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Operative Management of Unstable Radial Head Fractures in a Young Active Population

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Abstract

Background: Radial head and neck fractures are the most common elbow fracture in the general adult population; however, the optimal treatment for radial head fractures remains a topic of ongoing clinical controversy. The purpose of this study was to determine the rate of return to function, complications, and reoperation following operative management of unstable radial head fractures in a young, active patient population with intense upper extremity demands. **Methods:** A military health care database was queried for all US military servicemembers undergoing open reduction with internal fixation (ORIF; Current Procedural Terminology [CPT] code: 24665) and radial head arthroplasty (RHA; CPT code: 24666) between 2010 and 2015. All patients with minimum 2-year follow-up were included. Univariate and chi-square analyses were performed to evaluate the association between potential risk factors and the primary outcome measures. **Results:** A total of 67 ORIF (n = 69 elbows) and 10 RHA patients were included. The average age was 31 ± 8.0 years. At mean follow-up of 3.5 ± 1.1 years, 90% of patients overall were able to return to active military service, 96% of which with unrestricted upper extremity function. Nearly one-third (31.2%) of patients developed at least 1 postoperative complication. RHA has higher overall complication rates (70% vs 48%) when compared with ORIF, but this finding did not reach statistical significance ($P = .073$). However, RHA had significantly higher rates of implant failure (20% vs 2.9%, $P = .0498$). Seventeen (21%) individuals required reoperation, 5 of which (6.3%) were revision procedures. Dislocation, coronoid fracture, and concomitant ligamentous repair portended a significantly increased risk of sustaining 1 or more complications ($P < .05$), while dislocation and requirement for ligamentous repair independently predicted revision surgery ($P < .05$). **Conclusions:** Arthroplasty and ORIF are both viable options for treating unstable radial head fractures in a young, athletic population, offering comparable return to function despite increased complications with RHA.

Keywords: radial head fracture, radial head arthroplasty, open reduction with internal fixation, functional outcomes, complications, reoperation

Introduction

Radial head and neck fractures are the most common elbow fracture in a general adult population, accounting for approximately 4% of all fractures and 75% of all elbow fractures.[5,26] Despite their frequent presentation, the optimal treatment for radial head fractures remains a topic of ongoing clinical controversy. While nondisplaced, stable, partial articular injuries without a mechanical block to motion may be managed conservatively without surgery, operative intervention is recommended in the setting of a significant displacement, intra-articular incongruity, complete articular fractures, unstable fracture fragments, comminution, and/or more associated injury patterns, such as fracture dislocations.[13,24]

Radial head resection has historically been the treatment of choice for complex, nonreconstructible radial head fractures,[2,4] particularly those without involvement of the interosseous membrane. However, resection has largely been replaced by radial head arthroplasty (RHA) due to an improved understanding of the long-term sequelae associated with isolated resection, which can include alteration in

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Table 1. Patient Demographics.

Demographics	Overall	RHA (n = 10)	ORIF (n = 69)	*P* value
Age	31.0 ± 8.0	28.7 ± 5.6	31.3 ± 8.3	.3386
Male	67/77 (87.0%)	8 (80.0%)	59 (88.1%)	.6102
Junior enlisted rank (E1-5)	46/77 (59.7%)	6 (60.0%)	40 (59.7%)	1
Right upper extremity	43/79 (54.4%)	4 (40.0%)	39 (56.5%)	.4988

Note. Percentages reported out of total number of patients (N = 77). Right upper extremity N = 79, 2 patients with bilateral injury. RHA = radial head arthroplasty; ORIF = open reduction with internal fixation.

ulnohumeral kinematics, proximal migration of the radius, ulnar impaction, and accelerated radiocarpal osteoarthrosis.[2,3,15] Coupled with modern improvements in implant technology and internal fixation systems, RHA offers an alternative strategy to open reduction with internal fixation (ORIF) for highly comminuted or unstable radial head fractures due to the difficulty in achieving a stable anatomic reduction.[1,9,16,23,25,28] The clinical outcomes are mixed in the existent literature.[1,8-10,16,21,23,25,28,30] While there is evidence suggesting improved short-term functional benefits of RHA over ORIF,[9,16,23,25] these may be offset by long-term complications of implant loosening, failure, and ultimately revision.[8,10,21] Moreover, there is presently no comparative investigation evaluating treatment options in a young, active cohort with higher implant demands.

