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ORIGINAL ARTICLE

Open reduction and internal-fixation versus radial head replacement in treatment of Mason type III radial head fractures

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Abstract
Purpose The purpose of this study was to demonstrate whether open reduction and internal-fixation (ORIF) was superior to radial head replacement in treatment of Mason type III radial head fractures by comparing postoperative complication rate and satisfactory rate.
Methods Clinical trials comparing ORIF with radial head replacement for Mason type III radial head fractures were reviewed published up to September 1, 2012. Methodological quality of each included trials was assessed using the Jadad scale. The analyses were performed with Cochrane RevMan software version 5.1.
Results One prospective randomized controlled trial and one comparative study involving 67 patients with 67 cases were included in this systematic review and meta-analysis. Both the forest plots of complication rate and satisfactory rate indicated statistical differences between the two surgical techniques in treatment of Mason type III radial head fractures. The complication rate was 13.9 % in patients treated with radial head replacement and 58.1 % in patients treated with ORIF. The satisfactory rate was 91.7 % in patients treated with radial head replacement and 51.6 % in patients treated with ORIF.
Conclusions Given the available evidence, radial head replacement appeared to reach better outcomes in patients with Mason type III radial head fractures followed 5 years or less.
Level of evidence Therapeutic II.

Keywords Mason type III · Radial head fracture · Radial head replacement · Open reduction and internal-fixation

Introduction

Radial head fractures are common, with an estimated incidence of 2.5–2.9 per 10,000 people per year, and accounting for approximately one-third of all elbow fractures [1]. Radial head fractures are commonly classified under the Mason classification system. Mason type III radial head fractures (the entire radial head) are comminuted and difficult to treat, generally requiring plating if possible, or more commonly replacement or excision, which can give a variable outcome. The traditional resection of the radial head is seldom adopted due to complications of instability of the elbow joint, muscle force regression, proximal radius dislocation, elbow dislocation and long-term arthrosis [2, 3].

In recent years, open reduction and internal-fixation (ORIF) and radial head replacement have been used in the treatment of Mason type III radial head fractures [4–9]. However, the management of this issue remains a matter of controversy for the limitations of the two surgical techniques. It is important to note that no studies have found sufficient evidence to recommend either ORIF or prosthetic replacement in treating of Mason type III radial head fractures. Thus, this systematic review and meta-analysis were performed to answer the following questions: (1) What is the satisfactory rate of ORIF and radial head replacement in treatment of

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Mason type III radial head fractures? and (2) What is the complication rate of ORIF and radial head replacement in treatment of Mason type III radial head fractures?

Methods

Literature search

Electronic databases (Medline, Embase and Cochrane Central Register of Controlled Trials) were searched by two independent investigators, which were published up to September 1, 2012. The primary terms were "radial head arthroplasty" or "radial head replacement", "radial head fracture", "Mason III" and "clinical trial". We also used search engines such as Google™ to search related references on the internet, searched the references of included studies. Hand searching of the reference lists of included studies and reviews was undertaken, and unpublished studies were not sought.

Eligibility criteria

Studies were identified according to the following criteria: (1) radial head fracture of Mason type III, (2) the control and test groups are ORIF and radial head replacement and (3) full text was published in English.

Quality assessment

The quality items assessed were randomization, allocation concealment, blinding (participants, investigators, outcome assessors and data analysis) and completeness of follow-up. Conflicts were resolved by discussion.

Data collection

The relevant data, such as sample size, study design, patient age, gender, length of follow-up, complications, postoperative satisfactory and unsatisfactory rate, were extracted. According to elbow functional evaluation criteria by Broberg and Morrey [10], excellent or good outcome was considered to be satisfactory, and fair and poor outcome was considered to be unsatisfactory.

