



Complex radial head and neck fractures treated with modern locking plate fixation



Dominik Gruszka, MD*, Tobias E. Nowak, MD, PhD, Tomasz Tkacz, MD, Daniel Wagner, MD, Pol M. Rommens, MD, PhD

Department of Orthopedics and Traumatology, University Medical Center of Johannes Gutenberg University, Mainz, Germany

Background: Internal fixation of complex radial head and neck (CRHN) fractures is difficult, and postoperative complications are common. This study evaluated elbow function and patient clinical status after internal fixation of CRHN fractures with modern locking plates.

Methods: We included 40 patients with 41 fractures (1 bilateral lesion). In 25 patients (61%), a concomitant injury was found. Patients were an average age of 46 years (range, 22–70 years). The mean follow-up time was 36 months (range, 2–70 months). Postoperative assessments included evaluation of range of motion, functional scores, and radiologic findings. We assessed fracture healing, surgical complications, revision surgery, and the need for metal removal.

Results: Of the 34 fractures available for follow-up, 33 (97%) healed well. The mean extension deficit was 6° (range, 0°–30°). The average elbow flexion was 134° (range, 90°–160°), pronation was 70° (range, 30°–90°), and supination was 64° (range, 20°–90°). The Mayo Elbow Performance Score showed a mean of 90 points (range, 65–100 points). We observed no “poor” results. The mean Disability of Arm, Shoulder and Hand score was 16.5 (range, 2.5–58.3; n = 29). All patients continued activity without daily analgesics. There were 12 (34%) complications. In 11 (32%) patients, the plate was removed.

Conclusions: CRHN fractures fixed with modern locking plates and treated as an osseoligamentous lesion exhibited promising midterm results. The new fixation devices represent an improvement in the treatment of this difficult and common fracture while reducing the need for joint replacement or radial head resection. Diagnosis and treatment of concomitant injuries should be emphasized.

Level of evidence: Level IV; Case Series; Treatment Study

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Complex radial head and neck (CRHN) fractures occur primarily in young, active patients, and their treatment is demanding for trauma surgeons. Complications, such as implant malfunction with secondary displacement, nonunion, and bone necrosis, are common.^{11,16,49} Consequently, some authors prefer primary radial head resection or prosthetic replacement over internal fixation.^{20,38,46,53}

Intensive research in the field of elbow joint function has resulted in the identification of loading forces and

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*Reprint requests: Dominik Gruszka, MD, Department of Orthopedics and Traumatology, University Medical Center of Johannes Gutenberg University, Langenbeckstr. 1, D-55131 Mainz, Germany.

E-mail address: dominik.gruszka@unimedizin-mainz.de (D. Gruszka).

stabilizing structures, thus improving the understanding of the role of the radial head.^{10,42,43} CRHN fractures have a high rate of concomitant soft tissue injuries; thus, they need to be recognized as osseoligamentous injuries rather than isolated fractures.^{14,22,24,28} Consequently, simple radial head resection should not be considered as a treatment option in these acute and complex fracture dislocations.^{23,57} In such cases, clinical outcome may be poor.⁴¹

Several studies reveal that internal fixation offers advantages over radial head replacement.^{23,36} The question of when prosthetic replacement produces a better outcome than internal fixation continues to be discussed. The trend to replace instead of fixing the radial head is grounded in a 2002 study by Ring et al⁴⁹ that retrospectively analyzed complex radial head fractures with more than 3 fragments. The authors concluded that the outcome of fixation of such fractures was poor and consequently recommended replacement of the radial head.⁴⁹

At the time of that study, however, no appropriate plate systems to stabilize complex radial head fractures existed. The treatment paradigm of replacing rather than fixing the radial head has persisted since then, even though open reduction and internal fixation (ORIF) with more appropriate hardware may offer a valid alternative.

Radial head replacement allows the surgeon to directly mobilize the joint, thus achieving good early clinical results.^{2,29,52} However, the anatomy of the radial head is variable.^{32,58,59} At present, there is no perfectly anatomic radial head prosthesis on the market. As a result, surgeons must compromise between the patient's anatomy and the design of the prosthesis. In addition, radial head replacement is technically demanding.⁶² "Overstuffing" will inevitably lead to changes in load sharing in the elbow and wrist joint and may result in clinical complaints caused by early degeneration of the joint surfaces.^{55,56} These limitations give rise to poor long-term functional results.