The purpose of this study was to determine the rate of return to preoperative upper extremity function, perioperative complications, and reoperation rates between RHA and ORIF for unstable radial head fractures in a young, active population. In addition, we sought to elucidate prognostic variables significantly associated with these primary outcomes of interest. We hypothesized a moderate (60%-80%) rate of return to preinjury level of upper extremity function as well as a significant rate of revision surgery (20%-30%) given the intense upper extremity demands.

Methods

Following Institutional Review Board (IRB) approval, the Military Health System Management Analysis and Reporting Tool (M2) was queried for all US military servicemembers undergoing ORIF (Current Procedural Terminology [CPT] code: 24665] and RHA (CPT code: 24666) between 2010 and 2015. All radial head fractures in active-duty military patients were included. However, all other health care beneficiaries, those who underwent operative fixation of distal humerus or comminuted olecranon fractures, those of nonmilitary or retired status at the time of surgery, and patients with under 24-month minimum follow-up were excluded.

Demographic and occupational data were extracted from the database, including age, military rank, and branch of service. The investigators then performed line-by-line analysis of the Armed Forces Health Longitudinal Technology Application (AHLTA) electronic medical record to confirm the diagnosis, surgical procedure, date of surgery, as well as to collect additional patient-based (sex, military rank, laterality, handedness), injury (Mason classification,[17] concomitant fracture, ligamentous injuries, or elbow dislocation), and surgical variables (eg, technique, concomitant procedures). Clinical and functional outcomes including perioperative complications; postoperative range of motion (ROM); Disabilities of the Arm, Shoulder, and Hand (DASH) scores; secondary surgical interventions; return to upper extremity activity and military duty; and deployment history were also recorded. When available, radiographic records were reviewed to confirm fracture classification and surgical constructs. The primary outcomes of interest were return to full activity, final ROM, and rate of complications or reoperation.

Statistical means with standard deviation (SD) were calculated for the continuous variables. Categorical data were expressed as frequencies or percentages. Univariate and chi-square analysis was performed to evaluate the association between potential risk factors and the primary outcome measures. A P value of less than .05 was considered statistically significant.

Demographics

There were 67 patients who underwent 69 ORIF and 10 patients who underwent RHA procedures (Table 1). The average age was 31 ± 8.0 years and 87% were male. There were no significant differences between the RHA and ORIF subgroup demographics ($P > .05$).

Results

Injury Characteristics

The dominant extremity was involved in just over half (54.8%) of the cases. Thirty injuries were classified as Mason II, 27 as Mason III, and 5 as isolated Mason-Johnston IV fractures by the operative surgeon (Table 2). The remaining injuries were classified as radial head fractures in

Table 2. Injury and Surgical Characteristics.

Injury characteristics	Overall	RHA (n = 10)	ORIF (n = 69)	*P* value
Dominant extremity involvement[a]	21/40 (52.5%)	4/9 (44.4%)	17/31 (54.8%)	.7116
Mason classification				
Mason II	30/79 (38.0%)	0 (0.0%)	30 (43.5%)	.0111
Mason III	27/79 (34.2%)	6 (60.0%)	21 (30.4%)	.0824
Mason IV	5/79 (6.3%)	1 (10.0%)	4 (5.8%)	.5013
Monteggia fracture variant	4/79 (5.1%)	1 (10.0%)	3 (4.3%)	.4246
Terrible triad	13/79 (16.5%)	2 (20.0%)	11 (15.9%)	.666
Elbow dislocation	22/79 (27.8%)	4 (40.0%)	18 (26.1%)	.4524
Coronoid fracture	14/79 (17.7%)	2 (20.0%)	12 (17.4%)	1
Coronoid fracture fixation	6/79 (7.6%)	2 (20.0%)	4 (5.8%)	.1429
Ulna fracture	4/79 (5.1%)	1 (10.0%)	3 (4.3%)	.4246
LUCL repair	21/79 (26.6%)	4 (40.0%)	17 (24.6%)	.443
Concomitant injury	13/79 (16.5%)	0 (0.0%)	13 (18.8%)	.1945

