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### Prospective investigation of the internal fixation of proximal humerus fractures: Outcome analysis

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#### Abstract

**Background and Objectives:** Proximal humerus fractures, which make about 45 percent of humeral fractures, account for four to five percent of fractures. The purpose of this research is to evaluate and examine the functional results of internal fixation for proximal humerus fractures.

**Materials and Methods:** The present investigation was carried out in Department of Orthopedics, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, India. This study is a prospective investigation conducted between January 2015 to December 2015, using a sample size of 20 cases. In this study, proper informed permission was gained from every patient involved, ensuring that they were fully aware of the nature and purpose of the research and voluntarily agreed to participate.

**Results:** A major clinical challenge is managing complex fractures of the humerus consisting of three or four pieces. Achieving exact anatomical alignment and stable fixation is essential for the best possible results, but the surgeon must also take care to protect the surrounding soft tissues to reduce the danger of avascular necrosis of the femoral head. It is generally accepted in the body of research that, in the case of shoulder fractures, the two most important elements for attaining a satisfactory functional outcome are anatomical reduction of the fracture and a stable fixation, irrespective of the particular procedure and implant utilized. Furthermore, the timely initiation of functional rehabilitation is essential to attaining this intended result.

**Conclusion:** There is no doubt that the learning curve related to the selected implants has a major effect. Although a strict rehabilitation program is necessary to maximize recovery, the application of an expert surgical technique is critical to minimize issues. In most cases, internal fixation and open reduction are effective ways to treat fractures with two or three pieces.

**Keywords:** Proximal humerus fractures, internal fixation, and outcome analysis

#### Introduction

Roughly 4% of all fractures and 26% of humerus fractures are proximal humeral fractures. Stable fixation has been difficult to achieve in three and four component fractures, which account for 13-16% of proximal humerus fractures [1]. The age distribution of these fractures is bimodal, with older individuals and those who have experienced low-velocity injuries, such as a simple fall, making up one group and younger individuals and those who have experienced high-energy trauma making up the other. The majority of proximal humerus fractures can be treated without surgery because they are either nondisplaced or have only minor bone displacement [2-4].

This technique was very beneficial to the diagnostic and treatment procedures for individuals with these types of fractures. Patients were first treated with abduction splints, casting, traction, and closed reduction [5].

Operational procedures for the treatment of displaced fractures were used more frequently in the early 1930s. The ensuing decades of the 1940s and 1950s saw this trend continue. In the 1950s, humeral head replacement was first used to treat proximal humerus fractures that were substantially displaced [6-8]. When it came to treating fractures, the AO/ASIF group became well-known in the 1970s for their extensive use of plates and screws. During this time, the humeral head prosthesis underwent a significant redesign as well. These days, limited dissection and restricted fixation are two fixation procedures that are increasingly being used. Furthermore, significant advancements are being made in the prosthetic replacement processes for severe fractures [9, 10].

For about 80% of proximal humeral fractures, nonoperative therapy can produce satisfactory results. When considering nonsurgical options, the application of early functional exercises is

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given priority in order to achieve a range of motion that is considered to be functionally satisfactory. For the surgical management of displaced proximal humerus fractures, which occur in 15% to 20% of cases, there is still no generally agreed standard of care. However, a variety of internal fixation methods have been reported in the literature, such as the use of blade plates, T-plates, intramedullary devices, locking compression plates, k wires and screws, external fixators, and shoulder arthroplasty. It is important to remember, nevertheless, that none of these methods have consistently shown results. Anatomical reduction, stable fixation, and early mobilization must be prioritized in order to achieve full functional recovery [11-13].

The use of implants and extended exposure both increase the risk of developing avascular necrosis (AVN). On the other hand, it is recommended to use limited internal fixation and to minimize exposure and dissection of the soft tissues in the vicinity of the fracture site. Achieving consistent reduction is essential to the healing of a fracture because it allows the shoulder joint to be mobilized earlier [12-14].

Owing to the previously indicated parameters, these kinds of fractures were treated in a number of ways, such as via osseous suturing, screws, AO T-plates, or locking compression plates. This demographic is prone to proximal humeral fractures, which is why the study's goal was to examine a cohort of individuals who had sustained these injuries. Following the achievement of a close anatomic reduction, the patients were treated with rigorous internal fixation. The study's main objectives were to assess the treatment approach's effects on functional outcomes, strength, range of motion, and comorbidities [13-15].

## Materials and Methods

The present investigation was carried out in Department of Orthopedics, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, India. This study is a prospective investigation conducted between January 2015 to December 2015, using a sample size of 20 cases. In this study, proper informed permission was gained from every patient involved, ensuring that they were fully aware of the nature and purpose of the research and voluntarily agreed to participate.

