patients had normal muscle strength in shoulder. Patients with 2-part fracture had better functional outcome than 3 and 4-part fracture.

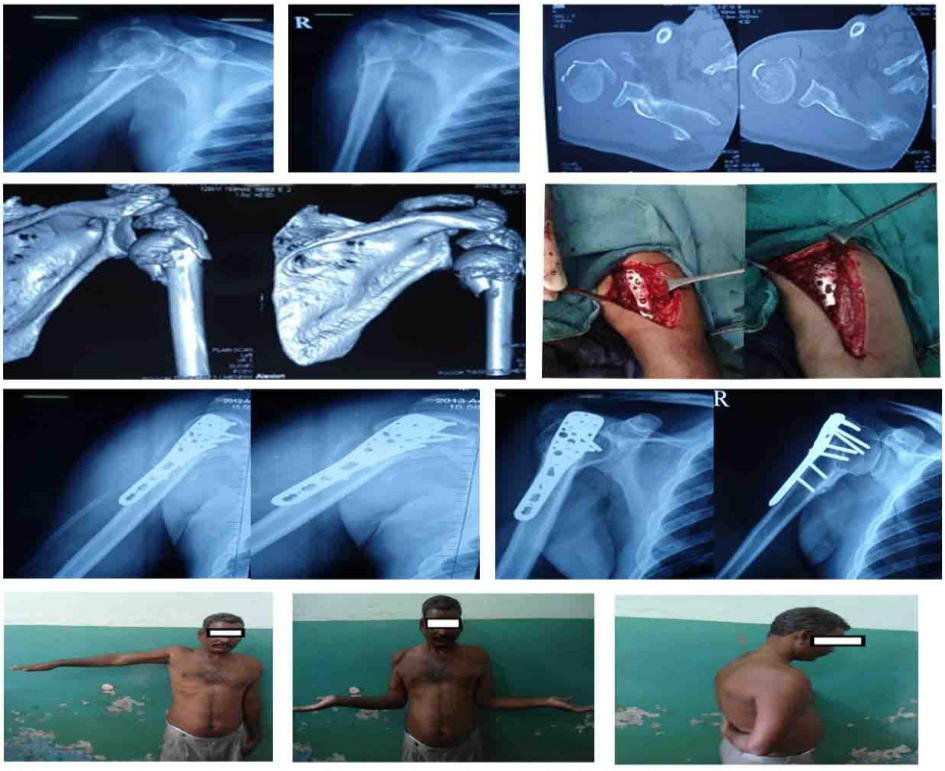

Figure showing the Pre Op X ray 2D & 3D CT with Intra Op Images and Immediate Post Op, 3 months & 6 months Post Op X rays of Proximal humerus fracture treated with PHILOS Plating. Clinical Outcome at 6 months post op is also shown.

All fractures unite within an average period of ten weeks.No cases of implant loosening or failurewere encountered.Sixteenpatientspresentedtouswithinfivedaysafterinjuryandpatientshadprevioustreatmenteitherint heformofnativesplinting,massageor POPapplication.Early complications were encountered in 3 (15%) patients.1 patient with diabetes mellitus developed wound gaping due to infection requiring secondary suturing after glycaemic control. Another patient with 3-part fracture developed skin necrosis which resolved with intravenous antibiotics. Another patient had deltoid atony after surgery which improved with sling and strengthening exercises.Late Complications were encountered in 5(25%) of patients. 1 patient with 3 part fracture hadmalunion of greater tuberosity, restricting abduction above 90°.The patient who had deltoid atony initially after surgery had mild inferior instability which was not incapacitating for the patient.2 patients had joint stiffness.Both patients later required manipulation under general anaesthesia.1 patient developed Heterotopic ossification with 3-part fracture, probably because the patient had exercised native treatment in the form of many attempted reduction, massage and splinting. 11(55%) patients said that may have had no pain and 6(3o%) patients had only mild pain, 3(15%) patients had pain after unusual activity. None of our patients had pain at rest or disabling pain.Functional outcome was evaluated with ability to perform day to day activities. Points were given according to the following scale:

4 - normal 3 - mild compromise2 - with difficulty 1 - with aid0 - unable NA - not available

Functional results were graded by following criteria: Good functional result 3.5 - 4.0 points Fair 2.5 - 3.4 pointsPoor < 2.5 points11 (55%) of the 20 patients had good functional result, 8 (40%) had fair functional results and 1(5%) had poor functional result.17 (85%) of patients had normal muscle strength in all the muscle groups evaluated and 2 (10%) patients had good muscle strength and 1 (5%) patient had fair muscle strength.Quality of reduction, fracture alignment, restoration of articular congruity, fractureunion, PHILOS plate deviation, screw penetration, back out, implant loosening and failure were assessed radiologically during follow up. All fractures united and the average time taken for union was approximately ten weeks. One patient with three-part fracture went for malunion. No cases of implant deviation, screw penetration, screw back out, impingement and failure was encountered.The overall results were rated according to the following criteria:
Maximum points - 100 Excellent - more than 86 Good - 71-85; Moderate: 56-70; Poor: 0 – 55
Of the 20 cases 7(35%) patients had excellent result, 10(50%) good, 2(10%) moderate and 1 (5%) poor.

V. Discussion

In this prospective study we have analysed 20 cases of Proximal Humerus Fractures treated surgically using PHILOS plates in our hospital. There was female preponderance in our study 12 (60%) similar to the conclusion of the study conducted by Hawkins & Bell involving fifteen (15) patients of proximal humeral fractures, there was female preponderance. In Kristiansen et al study of 565 proximal humerus fractures in 5,00,000 people, women were involved in 77% of fracture in all age groups. This is thought to be a result of advanced osteoporosis.In our study, the most common mode and mechanism of injury was free fall at ground level and fall on an outstretched hand and average age is 51 years were much comparative to the results of the study conducted by Flatow et al as fall on the outstretched arm was the predominant mechanism of injury and average age of the patient is 53 in their study. Since our people attain menopause at an earlier age and have poor quality of bone stock, the average age is little lower.Also in our study, unusual mode of injury like seizures was present in one patient. Neer Classification is the most widely used scheme for Proximal Humeral Fractures. It has gained universal clinical acceptance by orthopaedic surgeons and radiologists and is considered to have significant implications for both treatment options and outcomes. In our study, we also have followed the Neer'sfour-partclassification but several authors have reported low level of interobserver reliability. Sidor et al reported a reliability co-efficient of 0.48 for 1 viewing, 0.52 for 11 viewing and a reliability co efficient of 0.66.Computed tomographic scans were done in patients who had equivocal findings and also to find the direction of dislocation. Flatow et al believed that sole reliance on standard AP radiograph may lead to under estimation of the amount of displacement of fragments.There was a predominance of two-part fracture in our study (60%), of which greater tuberosity fractures were the most common. Associated dislocations were present in 40% of the patients. In the reduction of glenohumeral dislocation if tuberosity fragment remained displaced >1 cm or angulated more than 45°, ORIF was done. Repair in such patients restored the dynamic stability by reattachment of the muscles of the rotator cuff.Flatow et al [34] in a series of 12 patients reported 50% excellent results and 50% good results in patients treated by ORIF with PHILOS plates fortwo-part greater tuberosity fracture.Closed treatment of three-part fracture is oftenassociated withmoderate pain, poor range ofmotion and disability. Open Reduction and Internal Fixation (ORIF) was associated with good to excellent results in more than 80% of patients in a report by Hawkins et al [33] and recommended surgical treatment for healthy active individuals who have three part fractures of the Proximal Humerus. Cornell and Levine[35] reported good results with screw tension band technique for 3 part fractures. Prosthetic replacement for three-part fracture has been used by several authors.