Alternative methods to optimize internal fixation of complex fractures have been developed to overcome the need for prosthetic replacement of the radial head. The use of modern locking plates has led to increased stability in the osteosynthesis of radial head fractures.^{4,5,12,31} However, it remains unknown whether the statement by Ring et al⁴⁹ is still correct and whether the indications for internal fixation using modern implants can be extended to comminuted fractures.

In this study, we assessed joint function and clinical outcome of CRHN fracture treatment using internal fixation with modern locking plates as an alternative to radial head replacement or resection. We also analyzed the effects of additional injuries on the outcome.

Materials and methods

This study was a retrospective case series of CRHN fractures. Fractures were defined as displaced fractures that required operative therapy using methods that were more invasive than simple lag screw fixation. We reviewed all records of patients with a CRHN

fracture managed at our Level I trauma center between August 2008 and November 2013. Eight consultant surgeons were involved in the treatment of these fractures. The study included patients treated with a radial head rim plate (MRP) or a radial head buttress plate (MBP; both Medartis AG, Basel, Switzerland). Of 168 fractures treated operatively, 111 were stabilized with other implants and 11 were treated with head replacement and 5 with radial head resection. Exclusion criteria were simple radial head and neck fractures and fractures treated with radial head replacement or with other implants.

We analyzed 40 patient records with 41 fractures (1 bilateral fracture). In cases of an isolated fracture of the radial head, we chose a direct Kocher approach. If a terrible-triad lesion was present, we opted for the bilateral approach, whereas in cases of a combined lesion with a Monteggia-like fracture, we preferred an extensive dorsal approach through the olecranon.

Outcomes

Postoperative assessments included evaluation of the range of motion (ROM) and completion of the Mayo Elbow Performance Score (MEPS)¹³ and Disability of Arm, Shoulder and Hand (DASH)¹⁸ questionnaires during routine visits to the outpatient clinic. We classified MEPS according to the following scale: excellent (>90 points), good (75-89 points), fair (60-74 points), and poor (<60 points). DASH was scored on a scale ranging from 1 to 100 points. The lower the score, the better were the clinical results.

Where necessary, we obtained x-ray images in 2 planes or computed tomography (CT) scans. In addition, we recorded concomitant injuries and additional interventions for the elbow joint and their effects on the results. We also noted complication rate, fracture healing, need for reoperation with revision procedures or metal removal, and heterotopic ossifications classified according to Hastings and Graham.²¹

Implants

We treated all fractures with APTUS radial head plates (Medartis AG, Basel, Switzerland). Two implants are available in this system: the MRP and the MBP (Fig. 1). Both are multidirectional locking plates (thickness, 1.4 mm) with 2.0-mm screws. Both locking plates are low profile and anatomically formed to fit into the "safe zone."⁸

The MRP was developed to stabilize comminuted fractures of the radial head. Because it extends to the radiocapitellar joint surface, the plate must be positioned correctly in the safe zone. Improper placement will lead to reduced pronation or supination and chondral lesions in the proximal radioulnar joint. The head part of the plate offers 6 locking screw holes in 2 rows for optimal fixation of small fragments. Up to 4 locking screws can be accommodated in the shaft (Fig. 2). The MRP has a width of 19 mm and length of 30 mm.

The MBP is placed distally to the radioulnar joint surface, providing space for the annular ligament. As a result, it is not always necessary to place the MBP in the safe zone. Up to 7 screws can be used in the proximal T arm, and 4 locking screws can be placed in the shaft. The proximal screw orientation is oblique. These screws aim to fix the pieces of the head fracture to the neck of the radius (Fig. 3). The MBP has a width of 21 mm and length of 25 mm.