Note. Concomitant injury comprises other injuries besides radial head fracture to include contralateral radial head fracture. Percentages reported out of total number of injuries (N = 79). RHA = radial head arthroplasty; ORIF = open reduction with internal fixation; LUCL = lateral ulnar collateral ligament.
[a]Hand dominance available on 40 patients, 2 bilateral injury patients excluded.

Table 3. Patient Outcomes.

Outcomes	Overall	RHA	ORIF	*P* value
Range of motion				
Flexion	132 ± 12 (79/79)	131 ± 9.1	133 ± 12.4	.684
Limited (<130°)	32.9% (26/79)	30.0% (3/10)	33.3% (23/69)	1
Extension	8.6 ± 9.9 (79/79)	13.7 ± 9.1	7.8 ± 9.9	.0773
Limited (>30°)	2.5% (2/79)	0.0% (0/10)	2.9% (2/69)	1
Flexion-extension arc	122 ± 23 (79/79)	117 ± 15.9	123 ± 24.6	.2469
Limited (<100°)	10.1% (8/79)	10.0% (1/10)	10.1% (7/69)	1
Pronation	80.0 ± 15.9 (79/79)	74.8 ± 27.6	80.7 ± 13.6	.5155
Limited (<50°)	5.1% (4/79)	10.0% (1/10)	4.3% (3/69)	.4246
Supination	73.4 ± 23.4 (79/79)	76.5 ± 18.6	73.0 ± 24.1	.6725
Limited (<50°)	15.2% (12/79)	10.0% (1/10)	15.9% (11/69)	1
Pronosupination arc	151 ± 40 (79/79)	151 ± 45.0	151 ± 39.9	.8321
Limited (<100°)	13.9% (11/79)	10.0% (1/10)	14.5% (10/69)	1
DASH score	17.3 ± 15.6 (20/79)	13.2 ± 5.5 (5/10)	18.6 ± 17.7 (15/69)	.3167
Return to duty	89.6% (69/77)	90.0% (9/10)	89.6% (60/67)	1
Return to unrestricted function	95.7% (66/69)	88.9% (8/9)	96.7% (58/60)	.3469
Deployment postoperatively	75.0% (18/24)	100% (2/2)	72.7% (16/22)	1
Follow-up time, y, mean (SD)	3.6 (1.1)	3.4 (1.2)	3.6 (1.1)	.5553

Note. Percentages reported out of total number of injuries (N = 79). RHA = radial head arthroplasty; ORIF = open reduction with internal fixation; DASH = Disabilities of the Arm, Shoulder, and Hand.

the setting of terrible triad injuries (n = 13), which includes an additional elbow dislocation and coronoid process fracture, and Monteggia variants (n = 4), which includes a proximal ulnar fracture and radial head dislocation. Twenty-two patients (27.8%) had an associated dislocation, and 21 underwent lateral ulnar collateral ligament (LUCL) repair (26.6%). Fourteen (17.7%) had an associated coronoid fracture, with 6 undergoing coronoid fixation.

Outcomes

The average final follow-up was 3.4 ± 1.1 (2.1-5.5) years. Mean ultimate flexion-extension and pronation-supination arcs of motion were 122 ± 23° and 151 ± 40°, respectively. Of these, 86% of patients demonstrated a functional ROM, defined as greater than 100° of total motion in both flexion-extension and pronation-supination (Table 3). A total of 20

Table 4. Complications, Reoperations, and Revision Procedures.

