



## Distal 3rd Diaphysial Fracture of Humerus Fixed with Dynamic Compression Plate Using Posterior Approach- The Assessment of the Outcome

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### Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### ABSTRACT

**Objectives:** The effectiveness of open reduction and Dynamic Compression Plate (DCP) fixation with or without autogenous bone grafting using the posterior midline approach in the treatment of distal third diaphyseal humeral fractures was assessed.

**Methods:** For humeral nonunion, comminuted fractures, or early failure of conservative therapies, 33 patients (24 men, 9 women; mean age 37 years; range 20 to 60 years) were operated on. The study was carried out at Dhaka Medical College Hospital (DMCH), Dhaka from July 2005 to December 2006.

**Results:** After an average of 17 weeks, all of the patients had union (range 14 to 26 weeks). There was no deep infection, nonunion, malunion, implant failure, or nerve injury in any of the patients. In two cases, transient radial nerve palsy occurred. Minor infections were seen in four of the individuals. All of the patients were pain-free after surgery. The functional outcome was outstanding

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in all instances and good in 16 patients, yielding 87 % satisfying results. Functional outcomes increased considerably postoperatively compared to preoperatively ( $p < 0.001$ ). In 20 individuals, the range of motion of the shoulders was great. The range of motion at the elbow was considerable in 21 patients and moderate in seven others. More than three-quarters of the patients (75.8%) experienced no problems. Four patients (12.1%) were infected, and two patients (6.1%) developed iatrogenic radial nerve palsy as a result of the surgery. One patient (3%) had a loose screw, while another (3%) needed blood transfusions owing to extensive bleeding at the donor graft site.

**Conclusion:** In distal third humeral fractures, open reduction and posterior DCP fixing, with or without autogenous bone grafting, is a safe and effective treatment option, especially when there is no infection or bony or neurovascular damage. Very few study conducted on distal 3rd diaphysial fracture of humerus fixed with DCP using posterior approach, therefore this study conducted to know the assessment of the outcome.

*Keywords: Distal 3<sup>rd</sup> diaphysial fracture; humerus; DCP; posterior approach.*

## 1. INTRODUCTION

Distal humerus fractures are strenuous to treat because of their complexity. The humerus shaft is frequently fractured, making up for 1–3 percent of all fractures [1,2]. Adults suffer 16 percent of humeral shaft fractures and 10% of distal humerus fractures due to humeral shaft and extra-articular supracondylar humerus fractures [3]. The majority of them are easily treatable spiral diaphyseal fractures that have been complicated by enlargement of the articular surface.

In humerus shaft fractures, which are unique among all long bone fractures, hanging casts, functional braces, Velpeau dressing, coaptation splints, and abduction casts provide excellent results [4,5]. The sensitivity of humeral malunion leads to improved functional outcomes in these fractures. However, not all fractures can be treated conservatively. Open fractures, segmental fractures, pathological fractures, fractures connected to vascular injuries, bilateral humerus fractures, polytrauma, radial nerve palsy after fracture modification, neurological loss after penetrating injuries, fractures with unacceptable alignment, and failure of conservative treatment are all signs for surgical treatment of humeral shaft fractures [2]. Nonsurgical treatment involves a long period of immobility, which increases the risk of stiffness and pain in the shoulder joint [6]. Furthermore, around 10% of patients do not heal despite conservative therapy of these fractures, making care problematic [7,8].

There is a rising interest in using surgical methods to treat even mild humeral shaft fractures to minimize these complications & permit for earlier mobilization and get back to

duties [9]. The most typical operating method is to employ a dynamic compression plate (DCP) or an Interlocking Nail (ILN). According to Farragos, Schemitsch, and Mckee [10], DCP fixation is the "gold standard" among surgical treatment techniques. Compression plating is a traditional technique [11]. It is a recommended approach in chosen patients with humeral shaft fractures due to its high efficacy when combined with subsequent autogenous corticocancellous grafting. Plating, on the other hand, necessitates a large amount of exposure and the removal of soft tissues from the bone, but it provides for effective reduction and fixation and does not interfere with elbow and shoulder function [12]. The open reduction and internal fixation of a distal humeral shaft fracture has a favorable clinical result and should be done with the goal of providing main postoperative functional therapy [13]. Because of its unique hole shape, dynamic compression plates have the added benefit of allowing the screw to be inserted obliquely up to 45° if necessary. This guarantees that the comminuted pieces are held tightly.

