

Functional Outcome of Hahn-Steinthal Fracture Capitellum Fixed with Kirschner-wires Via Posterolateral Approach

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Abstract

Introduction: Isolated coronal shear fractures of the capitellum are extremely rare injuries. Authors continue to differ about the preferred methods of treatment and its results on the functional outcome. If the anatomical reduction is not achieved, elbow function is sub-optimal.

Materials and Methods: A retrospective evaluation of 15 patients, 11 females and 4 males, with Type 1/Hahn-Steinthal fracture capitellum according to Bryan-Morrey classification system, within the age-group (21-50), operated between February 2002 and August 2014 with open reduction and internal fixation in all cases with multiple (2-4) Kirschner-wires (K-wires), (3 K-wires in 11 patients, 2 K-wires in 2 patients, and 4 K-wires in 2 patients) in a Crisscross manner through a minimally invasive posterolateral approach. All 15 patients were available for clinical and radiographic evaluation at a minimum follow-up of 2-year postoperatively. The evaluation of functional outcome was done clinically, radiographically and accessed through Mayo elbow performance index, and the American shoulder and elbow surgeons (ASES) scale.

Results: All the 15 fractures united uneventfully by the 6-month follow-up on an average. The average Mayo score was 99, i.e., excellent in all 15 cases. The average ASES score was 91. Range of motion (ROM) in flexion/extension averaged 154°, while ROM in supination/pronation averaged 89°. All fractures healed in anatomic position with, no arthritis, avascular necrosis or heterotopic ossification was observed.

Conclusion: The authors hereby recommend multiple (2-4) K-wires as an effective modality of choice in Type-1 capitellum fractures inserted via a minimally invasive posterolateral approach, hence facilitating early mobilization, to achieve excellent functional outcomes.

Key words: Capitellum, Functional outcome, Hahn-Steinthal fracture, Kirschner-wires, Posterolateral approach

INTRODUCTION

Fracture of the capitellum of the humerus was first reported in 1853 by Hahn of Germany since then fracture of the capitellum has been an extremely rare injury accounting for 0.5-1% of the elbow fractures and 6% of the distal humerus fractures.¹ These fractures are frequently missed on the first examination, which also

contributes to the rarity of these fractures because they are not obvious on anteroposterior (AP) radiographs as the fracture line may not be recognized against the background of the distal humerus. Whereas they are best seen on a true lateral view.² Bryan and Morrey classification modified by McKee, classifies capitellar fractures as Type 1-3 and Type 4.^{3,4} Type 1, often referred to as the Hahn-Steinthal fracture, is a shear fracture in the coronal plane involving most of the capitellum and little or none of the trochlea (Figure 1). Many treatments have been advocated for these injuries including closed reduction (Dushuttle *et al.*, 1985; Ochner *et al.* 1996), open reduction and internal fixation (Ring *et al.*, 2003; Dubberly *et al.*, 2006; Ruchelsman *et al.*, 2008), excision of the fracture fragments (Collert, 1977; Grantham *et al.*, 1981), prosthetic replacement (Jakobsson, 1957; Cobb and

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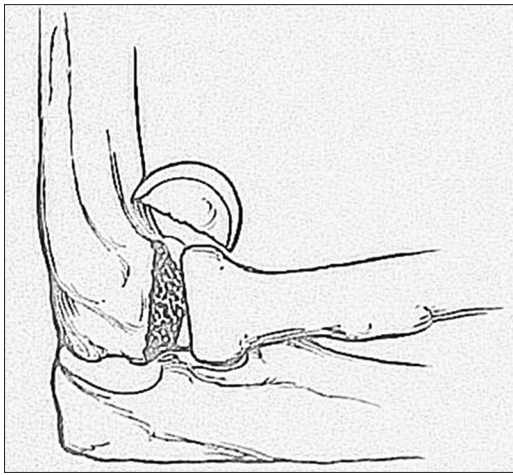


Figure 1: Hahn-Steinthal/Type-1 capitellum fracture

Morrey 1997), and fixation or excision of the fragments under arthroscopy (Hardy *et al.*, 2002).