Complications	Overall	RHA	ORIF	*P* value
Complication (total number of patients)	33.8% (26/77)	60.0% (6/10)	30.0% (20/67)	.0785
Complication (total number of injuries/elbows)	50.6% (40/79)	70.0% (7/10)	47.8% (33/69)	.0730
Average number of complications/elbow (SD)	0.51 (0.83)	0.70 (0.67)	0.48 (0.85)	.4334
Heterotopic ossification	16.5% (13/79)	30.0% (3/10)	14.5% (10/69)	.355
Stiffness	12.7% (10/79)	10.0% (1/10)	13.0% (9/69)	1
Posttraumatic osteoarthritis	6.3% (5/79)	0.0% (0/10)	7.2% (5/69)	1
Neurologic injury	5.1% (4/79)	10.0% (1/10)	4.3% (3/69)	.4246
Hardware failure	5.1% (4/79)	20.0% (2/10)	2.9% (2/69)	.0498
Delayed union, nonunion	3.8% (3/79)	0.0% (0/10)	4.3% (3/69)	1
Instability	1.3% (1/79)	0.0% (0/10)	1.5% (1/69)	1
Reoperation (total number of patients)	23.4% (18/77)	30% (3/10)	22.4% (15/67)	.6907
Reoperation (total number of injuries/elbows)	32.9% (26/79)	30.0% (3/10)	33.3% (23/69)	.0753
Average number of reoperations/elbow (SD)	0.33 (0.69)	0.30 (0.48)	0.33 (0.72)	.8880
Hardware removal	8.9% (7/79)	0.0% (0/10)	10.1% (7/69)	.5865
Heterotopic ossification excision	2.5% (2/79)	10.0% (1/10)	1.5% (1/69)	.2386
Capsular/contracture release	6.3% (5/79)	0.0% (0/10)	7.2% (5/69)	1
Delayed ligament reconstruction	1.3% (1/79)	0.0% (0/10)	1.5% (1/69)	.6660
Neurolysis/transposition	3.8% (3/79)	0.0% (0/10)	4.3% (3/69)	1
Manipulation under anesthesia	1.3% (1/79)	0.0% (0/10)	1.5% (1/69)	1
Revision surgery	6.3% (5/79)	10.0% (1/10)	5.8% (4/69)	.5013
Conversion to RHA	4.3% (3/69)	0.0% (0/10)	4.3% (3/69)	1
Revision (ORIF/ORIF or RHA/RHA)	2.5% (2/79)	10.0% (1/10)	1.5% (1/69)	.2386
Resection	2.5% (2/79)	10.0% (1/10)	1.5% (1/69)	.2386

Note. Percentages reported out of total number of injuries (N = 79). Percentages reported out of total number of patients (N = 77). RHA = radial head arthroplasty; ORIF = open reduction with internal fixation.

patients had available DASH scores at final follow-up, with an average of 17.3 ± 15.6. Ninety percent of patients overall were able to return to active military service, 96% of which resumed unrestricted upper extremity function.

Complications

Thirty-one percent of patients went on to develop at least 1 postoperative complication, with an overall rate of 50.6% (n = 40; Table 4). RHA was associated with an increased likelihood of complications (70% vs 48%, P = .073), although this failed to achieve statistical significance. Implant loosening and failure constituted the largest difference in complications between the RHA (20%) and ORIF (2.9%) cohorts (P = .0498). Sixteen (20.8%) individuals required reoperation, including 5 (6.3%) with revision procedures and 2 (2.5%) with salvage radial head resections. There was no significant difference between revision procedures between the RHA and ORIF cohorts (P = .501).