Statistical analysis

Meta-analysis was conducted with Cochrane Collaboration Review Manager 5.1. For continuous data, a weighted mean difference (WMD) and 95 % confidence interval (CI) were used in this study. For dichotomous outcomes, an odds ratio (OR) and 95 % CI were calculated as the summary statistics. The statistical heterogeneity was tested

Table 1 The quality and characteristics of the included studies

Study	Randomization	Allocated concealment	Blinding	Lost of follow-up	Sample size		Mean age (years)		Male (%)		Surgical approach		Follow-up
					RHR	ORIF	RHR	ORIF	RHR	ORIF	TR	ORIF	
Chen et al. [12]	Not clear	Not used	Single blinding	No	22	23	37 (19–68)		76.0 %		Kocher		1–5 years
Ruan et al. [13]	Not clear	Not used	Not used	No	14	8	37.4	40.1	57.1 %	62.5 %	PL	Not clear	10–27 months

ORIF open reduction and internal-fixation, *PL* posterolateral, *RHR* radial head replacement

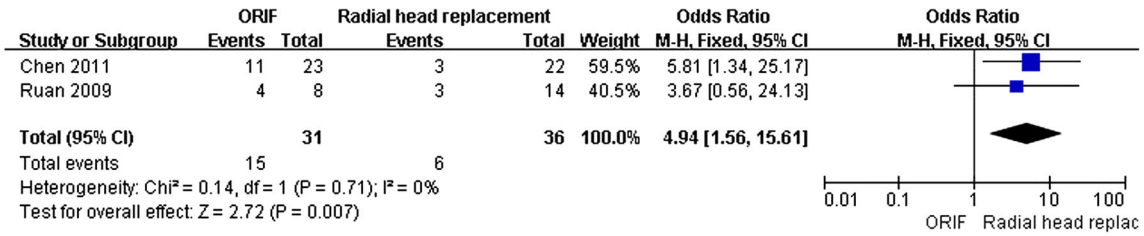

Fig. 1 Results of the meta-analysis for complication rates for open reduction and internal-fixation and radial head replacement groups

Table 2 Postoperative complications

Postoperative complications	No. of studies	No. of patients		RHR	ORIF (%)
		RHR	ORIF		
Bone nonunion/ bone absorption	1	14	8	0	4 (50)
Range of motion deficit >30°	1	22	23	2 (9.1 %)	4 (17.4)
Stiffness caused by prostheses	1	22	23	0	3 (13)
Secondary fragment displacement	1	22	23	0	3 (13)
Heterotopic ossification	2	36	31	3 (8.3 %)	2 (6.5)
No healing	1	22	23	0	1 (4.3)
Deep wound infection	1	22	23	0	1 (4.3)
Radial nerve injuries	1	14	8	0	0
Total	–	–	–	5 (13.9 %)	18 (58.1)

ORIF open reduction and internal-fixation, *RHR* radial head replacement

with the χ^2 test and I^2 test. $I^2 < 25$ % was considered low statistical heterogeneity; $I^2 < 50$ %, moderate statistical heterogeneity; $I^2 < 75$ %, high statistical heterogeneity [11]. The source of high heterogeneity was calculated by random effects.

Results

Search results

Ten potentially eligible trials were identified, and subsequently, eight trials were excluded for the following reasons: Seven were missing test group or control group and one clinical trial was not between ORIF and prosthetic replacement. Finally, one prospective randomized controlled trial [12] and one comparative study [13] met the predetermined inclusion criteria.

Characteristics and quality of included studies

The quality and demographic characteristics of the included studies were presented in Table 1. The dataset included 67 patients. Thirty-one patients with Mason type III radial head fractures were treated with ORIF, and 36 patients were treated with radial head replacement. The mean preoperative age, gender ratio and rehabilitation exercise between the two groups were generally consistent. Follow-up period ranged from 1 to 5 years.

Complication rate

The forest plot of complication rate indicated that statistical difference existed in patients treated with ORIF and radial head replacement ($P < 0.01$, $I^2 = 0$ %). There were 15 total complications in ORIF group and 6 in radial head replacement group (Fig. 1). Postoperative complications, such as bone nonunion/bone absorption, range of motion deficit >30°, stiffness, secondary fragment displacement, heterotopic ossification, no healing, wound infection and radial nerve injuries, were presented in Table 2. The complication rate was 13.9 % in patients treated with radial head replacement and 58.1 % in patients treated with ORIF.

Satisfactory rate

The forest plot of satisfactory rate indicated that statistical differences also existed between the two surgical techniques in treatment of Mason type III radial head fractures ($P = 0.04$, $I^2 = 63$ %) (Fig. 2). For satisfactory and unsatisfactory rates, Table 3 was presented in detail. The satisfactory rate was 91.7 % in patients treated with radial head replacement and 51.6 % in patients treated with ORIF.