Closed reduction of Type I capitellar fractures has been reported in a few series.^{5,6} Disadvantages of this treatment are the long period of immobilization and unsatisfactory functional results.^{4,7} Fitz-gerald says: "In all cases, the fragments should be removed as soon as possible after the injury."⁸ But after resection of the capitellar fragment, the remaining raw bone surface predisposes the elbow to capsular adhesions and results in restricted elbow mobility, instability, valgus deformity of the elbow, and risk of subsequent ulnar neuritis.² Lee *et al.* favor the employment of a bone peg or steel pin, while Buxton *et al.* sutures through drill holes or uses a transversely inserted bone peg, running into the trochlea. Immobilization to prevent tearing of the delicate new capillaries with their trailing osteoblasts explains this attitude for mechanical fixation. Various methods of mechanical fixation have been proposed such as Kirschner-wires (K-wires), cortical/malleolar screws, lag screws, absorbable screws, and herbert screws. However, yet there is no universal consensus on the preferred modality of fixation for these fractures. Internal fixation with K-wire has been the historically preferable method of fixation, as the cartilaginous component of the fragment is often very large with a minimal amount of cancellous or subchondral bone.⁹⁻¹¹ However, some studies suggest that K-wires penetrate the articular surface do not provide stable fixation and cast immobilization is mandatory for a long period. K-wires do not offer compression at the fracture site and require subsequent removal.²

In this study, we have tried to demonstrate how K-wires can be used in Type 1 capitellum fractures without damaging the articular cartilage, providing a rigid jigsaw puzzle like reduction with adequate compression, with early immobilisation, with no need for removal and as a

cost-effective method, with excellent results achieved in terms of clinical, radiographic, and functional outcomes (assessed via Mayo elbow score and American shoulder and elbow surgeons [ASES] index).

MATERIALS AND METHODS

Between February 2002 and August 2014, 15 patients who have sustained isolated coronal shear capitellum fracture presented to our hospital (Table 1). They were diagnosed and treated operatively within 2 weeks after injury (range 0-14 days), with a mean of 6 days. They were eleven females and four males; their age ranged from 21 to 50 years with 5 patients younger than 30 years. The right arm was dominant in all 15 patients, whereas the injured arm being left in 11 patients and right in 4 patients (Table 1). The fracture type was determined by a lateral radiograph, which showed a characteristic semilunar fragment detached from the humeral condyle and lying supero-anteriorly to the distal humerus, suggesting a completely displaced fracture of capitellum, a typical Hahn-Steinthal/Type 1 fracture, according to Bryan-Morrey classification system. An AP radiograph did not reveal a definite fracture (Figures 2 and 3). No other associated injuries were detected. Computed tomography-scan was not done in any of the cases due to financial constraints. All 15 patients were available for clinical and radiographic evaluation at a minimum follow-up of 2-year postoperatively.

We underwent open reduction and internal fixation in all cases with multiple (2-4), (3 K-wires in 11 patients, 2 K-wires in 2 patients, and 4 K-wires in 2 patients) K-wires in a criss-cross manner via a minimally invasive posterolateral approach.