Statistical Analysis

Coronoid fracture was associated with significantly decreased supination (P = .016). Conversely, secondary coronoid fixation was significantly associated with improved pronation (P = .009) and supination (P = .033). Associated ulnohumeral dislocation, coronoid fracture, and LUCL repair were associated with a significantly increased rate of sustaining 1 or more complications ($P < .05$), while dislocation and need for LUCL repair independently predicted revision surgery ($P < .05$). Statistical analysis is displayed in Table 5.

Discussion

The current study critically evaluates comparative surgical and functional outcomes, complications, and reoperation rates between RHA and ORIF for unstable radial head fractures in a high-demand patient population. The authors revealed that 90% of the patients in a young active cohort were able to return to active military duty, with 96% of returning to their preinjury level of function. RHA offered comparable function results with ORIF at short-term clinical follow-up, but patients experienced a nearly 2-fold higher overall complication rate (70% vs 48%) that approached significance (P = .073).

The contemporary literature evaluating return to preinjury level of activity, athletic involvement, or employment following either RHA or ORIF of radial head fractures is limited. In the only known series that evaluates these end

Table 5. Complete Univariate Analysis.

Risk factor	Extension, regression coefficient (SD)	*P* value	Flexion, regression coefficient (SD)	*P* value	Pronation, regression coefficient (SD)	*P* value	Supination, regression coefficient (SD)	*P* value	Nonreturn to duty, OR (95% CI)	*P* value	Nondeployment, OR (95% CI)	*P* value	1 or more complications, OR (95% CI)	*P* value	DASH score, regression coefficient (SD)	*P* value	1 or more revisions, OR (95% CI)	*P* value
Type of surgery: RHA vs ORIF	5.79 (9.81)	.0859	−1.51 (12.1)	.7137	−5.80 (16.00)	.2885	3.78 (23.55)	.6370	0.95 (0.11-8.68)	.9655	0.51 (0.01-23.45)	.7290	3.53 (0.90-13.86)	.0713	−5.36 (15.87)	.5213	1.62 (0.37-7.10)	.5199
Laterality: left vs right	−0.11 (10.01)	.9603	−4.60 (11.86)	.0940	2.38 (16.07)	.5194	−1.85 (23.57)	.7329	1.23 (0.28-5.30)	.7853	1.75 (0.23-13.31)	.5886	0.83 (0.32-2.14)	.6923	−10.11 (15.18)	.1619	1.09 (0.37-3.20)	.8804
Laterality: ipsilateral vs contralateral	0.96 (10.17)	.7649	2.36 (11.54)	.5171	−0.12 (17.27)	.9825	7.52 (21.53)	.2705	0.95 (0.12-7.46)	.9590	0.07 (0.01-2.53)	.1442	1.69 (0.48-5.93)	.4138	20.15 (18.49)	.1420	2.00 (0.48-8.30)	.3396
