

Functional Outcome (DASH and CMS Scoring System) of ORIF Compared to Shoulder Hemiarthroplasty on Proximal Humerus Fracture Neer Classification 3 and 4 Part: A Meta-Analysis

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Abstract

Despite proximal humerus fractures being one of the most common fractures, the decision on surgical interventions remains controversial. ORIF and hemiarthroplasty have certain advantages and disadvantages, and this study aims to evaluate and compare the functional outcome of ORIF and hemiarthroplasty for proximal humerus fracture Neer 3- and 4-part. Current literature supports the use of hemiarthroplasty with good outcomes when used in proximal humeral fracture Neer 3- and 4-part Study Design: Meta-analysis; level of evidence, 2. A systematic search was carried out until May 10th, 2021 in PubMed, Google Scholar, Cochrane Library and Clinical Key. Study quality and risk of bias assessed GRADE Working Group and the Agency for Healthcare Research and Quality (AHRQ) recommendations. The electronic research resulted in 76 records involving 138 patients undergoing ORIF and 131 patients undergoing hemiarthroplasty. In 4 studies, 97 patients treated with hemiarthroplasty and 95 patients treated with ORIF Plate Screw were evaluated using CMS and DASH scores. There is no significant difference between the two groups in DASH and CMS scores, with a mean difference of 6.14; 95% CI, $p < 0,05$ and a mean difference of -6,77; 95% CI; $p > 0,05$, respectively. Statistical analysis revealed no significant difference in CMS and DASH scores between ORIF and hemiarthroplasty groups.

Keywords: Hemiarthroplasty, ORIF, Proximal humerus fractures, Neer 3- and 4-part

Introduction

The incidence of proximal humerus fractures is steadily increasing, accounting for approximately 5% of all adult fractures and are the third most common fracture following hip and distal radius fractures.¹ Proximal humerus fractures are then further classified using Neer classification as the most frequently used classification. This classification is based on anatomical site of the proximal humerus fractures: humeral head, shaft and greater and lesser tubercles, and whether the fracture is displaced. The 4-part classification is a fracture with displacement of at least 10mm and/or angulation of 450 between the shaft fragments and the head, and a fracture of the lesser or greater tubercle with a displacement of a least 10mm.²

Although proximal humerus fractures are common, they often remain complex and challenging for surgeons. Surgical interventions for proximal humerus fractures include open reduction and internal fixation (ORIF) or arthroplasty, including hemiarthroplasty (HA) or reverse total shoulder arthroplasty (RTSA).³ The use of locking plates in ORIF has the potential ability to restore anatomical position. However, it risks complications related to the surgery and implant itself. HA is reserved for patients with displaced and comminuted fractures, in which the risk of avascular necrosis is high. The decision on this surgical management remains controversial. As for the surgical treatment of 4-part humeral fracture, it is not controversial for displaced 4-part fractures in younger patients. However, the varying degree of osteoporosis in the elderly patients and and displaced fractures after low-energy fractures make surgical options controversial.²

Hemiarthroplasty is commonly performed in most displaced 3- and 4- part proximal humeral fractures in elderly patients. However, the restoration of shoulder kinematics and function following HA remains doubtful. This study aims to compare clinical outcomes of proximal humerus fractures treated with either ORIF or Arthroplasty. We evaluate Constant Murray Score (CMS) and Disability of the Arm, Shoulder and Hand (DASH) score between the two intervention groups.

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Figure 1. Forrest plot analysis for DASH score