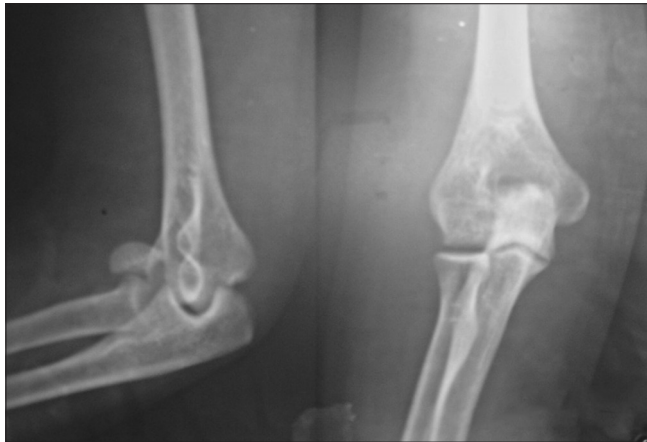
Surgical Technique

We took a gentle curved incision beginning over the posterior surface of the lateral humeral epicondyle, 5 cm proximal to the elbow joint, and then continuing downward up to the radial head posteriorly, taking due care that the incision should not extend beyond the annular ligament to avoid injury to the posterior interosseous nerve. And also fully pronating the forearm to move the posterior interosseous nerve away from the operative field. Incising the deep fascia in line with skin incision, the lateral humeral condyle was exposed by elevating the triceps from it, taking due care to preserve the lateral ulnar collateral ligament origin at the lateral epicondyle. Further retracting the triceps posteriorly and brachioradialis anteriorly, the dissection is continued distally identifying the interval between extensor carpi ulnaris and anconeus (Kocher's interval), after which capsulotomy is done by incising the capsule anteriorly over the capitellum. Subperiosteal reflection of brachioradialis, extensor carpi

Table 1: Patient demographics

S. No.	Gender	Age	Dominant	Injured	Mechanism	Type	Follow-up months	Management
1	Female	21	Right	Left	On extended elbow	1	28	ORIF with 3 K-wires
2	Female	36	Right	Right	On extended elbow	1	24	ORIF with 2 K-wires
3	Female	27	Right	Left	On extended elbow	1	36	ORIF with 3 K-wires
4	Male	35	Right	Left	On extended elbow	1	48	ORIF with 3 K-wires
5	Male	38	Right	Left	On extended elbow	1	35	ORIF with 3 K-wires
6	Female	42	Right	Right	On extended elbow	1	29	ORIF with 3 K-wires
7	Male	50	Right	Left	On extended elbow	1	32	ORIF with 3 K-wires
8	Male	41	Right	Left	On extended elbow	1	24	ORIF with 3 K-wires
9	Female	31	Right	Right	On extended elbow	1	28	ORIF with 3 K-wires
10	Female	46	Right	Left	On extended elbow	1	36	ORIF with 4 K-wires
11	Female	39	Right	Left	On extended elbow	1	18	ORIF with 3 K-wires
12	Female	50	Right	Left	On extended elbow	1	36	ORIF with 3 K-wires
13	Female	27	Right	Left	On extended elbow	1	48	ORIF with 3 K-wires
14	Female	22	Right	Right	On extended elbow	1	40	ORIF with 4 K-wires
15	Female	30	Right	Left	On extended elbow	1	30	ORIF with 2 K-wires
Average	73% Females	35 years					32 months	

K-wires: Kirschner-wires

**Figure 2: Pre-operative X-ray****Figure 3: Pre-operative X-ray**

radialis anteriorly and triceps posteriorly will improve joint exposure and make space for K-wire insertion from the posterior aspect. Further manipulation of the fragment by simply pressing it into the joint space, allowed a Jigsaw puzzle

like reduction, which was held in correct position by all the natural forces in that region like the cup-like head of the radius, the humerus, the lateral ligaments, and the ulna, which was further consolidated by inserting multiple (2-4) K-wires from posterior to anterior direction in a criss-cross manner to give rotational stability, at the same time avoiding any penetration of the articular cartilage (Figures 4 and 5). The K-wires were buried into the posterior aspect of the humerus to avoid any impingement. The radial wrist extensors and the triceps are repaired to the soft-tissue cuff on the lateral supracondylar ridge, and the Kocher interval is closed in continuity with the proximal exposure of the lateral column to preserve the precarious blood supply of the capitellum. An intraoperative dynamic examination showed satisfactory stability of the osteosynthesis and anatomic articular congruity. Postoperatively all the patients were immobilised in an above elbow slab at 90° flexion, with forearm in supine position for 3 weeks. At first follow-up after 3 weeks, slab was removed and aggressive physiotherapy was started. At subsequent follow ups clinical examination for evaluation of ROM including the arc of flexion-extension measured by handheld goniometer, and stability evaluated by history and provocative physical examination manouvre for valgus and varus. Serial AP and lateral radiography were done for fracture union, osteonecrosis, heterotopic ossification (HO), or osteoarthritis.