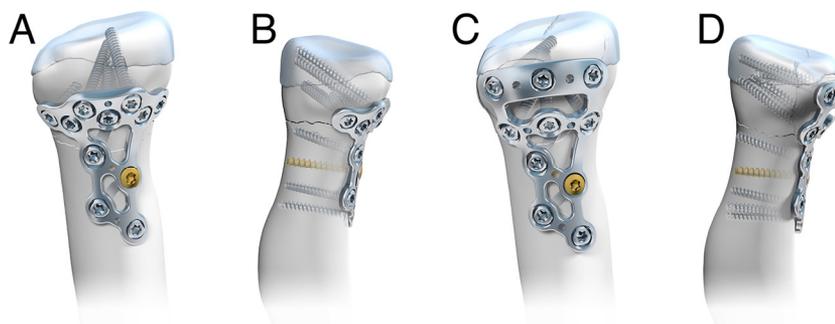


Figure 1 (A) Anteroposterior (B) lateral views of the radial head buttress plate and (C) anteroposterior and (D) lateral views of the radial head rim plate. (Image courtesy of Medartis AG, Basel, Switzerland.)



Figure 2 Clinical example of fixation of a Mason/Johnston type III fracture with a radial head buttress plate. Metal removal in a 22-year-old man was performed due to plate impingement causing severe limitation of supination. The patient recovered fully after the second operation. (A) Anteroposterior and (B) lateral x-ray radial head view. (C) Anteroposterior and (D) lateral x-ray views after internal fixation. (E) Anteroposterior and (F) lateral x-ray views after metal removal.

The choice of MRP or MBP was always made by a consultant surgeon attending the operation, according to the configuration of the fracture fragments. The MRP was preferred in cases of intra-articular fractures of the radial head.

Postoperative algorithm

All patients underwent active and active-assisted physiotherapy from the second day after surgery to regain full ROM and train the active stabilizers. Forearm rotation was performed in 90° of elbow flexion to protect the collateral ligaments where necessary. A sling was used for 2 weeks to reduce pain. In complex cases, we applied an arm splint for a maximum of 10 days, but it was removed during physiotherapy. Weight bearing was not allowed for 6 weeks in all patients.

Statistical analysis

For qualitative variables, we computed frequency distributions and percentages, and quantitative variables are expressed as means and ranges or means \pm standard deviations (SDs). Means were compared using *t* tests, with $P \leq .05$ considered statistically significant. The data were processed and analyzed using the SPSS 22.0 software (IBM, Armonk, NY, USA).

Results

We included 16 women (40%) and 24 men (60%) in this analysis. Patients were a mean age of 46 years (range, 22-70 years) at the time of trauma. There were 3 type II fractures, 30 type III fractures, and 8 type IV fractures categorized according to the modified Mason/Johnston classification.^{26,40} All Mason II fractures involved the radial neck and could not be treated with simple screw fixation and were therefore included in this analysis. Eleven (27%) CRHN fractures involved 4 or more fragments. Three patients had bilateral fractures. The first patient underwent bilateral locking plate fixation, and both fractures were included in the present study. In the second patient, the fracture on one side was fixed with a locking plate, and the fracture on the contralateral side was fixed with screws only. In the third patient, the contralateral side was treated conservatively. The frequency of side involvement was almost equal (right side: 51%).



Figure 3 Clinical example of fixation of a Mason/Johnston type III fracture with a radial head rim plate. Metal removal was necessary in this 36-year-old patient because of an over-length of a shaft screw causing irritation of the ulna and crepitation. (A) Lateral view of a 3-dimensional computed tomography (CT) reconstruction shows the shortening of the radial column. Sagittal CT reconstructions of the (B) multfragmented radial head and (C) the broken processus coronoideus. (D) Coronal CT reconstruction of the 90° rotated rim-fragment of radial head. (E) Anteroposterior and (F) lateral x-ray views after internal fixation. (G) Anteroposterior and (H) lateral x-ray views after metal removal.

Seven patients were lost to follow-up. Mean follow-up time was 36 months (range, 2-70 months). There were 2 patients with a 2-month follow-up. One patient needed complete metal removal with radial head resection due to peri-implant infection and failure of fixation. This patient was not monitored any further. The second patient achieved a maximal flexion of 110° and a residual extension deficit of 10°, with full pronation and supination and no pain after 2 months. Of the 34 fractures that were monitored, 33 (97%) healed, and 2 fractures exhibited incomplete fusion. These patients were satisfied enough with the surgical outcome and refused further operative procedures.