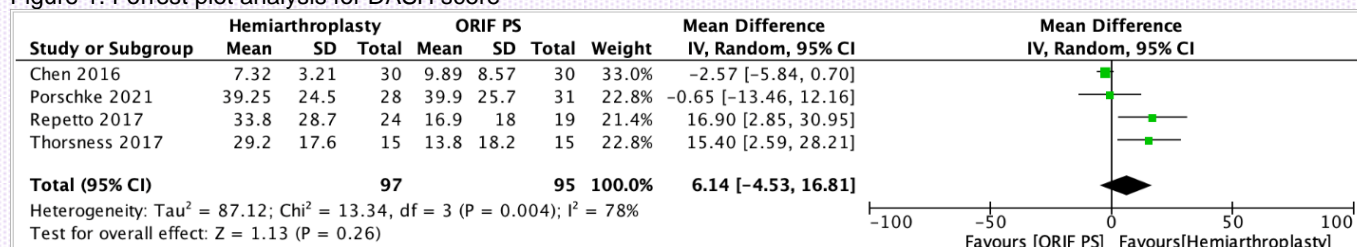
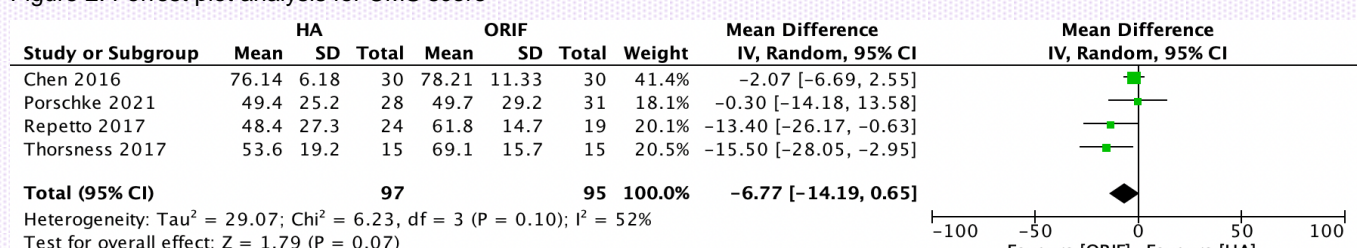


Figure 2. Forrest plot analysis for CMS score



METHODS

Search Strategy

A systematic search was performed to identify potential studies for inclusion in this systematic review up to May 10th 2021. The studies included in this study were those in English language, having abstracts, and with the aforementioned surgical interventions conducted on humans. The databases used included PubMed, Google Scholar, Clinical Key and Cochrane Library. The focus of this meta-analysis is to compare the outcome of DASH and CMS between ORIF using plate versus hemiarthroplasty. Keywords in the search matched and used in the databases were ORIF and Arthroplasty in Proximal Humerus Fracture, DASH score and CMS score. The word "AND" was used as conjunction in between keywords in Pubmed, Google Scholar, Clinical Key and Cochrane Library.

Inclusion Criteria

Studies were included if they met these following criteria: any studies about the outcome following ORIF and Arthroplasty in proximal humerus fracture, with DASH and CMS scores as the outcomes assessed.

Quality Evaluation

The study quality and risk of bias were assessed using a criteria developed by the Oxford Center for Evidence-based Medicine, perspicacity defined by the Grades of Recommendation Assessment, Development and Evaluation (GRADE) Working Group, and sanction made by the Agency for Healthcare Research and Quality (AHRQ). Level of evidence of the studies were categorized into "class I" for good quality RCT, "class II" for moderate to poor quality RCT and good quality cohort, "class III" for moderate or poor-quality cohorts and case-control studies, and "class IV" for case series studies.

RESULTS

Literature Search, Study Selection and Study Characteristics

The electronic research resulted in 76 records from various databases. After the process of duplication elimination, screening, and exclusion, the remaining 7

studies were included in qualitative synthesis. The remaining articles were excluded due to lack of mean and standard deviation data and did not meet the inclusion and exclusion criteria.