Because of recent technology advancements and the effectiveness associated with nailing in other long bone fractures, there is a lot of interest in employing the humeral intramedullary nail to treat this fracture [14]. The ILN method is less invasive, and the implant's biomechanics and load-sharing capabilities are improved. Fractures treated with ILN have a better likelihood of healing since there is no periosteal stripping and the reaming acts as an autograft. Intramedullary (IM) nail fixation was documented in a previous study to achieve a 100% fusion rate [15]. The IM nail's relative stability has been discovered to have a variety of advantages, including less soft tissue dissection and the ability to apply appropriate reduction. However, it has a number

of disadvantages, including less perfect reduction with an increased risk of interruption, failure to remove interpositional nonunion tissue, increased risk of radial nerve injury due to failure to visualize the nerve, and technical difficulty passing the guide rod, which may injure the soft tissue around the shoulder joint.

### 1.1 Objective

The purpose of this study was to evaluate the results of open reduction and DCP fixation with or without autogenous grafting using the posterior technique in the treatment of humeral diaphysis fractures in the lower third.

## 2. MATERIALS AND METHODS

### 2.1 Study Design

This was an interventional study (quasi experimental type).

### 2.2 Place of the Study

The study was carried out at Dhaka Medical College Hospital (DMCH).

### 2.3 Study Period

This study was conducted from July 2005 to December 2006.

### 2.4 Study Population

Patients who visited the DMCH OPD or emergency department with clinical and radiological evidence of a distal fracture third of the humeral shaft.

### 2.5 Sample Size

In a sequential order, 33 patients with distal third humeral shaft fractures were chosen. The cases were identified clinically and radiologically in the outpatient or emergency departments of Dhaka Medical College & Hospital. Before the ultimate conclusion could be ascertained, two patients died during follow-up. They were left out of the final functional outcome assessment. The remaining 31 patients were given a 6- to 8-month follow-up appointment.

### 2.6 Inclusion Criteria

- Adult patients between 18 years to 60 years of either sex.

- The distal portion of the humeral diaphysis has a closed fracture.

### 2.7 Exclusion Criteria

- Patients who are skeletally immature and those who are over 60 years old.
- Open fractures.
- Pathological fractures
- Patients who were unable to comply with the function assessment due to head traumas or other factors (senility, neurotic, etc.).

### 2.8 Data Collection

Data was collected using a pre-tested, standardized questionnaire that covered history, clinical, and laboratory examination findings.

### 2.9 Statistical Analysis

SPSS (Statistical Package for Social Sciences) version 11.5, which was used to handle and analyze the data, was used. The data was analyzed using descriptive statistics, Wilcoxon Signed Rank Test, and one-tailed Z-test. The quantitative data was presented as mean and standard deviation (SD) from the mean, whereas the categorical data was presented as frequency and percentage. To compare preoperative and postoperative data, the Wilcoxon Signed Rank Test was performed (as determined by the Modified Constant and Murley scoring systems). The Z-test was utilized to assess the final post-operative outcome. For all analyses, the level of significance was set at 0.05, and p-values less than 0.05 were considered significant.

## 3. RESULTS

One-third (33.3%) of the 33 subjects were under the age of 30, and 30.3 % were between the ages of 30 and 40, accounting for more than half (63.3%) of the subjects under the age of 40. 18.2 % of the remaining participants were between the ages of 40 and 50, and another 18.2 % were 50 or older. The average age was (36.7 ± 11.2) years, with the youngest and oldest being 20 and 60 years old, respectively (Table 1).

The 33 patients were almost three-quarters (73%) male and the balance (27%) female, resulting in a male-female ratio of 3:1.

Injuries to pedestrians happened in over 45.5 percent of cases while walking along the street,

12.1 percent as a consequence of a fall from a height, another 12.1 percent as a result of sports activities, and 9.1 percent as a result of motorcycle driving, according to Table 2. Driving a car, being assaulted, and having an accident at home each accounted for 6.1 % of the total. Only one patient (3%) was injured by equipment.