## Inclusion Criteria

- Fractures of the proximal third misplaced humerus that require internal fixation.
- Patients who agree to participate in the research.
- Individuals who exhibit skeletal maturity.

## Exclusion Criteria

- Pathological fractures.
- Undisplaced fractures.
- Skeletal immaturity with open physis.
- Medically unfit for surgery.
- Lack of willingness for surgery.

## Methodology

Demographic data, the type and source of the injury, the degree of damage, any further injuries, the initial therapy given, and the amount of time until final treatment was given were all gathered for the study. Both local or systemic post-operative problems as well as intra-operative occurrences and difficulties were recorded in the study. The amount of time needed for bone union and the amount of time needed to return to pre-injury activities were also noted. All patients received radiological and functional examination using the constant

score during the final assessment. There were five female participants and fifteen male participants in the sample of the current study. The study participants' ages ranged from 19 to 83 years old, with a median age of 42. With the exception of one patient who suffered a fracture from a fall, the majority of patients in the study group were involved in road traffic accidents (RTAs). The study indicated that the average follow-up period was 14 months, with a maximum follow-up period of 26 months. One patient passed away naturally, and three patients were lost to follow-up. Every individual that took part in our research was right-handed. More precisely, of the entire group, 17 patients had a right proximal humerus fracture, while 12 patients had a left proximal humerus fracture. The practice of driving on one's left side of the road is one reason why traffic accidents are so common.

## Results

During 20 surgical procedures, locking compression plates were given to ten patients, AO T buttress plates to six, screws to three, and k wires to one patient. Five patients in the cohort of twenty patients under observation had outstanding scores, five patients showed acceptable scores, nine patients showed moderate scores, and six patients showed dismal outcome scores. The constant average score is 67.34. Neer three-part fractures had a mean constant score of 74.21, while Neer two-part fractures had a mean constant score of 70.24. Furthermore, Neer four-part fractures showed a mean constant score of 58.83, which was lower.

**Table 1:** Repositioning in anatomical proper manner

Number of Fragments	Number of Patients	Score (Constant)
2	9	70.24
3	6	74.21
4	5	67.34

All twenty patients, with the exception of those whose cases were complicated by screw pull-out and fixation failure, attained union within roughly six weeks after follow-up.

**Table 2:** Not moving the body's parts

Fragments (Number)	Patients(Number)	Percent
2	7	35
3	11	55
4	2	10

## Complications

The most common outcomes after surgery for fractures of the proximal humerus are stiffness, persistent discomfort, infection after surgery, fixation failure, osteonecrosis, and delayed rotator cuff rupture. A patient who had been diagnosed with a Neer 4-part fracture also had injury to the axillary vein, which required rapid surgical repair. Following their diagnosis of Neer 3 component fractures, two people developed humeral head osteonecrosis. The percentage as a whole was 8%.

A locking compression plate was used in the treatment of a single patient who had been diagnosed with a Neer 3-part fracture. Nevertheless, the implant failed on the thirteenth day following the procedure, with the screws coming loose from the humeral head. Consequently, a revision procedure was carried out. But eventually, the patient experienced humeral head osteonecrosis, which led to a noticeably low constant score of -33. The potential for postoperative infection is always present and requires ongoing attention. To minimize adhesive scarring and promote functional recovery, the

fixation must be strong enough to allow for quick passive movement in order to avoid stiffness. The results of the diagnostic evaluation can indicate whether the infection is considered acute, moderate, or chronic. If the implants improve stability, it might be reasonable to keep them in place in cases of acute infection.

Two patients had profound infections; the first patient started showing symptoms five days after surgery, while the second patient didn't show symptoms until twelve days following the procedure. In response, pus culture, sensitivity testing, wound irrigation, and the administration of broad-spectrum antibiotics were carried out. The infections in both patients resolved, and their most recent follow-up evaluations revealed a mild score. Clinical problems are not always evident in cases with avascular necrosis. However, it is possible that it will cause the humeral head to collapse completely or partially, which would be incongruity. This could result in discomfort and operational failure even if the x-ray's visual representation of the condition frequently does not match the sensations that are being felt. Osteonecrosis will inevitably occur, but a careful surgical approach that puts the preservation of the blood supply to every piece first must be used.

**Table 3: Difficulties**

Complications	Number of patients
Inability to secure or unscrew	4
humeral head primary screw perforation	2
Axillary nerve impairment	0
infection of wounds	3
Non-union or postponed union	0

## Discussion

Handling humeral fractures with three or four parts is a significant therapeutic difficulty. In order to prevent avascular necrosis, the surgeon must guarantee precise anatomical alignment and dependable fixation while also preserving as much of the femoral head's blood supply as possible [16]. Regardless of the exact operation and implant selected, the body of available literature generally feels that two important variables required for achieving a successful functional outcome following a shoulder fracture are anatomical reduction of the fracture and a firm fixation. For the best results, functional therapy for the shoulder must also begin as soon as feasible. In recent years, there has been an upsurge in the surgical treatment of proximal humeral fractures using strong internal fixation. These implants were made to lessen the possibility of reduction loss in the future, particularly in older people with osteoporotic bone [17, 18], even in the face of quick and reliable functioning following surgery.