Functional evaluation at the last visit was done with the use of [A] ASES assessment form,¹² [B] the Mayo elbow performance index (MEPI) which is based on 100 points scale.¹³

RESULTS

All the 15 fractures united uneventfully by the 6-month follow-up on an average. The average Mayo score was 99,

i.e., excellent in all 15 cases. The average ASES score was 91. Range of motion (ROM) in flexion/extension averaged 0-154° (Figures 6-9), while ROM in supination/pronation averaged 89° (Table 2).

Radiographically, there were no complications seen such as arthritis, avascular necrosis, or heterotopic ossification. There were also no instances of instability, nonunion, hardware failure, or iatrogenic fracture on



Figure 4: Post-operative X-ray



Figure 7: Range of extension

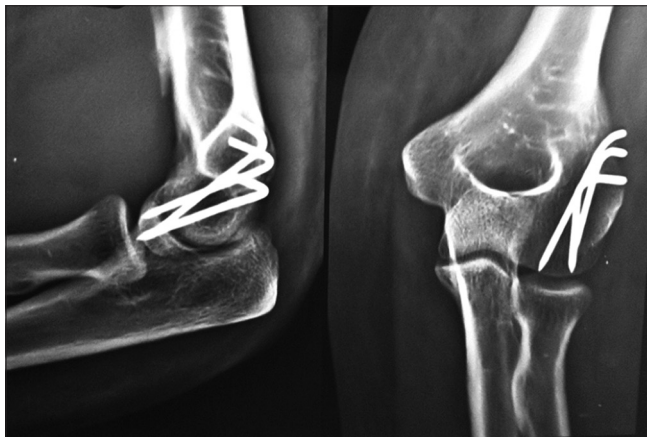


Figure 5: Post-operative X-ray



Figure 8: Range of flexion



Figure 6: Range of flexion



Figure 9: Range of extension

Table 2: Clinical outcomes

S. No.	Mayo score	Total ASES index	ROM-flex/ext	ROM-sup/pron	Complication
1	100	97	0-160	90-90	None
2	100	90	0-155	90-90	None
3	100	89	0-145	90-90	None
4	100	90	0-152	90-90	None
5	100	98	0-160	90-90	None
6	100	86	0-145	90-80	None
7	100	90	0-155	90-90	None
8	100	94	0-160	90-90	None
9	100	92	0-160	90-90	None
10	85	82	0-140	80-80	Mild pain
11	100	88	0-150	90-90	None
12	100	91	0-160	90-90	None
13	100	93	0-156	90-90	None
14	100	95	0-160	90-90	None
15	100	90	0-160	90-90	None
Average	99	91	0-154.5	89.33-88.66	

ASES: American shoulder and elbow surgeons, ROM: Range of motion

the most recent radiographs (Table 3). All patients were satisfied with the outcome and returned to their pre-injury status resuming all daily routine activities, except one who was concerned about the mild pain at his last follow-up.

DISCUSSION

Presently, the preferred method of treatment for capitellum fractures is open reduction and internal fixation, and a wide variety of techniques are described such as K-wires, compression screws, Herbert screws, and biodegradable pins.