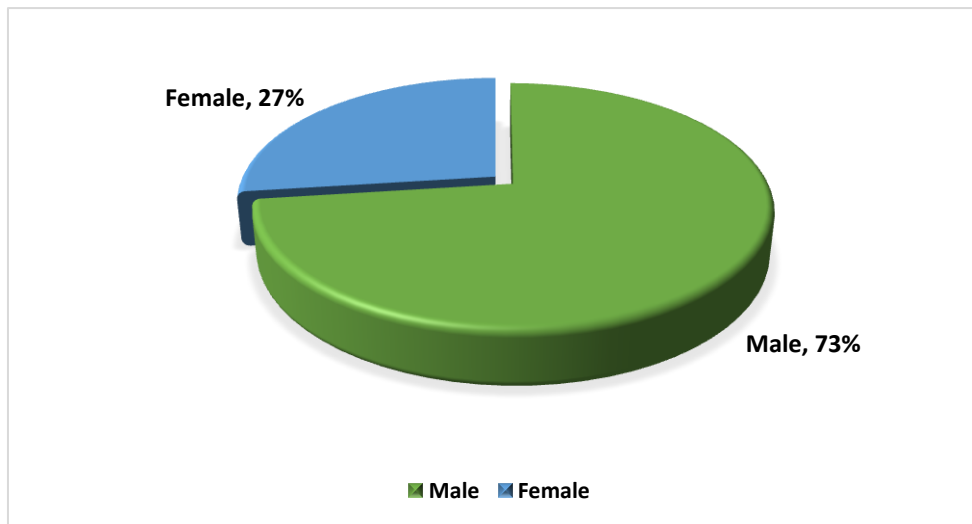
Table 3 compares the gaps between injury and surgery in the 3 categories of fracture patients. Non-united fractures had the largest time interval (43.92 ±14.91 weeks), which was linked to early conservative treatment failure (1.82 ±0.41 weeks) and comminuted fracture (2.33±1.12 weeks). The groups differed significantly in terms

of the period between injury and surgery ( $p < 0.001$ ).

Table 4 shows that the patients' average hospital stay was 9.76 days, with a standard deviation of ± 3.03 days. The longest and shortest stays were respectively 17 and 7 days. All of the cases were found to be linked radiologically, with a mean length of presence of the sign of union of 17.06 ± 2.01 weeks and a minimum and maximum time necessary for union of 12 and 24 weeks, respectively. Patients were followed for an average of 24.58 ±3.56 weeks, with the shortest and longest periods being 15 and 32 weeks, respectively.

**Table 1. Age distribution of the patients (n=33)**

Age (in years)	Frequency (n)	Percentage (%)
<30	11	33.3
30 to 40	10	30.3
40 to 50	6	18.2
≥50	6	18.2
Total	33	100



**Fig. 1. Gender distribution**

**Table 2. Distribution of the patients by cause of injury (n = 33)**

Cause of injury	Frequency (n)	Percentage (%)
Motor car driving	02	6.1
Motorcycle driving	03	9.1
Pedestrian	15	45.5
Fall from height	04	12.1
Assault	02	6.1
Machinery injuries	01	3.0
Accident at home	02	6.1
Sports activities	04	12.1

**Table 3. Comparison of time interval among the type of fractures (n = 33)**

Type of fracture	Frequency	Time interval (weeks)		p-value
		Mean	SD	
Early failure of conservative treatment	11	1.82	0.41	<0.001
Non-united	13	43.92	14.91	
Comminuted	9	2.33	1.12	

**Table 4. Post operative status (hospital stays and follow up) and time taken for union**

Variables	Mean ± SD	Range
Post operative stay (days)	9.76 ± 3.03	7 to 17
Presence of sign of union (weeks)	17.06 ± 2.01	12 to 24
Duration of follow up (weeks)	24.5 ± 3.56	15 to 32

Table 5 shows that more than three-quarters of the patients (75.8%) experienced no problems. Four patients (12.1%) were infected, and two patients (6.1%) developed iatrogenic radial nerve palsy as a result of the surgery. One patient (3%) had a loose screw, while another (3%) needed blood transfusions owing to extensive bleeding at the donor graft site.

Table 6 depicts the variety of motion just prior to the last assessment visit. The table displays the mean values as well as the various active and passive shoulder and elbow motions available.

Table 7 contrasts the preoperative and postoperative total score (100), which is based on a combination of four factors: pain (score 15), activities of daily life (score 20), strength (score 25), and range of motion (score 30). (score 40). The average postoperative score improved significantly from the preoperative mean of  $8.16 \pm 7.23$  to  $75.87 \pm 13.47$  ( $p < 0.001$ ).

Fig. 2 reveals that 11 (35.5%) of patients had outstanding postoperative functional outcomes, whereas 16 (51.6%) had good outcomes. 4 (12.9 percent) had a favorable outcome, while none had a negative consequence.