In 25 fractures (61%), we found a concomitant injury other than an isolated radial head fracture (Supplementary Table S1). Overall, 10 fractures (24%) were accompanied by injuries involving regions other than the elbow. In 19 patients (46%), there was an additional injury to the ipsilateral elbow. Overall, 10 fractures (24%) were accompanied by a fracture of the coronoid process. Elbow dislocation was observed in 9 patients (22%), and 6 patients (15%) sustained a lateral collateral ligament (LCL) lesion. Terrible-triad injury and Monteggia-like fractures occurred in 4 patients (10%) each. Less common injuries were also observed, including an Osborne-Cotterill lesion or fracture of the capitulum in 2 patients (5%) each, and an Essex-Lopresti fracture and medial collateral ligament (MCL) lesion in 1 patient (2.5%) each. We observed no simultaneous ruptures of the MCL and LCL.

The operations were performed an average of 6 days (range, 1-24 days) after the trauma. The type of plate was

selected by the surgeon according to the fracture configuration determined preoperatively or intraoperatively. The MBP was used in 25 patients (61%), and the MRP was used in 15 (39%).

Additional fixation was needed in 29 patients (71%). In 14 patients (34%), sole plating of the radial head was not sufficient, and additional free screws were used. The remaining patients needed ligament refixation or additional osteosynthesis of another bony lesion.

Among the 34 fractures that were monitored, we observed 11 (32%) complications. Reoperation was required in 13 fractures (38%), and revision surgery to correct the fixation or functionality of the elbow joint was performed in 7 fractures (21%). A revision/metal removal was performed in 3 patients due to hardware penetration. There were no statistically significant differences in outcomes between the groups with and without concomitant injuries. In 11 fractures (32%), the plate was removed. The mean time to metal removal was 11 months (range, 1-27 months).

One patient had to undergo early revision surgery to correct plate fixation because the fracture displaced postoperatively. After this reoperation, the fracture healed without further complications. Early peri-implant infection with *Staphylococcus aureus* occurred in 2 patients. The first fracture healed after revision with débridement of the wound and postoperative intravenous antibiotics, but the clinical result was unsatisfactory, with a fair MEPS result (60 points) and the second lowest DASH score (54.1 points) among the study cohort. The second patient who underwent metal removal

and radial head resection due to severe infection was mentioned above. There were 5 fractures with functionally relevant periarticular ossifications according to Hastings and Graham classification (grade 2 or higher); 2 of these were resected during plate removal to increase the ROM. Metal removal and arthrolysis with soft tissue balancing was performed in 2 additional patients.

In 1 patient whose radial neck was incongruent, but the head fracture had healed well, we conducted corrective osteotomy of the radial neck using the same implant. Transient radial nerve palsy occurred in 1 patient after the operation due to traction on the deep branch of the radial nerve ventral to the radial neck as a result of improper hook positioning. The nerve injury resolved without further intervention.

The mean extension deficit in the 33 patients who were monitored amounted to 6° (range, 0°-30°). Average elbow flexion was 134° (range, 90°-160°), pronation was 70° (range, 30°-90°), and supination was 64° (range, 20°-90°).

The MEPS was calculated in 29 patients, with a mean of 90 points (range, 65-100 points). The result was “excellent” in 15 patients (52%), “good” in 12 (41%), and “fair” in 2 (7%). There were no “poor” results. Of the 33 patients, 17 (52%) did not complain of pain, 12 (36%) complained of mild pain, and 3 (9%) reported moderate pain. All patients were able to continue normal activity without daily analgesics. One patient presented with asymptomatic mild instability. The mean DASH score was 16.5 (range, 2.5-58.3; n = 29). The patient with the lowest DASH score had additional shoulder complaints that influenced the DASH result. All but 1 patient in the group with 4-fragment or 5-fragment fractures achieved excellent or good MEPS results. These patients had a mean DASH score of 16.5 (range, 2.5-58.3; n = 11), which did not differ from the whole cohort. The *t*-test results for the MBP and MRP with respect to ROM and functional scores did not differ significantly (Table I).

