Capitellum Fracture Fragment Excision: a Case Series

Matthew R. Garner, MD · Patrick C. Schottel, MD · Robert N. Hotchkiss, MD · Aaron Daluiski, MD · Dean G. Lorch, MD

Received: 24 February 2015/Accepted: 29 May 2015/Published online: 1 August 2015
© Hospital for Special Surgery 2015

Abstract *Background:* Fractures of the capitellum are rare injuries, and few studies have reported the results of fragment excision. *Questions/Purposes:* The purpose of this study was to determine range of motion and short-term clinical outcomes for patients treated with capitellum excision. *Methods:* A retrospective review was performed to identify all patients with an isolated capitellum fracture who underwent excision as definitive treatment at our institutions. Mechanism of injury, associated elbow injuries, type of capitellum fracture, complications, and postoperative outcomes including final elbow range of motion (ROM), elbow instability, and Disabilities of the Arm, Shoulder and Hand (DASH) score were recorded. *Results:* Four patients met the inclusion and exclusion criteria of this study. All patients were female with an average age of 69 years (range 42–85). Based on the Bryan and Morrey classification system, three (75%) fractures were classified as type I and one (25%) fracture as type III. The average clinical follow-up was 11 months. Final examination

demonstrated a mean elbow range of motion from 14° (range 0–30) of extension to 143° (range 130–160) of flexion. All patients had full forearm rotation, and there was no clinical evidence of elbow instability. The average DASH score was 18.3 (12.5–24.2) at final follow-up. *Conclusion:* Excision of the capitellum, much like excision of the radial head, results in acceptable short-term outcome scores and elbow range of motion in patients with fractures that are not amenable to open reduction and internal fixation.

Keywords capitellum fracture · capitellum excision · elbow fracture · elbow trauma

Introduction

Coronal shear fractures of the distal humeral articular surface are uncommon, accounting for only 1% of all elbow fractures and 6% of distal humerus fractures [4, 17]. Variations in the size and complexity of the capitellum fracture fragment have been described with two commonly observed patterns being the *Hahn-Steinthal fracture*, which represents a complete fracture of the capitellum [1, 12, 34, 35], and the *Kocher-Lorenz fracture*, involving the articular cartilage and a thin layer of underlying subchondral bone [1, 8, 10, 11, 14, 34]. More recently, with the utilization of three-dimensional imaging, more complicated patterns are being identified [24]. These injuries typically occur as a result of a direct blow to the lateral aspect of the elbow or secondary to axial loading with the elbow in full extension [26]. Greater than 80% occurs in women, which has been attributed to increased cubitus valgus, recurvatum, and osteoporosis [6, 9, 11, 16, 21, 25, 32].

Due to the rarity of this fracture pattern and the variability in fragment size and shape, treatment recommendations vary widely. Closed treatment with immobilization has been advocated by some if anatomic alignment can be maintained [5, 10, 11, 22], but prolonged immobilization of the elbow is

Level of Evidence: Treatment Level IV

Electronic supplementary material The online version of this article (doi:10.1007/s11420-015-9452-x) contains supplementary material, which is available to authorized users.

M. R. Garner, MD (✉) · R. N. Hotchkiss, MD · A. Daluiski, MD · D. G. Lorch, MD
Hospital for Special Surgery,
535 East 70th Street,
New York, NY 10021, USA
e-mail: garnermr@gmail.com

M. R. Garner, MD · R. N. Hotchkiss, MD · A. Daluiski, MD · D. G. Lorch, MD
Weill Cornell Medical College,
New York, NY 10065, USA

P. C. Schottel, MD
The University of Texas-Houston,
Houston, TX 77030, USA

a well-known cause of stiffness. For these reasons, internal fixation with early mobilization is more commonly performed [3, 5, 9–11, 17, 18, 21, 23, 28, 29, 33]. For cases with irreparable, capitellum fractures, hemiarthroplasty, and excision are two other surgical techniques that have also been described [1, 7, 10, 11, 28, 30, 31]. However, no reports of clinical outcomes after hemiarthroplasty have been published and capitellum excision has historically been avoided based on reports of poor clinical outcomes [1, 7, 8, 10, 11, 15].