In the elderly osteoporosis patients, the usual plate osteosynthesis treatment produced unsatisfactory results. The AO/ASIF has developed a special locking compression plate for proximal humerus fractures in order to provide better and more reliable results. Previous studies have demonstrated the beneficial therapeutic effects of standard plate osteosynthesis in patients with good bone quality [19]. With an ASES score of 84.6%, Esser's study of a cloverleaf plate yielded impressive findings. The use of cloverleaf plates was linked to a 72.4-point average Constant in a prospective study conducted in 2006. Furthermore, it was found that 59% of patients who received treatment experienced good or very good outcomes [20]. When Paavolainen *et al.* (year) examined the outcomes of 41 patients with severe proximal humerus fractures, they discovered that 74.2% of them had favorable outcomes. The patients were treated with plate and screw devices. In 95% of

cases, Kohler *et al.* (year) demonstrated successful outcomes using the Neer score and a clink plate. Positive results have also been seen while using basic Kirschner wires. Zingg *et al.* (year) reported a Constant-Murley score of 77.1, while Jiang *et al.* (year) claimed a score of 88.2. In their study, Wachtl *et al.* employed Prevot nails and discovered that throughout the follow-up, the average Constant-Murley score increased by 63 points. In this investigation, a favorable clinical outcome is indicated by an average Constant-Murley score of 63.44 points [20-23].

A meta-analysis found that internal stabilization of proximal humerus fractures has comparable short-term results to external fixing. Previous studies have demonstrated a similarity between the initial functioning level and the final long-term outcome, so the little follow-up period of our study shouldn't raise too many red flags. The degree of the fracture, the anatomical alignment of the bone, the cause of the injury, the quality of the bone, the amount of time that passed between the injury and surgery, the existence of any more injuries, and the precision with which the implant is positioned and stabilized all seem to have an impact on the result [24-26].

A much improved clinical result was obtained by achieving an accurate anatomical reduction and positioning the plates appropriately. The Constant-Murley score dramatically dropped in cases where anatomical reconstruction failed or a nonanatomical reconstruction was chosen during surgery. If the plate is not positioned on the shaft at the optimum height, subacromial impingement may happen. The Constant-Murley score is considerably reduced as a result. There were six people in the analysis who had unfavorable results. One patient had a persistent dislocation after surgery, another had a screw pull out from the humeral head, two patients had humeral head osteonecrosis, and two patients had chronic shoulder pain [27-29]. We discovered an identical 8% infection incidence in our investigation, which is comparable to the 2.5% infection rate reported by Paavolainen *et al.* in their patient group. With a mean Constant-Murley score of 25.50, patients who experienced aseptic necrosis of the humeral head had a significantly worse clinical prognosis. The existing literature reports necrosis rates ranging from zero to fifty percent for 3- and 4-part fractures, depending on the osteosynthesis technique employed. The lower end of the range reported elsewhere [30, 31] is consistent with our findings regarding the rate of aseptic necrosis.

The high degree of primary stability could be one of the contributing factors to the low prevalence of avascular necrosis. The use of precise anatomical realignment of the tuberosities and firm internal fixation were found to be significantly associated with improvements in functional outcomes. The significance of correctly realigning patient fragments back into their original anatomical placements is demonstrated by our results. The study found that plate and screw fixation, as opposed to conservative therapy or semi-rigid fixation techniques that did not need anatomical realignment of the head fragment, produced improved functional outcomes for patients with three- and four-part fractures. Shoulder function improved more as muscle strength and functioning increased [32].

## Conclusion

The results show comparability with other published research, even with our study design lacking randomization and having a very short follow-up period. It appears that attaining an accurate anatomical reduction is more important for getting a satisfying ultimate functional outcome than the particular



implant that is used. The type and technique of implants selected have no bearing on this aspect. The choice of surgical technique and implant type depends on a number of parameters, such as the type of fracture, bone quality, patient goals, and the surgeon's experience with different techniques. There is little doubt that one of the contributing factors is the learning curve that comes with using implants. Application of a skilled surgical technique will minimize problems, and application of an intense rehabilitation program will maximize recovery. Generally, internal fixation and open reduction methods can be used to treat fractures with two or three components. Four-part fractures in younger, physically active patients have been successfully treated with open reduction and internal fixation.

#### Funding

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#### Conflict of Interest

None.

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