The clinical results in the subgroup of 10 patients with an additional coronoid fracture were less favorable, but the differences between the patients with and without coronoid fractures were not statistically significant (Table I). ROM was reduced (ie, mean extension deficit increased by 1°, flexion deficit increased by 13°, pronation was reduced by 8°, and supination was reduced by 8°) compared with the mean values of the remaining cohort. There was a trend toward lower mean values of MEPS (86 points; *P* = .362) and DASH (28 points; *P* = .102).

The subgroup with Monteggia-like fractures (n = 4) also exhibited somewhat worse functional outcomes, with a mean extension deficit of 3°, mean reduction in flexion of 11°, mean reduction in pronation of 19°, and mean reduction in supination of 8° compared with the means of the remaining cohort (Table I). Again, there was a trend toward reduced mean values of MEPS and DASH scores, but the differences between the group of patients with Monteggia-like fractures and the remaining cohort was not statistically significant (*P* = .643 and *P* = .580, respectively). Two patients in this subgroup

Table I Mean values for ROM and MEPS and DASH functional scores at the final follow-up visit

Group	No.	Deficit in extension, °		Flexion, °		Pronation, °		Supination, °		MEPS, points		DASH, points	
		Mean (SD)	<i>P</i> *	Mean (SD)	<i>P</i> *	Mean (SD)	<i>P</i> *	Mean (SD)	<i>P</i> *	Mean (SD)	<i>P</i> *	Mean (SD)	<i>P</i> *
MBP	25	6 (8.8)	.709	134 (17.2)	.856	74 (18.4)	.143	65 (21.0)	.884	90 (8.7)	.716	16 (16.2)	.894
MRP	16	5 (5.9)	.709	133 (21.1)	.856	64 (20.6)	.143	64 (19.5)	.884	91 (15.5)	.716	17 (20.7)	.894
With 4 and more fragments	11	9 (10.6)	.263	127 (23.7)	.229	63 (21.9)	.254	56 (17.9)	.212	85 (14.8)	.206	19 (18.8)	.751
With coronoid fracture	10	7 (4.1)	.829	123 (24.2)	.127	63 (19.7)	.357	58 (19.9)	.384	86 (16.4)	.362	28 (19.2)	.102
With Monteggia-like fracture	4	9 (7.5)	.464	124 (25.6)	.251	54 (24.2)	.075	58 (20.2)	.493	93 (11.5)	.643	22 (19.2)	.580

ROM, range of motion; MEPS, Mayo Elbow Performance Score; DASH, Disability of Arm, Shoulder and Hand; SD, standard deviation; MBP, radial head buttress plate; MRP, radial head buttress plate. * *P* values derived from independent *t* tests.

required implant removal and resection of heterotopic ossifications or joint arthrolysis.

Discussion

Treatment of CRHN fractures with open reduction and stabilization using angular stable anatomic plates can achieve good clinical results.^{12,23,31,35,37,50,63} Burkhart et al³ initiated biomechanical testing of different fixation methods of the radial head. They compared screws and nonlocking and locking plates, showing that 2.0-mm locking screws provided better fixation than bulky 2.4-mm nonlocking plates and screw fixation.³ The MBP and MRP were designed as 2.0-mm locking plates to optimally fit the complex anatomy of the radial head and address multiple small fragments in comminuted fractures. Comparison of the anatomic fit of the MBP and MRP with that of other precontoured low-profile radial head plates from other manufacturers in cadavers showed the MBP and MRP had the lowest distances from the fixed plate to the outer cortical bone.⁵

In a further cadaveric study, the MBP exhibited the largest covering of the radial head circumference (99°) among the tested plates, providing more options for stabilizing complex radial head and neck fractures. At the same time, the anterior part of the plate, which lies at the very proximal radial neck, was able to partially pass the lesser sigmoid notch during rotation, allowing a significant extension of the safe zone.⁴⁸

The purpose of our study was to evaluate the clinical outcomes of patients with CRHN fractures treated with ORIF using MBP or MRP anatomic locking plates. The observed healing rate was 97%. We found a considerable rate of minor complications (12 [34%]) and reoperations (13 [37%]), but ultimately, all patients were able to preserve their joint mobility and continued their daily activities without taking analgesics. The MEPS result was excellent or good in 27 patients (93%), and the mean DASH score was 16.5 (range 2.5–58.3; n = 29).