**Table 5. Distribution of patients by postoperative complications (n = 33)**

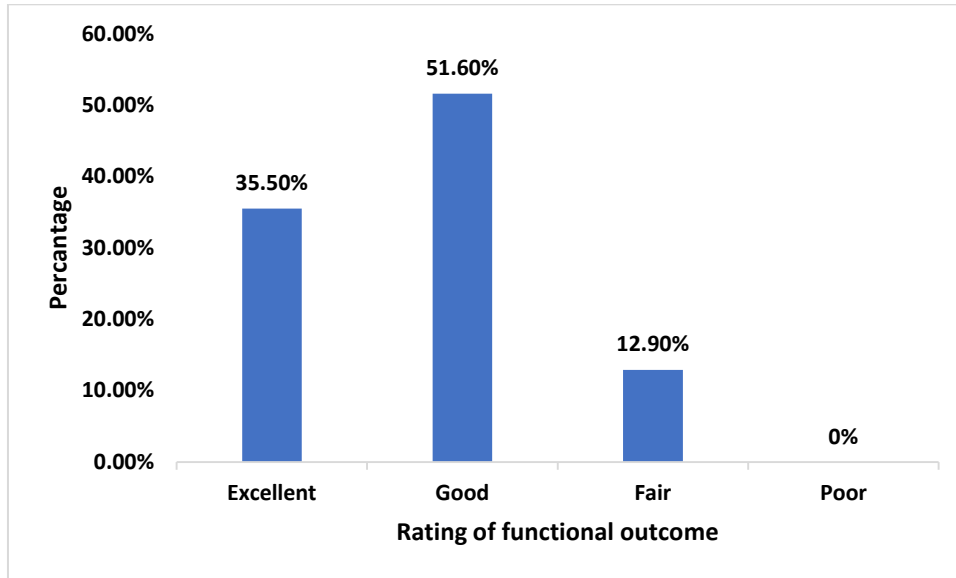
Postoperative complication	Frequency (n)	Percentage (%)
Iatrogenic radial nerve palsy	02	6.1
Infection	04	12.1
Loosening of the screw	01	3.0
Post operative blood transfusion	01	3.0
No complication	25	75.8

**Table 6. Range of motion immediately before the last assessment visit (n=33)**

Range of motion	Mean ± SD	Range
<b>Shoulder</b>		
Flexion (active)	130+ 15	100 to 160
Flexion (passive)	136± 15	100 to 160
Extension (active)	38±4	30 to 45
Extension (passive)	38 + 4	30 to 45
Abduction (active)	129±11	110 to 150
Abduction (passive)	134±12	110 to 150
<b>Elbow</b>		
Flexion (active)	116+10	100 to 130
Flexion (passive)	116±10	100 to 130
Extension (active)	0±0	0
Extension (passive)	0±0	0

**Table 7. Comparison between preoperative and postoperative functional outcome score (n=31)**

Variables	Mean ± SD	p-value*
Pre-operative	8.16 ± 7.23	<0.001
Post-operative	75.87 ± 13.47	



**Fig. 2. Rating of postoperative functional outcome**

According to the shoulder motion test, 20 (64.51 percent) of the 31 participants had excellent range of motion (less than 10° deficit), 22.58 percent (n= 7) had intermediate (10°-30° deficit), and 12.90 percent had poor range of motion (more than 30° deficit). More over half of the participants (67.74%) had a moderate functional result of elbow mobility, 22.58 percent had an outstanding result, and only 9.67 percent had a bad functional result of elbow motion.

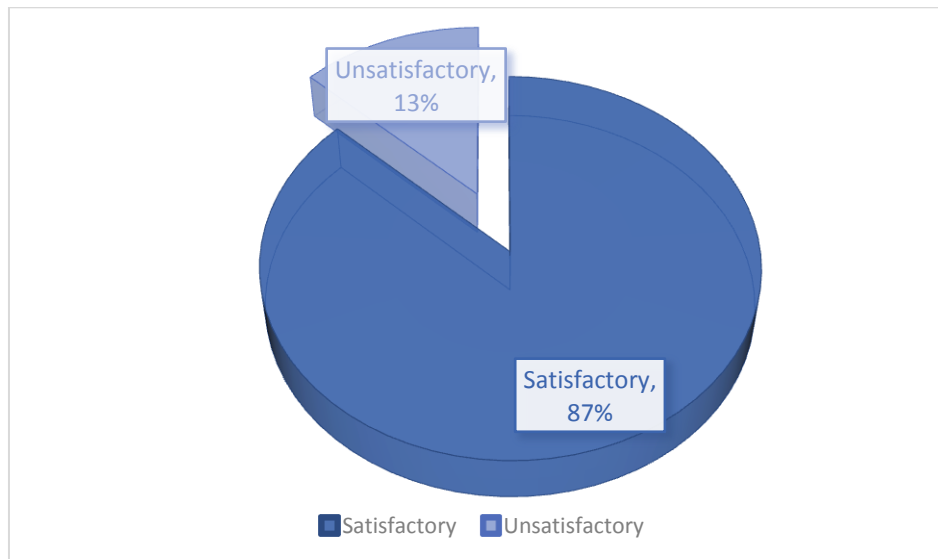
Fig. 3 demonstrates that the majority of participants (87%) received satisfactory results (excellent and good), while the remaining 3% had a fair result. The result was deemed significant (p <0.001) using Z-approximation.

