

Outcomes of Operative Management of Humerus Fracture Nonunion Among Adults Attending Moi Teaching and Referral Hospital, Eldoret, Kenya

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Abstract- Background: Humeral fracture account for 5-8% of all fractures in adults. Most of these fractures tend to heal; however, up to 33 % will develop non-union. Humeral fracture non-union causes major functional disability, chronic pain and reduced quality of life. Data on the functional outcomes of operational management of humeral fracture non-union at Moi Teaching and Referral Hospital (MTRH) Eldoret are scanty. This study intends to close the knowledge gap and advance the field.

Objective: To evaluate the outcomes of operative management of humeral fracture non-union among adult patients.

Methods: Hospital based descriptive prospective study involving 32 adult patients (M= 18, F=14) with humerus fracture non-union at MTRH. The demographic characteristics, the initial injury patterns, operative modalities used and union rate were recorded and analyzed. The functional outcomes were assessed using the ASES score tool at 6, 12, 18 and 24 weeks after the operation.

Results: The mean age was 52.2 years (SD: 11.84) with male predominance. Union rate of 96.2% was achieved at mean time of 21 weeks (SD:4.5). The mean ASES score at week 6 and week 24 was 48.90 points (SD:12.67) and 78.98 points (SD:6.86) respectively. Bivariate analysis using Fischer's exact test showed no association between smoking, alcohol use, gender and improved American Shoulder and Elbow Surgeons (ASES) score ($p > 0.05$). Younger age and earlier diagnosis of humerus non-union were associated excellent union ($p < 0.05$).

Conclusion: A union rate of 96.2% and improved functional outcomes with few complications was achieved.

Index Terms- Humerus, Nonunion, Functional Outcomes, ASES, Adults

I. INTRODUCTION

Fracture nonunion is a serious complication that can occur in any bone healing process following a fracture. The Food and Drug Administration (FDA) defines fracture nonunion as a failure of bone healing lasting more than nine months without any sign of

healing for three consecutive months. It occurs when the biological process of bone healing cannot overcome the local biology and mechanics of the bone injury (Thomas & Kehoe, 2023).

Many factors contribute to proper bone healing following a fracture, including host factors, biological factors and mechanical factors. Patient, fracture type, surgeon and clinical factors should be considered and implemented for adequate bone healing to occur. The main patient factor in nonunion is inadequate blood supply. A decrease in the blood supply to the fracture site leads to delayed bone healing and nonunion. Lifestyles activities like chronic smoking and poor nutritional status contribute to poor blood supply (Xu, et al., 2021). The presence of systemic diseases like diabetes mellitus, renal insufficiency and peripheral vascular disease cause poor blood flow and poor bone healing. Prolonged use of some medications like steroids, non-steroidal anti-inflammatory drugs and opioids prolong the fracture healing process. The main determinant in fracture nonunion for patient factors is inadequate blood flow. Bone loss with a gap bigger than 3 mm, heavily comminuted, and butterfly fragments are fracture pattern characteristics that cause nonunion. Early bone healing and function restoration are caused by a balance among all the elements (Mills, et al., 2016).

Clinical and radiological assessment can identify humerus fracture nonunion early enough for appropriate action to be planned. The presence of persistent pain and significant functional limitation are a common feature. Gross mobility at the fracture site with significant deformity is also seen in cases of humerus fracture nonunion. Radiologically, plain radiography shows evidence of fracture healing includes cortical bridging of the fracture line. The most reliable method of identifying humerus fracture nonunion is the use of callus scoring criteria that reduce the subjectivity of the assessor. The use of modified Radiographic Union Scale for the Tibia (RUST) for the humerus diaphyseal fractures at six weeks post injury was well described by Oliver and others (Oliver, et al., 2019). The score ranges from 4 to 16, with a score of four representing no callus on any of the four cortices while a score of sixteen represents a complete remodeling of all the four cortices. The Radiographic Union

Score for Humeral fractures (RUSHU) is a reliable and effective in identify patients at risk of Nonunion (Oliver, et al., 2019).

The outcomes of operative management include clinical evaluation of the union, the range of motions, functional outcomes and complications. The union of the fracture line is determined using serial post-operative plain radiographs. The presence of cortical callus bridge is a good sign for predicting union in long bones (Nicholson, et al., 2021).