Concomitant coronoid or Monteggia-like fractures are more difficult to treat and usually result in poorer functional outcomes.^{19,27} We also noted this trend in our limited cohort, but statistical analysis was not useful due to the low number of patients who were monitored.

The low number of elbow dislocations (9 [22%]) in our cohort may partly have resulted from insufficient documentation in the emergency department. In addition, spontaneous reduction of some elbow dislocations may have occurred, or interventions by paramedics and splinting done at the scene of the accident might have hidden the dislocation from the examiner.

Burkhart et al¹ stated that from a biomechanical point of view, most patients with a complex radial head fracture and concomitant injuries must have suffered at least brief but complete dislocation of the elbow during trauma. They reviewed 16 simple Mason I fractures with long-term complaints and found persistent posterolateral rotational instability due to the

primary lesion of the LCL in 4 fractures. It appears that the complex trauma mechanism involved in radial head fractures remains insufficiently well understood.

Because the radial head transmits 60% of the load in extension, compared with 40% for the ulna, it plays an important role as an elbow stabilizer.^{43,44} CRHN fractures due to axial loading are the result of a high-energy impact, which also leads to ligament rupture or avulsion fractures of the coronoid process.¹⁵ In 39% of the study population, we found concomitant lesions of the ipsilateral elbow. We thus confirm the notion that CRHN fractures rarely occur in isolation but tend to be a marker of complex elbow injuries.

Rhyou et al⁴⁷ emphasized the important correlation between collateral ligament injury and displaced radial head and neck fractures. They examined 29 young, surgically treated patients after an average follow-up time of 32 months (range, 12–63 months). In this cohort, magnetic resonance imaging (MRI) examination showed a high incidence of complete ulnar collateral ligament (UCL) rupture in Charalambous type 3D and 4D fractures and complete lateral UCL rupture in Charalambous type 1D and 2D fractures. Nevertheless, the best treatment for an elbow with a firm end point under valgus stress testing and MRI-confirmed torn UCL was conservative management. The integrity of the overlying flexor-pronator teres muscles, which are known to be secondary stabilizers, was believed to prevent instability in cases of UCL rupture.

MRI was not part of our treatment protocol for patients with CRHN fractures because this has shown limited clinical value. This may explain the small number of ligamentous ruptures identified in our study.

The operative technique of radial head reconstruction depends on the type of fracture. In cases of partial articular fractures, in which only part of the articular surface is disconnected from the radial head, simple screw fixation of loose parts to the stable parts of the articular surface may be sufficient.⁶ In cases of a complete articular fracture, in which the whole articular surface is separated from the radial shaft, the fracture fragments of the head must be reconstructed first and consecutively fixed to the shaft. Locking-plate fixation using the Kocher approach and positioning of the plate in the safe zone are recommended.⁸ The safe zone can be located between the easily palpable radial styloid and the Lister tubercle and transferred to the proximal radius. If fracture fragments do not show any contact with a shaft, an established technique of on-table reduction of head fragments can be used.^{7,30} Fractures with more than 5 small fragments or extensive shear fractures of the cartilage surface accompanied by instability of the elbow joint are unsuited for reconstruction by plate fixation. These lesions are better treated with radial head replacement.^{33,39,51}

In young patients, there is a need to preserve the radial head and avoid radial head excision, which makes internal fixation the preferred treatment option.²³ Kusnezov et al³⁴ found arthroplasty and ORIF were both viable options for treating unstable radial head fractures in young, athletic patients. The

functional outcomes were comparable despite the higher complication rate associated with radial head arthroplasty.³⁴ Charalambous et al⁹ and Solarino et al⁵⁴ postulated that radial head excision in acute situations should be limited to low-demand or elderly patients. Older patients were not sufficiently represented in our cohort, because the average age was 46 years.

van Riet and Morrey⁵⁷ also suggested that whenever possible, the radial head should be preserved or replaced if there is an associated ligamentous or articular injury involving the elbow or the distal radioulnar joint. ORIF should be chosen over prosthetic replacement if possible. Interesting results published by Neumann et al⁴⁵ proved that fixation of the reconstructed head to the shaft is not always necessary and that functional outcome is at least equivalent to that of conventional techniques of fixation of the radial head to the shaft. The recognition that multiple locking screws in the radial head can support smaller parts of the articular surface leads to the concept of a “biologic prosthesis” as an alternative to full radial head replacement, even if nonunion in the radial neck occurs. Because the biomechanical properties of the remaining cartilage of the radial head are similar to those of the opposite joint cartilage, onset of arthrosis can be delayed. In our cohort, 2 patients did not experience complete healing of the fracture, but they were satisfied with the results and rejected further procedures.