**4. DISCUSSION**

The humerus fracture is unique among long bone fractures in that it may withstand less-than-anatomical reductions. It is permitted to shorten up to 3 cm, rotate less than 30 degrees, and angulate less than 20 degrees [16]. As a result, the majority of humerus fractures are still treated conservatively, with satisfactory results. The most prevalent cause for surgical intervention is inability to achieve acceptable reduction, which is followed by concurrent vascular lesions, open fractures, radial nerve palsy, polytrauma patients, floating elbow, and pathological fractures [17]. Our series revealed a prevalence of fractures in young males, most typically in their

**Table 8. Distribution of patients by restriction in motion at final assessment (n = 31)**

Outcome	Range of motion	Frequency (n)	Percentage (%)
<b>Shoulder motion</b>			
Excellent	(< 10° deficit)	20	64.51
Moderate	(10°-30° deficit)	7	22.58
Poor	(> 30° deficit)	4	12.90
<b>Elbow motion</b>			
Excellent	(< 10° deficit)	21	67.74
Moderate	(10°-30° deficit)	7	22.58
Poor	(> 30° deficit)	3	9.67



**Fig. 3. Final outcome**

3<sup>rd</sup> and 4<sup>th</sup> decades of life, as described by other similar investigations [18]. The most recurrent cause of injury, particularly in younger patients, is a traffic accident. When operational therapy is required, plate fixation is likely to remain the first option of most surgeons, delivering good functional outcomes and a high union rate [19].

Fractures of the humeral shaft are usually associated with radial nerve abnormalities. The physical proximity and connection of the bone and nerves in the humeral shaft accounts for between 8% and 12% of the cases [20,21]. Twelve of the 58 individuals tested positive for complete primary radial nerve palsy (20.7 percent). The most effective treatment for humeral shaft fractures with radial nerve injury is controversial [22,23]. Although concomitant nerve injury has been used in the past to justify immediate fracture surgery (via a posterior approach and visualization of the radial nerve) [24], recent studies have found no significant difference in radial nerve palsy recovery between initial operative and nonoperative management strategies [25,26].

Epidemiological data of fractures differs between communities due to variances in socioeconomic, cultural, degree of urbanization, and other demographic variables [27]. Some writers have informed on humeral fracture trends and patterns. According to research done by Chaudhary et al. [28], the occurrence of humeral fractures was 39 and 35 years for the ILN and plating groups, respectively, as compared to those in the younger age group (p0.001).

In this study, one-third (33.3%) of the 33 current study participants were under the age of 30, and 30.3 % were between the ages of 30 and 40, accounting for more than half (63.3%) of the subjects under the age of 40. The average age was 36.7 + 11.2 years, with the youngest and oldest participants being 20 and 60 years old.

In terms of gender, the study discovered that about three-quarters (73%) of the individuals were male, resulting in a male-female ratio of around 3:1. In a similar study, Modi and Pundkar found 77 percent of males [29]. Mohammad Shoaib Khan et al. used bone grafting and DCP to operate on 15 patients in the study. Males accounted for 80% of the 15 cases, while females accounted for 20% [30]. Males make up the bulk of our society's labor force, and as a result, they are more consistently exposed to the outside world, which explains their predominance. According to the findings of this study, over 45 percent of the injuries occurred while walking down the street (pedestrian), with 60 percent of the injuries being caused by a motor vehicle accident, 12.1% by a fall from a great height, another 12.1% by sports activities, and 9.1% by motorcycle driving. Each had a 6.1 percent risk of being in a car accident, getting assaulted, or having a home mishap. Only one patient (3%) was hurt by the device. A similar outcome was reported in another study [31].