Some authors have found that capitellum excision results not only in limited range of motion but also in postoperative instability to varus and valgus stress [7, 11]. Not all authors, however, have experienced such disappointing results, and Alvarez et al. advocated the use of surgical excision after reporting excellent results in a small series [1]. In their cohort, only 10% of patients were found to have poor elbow range of motion postoperatively, 60% had no pain, and none were unstable to varus or valgus stress. More recently, a 12-year-old patient with a capitellum shear fracture treated with delayed excision resulted in a complete functional recovery [8].

Over the past decade at our large orthopedic hospital and associated level 1 trauma center, our experience with excision of the capitellum for coronal shear fractures has been limited, but favorable. It was therefore the goal of the present study to describe our experience with this procedure and to determine if fragment excision after coronal shear fracture of the capitellum led to range of motion deficits or elbow instability. A secondary aim was to quantify the mean Disabilities of the Arm, Shoulder and Hand (DASH) score for these patients postoperatively.

Patients and Methods

During a 10-year period (2003–2013) at our institution, all patients that underwent surgical excision of an isolated capitellum fracture by one of the three senior authors were identified and included for study (Fig. 1). After obtaining institutional review board's approval, a retrospective review of each patient's radiographs and clinical course was conducted. Associated elbow injuries as well as postoperative outcomes such as final elbow range of motion (ROM) and DASH score were reviewed and recorded from the final postoperative visit. Other collected data included the type of capitellum fragment as determined by the Bryan and Morrey classification system with McKee modification (Table 1) [4, 16]. All postoperative complications including need for additional surgical procedures were also recorded.

Four patients met the inclusion and exclusion criteria of this study. All injuries were closed and sustained during a fall from standing height. A lateral surgical approach was utilized, and all dissections were performed anterior to the lateral ulnar collateral ligament. After fragment excision, all elbows were examined for varus and valgus instability in the operating room and no ligamentous procedures were performed for any of the four patients. The treating surgeon dictated each

Fig. 1. **a** Preoperative AP and lateral radiographs and **b** postoperative AP and lateral radiographs after surgical excision of an isolated coronal shear fracture of the capitellum.

patient's subsequent postoperative course. Immediate unlimited ROM was instituted for two patients. Of these patients, one had no restrictions while the second was not permitted to begin strengthening until 6 weeks following surgery. The other two patients were immobilized postoperatively in a posterior splint to allow for wound healing. The splint was removed on postoperative day 3 for one patient who was then permitted to use the extremity without restrictions. The other patient had her splint removed on postoperative day 15 at which point passive ROM was started; active ROM began at 4 weeks followed by strengthening at 8 weeks and unlimited use at 4 months.

Results

All four patients were female with an average age of 69 years (range 42–84). Based on the Bryan and

Table 1 Bryan and Morrey classification system with McKee modification [1, 4]

Fracture type	Fracture description
Type I	Large osseous piece of capitellum
Type II	Shear fracture of articular cartilage with little subchondral bone (Kocher-Lorenz fracture)
Type III	Severe comminution
Type IV	McKee modification—coronal shear involving capitellum and trochlea

Morrey classification system, three (75%) fractures were classified as type I and one (25%) fracture as type III. Two (50%) patients had no associated elbow injuries, whereas one patient had a stable, impacted lateral trochlear fragment that was not in continuity with the capitellum fracture and that did not require operative intervention. The final patient reported dislocating her elbow at the time of initial injury but showed no signs of instability at the time of surgery. General patient and injury characteristics can be found in Table 2. In each case, excision was performed for different reasons: (1) comminution, (2) non-union after an open reduction internal fixation (ORIF) attempt, (3) patient preference due to a mechanical block to flexion, and (4) an avascular appearing fragment at the time of surgery. The average clinical follow-up was 11 months (range 2.3–20.4). There were no surgical wound complications, and no patients required a secondary surgery for any reason.

At their final office examination, the patients demonstrated mean elbow range of motion from 14° (range 0–30) of extension to 143° (range 130–160) of flexion (Table 3). All patients had full forearm pronation and supination, and no patients were determined to have postoperative instability. DASH scores were available for two of the four patients, and the mean values were 12.5 and 24.2 (mean=18.3). Results of our study compared to those of previous authors can be seen in Table 4.