The same MBP and MRP locking plates were used by Croenlein et al,¹² who treated 24 patients with Mason type III and IV fractures. After a mean follow-up time of 30 months, 17 patients were highly satisfied, and 3 patients were satisfied. Unrestricted ROM was obtained in 10 patients. Only 4 patients exhibited extension and supination deficiencies of 10°. Mean MEPS was 98, and the average 11-item version of the DASH was 3. Our study results are somewhat less impressive, with a mean extension deficit of the elbow of 6° and mean flexion of 134°, whereas mean pronation was 70° and mean supination was 64°. Our patients reached a mean MEPS of 90 points and a mean DASH score of 16.5.

Nonlocking plates were used in a study by Watters et al,⁶⁰ who compared internal fixation of the radial head with arthroplasty in terrible-triad injuries. Of 39 patients with a minimum of 18 months of follow-up, 9 patients with Mason III fractures were treated with modular hand plates manufactured by DePuy Synthes (Warsaw, IN, USA). The groups did not differ with respect to ROM or DASH (15.7 for ORIF vs. 16.1 for arthroplasty). Wu et al⁶¹ also compared radial head replacement to internal fixation of the radial head. Fixation involved either a 2-mm Synthes plate (n = 12) or headless compression screws (n = 16) in Mason III and IV types of radial head fracture. After a mean follow-up period of 43 months, the 3 groups were comparable with respect to ROM and MEPS (83.2 points in the plate group, 85.8 in the arthroplasty group, and 87.7 in the screw-fixation group), but the plate-fixation group exhibited the highest complication rate (50%). These results are similar to those achieved in our study, but new, anatomically formed locking plates may

facilitate stabilization of the fracture fragments in complex radial head lesions.

Because the anatomy of the radial head varies among individuals, reconstruction of the fractured radial head may be difficult, both during arthroplasty and internal fixation. The radial head has a slightly oval shape at the proximal end, and the neck-shaft angle may vary among individuals.^{25,32,48} In a cadaveric study, Giannicola et al¹⁷ reported that even anatomically contoured plates (Mayo Clinic Radial Head Plate System; Acumed, Hillsboro, OR, USA) matched the proximal radius in only 27% of fractures, while the fit was moderate (43.2%) or poor (29.5%) in the remaining fractures). As a result, it might be necessary to bend the anatomically shaped plates to fit the anatomy of the patient. To facilitate plate bending, Giannicola et al recommended obtaining a preoperative radiograph of the contralateral, uninjured proximal radius.

A meta-analysis comprising 58 clinical studies using various surgical methods to stabilize radial head and neck fractures emphasizes the role of ORIF in modern treatment protocols of CRHN.⁶³ Based on the outcome of the meta-analysis, Zwingmann et al⁶³ recommended ORIF as the first-line procedure for Mason III fractures (92% success rate) because this treatment method proved superior to resection or implantation of prostheses. Similar results were reported in Mason type IV fractures. However, a survey of treatment patterns of radial head fractures in the USA revealed that the need for revision at 1 year and 2 years after ORIF is higher than after arthroplasty.³³ The reoperation rate of 35% in our study supports this finding.

This was a retrospective study with a limited sample size that did not allow us to draw statistical conclusions regarding several parameters; however, it was possible to infer correlations and trends. A prospective, randomized study comparing the use of a radial head prosthesis with ORIF using modern locking plates is warranted, but recruitment of a sufficiently large number of study participants is difficult.

Conclusions

Stabilizing CRHN fractures with modern locking plates and treating the fractures as multistructural lesions led to highly satisfactory ORIF results, although minor complications and reoperations occurred at a rate of approximately 35%. We postulate that the new locking devices represent an advancement in the treatment of these complex fractures.

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Supplementary data

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