Cannulated screw fixation enables adequate interfragmentary reduction and compression. Contrary to pin or wire techniques, this type of fixation does not require further hospital admissions and the rehabilitation program starts earlier and is uninterrupted.^{14,15}

Cannulated screws introduced posteriorly through the humerus into the capitellum avoid this problem.¹⁶ However, if the osteochondral fragment is small, the screw may split it. Headless double-threaded screws (Herbert type) could also be used.^{14,10} However, we feel that for thin fragments this type of screw can fail to confer satisfactory fixation due to its compression mechanism. Headless screws such as Herbert screw and biodegradable screws can be used without the need for removal; however, these are substantially expensive and special instruments and experience are needed when compared with standard convenient screws. Poynton *et al.*, in his study, divided patients into two groups consisting of K-wire fixation and Herbert screw fixation, and then, reported better results in the screw group.¹⁴

Table 3: Radiographic outcomes

S. No.	Arthritis	Non-union	HO	AVN	Instability	Union
1	Grade 0	No	None	Absent	None	Yes
2	Grade 0	No	None	Absent	None	Yes
3	Grade 0	No	None	Absent	None	Yes
4	Grade 0	No	None	Absent	None	Yes
5	Grade 0	No	None	Absent	None	Yes
6	Grade 0	No	None	Absent	None	Yes
7	Grade 0	No	None	Absent	None	Yes
8	Grade 0	No	None	Absent	None	Yes
9	Grade 0	No	None	Absent	None	Yes
10	Grade 0	No	None	Absent	None	Yes
11	Grade 0	No	None	Absent	None	Yes
12	Grade 0	No	None	Absent	None	Yes
13	Grade 0	No	None	Absent	None	Yes
14	Grade 0	No	None	Absent	None	Yes
15	Grade 0	No	None	Absent	None	Yes

AVN: Avascular necrosis, HO: Heterotopic ossification

However, we feel that each mode of treatment has its proponents and opponents. In this cohort analysis and evaluation, a minimally invasive posterolateral approach was used which did not necessitate extensive soft tissues dissection to avoid postoperative scarring, HO and hence preserving the precarious blood supply of the capitellum. The exposure is merely to achieve an anatomic jigsaw-puzzle like reduction and visualize the passage of the K-wire through the elbow joint. Stable fixation could be achieved by this method as MEPI scores, and ASES index showed the results which far exceeded the results of Ruchelsman *et al.*¹⁷ who followed extensile lateral approach with elevation of common extensor and pronator tendons to insert headless screws from anterior to posterior direction. The overall ROM results and the elbow specific outcome compared favorably with Doornberg *et al.*¹⁸ and by far exceeded the results of Stamatis and Paxinos.¹⁹ The mean UHM arc of 0-154°, a mean MEPI score of 100 points corresponded with a series of 17 patients

by Dubberley *et al.*,²⁰ who used cancellous lag screws inserted from posterior to anterior direction with flexion contracture in his series (40°-22°). The significant loss of terminal extension in other studies is due to the extended operative dissection (Ruchelsman *et al.*¹⁷) to create a space for AP insertion of screws while K-wire does not necessitate that extent of dissection.

The number of 15 patients reported in this cohort is regarded a considerable size, compared to a series of Ring *et al.*²¹ MacDermid *et al.*²² Mighell *et al.*²³ However, we as authors understand the limitation of our study, which being restricted to only Type-1 capitellum fractures. Furthermore, the average follow-up in this series was 32 months. While it is clear that complications such as pain and instability show up early, longer follow-up is essential to assess the development of post-traumatic arthritis. Hence, we recommend that a more extensive study involving all types and with a longer follow-up period needs to be done.

CONCLUSION

In Hahn-Steinthal (Type-1) fracture capitellum, the fixation method used should depend on the fracture type, anatomic articular reduction, minimal articular damage, minimal soft tissue damage, rigid fixation, early immobilization, and cost-effectiveness of the implant.

We through our study recommend using multiple K-wires (2-4) inserted in a criss-cross manner through a minimally invasive posterolateral approach which helps in achieving an anatomic jigsaw-puzzle like reduction without any extensive dissection hence preserving the precarious blood supply of the capitellum and also allowing early mobilisation to achieve the excellent functional results assessed via Mayo score and ASES index.

Although our series is one of the largest series in the literature, we believe larger series that includes other types of capitellum fractures as well, with a longer follow-up and with control groups are necessary to draw more firm conclusions.

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