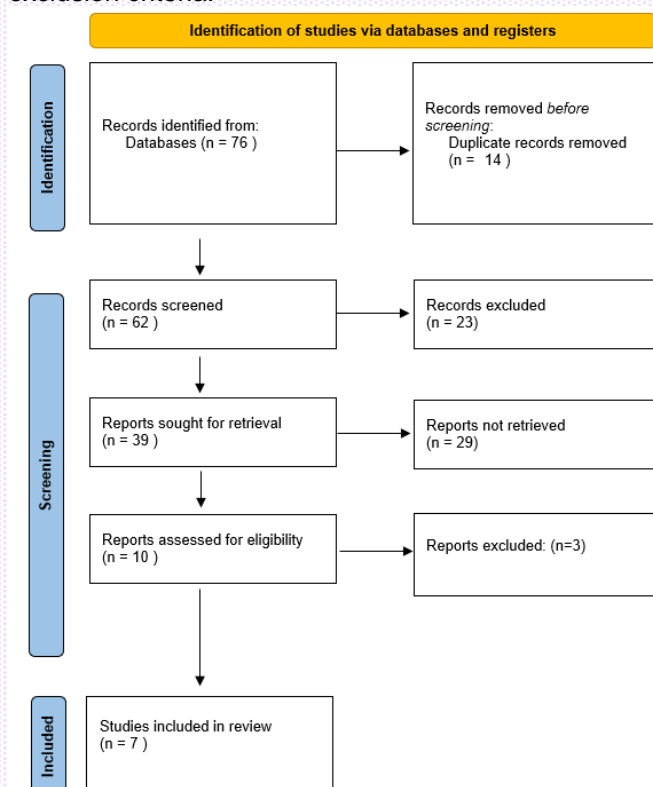


Figure 3. The strategy for conducting this study is based on the PRISMA guideline described in this flow diagram.⁸

Table 1. Characteristics of the studies

No.	Reference	Journal	Study Design	Level of Evidence
1.	Spross C, Platz A, Erschbamer M, Lattman T, Dietrich M, 2011	Clinical Orthopaedics and Related Research	Cohort Study	II
2.	Cai M, Tao K, Yang C, and Li S, 2012	Internal Fixation Versus Shoulder Hemiarthroplasty for Displaced 4-part Proximal Humeral Fractures in Elderly Patients	Randomized Controlled Trial	I
3.	Chen H et al., 2016	Orthopaedics and Traumatology, Surgery and Research	Cohort Retrospective	III
4.	Repetto, 2017	Surgical management of complex proximal humerus fractures: pinning, locked plate and arthroplasty	Retrospective	IV
5.	Thorsness et al., 2017	Journal of Shoulder and Elbow Arthroplasty	Retrospective cohort study	III
6.	Sahu & Chatterjee, 2019	International Journal of Orthopaedics Sciences	Retrospective study	III
7.	Porschke et al., 2021	Journal of Clinical Medicine	Retrospective cohort study	III

Table 2. Characteristics of the study populations

No.	Reference	Total Sample Size	Mean Age (Age range) in years	Male	Female	Study Comparison	Surgical Technique
1	Spross C, Platz A, Erschbamer M, Lattman T, Dietrich, 2011	44 patients with Neer type IV fracture of the proximal humerus	40 patients (mean age 77,3 range 55-93) 4 patient (mean age 54,4 range 42-66)	-4 (PHILOS Group) -3 (hemiarthroplasty Group)	-18 (PHILOS Group) -19 (hemiarthroplasty Group)	Comparison of PHILOS and hemiarthroplasty in treatment for Neer Group IV Proximal Humerus Fractures	PHILOS Hemiarthroplasty
2.	Cai M, Tao K, Yang C, and Li S, 2012	32 Patients	71.9 years (range 67-86)	4	28	Internal fixation vs. shoulder hemiarthroplasty for displaced 4-part proximal humeral fractures in elderly patients	PHILOS plate (Synthes, Stockholm, Sweden) in ORIF group, Hemiarthroplasty prosthesis (Depuy, Warsaw, Indiana) in Hemiarthroplasty group
3.	Chen H et al., 2016	60 patients with four-part PHF and/or fracture-dislocation	68 (IFA and LCP's group) 64 (HA group)	13 (IFA and LCP's group) 15 (HA group)	17 (IFA and LCP's group) 15 (HA group)	Comparison of Intramedullary fibular allograft with locking compression plate versus shoulder hemiarthroplasty for the repair of osteoporotic four-part proximal humerus fracture	Intramedullary fibular allograft with locking compression plate, Shoulder hemiarthroplasty
4.	Repetto, 2017	4 Patients with ACL Reconstruction, PLC Reconstruction	67.7 ± 11.0 years old (range 38–89)	N/A	N/A	Pinning vs. locked plate dan hemiarthroplasty in three-four-part displaced fractures	Pinning Technique (CRIF), PHILOS Plate, Hemiarthroplasty

Table 2. Characteristics of the study populations (cont...)