Discussion

In the present series, we have retrospectively reviewed four patients who have been treated with fragment excision for vertical shear fractures of the capitellum in

order to determine if they experience functional limitations secondary to elbow range of motion or elbow instability postoperatively. We further intended to quantify clinical outcomes using DASH scores for those with available scoring. Although our numbers are small, all patients achieved functional elbow flexion range of motion and acceptable DASH scores. No patient demonstrated evidence of clinical instability, and no postoperative complications were observed.

We recognize that our study has several limitations. The retrospective nature of our data prevents us from having control over the information collected for each patient. Ideally, all four patients would have had DASH scores, but this was not a routine part of follow-up care for all treating surgeons. Also, despite practicing in a high volume center, we were only able to identify four patients treated for an isolated capitellum fracture with surgical excision. This is likely due to both the rarity of this injury pattern, and the increasing body of literature supporting ORIF as the treatment of choice [3, 5, 9–11, 17, 18, 21, 23, 28, 29, 33]. Follow-up was limited with one patient returning for her last appointment only 2.3 months following surgical excision. This patient also had the worst ROM of the cohort (Table 3), and it is possible that her results may have improved had she has been examined at a later date. Lastly, three of our four patients were treated with excision due to factors that would have precluded primary ORIF (comminution, avascularity, and failed ORIF) and the fourth patient was treated 47 days post-injury after failed non-operative management. These varying indications prevent us from reliably comparing the results of our excision cohort against those treated with ORIF or closed reduction and immobilization.

Despite the limitations of this study, we are encouraged by the results, especially with regard to postoperative range of motion (Table 3). Our four patients demonstrated no deficits with regard to pronation and supination, and all achieved what is considered to be functional flexion and extension (30° extension, 130° flexion). Our results are supported by previous studies, including those by Alvarez et al. in 1975 and Cottalorda and Bouelle as recently as 2009 [1, 8]. Both groups found excellent results with regard to postoperative range of motion. However, these results are in direct contrast to those found by Collet et al. in 1975 who

Table 2 Patient demographics, injury patterns, and duration of postoperative immobilization

	Patient #1	Patient #2	Patient #3	Patient #4
Age	78.3	71.7	42.5	84.8
Time to surgery (days)	12	9	160	47
Follow-up (months)	11.9	2.3	9	20.2
B/M classification (1, 4)	I	III	I	I
Associated injuries	Trochlea fracture	Elbow dislocation	None	None
Reason for excision	Avascular fragment	Comminution (>10 pieces)	Non-union of prior open reduction and internal fixation (ORIF)	Mechanical block to flexion
Postoperative immobilization (days)	15	3	0	0

Table 3 Postoperative elbow range of motion for each patient

	Patient #1	Patient #2	Patient #3	Patient #4
Flexion	130	140	140	160
Extension	0	30	25	0
Supination deficit	0	0	0	0
Pronation deficit	0	0	0	0

treated 8 patients with fragment excision and compared results to 12 patients who underwent internal fixation. They found that three of the eight excision patients had poor results which they defined as limitations of mobility exceeding 30° of extension or 120° of flexion. Further, no excision patient was found to have normal range of motion. Based on these results, they determined that ORIF was superior and excision should be avoided if possible.

It is important to note that no patient in our study demonstrated postoperative elbow instability, and we feel strongly that this is likely secondary to the use of a surgical approach that avoids dissection of the lateral ulnar collateral ligament (LUCL). Although previous authors have cited postoperative instability as a reason to avoid fragment excision [11], the biomechanical consequence of capitellum excision has been tested by Dushuttle et al. who showed that isolated excision of the capitellum in cadaveric specimens did not result in valgus instability of the elbow provided there was no evidence of medial ligamentous injury [10]. Alvarez et al. reported no evidence of instability after capitellum excision in ten patients, and [1] more recently, Root et al. showed a negligible degree of valgus or varus instability after fragment excision in a ligamentously intact elbow [27]. Their conclusion was that isolated capitellar fractures could be excised in cases with an irreparable fracture as the vast majority of daily activities placed a varus and, not valgus, stress on the elbow. Interestingly, these findings are comparable to those seen in biomechanical studies of radial head excision showing that valgus laxity is not a con-

cern provided the medial collateral ligament remains intact [2, 13, 19, 20]. Extending the similarity of these biomechanical findings to clinical outcomes, it would therefore be unsurprising to see acceptable clinical outcomes in selected patients after excision of an isolated capitellar fracture as seen in patients after isolated radial head excision.

