Surgical and Non-Surgical Treatments for 3 and 4-Part Proximal Humerus Fractures in the Elderly: a Network Meta-Analysis

Sebastian Orman B.S., Amin Mohamadi MD-MPH, Joseph Serino B.S., Jordan Murphy B.S., Philip Hanna MD, MSc, Michael Weaver, MD, George Dyer MD, Ara Nazarian PhD, Arvind von Keudell MD

Investigation Performed at: Beth Israel Deaconess Medical Center, Georgetown University School of Medicine, Harvard School of Medicine

ORTHOPEDIC TRAUMA INITIATIVE
HARVARD MEDICAL SCHOOL

Introduction

Proximal humerus fractures (PHFs) are the third most common fracture type in individuals over 65. Approximately one fifth of PHFs are Neer's 3 and 4-part fractures. Treatment strategies include non-surgical treatment (NST), open reduction internal fixation (ORIF), hemiarthroplasty (HA) and reverse total shoulder arthroplasty (rTSA). While evidence that favors NST over surgical intervention is mounting, the superiority of any one surgical strategy has yet to be determined [1]. Additional research and subsequent formulation of guidelines is necessary to optimize patient care for elderly patients with proximal humerus fractures.

Purpose

The purpose of this network meta-analysis (NMA) was to analyze RCT data for the treatment of 3-part and 4-part proximal humerus fractures in patients over 51 years old. We aim to determine the most successful treatment modality based on functional outcome scores as well as adverse event and additional surgery rates.

Methods

We searched the MEDLINE, EMBASE, Web of Science, and Cochrane Central electronic databases for studies that met the following inclusion criteria (1) Randomized Controlled trials, (2) Available in English language, (3) 3-part or 4-part proximal humerus fractures, and (4) Using one of the following for management: non-operative treatment, open reduction internal fixation (ORIF) with locking plate, hemiarthroplasty, and reverse total shoulder arthroplasty. Abstracts and meeting presentations, reviews, case reports, and 1-part and 2-part proximal humerus fractures were excluded. Of the 3,617 papers collected, 43 were selected for detailed evaluation based on title and abstract, and 8 met our inclusion criteria for meta-analysis (**Table 1**).

The methodological quality of the included studies were evaluated using the Jadad scale for randomized clinical trials [2]. Data synthesis was only done on high quality studies (defined as a Jadad score ≥ 2) and entered into meta-analysis. Outcomes included the Constant-Murley Shoulder Outcome Score [3], the Disabilities of the Arm, Shoulder and Hand (DASH) Score [4], adverse event rate, and additional surgery rate.

The following adverse events were pooled in this study: avascular necrosis of humeral head, hematoma or infection, nonunion, secondary displacement, implant failure, primary or secondary screw penetration, proximal migration of humeral head, and greater tuberosity mal-union or resorption. The pooled additional surgery rate was reported to avoid double counting for cases that underwent additional surgery to treat an adverse event.

Table 1 – Studies Included for Meta-Analysis.

STUDY	COUNTRY	MEAN AGE (RANGE)	CONTROL (N)	INTERVENTION (N)	FRACTURE	OUTCOME MEASURES
Boons 2012	Netherlands	78.2 (N/A)	NST (23)	HA (24)	4 part	Constant, adverse events, reoperation
Cai 2012	China	71.9 (67-86)	ORIF (15)	HA (12)	4 part	Constant, DASH, adverse events, reoperation
Chen 2015	China	66 (51-81)	ORIF (28)	HA (28)	4 part	Constant, DASH, adverse events, reoperation
Fjalestad 2014	Norway	72.6 (60-88)	NST (19)	ORIF (23)	3 and 4 part	Constant, adverse events, reoperation
Olerud (a) 2011	Sweden	77 (58-92)	NST (25)	HA (24)	4 part	Constant, DASH, adverse events, reoperation
Olerud (b) 2011	Sweden	74 (56-92)	NST (26)	ORIF (27)	3 part	Constant, DASH, adverse events, reoperation
Sebastia-mForcada 2014	Spain	74 (70-85)	HA (30)	rTSA (31)	3 and 4 part	Constant, DASH, reoperation
Zyto 1997	Sweden	74 (N/A)	NST (15)	ORIF (14)	3 and 4 part	Constant

N/A: none available; NST: non-surgical treatment; ORIF: open reduction internal fixation; HA: hemi-arthroplasty; rTSA: reverse total shoulder arthroplasty.

Results

We found that NST was associated with a lower rate of adverse events (RR = 1.45; $p < 0.01$) and additional surgery (RR = 8.13; $p < 0.01$) compared to ORIF, and in all other respects it performed similarly to the surgical interventions. Among the surgical interventions, rTSA produced better functional outcomes than HA (SMD = 0.89; $p < 0.01$), a lower rate of adverse events (RR = 0.57; $p = 0.02$), and no significant difference in rate of additional surgery (RR = 0.17; $p = 0.09$). Besides the aforementioned findings, there were no significant differences between the various treatments (**Table 2**).

Table 2 – Outcome Comparison Between Interventions

Outcomes	Constant/Dash Score		Additional Surgery		Adverse Events	
Interventions	*SMD (95% CI)*	*P-value*	*RR (95% CI)*	*P-value*	*RR (95% CI)*	*P-value*
ORIF vs. NST	0.04 (-0.31 – 0.41)	0.81	1.45 (1.10-1.91)	<0.01	8.13 (2.1-31.60)	<0.01
HA vs. NST	0.22 (-0.18 – 0.62)	0.28	1.32 (0.69-2.50)	0.40	1.98 (0.36-10.97)	0.43
ORIF vs. HA	0.26 (-0.18 – 0.70)	0.25	0.96 (0.35-2.63)	0.94	1.40 (0.40-4.53)	0.58
HA vs. rTSA	0.89 (0.36 – 1.41)	<0.01	0.57 (0.36-0.90)	0.02	0.17 (0.21– 1.81)	0.09

Abbreviations: HA: Hemiarthroplasty; NNH: Number Needed to Harm; NST: Non-Surgical Treatment; RR: Risk Ratio; ORIF: Open Reduction Internal Fixation; rTSA: reverse Total Shoulder Arthroplasty; SMD: Standardized Mean Difference

Conclusion

This study improves upon the limitations of other studies in several ways. We focused on 3 and 4-part fractures rather than combining them with 1 and 2-part fractures, which are often managed differently. Compared to previous NMAs [5], we used a narrower age range (51-92) and a mean age (73.4) more accurately representing the population most affected by PHFs. Additionally, we are the first to utilize exclusively RCT data for such a study.

Based on our results, NST should be the preferred treatment: it has a lower adverse event rate than ORIF and is similar to HA; it has a lower additional surgery rate than ORIF and is similar to HA; and it has similar functional outcome scores to ORIF and HA. Furthermore, rTSA should be preferred to HA, as it has better functional outcomes, a lower adverse event rate, and a similar additional surgery rate.

Disclosures

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