In the treatment of four-part fracture and fracture dislocations, less than 10% good or excellent results are obtained by open reduction and internal fixation. Isolated reports of revascularization of head of humerus following open reduction and internal fixation indicate satisfactory healing.Unfortunately, many of the cases referred in the literature often have not been true four part fractures with isolation of articular fragment and follow-up is not sufficient to rule out long term osteonecrosis. Hugg and Lundberg noted 74% AVN when ORIF was used for these fractures. AVN is reported to be as be as high as 90% in four part fractures and 3-25% in 3 part.All authors agree that pain relief has been greater than 90% with prosthetic replacement, but there has been varying results with regard to function, motion and strength. Neer and McIlveen have reported nearly 90% excellent results with an improved technique utilizing long deltopectoral approach and better rehabilitation.From the data presented in this study we have demonstrated that majority of the patients had no pain or only mild pain (85%) which is comparable to the study by Hawkins et al and Flatow et al.The average active elevation in our study in two part fractures was 126.25° and average external rotation was 47° which is comparable to the study byFlatow et al in a study of 12 patients of two part fractures treated surgically.The average elevation in our study with three-part fracture was 124.25° and external rotation was 45.5° which is also comparable to the study by Hawkins et al of 15 cases of 3 part Proximal Humerus fractures treated surgically.Of the 8 patients with 3 and 4 part fractures, 40% regainedat least 90° abduction and elevation. About 85% of the patients had full muscle strength which is also comparable to the study by Hawkins et al and Flatow et al.We have seen few complications in our study. All fractures united and the average time taken for union was approximately ten weeks. One patient with three-part fracture went for malunion. No cases of implant deviation, screw penetration, screw back out, impingement and failure was encountered. Malunion ofgreater tuberosity fragment in a patient with 2-part fracture treated with PHILOS plate resulted in restriction of abduction and impingement. In this patientpoor radiological outcome lead to poor functional outcome as well. Some patients despite having malunion may have a good functional capacity reflecting the fact that radiological outcome may not imply functional outcome.Heterotopic ossification occurred in one patient with 3-part fracture, probably because the patient had exercisednative treatment in the form of many attempted reduction, massage and splinting.Many authors have reported an incidence of up to 10% of heterotopic ossification in proximal humeral fractures. There was no non-union or radiographic evidence of avascular necrosis or deep infection in our study.Finally, a prolonged closelymonitored and well defined program of rehabilitation was necessary to obtain the best functional results. We have followed the three phase rehabilitation protocol of Hughes and Neer in all our patients and this has provided good results.The average constant score in our study with 20 patients was 81.7 which is slightly better than the the study by Koukakis et al.In summary, fractures of Proximal Humerus may be extremely demanding. There are many pitfalls for the unwary patient and surgeon to avoid during the course of treatment. Emphasis is placed on complete and accurate diagnosis and formulation of safe and simple techniques for restoration of anatomical stability, fracture union, cuff integrity, range of motion and adequate muscle strength.

VI. Conclusion

As PHILOS plate has options for more number of screws for humeral head than conventional locking plate, it will lead to more stable fixation of fracture fragments and early mobilization of the patients.Moreover, PHILOS plate has options of multidirectional screws, it will aid in better stability.Earlier the surgery is done better are the results.Functional outcome is better with isolated fractures than with fracture dislocations.Results are best when operative method results in stable fixation that allows early passive mobilization. Functional outcome of 2 part fractures is better than 3 part and 4 part fractures.Radiological outcome assessed by means of quality of reduction and union of fracture in two and three part fractures is better than in four part fractures.Finally, we concluded that proximal humeral fractures when treated surgically especially using PHILOS plate provided better stability and early mobilization, and hence lesser stiffness and greater ROM.This study is the authentic work of the authors. No financialbenefits were received from any commercial party for this study.

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4.2 Consent:
Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

4.3 Competing Interest
The authors declare that they have no competing interests.

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