5.	Thorsness et al., 2017	30 patients: 15 ORIF patients 15 HA patients	N/A Minimum age: 18 yo	N/A	N/A	ORIF vs. Hemiarthroplasty in management of complex articular fractures and fracture-dislocations of the proximal humerus	Primary fixation with plate and screw or primary hemiarthroplasty
6.	Sahu & Chatterjee, 2019	60 patients	66.3 for the hemiarthroplasty group 63.6 for the PHILOS group	9 for hemiarthroplasty 16 for PHILOS	12 for hemiarthroplasty 23 for PHILOS	Hemi Open reduction and internal fixation with the PHILOS and primary hemiarthroplasty in Neer Group (IV-VI)	ORIF with PHILOS and Hemiarthroplasty
7.	Porschke et al, 2021	59 patients; 31 ORIF patients 28 arthroplasty patients	75.3 ± 5.5	47 (24 ORIF and 7 arthroplasties)	12 (7 ORIF and 5 arthroplasties)	ORIF using locking plate vs. arthroplasty in geriatric proximal humeral fractures	Osteosynthesis with a standard deltopectoral approach was performed if the fracture was deemed reconstructable, using proximal humeral locking-plate (PHILOS) Arthroplasty using a standard deltopectoral approach was performed if the fracture was not deemed reconstructable (hemiarthroplasty or reverse total shoulder arthroplasty)

Table 3. Summary of outcomes

No.	Reference	Study Comparison	Follow up Duration	Clinical outcomes	Complications
1.	Spross C, Platz A, Erschbamer M, Lattman T, Dietrich M	Comparison of PHILOS and hemiarthroplasty in treatment for Neer Group IV Proximal Humerus Fractures	AP and transcapular at the time of injury, after surgery, at the time of last follow up Minimum follow-up 12 months (Mean 30 months, range 12-83 months)	Comparison of complication between PHILOS Group and hemiarthroplasty treatment using Constant-Murley score	-PHILOS Group 10 (45,4%) revision surgery Avascular necrosis Screws cut-outs Secondary perforation of the head screws in the glenohumeral joint. hemiarthroplasty Group Malreduction of the greater tuberosity Revision surgery
2.	Cai M, Tao K, Yang C, and Li S, 2012	Internal fixation vs shoulder hemiarthroplasty for displaced 4-part proximal humeral fractures in elderly patients	24 month of follow up period	The Clinical Outcome used were ROM and Strength. In ORIF group, in final follow up, ROM of flexion and abduction were 117 degree and 111 degree meanwhile in hemiarthroplasty group , in final follow up, ROM were 129 degree and 123 degree, respectively	In ORIF Group, 3 patients (23%) experienced complication 1 non-union, 2 fixation failures. In hemiarthroplasty Group, 3 patients (15%) experienced 1 dislocation, 1 infection, 1 prosthesis loosening
3	Chen, H, et al, 2016	Comparison of Intramedullary fibular allograft with locking compression plate versus shoulder hemiarthroplasty for repair of osteoporotic four-part proximal humerus fracture	Follow up 4, 8, 13 weeks, second surgery at 6,12, 24 months.	The outcomes of surgery on patients' subjective ratings were recorded as follows: Functional outcomes were evaluated based on the disability of arm, shoulder and hand (DASH) and Constant-Murley score (CMS)	Loss reduction, avascular necrosis, screw perforation (IFA and LCPs group) Superficial infection, shoulder stiffness, tuberosity migration (HA group)

Table 3. Summary of outcomes (cont...)