Discussion

The current study revealed that ORIF had higher complication rate and lower satisfactory rate than radial head replacement in treatment of Mason type III radial head

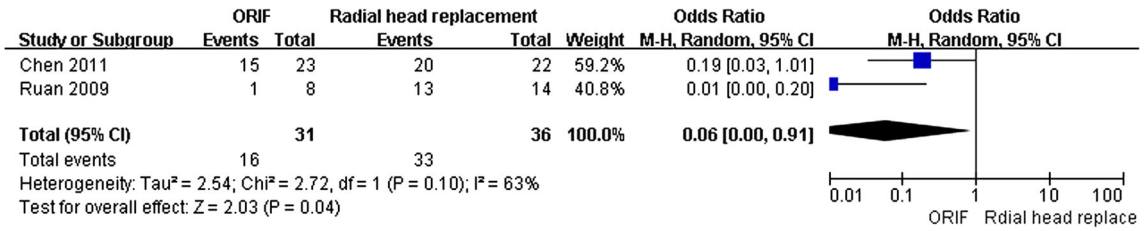

Fig. 2 Results of the meta-analysis for satisfactory rates for open reduction and internal-fixation and radial head replacement groups

Table 3 Satisfactory and unsatisfactory rate

Author	Number of patients (%)							
	RHR				ORIF			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Chen et al. [12]	15 (68.2 %)	5 (22.8 %)	1 (4.5 %)	1 (4.5 %)	9 (39.1 %)	6 (26.1 %)	5 (21.7 %)	3 (13.1 %)
Ruan et al. [13]	9 (64.3 %)	4 (28.6 %)	1 (7.1 %)	0 (0 %)	0 (0 %)	1 (12.5 %)	4 (50 %)	3 (37.5 %)
Total	24 (66.7 %)	9 (25.0 %)	2 (5.6 %)	1 (2.8 %)	9 (29.0 %)	7 (22.6 %)	9/31 (29.0 %)	6 (19.4 %)

ORIF open reduction and internal-fixation, *RHR* radial head replacement

fractures. However, the result did not have much power as expected for the relatively small number of participants. As for the two included studies, neither of them clearly described the randomized method nor mentioned allocated concealment, so it might not allow for a reliable conclusion because of high risk of performance bias, measuring bias and selective bias. Therefore, future research should clearly spell out the randomized method and allocation conceal. More high-quality multicenter randomized controlled trials were still needed to compare the two surgical techniques in treatment of Mason type III radial head fractures.

This study revealed a higher complication rate for ORIF than radial head replacement for Mason Type III radial head fractures (58.1 % versus 13.9 %). As for satisfactory rate, this current study was lower for ORIF than radial head replacement for Mason Type III radial head fractures (51.6 % versus 91.7 %). One study reported that 92.9 % (13/14) patients with a Mason Type III comminuted fracture with more than three articular fragments treated by ORIF had an unsatisfactory result [4]. However, of the 12 patients with a Mason Type III comminuted fracture with two or three simple fragments, none had early failure, all had an arc of forearm rotation of >100° [4]. The finding by Koslowsky et al. [14] was that 12 patients with Mason type III fractures treated by ORIF had 100 % satisfactory rates (excellent in eight and good in four). Thus, we predicted that complication rate might be similar between ORIF and radial head replacement for Mason Type III comminuted fractures with two or three simple fragments, but for Mason Type III comminuted fractures with more than three articular fragments, ORIF might be not a better surgical technique.

Bone nonunion/bone absorption was the main complication of ORIF in treatment of Mason type III radial head fractures, and its percentage was 50 %. This phenomenon could be explained that ORIF caused more soft tissues trauma. Moreover, due to a small number of studies were included in this current systematic review and meta-analysis, complications like pain or loosened devices were not reported in the included studies.

Given the available evidence, radial head replacement appeared to reach better outcomes in patients of Mason type III radial head fractures followed 5 years or less. However, radial head replacement also had several limitations. First, the insertion of a metal prosthesis was too large in longitudinal length [15, 16], which could cause subluxation of the elbow and capitellar wear. Second, only a few prosthetic radial head designs attempted to recreate the anatomy of the radial head precisely [17]. Third, replacement prosthesis revision might be needed every 10–15 years after surgery, and its cost was much higher than that of ORIF. Therefore, to get a more objective outcome, more high-quality multicenter randomized controlled trials comparing ORIF with radial head replacement were still needed.

Conflict of interest Both authors have contributed significantly and are in agreement with the content of the manuscript. Both authors have no relevant financial relationships to disclose.

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