With regard to postoperative clinical outcomes, we believe that we were able to show acceptable DASH scores in our small series of patients (12.5 and 24.2). To our knowledge, there are no published studies with validated clinical outcome scores after isolated excision of the capitellum, which prevents us from making direct comparisons. With regard to studies assessing both closed reduction and ORIF, DASH scores in our patients are inferior, but comparable. Puloski et al. recently published a series of seven patients treated with closed reduction under general anesthesia [22]. In this study, patients were permitted gentle active range of motion after 2 weeks of immobilization and DASH scores ranged from 6 to 13 after a mean follow-up of 18 months (range 12–46). Ruchelsman et al. described similar results after ORIF in 16 patients [29]. Comparison between these two studies is limited by the heterogeneity of the injury patterns; however, the results after ORIF showed no postoperative instability, a mean arc of total elbow motion of 123°, no pronation or supination deficits, and a mean Mayo Elbow Performance Index score of 92.

In summary, despite the aforementioned limitations, we believe that fragment excision through a surgical approach that does not violate the LUCL provides acceptable clinical outcomes in patients with isolated capitellum shear fractures that are not amenable to primary ORIF or closed reduction and immobilization. While the cohort size of our study limits the generalizability of our findings, we believe that this procedure should be an option in a surgeon's armamentarium when treating irreparable coronal shear fractures of the distal humerus.

Table 4 Comparison of range of motion deficits and elbow stability for published series of patients with capitellum fragment excision

	# of patients with outcomes	# of patients with trochlear extension, n (%)	Mean flexion deficit (°)	Mean extension deficit (°)	Mean supination deficit (°)	Mean pronation deficit (°)	% with elbow instability
Garner et al.	4	0 (0)	18	14	0	0	0
Cottalorda et al. [8]	1	0 (0)	0	0	0	0	0
Grantham et al. [11]	11	6 (55)	128	22	6	2	36
Alvarez et al. [1]	10	0 (0)	120	15	4	0	n/a

Disclosures

Conflict of Interest: Matthew R. Garner, MD; Patrick C. Schottel, MD; Robert N. Hotchkiss, MD; Aaron Daluiski, MD; and Dean G. Lorch, MD have declared that they have no conflict of interest.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