4.	Repetto, 2017	Pinning vs locked plate dan arthroplasty in three-four-part displaced fractures	follow-up was 38.7 ± 17.0 months (12–78 months).	Comparison of complication between Pinning vs locked plate dan arthroplasty in three-four-part displaced fractures	postoperative complications (two cases of painful migration of Kirschner wires, two cases of loss of reduction not requiring revision surgery), seven patients (36.8%) for ORIF (four cases of avascular necrosis, one case of transient circumflex nerve palsy and two cases of plate impingement with the acromion), nine patients (37.5%) for HA (five cases of tuberosities non-union/malunion, one case of secondary cuff failure, two case of traumatic periprosthetic fracture and two cases of stiffness) and nine patients (33.3%) for RSA (four cases of clinically silent scapular notching, two cases of instability, one case of traumatic periprosthetic fractures, one case of postoperative haematoma and one case of deep infection)
5.	Thorsness et al, 2017	ORIF vs Hemiarthroplasty in management of complex articular fractures and fracture-dislocations of proximal humerus	mean follow up of 60 months	Constant Murley Score DASH score ASES score SF-36 physical composite score (PCS) Radiographic outcome: Osteonecrosis, malunion, non-union	Hardware complications, neurovascular injury, infection
6.	Sahu & Chatterjee 2019	Open reduction and internal fixation with the PHILOS and primary hemiarthroplasty in Neer Group (IV-VI)	Follow up was done 3,6,9,12 months after surgery	The clinical outcomes were evaluated using the age and gender specific Constant-Murley score (CMS) and the Range of Motion of shoulder	In PHILOS group : stiffness of the shoulder joint In Hemiarthroplasty group : AVN of the head, posterior malreduction of the greater tuberosity, complete resorption of the greater tuberosity with primary posterior malposition, and postoperative stiffness
7.	Porsche et al, 2021	ORIF using locking plate vs arthroplasty in geriatric proximal humeral fractures	mean follow up of 2.7 ± 1.7 years	Hospital course Constant Murley score DASH score Range of motion (flexion, abduction, external rotation)	All events potentially subject to revision surgery were evaluated as complication

Table 4. Characteristic of Outcome of studies

No	References	Outcome Measure		
		Constant-Murley Score	DASH	Clinical Outcome
1	Spross C, Platz A, Erschbamer M, Lattman T, Dietrich M, 2011	<p>Patient 1 (Ectopic bone formation): 86 points</p> <p>No difference between PHILOS and HA treated fracture Constant Marley (p=0,4)</p> <p>No difference between fracture subtype (dislocation, head impression, head split)</p> <p>In the HA Group, neither posterior malposition of the greater tuberosity nor an acromial distance less than 7 mm Constant-Marley (p=0,2)</p> <p>Patients without complication had a mean final Constant-Murley score of 72.8 in PHILOS and significantly higher than the HA Group</p>	N/A	<p>PHILOS Group</p> <p>10 (45,4%) revision surgery</p> <p>Avascular necrosis</p> <p>Screws cut-outs</p> <p>Secondary perforation of the head screws in the glenohumeral joint.</p> <p>-Hemiarthroplasty Group</p> <p>Malreduction of the greater tuberosity</p> <p>Revision surgery</p>
2	Cai M, Tao K, Yang C, and Li S, 2012	<p>In the ORIF group, the mean Constant scores were 48,4 (4 mo), 55,5 (12 mo), and 60,7 (24 mo)</p> <p>In the hemiarthroplasty group, the mean Constant scores were 57,4 (4 mo), 60,1 (12 mo), and 72,9 (24 mo).</p>	<p>In the ORIF group, the mean DASH score were 31,7 (4 mo), 28,4 (12 mo), and 15,3 (24 mo)</p> <p>In the hemiarthroplasty group, the mean DASH score were 33,4 (4 mo), 21,1 (12 mo), and 9,2 (24 mo).</p>	<p>postoperative complications (two cases of painful migration of Kirschner wires, two cases of loss of reduction not requiring revision surgery), seven patients (36.8%) for ORIF (four cases of avascular necrosis, one case of transient circumflex nerve palsy and two cases of plate impingement with the acromion), nine patients (37.5%) for HA (five cases of tuberosities non-union/malunion, one case of secondary cuff failure, two case of traumatic periprosthetic fracture and two cases of stiffness) and nine patients (33.3%) for RSA (four cases of clinically silent scapular notching, two cases of instability, one case of traumatic periprosthetic fractures, one case of postoperative hematoma and one case of deep infection)</p> <p>The Clinical Outcome used were ROM and Strength. In the ORIF group, in the final follow up, ROM of flexion and abduction were 117 degrees and 111 degrees; meanwhile, in the hemiarthroplasty group, in the last follow up, ROM was 129 degrees and 123 degrees, respectively</p>
3	Chen H et al., 2016	<p>Three month</p> <p>- 77.91 ± 9.13 (IFA and LCPs)</p> <p>- 72.1 ± 5.21 (HA)</p> <p>6month</p> <p>- 76.84 ± 9.27 (IFA and LCPs)</p> <p>- 75.13 ± 6.11 (HA)</p> <p>12month</p> <p>- 78.21 ± 11.33 (IFA and LCPs)</p> <p>- 76.14 ± 6.18 (HA)</p> <p>24month</p> <p>- 80.11 ± 10.23 (IFA and LCPs)</p> <p>75.39 ± 6.21 (HA)</p>	<p>3month</p> <p>- 9.32 ± 9.11 (IFA and LCPs)</p> <p>- 10.8 ± 8.32 (HA)</p> <p>6month</p> <p>- 10.11 ± 7.11 (IFA and LCPs)</p> <p>- 8.97 ± 9.14 (HA)</p> <p>12month</p> <p>- 9.89 ± 8.57 (IFA and LCPs)</p> <p>- 7.32 ± 3.21 (HA)</p> <p>24month</p> <p>- 10.33 ± 8.21 (IFA and LCPs)</p> <p>7.11 ± 5.64 (HA)</p>	N/A