Functional outcome of operative management of humerus nonunion can be assessed using validated scoring systems. The ASES score has been validated (Michener, McClure & Sennett, 2002). The results of the ASES score are in the range of 10 to 100, where 0 indicates worse shoulder condition whereas a score of 100 indicates best shoulder conditions. The score evaluates two dimensions of shoulder function. These are pain and performance of activities of daily living (Wylie, et al., 2014). Improvement of the ASES score following operative management of humerus nonunion is the goal of operative management. This will enable resumption of activities of daily living and productivity (ASES - Orthopaedic Scores, 2020; Michener, McClure & Sennett, 2002).

The purpose of this study was to evaluate the operative management and outcomes of humeral fracture non-union among adult patients at the MTRH. The functional outcomes were assessed using the ASES standardized forms at various points in time after the operation.

III. STUDY FINDINGS

The findings of this study were based on 32 patients aged 18 years and above with the diagnosis of humerus fracture nonunion who underwent operative management at the Orthopedic and Trauma Department of the MTRH, Eldoret, Kenya, between August 2021 and July 2022.

There were 18 male participants and 14 female participants, with a male/female ratio of 1.29: 1. The males made up n=18(56.25%) of the study participants while the female was n=14(43.75 %).

The humerus shaft was the most affected site in 18(56.27%) while the distal and proximal end were equally affected in 7(21.8 %) of the respondents studied. Road traffic accident was the leading cause of injury to the humerus 26(81.25 %), followed by low energy such as falls 4(12.5%) and last by assaults 2(6.25%). The average time from injury to nonunion was 10 months (Range: 7- 13 months). The type of union was categorized according to the Weber and Cech group (van Basten Batenburg, et al., 2019). Majority of the non-union was atrophic in 24(75%), followed by hypertrophic in 5(15.62%), pseudo arthrosis in 2(6.25%) and the least was oligotrophic in 1(3.12 %) of the respondents studied. The degree of bone healing was assessed on the radiographs and the severity of the nonunion was scored using the Non-Union Scoring System (NUSS). The average NUSS score was 23.34 (46.68%) with a range of 15-35%.

Functional assessment was done using the ASES score. Scoring was done on each post-operative visit. The final score was done at 24 weeks after the operation. The average ASES score at each visit was summarized in the table below. The mean change in the ASES score was documented for each visit.

II. METHODOLOGY

The study was conducted at the Orthopedic Unit (Outpatient Clinic (OPD)) and Orthopedic Wards of the MTRH. The department attends to an average of 36 patients with humerus fracture nonunion every year.

The study design was a hospital-based descriptive prospective study. All patients undergoing operative management for humerus fracture nonunion were considered for the study and followed up for a minimum period of 6 months from date of the operative procedure. Patients were recruited and followed up at an interval of every 6 weeks after the surgery during their routine Orthopedic Outpatient Clinic visit. The points of encounter with the patients were at day 0, 6 weeks, 12 weeks, 18 weeks and 24 weeks after the operation. During these visits, the clinical and functional outcome assessment using the ASES score and radiological union were recorded.

Approval of the study was obtained from the Institutional Research and Ethics Committee (IREC) and the National Commission for Science Technology and Innovation (NACOSTI).

The mean ASES score was 48.90 (SD: 12.2) at week 12 and the final ASES score was 78.98 (SD: 6.7) at the end of the study period of 24 weeks.

The mean ASES score change was 49.65 (SD: 5.7) points from the first post-operative review to the last post-operative review. The range was 29.89- 78.98 points. The table below summaries the ASES score measurements.

In this study the mean time to union was 19.04 (SD: 2.9) weeks. The range was 18-24 weeks. Thirty-one (31) of the cases had union at the end of the study period N=31(96.8%).

Variable	Parameter	Value
Time to union	Mean	19.06 (SD: 2.9)
	Range	weeks (18-24 weeks)
Mean ASES score at post-operative review visit (%)	ASES 6-	29.89 (SD: 6.1)
	ASES 12-	48.90 (SD: 12.2)
	ASES 18-	67.254 (SD: 5.2)
	ASES 24-	78.98 (SD: 6.7)
Mean ASES change	Mean	49.65 (SD: 4.1)
	change Range	(29.89-78.98)

IV. CONCLUSION

The use of locking compression plate with autologous bone graft achieved 96.2 % union rate at the end of study period among adult patients with humerus fracture nonunion managed operatively at the MTRH. There was improved function as assessed using the ASES score, reduced disability and improved quality of life for patients following operative management of humerus fracture nonunion among adult patients attending the MTRH.

IV DISCUSSION (MISSING)

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