Rank: junior vs senior/officer	0.62 (10.01)	.7896	3.38 (11.97)	.2275	1.63 (16.10)	.6644	4.83 (23.46)	.3786	13.91 (0.74-262.28)	.0789	1.14 (0.12-10.91)	.9109	1.43 (0.54-3.82)	.4718	3.30 (15.98)	.6771	0.95 (0.32-2.85)	.9302
Age	0.20 (0.33)	.5455	−0.25 (0.46)	.6010	0.15 (0.43)	.7285	0.26 (0.61)	.6745	0.98 (0.89-1.08)	.6784	1.09 (0.91-1.29)	.3554	1.00 (0.94-1.06)	.9122	0.76 (0.52)	.1594	1.06 (0.99-1.13)	.1039
Sex, male vs female	3.06 (9.96)	.3675	−6.54 (11.88)	.1087	−8.22 (15.87)	.1306	−15.28 (23.01)	.0539	1.05 (0.12-9.57)	.9655	1.97 (0.04-90.91)	.7290	0.73 (0.19-2.87)	.6558	−7.14 (15.77)	.4283	0.62 (0.14-2.69)	.5199
Mason: II vs III	1.14 (9.37)	.6560	3.55 (11.96)	.2808	7.57 (15.87)	.0858	8.34 (23.62)	.2003	9.74 (0.47-201.45)	.1409	1.40 (0.12-15.78)	.7854	0.73 (0.19-2.74)	.6349	11.54 (17.88)	.2704	0.92 (0.17-5.02)	.9233
Dislocation: yes vs no	2.51 (9.94)	.3204	−4.00 (11.95)	.1884	−2.77 (16.07)	.4960	−3.85 (23.52)	.5179	2.83 (0.64-12.53)	.1697	1.00 (0.14-7.10)	1.0000	8.57 (2.81-26.12)	.0002	−3.97 (15.94)	.6163	8.17 (2.48-26.85)	.0005
Coronoid fracture: yes vs no	2.68 (9.96)	.3647	−6.75 (11.79)	.0564	−8.10 (15.80)	.0868	−16.58 (22.68)	.0156	3.16 (0.66-15.21)	.1504	0.70 (0.06-7.85)	.7725	7.34 (2.02-26.70)	.0025	−6.42 (15.83)	.4774	2.36 (0.67-8.33)	.1818
Coronoid fixation: yes vs no	6.17 (9.01)	.2167	−4.44 (13.22)	.5346	20.56 (12.78)	.0093	29.17 (23.16)	.0327	19.00 (0.64-568.15)	.0895	7.00 (0.09-572.05)	.3864	2.50 (0.19-32.19)	.4822	−12.15 (6.98)	.2239	7.00 (0.69-70.74)	.0992
Ulna fracture: yes vs no	5.37 (9.94)	.2963	2.31 (12.07)	.7107	−1.15 (16.12)	.8895	5.85 (23.55)	.6302	3.14 (0.29-34.43)	.3481	—	—	2.04 (0.27-15.39)	.4886	−6.17 (15.99)	.7114	3.87 (0.50-29.75)	.1939
LUCL/ligament repair: yes vs no	1.84 (9.98)	.4734	−7.17 (11.64)	.0185	−2.21 (16.09)	.5932	−5.39 (23.46)	.3719	1.70 (0.37-7.84)	.4964	0.40 (0.04-4.24)	.4467	10.23 (3.23-32.42)	<.0001	−1.28 (16.04)	.8723	6.36 (1.98-20.43)	.0019
Concomitant injury: yes vs no	1.61 (9.99)	.5980	2.59 (12.05)	.4825	1.57 (16.11)	.7487	3.54 (23.55)	.6222	0.68 (0.08-6.04)	.7281	0.51 (0.01-23.45)	.7290	1.89 (0.56-6.34)	.3049	10.25 (15.88)	.5371	2.71 (0.75-9.76)	.1276
HO ppx: yes vs no	−3.61 (9.97)	.6151	−7.68 (12.02)	.3756	−9.97 (16.10)	.3902	−11.45 (23.35)	.4961	1.80 (0.04-80.10)	.7613	—	—	10.96 (0.26-466.97)	.2110	—	—	3.93 (0.23-66.60)	.3428