Table 4. Characteristic of Outcome of studies (cont...)

4	Repetto, 2017	<p>Pinning 63.8 ± 13.9</p> <p>Locked plating 61.8 ± 14.7</p> <p>HA 48.4 ± 27.3</p> <p>RSA 58.5 ± 8.5</p>	<p>Pinning 20.0 ± 15.1</p> <p>Locked plating 16.9 ± 18.0</p> <p>HA 33.8 ± 28.7</p> <p>RSA 28.6 ± 12.3</p>	<p>postoperative complications (two cases of painful</p> <p>migration of Kirschner wires, two cases of loss of reduction</p> <p>not requiring revision surgery), seven patients (36.8%) for</p> <p>ORIF (four cases of avascular necrosis, one case of transient</p> <p>circumflex nerve palsy and two cases of plate</p> <p>impingement with the acromion), nine patients (37.5%) for</p> <p>HA (five cases of tuberosities non-union/malunion, one</p> <p>case of secondary cuff failure, two cases of traumatic</p> <p>periprosthetic fracture and two cases of stiffness) and nine</p> <p>patients (33.3%) for RSA (four cases of clinically silent</p> <p>scapular notching, two cases of instability, one case of</p> <p>traumatic periprosthetic fractures, one case of postoperative</p> <p>hematoma and one case of deep infection)</p>
5	Thorsness et al, 2017	<p>ORIF: 69.1 ± 15.7</p> <p>HA: 53.6 ± 19.2 p=0.03</p>	<p>ORIF: 13.8 ± 18.2</p> <p>HA: 29.2 ± 17.6 p=0.01</p>	N/A
6	Sahu & Chatterjee, 2019	<p>Hemiarthroplasty group :</p> <p>-poor : 2</p> <p>- moderate : 4</p> <p>- good : 8</p> <p>Excellent: 7</p> <p>PHILOS</p> <p>-poor; 1</p> <p>- moderate: 8</p> <p>- good: 12</p> <p>- excellent: 18</p>	N/A	<p>ROM</p> <p>Hemiarthroplasty group :</p> <p>- good: 12</p> <p>- moderate: 7</p> <p>- poor: 2</p> <p>PHILOS</p> <p>- good : 30</p> <p>- moderate : 8</p> <p>- poor : 1</p> <p>The clinical outcomes were evaluated using the age and gender-specific Constant-Murley score (CMS) and the Range of Motion of the shoulder</p>

Table 4. Characteristic of Outcome of studies (cont...)