A extended hospital stay after surgery is detrimental to the patient's psychological and financial well-being. The average length of stay in the hospital for the responders was 9.76 days,

with a standard deviation of 3.03 days postoperatively. Seven days was the smallest stay, while seventeen days was the longest. Patients who had a surgical infection needed to remain a little longer. All of the cases in this series were radiologically connected, with a mean bridging callus existence of  $17.06 \pm 2.01$  weeks and a minimum and maximum time necessary for union of 12 and 24 weeks, respectively. M.Walker et colleagues discovered that unionization rates varied from 92 to 96 percent, with an average period to unionization of roughly 12 weeks [32].

Aizaz Saleem Khan et al compared two groups of 30 patients who were both treated with an intramedullary nail and DCP in this research. Three patients in group A (10%) suffered transient radial nerve palsy, and two (6%) developed mild wound infection [33]. We discovered that more than three-quarters (75.8%) of the subjects in this study had no issues. After surgery, four patients (12.1 percent) had superficial infections caused by cross infections. Before the patient was discharged, they were given enough drugs and wound care, and the infection had subsided. In two cases, radial nerve palsy was caused by a medical procedure (6.1 percent). These had neuropraxia, and they recovered completely within two months. One (3%) demonstrated undoing of the bottommost screw, which persisted throughout the research period but did not impair alignment. loosening of the union or plate due to extensive bleeding from the graft donor site, one (3%) patient required two units of whole human blood, which was controlled within 24 hours. There were no cases of delayed healing seen, and no patients required reoperation.

The most prevalent complaint with antegrade humeral nailing is that it impairs shoulder function. According to Crates et al. [34], 90 percent of patients regained full shoulder function. The present research came up with similar results. Shoulder motion tests revealed that 20 of the 31 patients (64.51 percent) had excellent range of motion (less than  $10^\circ$  deficiency), 22.58 percent ( $n=7$ ) had intermediate ( $10^\circ - 30^\circ$  deficit), and 12.90 percent had poor range of motion (more than  $30^\circ$  deficit). More over half of the individuals (67.74%) had a moderate elbow mobility functional outcome, 22.58 percent had an excellent functional outcome, and just 9.67 percent had a poor functional outcome.

In 22 senior patients, Ring, Perey, and Jupiter [35] investigated the functional outcome of operative therapy of ununited humeral diaphysis fractures. The mean score according to Constant and Murley's modified rating system increased from 9 points (range, 0-27 points) preoperatively to 72 points (range, 34-95 points) postoperatively at the time of the most recent follow-up ( $p < 0.001$ ). It was done on a total of 31 patients, with an average follow-up time of  $24.58 \pm 3.56$  weeks. Pain (score 15), activities of daily living (score 20), power (score 25), and range of motion (score 25) were used to generate the preoperative and postoperative total score (100) in this study (score 40). The average postoperative score skyrocketed from  $8.1 \pm 6.723$  ( $p < 0.001$ ) to  $75.87 \pm 13.47$ , which was perfectly consistent with Ring, Percy, and Jupiter's achievements.

Jupiter's criteria indicated that the outcomes were outstanding in six areas (17.7%). Patients were rated as good in 15 (44.1%), average in nine (26.4%), and bad in four (11.8%). In the current study, 35.5% (11 out of 31 respondents) had outstanding postoperative functional result, over half (51.6 percent) had good ( $n=16$ ), 12.9 percent had fair, and none had bad. Similar findings have been found in other investigations [36]. In this study, the majority of individuals (87%) achieved satisfactory results (excellent and good), while the remaining 13 % had fair results. The outcome was declared significant ( $p < 0.001$ ) based on Z-approximation, proving the technique to be safe and effective.

## 5. CONCLUSION

The DCP via posterior approach was shown to be a successful and reliable technique for the treatment of distal third diaphyseal humerus fractures in this research. This result in a quicker union time and a lower risk of significant complications such gross infection, radial nerve palsy, and implant failure. There appears to be a considerable functional difference between preoperative and postoperative outcomes. The lack of a large number of patients is one of the study's flaws. Debridement of avascular bone and fibrous, inflammatory, and synovial tissues from the nonunion site, drilling of sclerotic areas to encourage revascularization, using circumferential bone clamps as little as possible, and exercising extreme caution to avoid devitalizing the bone and soft tissues are all important practical aspects.



## CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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