Note. OR = odds ratio; CI = confidence interval; DASH = Disabilities of the Arm, Shoulder, and Hand; RHA = radial head arthroplasty; ORIF = open reduction with internal fixation; LUCL = lateral ulnar collateral ligament; HO ppx = heterotopic ossification prophylaxis.

points, Moro et al found that 88% of patients were able to return to their previous level of function at a minimum 2-year follow-up following RHA for comminuted radial head fractures.[18] By comparison, the average age, however, was 54 ± 14 years and the type and level of physical activity were undefined. While distinct from this prior subset, the current investigation reports a comparably favorable rate of return to activity among a younger and more homogenously active patient population with routine upper extremity demands. In addition, we acknowledge that a 2-year minimum follow-up is relatively short and must be followed by a long-term follow-up in the future.

While functional requirements vary based on specific military occupation and branch of military service, minimum standards for fitness are universally enforced and must be maintained to remain on active duty. Specific to the upper extremity, individuals are uniformly required to perform timed pushups on a semiannual basis, and military patients must perform core military tasks such as carrying and firing a weapon, evading direct and indirect fire, and moving 18 kg with protective gear for at least 91 m. Given these perquisites, the functional demands of this cohort are perceivably much greater than those of the general population, although this may be effectively extrapolated to young, predominantly upper extremity athletes. Likewise, this cohort may have amplified motivation to comply with treatment, rehabilitation, and follow-up considering their active-duty status depends on a full recovery. Despite the significant upper extremity demands placed on these patients, 90% were able to remain on active duty. However, these high demands are likely responsible for the significant complication rate (50%).

There are presently no guidelines for management of unstable radial head fractures in young active patients. Prior to the advent of RHA and improved, low-profile implants for radial head fixation, radial head resection was the treatment of choice for comminuted radial head fractures not amenable to anatomic reconstruction.[4] Although typically reserved for sedentary elderly individuals with isolated radial head fractures, radial head resection has been shown to afford long-term satisfactory results in young patients.[2,7] However, radial head resection has largely fallen out of favor due to concerns over alterations in elbow stability and kinematics,[3] accelerated ulnohumeral osteoarthritis,[2] and the potential for attritional failure of the interosseous membrane.[15] These effects could be compounded by the higher loads across the elbow and increased postoperative expectations in more athletic demographics. Several contemporary studies comparing radial head resection with ORIF, even for more complex fractures, have demonstrated superior results with ORIF.[11,29] In a retrospective series of 28 patients with Mason type III fractures, Zarattini et al showed that the ORIF group had better overall ROM as well as significantly greater strength and standardized functional outcomes than those who underwent resection.[29] Internal fixation has furthermore been found to offer excellent short-term outcomes in patients with Mason III and Mason-Johnston IV fractures.[6,12,14,30] In a study by Ring et al, the authors showed that ORIF of Mason II and Mason III fractures with greater than 3 articular fragments portended significantly worse results than lower grade injuries, particularly in regard to revision rates, limitation in pronosupination, and functional outcome scores.[22] As a result, the authors advocated for RHA for these injury subtypes with more extensive comminution.

Arthroplasty has emerged as comparable alternative to ORIF and has largely replaced radial head resection for the treatment of comminuted radial head fractures.[1,28] A retrospective comparison of RHA with ORIF for 39 terrible triad injuries (23 Mason II, 16 Mason III) found comparable standardized outcome measures and ROM at 18-month follow-up.[28] However, RHA was associated with greater elbow stability and lower short-term reoperation rates. With increasing fracture complexity, specifically Mason III fractures, RHA may contribute to improved short-term patient satisfaction and decreased complication profile.[9,16,23,25] These relative comparison may reflect an inherent selection bias favoring RHA for older individuals with poor bone quality and/or higher energy injuries.

Modern radial head implants have demonstrated mixed long-term outcomes that may offset these short-term benefits, especially in a younger population.[8,10,21] At a mean 12-year follow-up of 44 cases of RHA for Mason-Johnston IV injuries in older individuals of undefined physical demands, the authors noted no cases of loosening or late instability.[10] In a separate analysis of 37 similarly aged patients with metallic, press-fit RHA for unstable Mason II and III radial head fractures, 12 patients (32%) demonstrated symptomatic implant loosening during average 50-month follow-up, with 9 patients (24%) undergoing revision resection.[8] Further analysis revealed that loosening most often occurred within the first 24 months. Popovic et al evaluated the outcomes following bipolar metallic RHA in 55 consecutive patients (average age, 51 years) at mean 8.4 years postoperatively.[21] In this series, 27 patients had radiographic evidence of progressive periprosthetic lucency and 5 had extensive osteolysis with complete implant loosening. Given the preponderance of implant loosening, the authors cautioned against RHA in young active patients. As a result, symptomatic implant loosening remains a significant concern in the long term, especially given the activity demands of younger individuals.