- Alvarez E, Patel MR, Nimberg G, et al. Fracture of the capitulum humeri. *J Bone Joint Surg Am.* 1975; 57(8): 1093-1096.
- Beingessner DM, Dunning CE, Gordon KD, et al. The effect of radial head excision and arthroplasty on elbow kinematics and stability. *J Bone Joint Surg Am.* 2004; 86-A(8): 1730-1739.
- Bilsel K, Atalar AC, Erdil M, et al. Coronal plane fractures of the distal humerus involving the capitellum and trochlea treated with open reduction internal fixation. *Arch Orthop Trauma Surg.* 2013; 133(6): 797-804.
- Bryan RS, Morrey BF. Fractures of the distal humerus. In: Morrey BF, ed. *The elbow and its disorders*. Philadelphia: WB Saunders; 1985: 325.
- Cheung EV. Fractures of the capitellum. *Hand Clin.* 2007; 23(4): 481-486. vii.
- Clough TM, Jago ER, Sidhu DP, et al. Fractures of the capitellum: a new method of fixation using a maxillofacial plate. *Clin Orthop Relat Res.* 2001; 384: 232-236.
- Collert S. Surgical management of fracture of the capitulum humeri. *Acta Orthop Scand.* 1977; 48(6): 603-606.
- Cottalorda J, Bourelle S. The often-missed Kocher-Lorenz elbow fracture. *Orthop Traumatol Surg Res.* 2009; 95(7): 547-550.
- Dubberley JH, Faber KJ, Macdermid JC, et al. Outcome after open reduction and internal fixation of capitellar and trochlear fractures. *J Bone Joint Surg Am.* 2006; 88(1): 46-54.
- Dushuttle RP, Coyle MP, Zawadsky JP, et al. Fractures of the capitellum. *J Trauma.* 1985; 25(4): 317-321.
- Graham SA, Norris TR, Bush DC. Isolated fracture of the humeral capitellum. *Clin Orthop Relat Res.* 1981; 161: 262-269.
- Hahn NF. Fall von einer besonderes varietat der frakturen des ellenbogens. *Z Wund Geburt.* 1853; 6: 185.
- Jeon IH, Sanchez-Sotelo J, Zhao K, et al. The contribution of the coronoid and radial head to the stability of the elbow. *J Bone Joint Surg (Br).* 2012; 94(1): 86-92.
- Lansinger O, Mare K. Fracture of the capitulum humeri. *Acta Orthop Scand.* 1981; 52(1): 39-44.
- McKee MD, Jupiter JB. A contemporary approach to the management of complex fractures of the distal humerus and their sequelae. *Hand Clin.* 1994; 10(3): 479-494.
- McKee MD, Jupiter JB, Bamberger HB. Coronal shear fractures of the distal end of the humerus. *J Bone Joint Surg Am.* 1996; 78(1): 49-54.
- Mighell MA, Harkins D, Klein D, et al. Technique for internal fixation of capitellum and lateral trochlea fractures. *J Orthop Trauma.* 2006; 20(10): 699-704.
- Mighell M, Virani NA, Shannon R, et al. Large coronal shear fractures of the capitellum and trochlea treated with headless compression screws. *J Shoulder Elb Surg.* 2010; 19(1): 38-45.
- Morrey BF, Chao EY, Hui FC. Biomechanical study of the elbow following excision of the radial head. *J Bone Joint Surg Am.* 1979; 61(1): 63-68.
- Morrey BF, Tanaka S, An KN. Valgus stability of the elbow. A definition of primary and secondary constraints. *Clin Orthop Relat Res.* 1991; 265: 187-195.
- Poynton AR, Kelly IP, O'Rourke SK. Fractures of the capitellum—a comparison of two fixation methods. *Injury.* 1998; 29(5): 341-343.
- Puloski S, Kemp K, Sheps D, et al. Closed reduction and early mobilization in fractures of the humeral capitellum. *J Orthop Trauma.* 2012; 26(1): 62-65.
- Rapariz JM, Martin S, Far-Riera A, et al. Distal humerus shear-fractures: “Built-on” surgical technique. *Int J Shoulder Surg.* 2014; 8(1): 34-37.
- Ring D. Apparent capitellar fractures. *Hand Clin.* 2007; 23(4): 471-479. vii.
- Ring D, Jupiter JB, Gulotta L. Articular fractures of the distal part of the humerus. *J Bone Joint Surg Am.* 2003; 85-A(2): 232-238.
- Rizzo M, Nunley JA. Fractures of the elbow's lateral column radial head and capitellum. *Hand Clin.* 2002; 18(1): 21-42.
- Root CG, Meyers K, Wright T, et al. Capitellum excision: mechanical implications and clinical consequences. *J Orthop Res.* 2014; 32(2): 346-350.
- Ruchelsman DE, Tejwani NC, Kwon YW, et al. Coronal plane partial articular fractures of the distal humerus: current concepts in management. *J Am Acad Orthop Surg.* 2008; 16(12): 716-728.
- Ruchelsman DE, Tejwani NC, Kwon YW, et al. Open reduction and internal fixation of capitellar fractures with headless screws. Surgical technique. *J Bone Joint Surg Am.* 2009; 91(Suppl 2 Pt 1): 38-49.
- Sabo MT, Shannon HL, Deluce S, et al. Capitellar excision and hemiarthroplasty affects elbow kinematics and stability. *J Shoulder Elb Surg.* 2012; 21(8): 1024-1031.e4.
- Sabo MT, Shannon H, Ng J, et al. The impact of capitellar arthroplasty on elbow contact mechanics: implications for implant design. *Clin Biomech (Bristol, Avon).* 2011; 26(5): 458-463.
- Sano S, Rokkaku T, Saito S, et al. Herbert screw fixation of capitellar fractures. *J Shoulder Elb Surg.* 2005; 14(3): 307-311.
- Sen MK, Sama N, Helfet DL. Open reduction and internal fixation of coronal fractures of the capitellum. *J Hand Surg [Am].* 2007; 32(9): 1462-1465.
- Simpson LA, Richards RR. Internal fixation of a capitellar fracture using Herbert screws. A case report. *Clin Orthop Relat Res.* 1986; 209: 166-168.
- Steinthal D. Die isolierte fraktur der eminentia capetala in ellenbogengelenk. *Zentralb Chir.* 1898; 15: 1.