7	Porschke et al, 2021	Osteosynthesis: 49.7 ± 29.2	Osteosynthesis: 39.9 ± 25.7	<u>Hospital stay</u>
		Arthroplasty: 49.4 ± 25.2 p=0.731	Arthroplasty: 39.25 ± 24.5 p=0.922	Osteosynthesis: 10.6 ± 5.2 days
				Arthroplasty: 13.7 ± 3.7 days
				p=0.001 <u>Complication</u>
				Osteosynthesis: 10 (32.6) Arthroplasty: 2 (7.1)
				p=0.023
				<u>Revision</u>
				Osteosynthesis: 9 (29.0)
				Arthroplasty: 2 (7.1)
				p=0.045
				Flexion
				Osteosynthesis: 88.6 ± 38.9
				Arthroplasty: 102.0 ± 24.4 p=0.394
				Abduction
				Osteosynthesis: 88.6 ± 29.7
				Arthroplasty: 93.0 ± 30.6 p=0.770
				External rotation
				Osteosynthesis: 21.3 ± 14.6
				Arthroplasty: 8.0 ± 9.2 p=0.036

Outcome Analysis

This meta-analysis included a total number of 377 patients with 138 patients undergoing ORIF and 131 patients undergoing hemiarthroplasty. The follow-up period differed within each study, ranging from 3 months until 2 years post-operatively. The patient's ages ranged from 18-93 years old.

Functional outcome

We performed a subgroup analysis to evaluate whether hemiarthroplasty or ORIF had better significant outcome compared to control group. DASH and CMS score were measured to evaluate function of the shoulder. In 4 studies, 97 patients treated with hemiarthroplasty and 95 patients treated with ORIF were evaluated using CMS and DASH score. There is no significant difference between the 2 groups in DASH and CMS score with mean difference 6.14; 95% CI, p<0,05 and mean difference - 6,77; 95% CI; p>0,05, respectively.

DISCUSSION

Poor bone quality, comminution of tuberosity fragment and medial strut have complicated surgery,

resulting in more complicated and difficult management of proximal humerus fracture, especially in the older population. The high risk for AVN and deformity and varus collapse has made shoulder HA favourable for this patient group. However, despite its advantages over ORIF, its outcomes in terms of function restoration have remained debatable.⁴ We investigated the functional outcome with CMS and DASH score in this study and observed that there is no significant difference between the two groups in DASH and CMS score.

Similarly, Spross et al. also observed no significant difference in CMS score between ORIF plate and primary hemiarthroplasty group (p=0.4).⁵ Another study conducted by Porschke et al in Germany involving geriatric patients with proximal humerus fractures treated surgically with either ORIF

or arthroplasty with the minimum follow-up time of one year also revealed no significant difference in DASH and CMS, with DASH 39.9 ± 25.7 vs. 39.25 ± 24.5, p = 0.922 and CMS 49.7 ± 29.2 vs. 49.4 ± 25.2, p = 0.731.⁶ However, it is observed in a study by Chen et al that among total cases of 60 patients with osteoporotic four-

part proximal humerus fracture, the CMS and DASH score were statistically higher in group receiving plate than in hemiarthroplasty group.⁴ Repetto et al investigated the difference in outcome between pinning, locked plating, hemiarthroplasty and reversed shoulder arthroplasty and it was concluded that there were better outcome scores with $p < 0.05$ favouring locked plating over hemiarthroplasty.⁷ On the contrary, DASH score was found to be significantly higher in hemiarthroplasty group at a 2-year follow-up in a study by Cai *et al.*²

The finding in this study did not indicate any advantages of certain surgical treatment of proximal humerus fractures in functional outcome aspects measured by CMS and DASH score. However, previous studies have mentioned that there is currently no standard for proper surgical technique for proximal humerus fractures. The decision on surgical treatment would be influenced by the patient's characteristics (including age, compliance, co-morbidity, risk factors), the fracture itself (pattern or classification, bone quality), and damage to the surrounding tissue) and the surgeon's preference and experience. The limited number of previously eligible studies included in this study and the limited outcome variables have become the limitation of this study.

CONCLUSIONS

Although several previous studies mentioned that hemiarthroplasty is the preferred surgical option for treating Neer 3- and 4-part proximal humerus fractures especially in older population, our investigation did not reveal any significant difference in CMS and DASH scores between ORIF plate and hemiarthroplasty. Further studies exploring the advantages of the currently-available surgical options are necessary to provide adequate information for surgeons regarding the best outcomes of each techniques for future application.

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