While there were no major differences in functional outcomes following RHA versus ORIF in our series, there was nearly twice the number of complications associated with RHA than ORIF (70% vs 48%, P = .073). RHA was also associated with a significantly greater risk of implant loosening and failure (P = .0498) in the current study, and this is corroborated by recent literature.[27] A retrospective review of mechanisms of modern metallic radial head implant failures showed that painful loosening was the most common indication for reoperation (66%), followed by stiffness

(38%) and instability (19%).[27] The complication and reoperation profiles following ORIF are less well defined. Major complications, including loss of reduction disabling elbow stiffness, ulnar neuritis, and instability, have been reported with an incidence as high as 18% following ORIF.[20] In the same study, reoperation for stiffness at an average of 4 years postoperatively was reported at 9.8%. Stiffness was reported in only 13% of our cohort, although 22% of patients had either functionally limited (<100°) flexion-extension or pronation-supination arcs of motion. Roughly one-half (6.3%) of these patients underwent subsequent capsular release. While our overall revision rate was comparable with existing studies, we report relatively high complication (51%) and reoperation (33%) rates. Yet, despite these rates, the likelihood for a successful return to full preoperative function remains fairly high. This may reflect more minor complications that pose less of a threat to daily functional demands within this population.

Another important finding was that associated coronoid fractures, elbow dislocations, and LUCL injuries predicted a significantly greater risk of complications, reoperation, and revision surgery. Previous investigations have supported improved outcomes with isolated radial head fractures over those with concomitant elbow dislocations.[6,12,19,20] Pike et al retrospectively compared outcomes following ORIF for isolated radial head fractures with those with associated elbow dislocation in a series of 81 patients, the majority of which were heavy laborers or involved in weight-bearing or contact sports.[20] The authors noted twice the amount of major complications as well as an increased necessity for secondary capsular release and prevalence of posttraumatic osteoarthrosis in the complex subgroup. Similarly, Esser et al found that Mason-Johnston IV injuries corresponded to poorer outcomes following ORIF.[6] These variables are likely associated with inferior outcomes given their association with higher energy injuries, as well as more prolonged periods of postoperative immobilization and activity restriction. Interestingly, we found that coronoid fixation resulted in significantly improved ROM. This may be attributed to improved stability and dynamic joint congruity in those select cases necessitating coronoid fixation. Our population is furthermore younger and presumably healthier.

Our findings offer valuable perspective on the management of radial head fractures in a young high-demand patient population. This study is inherently limited by its retrospective nature and its reliance on existing documentation in the medical record. As a result, we are limited to the outcome measures captured by the database and did not have routine access to mechanism of injury, operative reports, radiographic studies, or data on surgeon training or experience. This additionally precluded classification of coronoid fractures. Furthermore, there is an inherent selection bias toward RHA in the setting of more comminuted, complex fracture patterns. Likewise, the external validity may be called into question considering 87% of our cohort was male. Given the limited number of RHA, our statistical analysis is underpowered similar to existing studies, precluding comparisons of outcomes based on fracture severity as well as stratification of outcomes based on type of implant used for either ORIF or RHA. Further comparative studies are warranted in younger active individuals to investigate long-term failure rates.

Conclusion

Arthroplasty and ORIF are viable options for treating radial head fractures in a young, athletic population. We found that 90% of patients were able to return to full activity following surgery. Complication rates were high, though this did not significantly impact return to function. While increased fracture complexity had a negative impact on ROM, complications, and reoperation, there was no significant difference in functional outcomes between RHA and ORIF cohorts.

Authors' Note

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Department of Defense or the US government. Research was performed at the Department of Orthopaedic Surgery, William Beaumont Army Medical Center, Fort Bliss, Texas.

Ethical Approval

This study was approved by the William Beaumont Army Medical Center institutional review board—Package #399155-4: Clinical Outcomes After Shoulder and Elbow Surgery in the Military.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

This study involves no human participants, so informed consent was not sought or required.

Declaration of Conflicting Interests

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