

World Journal of *Clinical Cases*

World J Clin Cases 2021 June 16; 9(17): 4116-4459



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RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Jia-Hui Li; Production Department Director: Yu-Jie Ma; Editorial Office Director: Jin-Lai Wang.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Dennis A Bloomfield, Sandro Vento, Bao-Gan Peng

EDITORIAL BOARD MEMBERS

<https://www.wjnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

June 16, 2021

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INSTRUCTIONS TO AUTHORS

<https://www.wjnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>

Lateral epicondyle osteotomy approach for coronal shear fractures of the distal humerus: Report of three cases and review of the literature

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Author contributions: Yu B was responsible for the patients' surgical treatment; Martin VT, Su ZW, Li DT, and Zhai QY were part of the surgical team; Li J drafted the manuscript; all authors read and approved the final manuscript; all authors helped collect the data and write and revise the manuscript.

Informed consent statement: All patients gave their informed consent.

Conflict-of-interest statement: All authors declare that they have no conflicts of interest to disclose.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CAREChecklist-2016.

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external

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Abstract

BACKGROUND

Coronal shear fractures of the distal humerus are rare injuries and are technically challenging to manage. Open reduction and internal fixation (ORIF) has become the preferred treatment because it provides anatomical reduction, stable internal fixation, and early motion, but the optimal surgical approach remains controversial.

CASE SUMMARY

We report three cases of coronal shear fractures of the distal humerus treated successfully by ORIF via a novel surgical approach, in which lateral epicondyle osteotomy was performed based on the extended lateral approach. We named the novel surgical approach the lateral epicondyle osteotomy approach. All patients underwent surgical treatment and were discharged successfully. All patients had excellent functional results according to the Mayo elbow performance score. The average range of motion was 118° in flexion/extension and 172° in pronation/supination. Only case 2 had a complication, which was implant prolapse.

CONCLUSION

We demonstrated that the lateral epicondyle osteotomy approach in ORIF is effective and safe for coronal shear fractures of the distal humerus.

Key Words: Distal humerus fracture; Coronal shear fracture; Lateral epicondyle; Surgical approach; Osteotomy; Case report

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Manuscript source: Unsolicited manuscript

Specialty type: Orthopedics

Country/Territory of origin: China

Peer-review report's scientific quality classification

Grade A (Excellent): A, A
Grade B (Very good): 0
Grade C (Good): 0
Grade D (Fair): 0
Grade E (Poor): 0

Received: January 13, 2021

Peer-review started: January 13, 2021

First decision: February 11, 2021

Revised: February 24, 2021

Accepted: April 2, 2021

Article in press: April 2, 2021

Published online: June 16, 2021

P-Reviewer: de Sousa Arantes Ferreira G

S-Editor: Liu M

L-Editor: Wang TQ

P-Editor: Wang LL



Core Tip: Coronal shear fractures of the distal humerus are rare and technically challenging to manage. Open reduction and internal fixation (ORIF) has become the preferred treatment, but the optimal surgical approach remains controversial. We report three cases of coronal shear fractures of the distal humerus treated successfully by ORIF *via* the lateral epicondyle osteotomy approach, in which lateral epicondyle osteotomy was performed based on the extended lateral approach. Our management experience in the three cases demonstrated the effectiveness and safety of this novel approach.

Citation: Li J, Martin VT, Su ZW, Li DT, Zhai QY, Yu B. Lateral epicondyle osteotomy approach for coronal shear fractures of the distal humerus: Report of three cases and review of the literature. *World J Clin Cases* 2021; 9(17): 4318-4326

URL: <https://www.wjgnet.com/2307-8960/full/v9/i17/4318.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v9.i17.4318>

INTRODUCTION

Coronal shear fractures of the distal humerus are rare, accounting for 6% of distal humerus fractures and 1% of elbow fractures[1]. These fractures are technically challenging to manage due to their small size, associated osteochondral fragments, and propensity to displace, and they lead to limited elbow motion. Open reduction and internal fixation (ORIF)[2-10] has become the preferred treatment because it provides anatomical reduction, stable internal fixation, and early motion, but the optimal surgical approach remains controversial. Currently, the common surgical approaches include the anterolateral approach[2,3], posterior olecranon osteotomy approach[4-7], and extended lateral approach[7-10].

We report three cases of coronal shear fractures of the distal humerus treated successfully by ORIF *via* a novel surgical approach, in which lateral epicondyle osteotomy was performed based on the extended lateral approach. We named the novel surgical approach the lateral epicondyle osteotomy approach. We discuss the advantages and disadvantages of various surgical approaches with regard to our management experience.

CASE PRESENTATION

Chief complaints

Case 1: Right elbow and right upper arm pain accompanied by limited range of motion (ROM).

Case 2: Left elbow pain accompanied by limited ROM.

Case 3: Right elbow pain accompanied by limited ROM.

History of present illness

Case 1: A 57-year-old man was admitted to our hospital with right elbow and right upper arm pain accompanied by limited ROM for 12 d after he accidentally fell from a ladder and landed on his right hand.

Case 2: A 64-year-old man was admitted to our hospital with left elbow pain accompanied by limited ROM for 7 d after he accidentally fell onto his outstretched left hand when walking down stairs.

Case 3: A 31-year-old man was admitted to our hospital with right elbow pain accompanied by limited ROM for 3 d after he fell accidentally and landed on his right elbow.

History of past illness

Case 1 underwent ORIF of the left calcaneus fracture 4 years earlier. Cases 2 and 3 had no history of other diseases.

Personal and family history

No family history to note.

Physical examination

Case 1: The physical examination revealed pain in the right elbow and right upper arm accompanied by limited ROM but no open wounds.

Case 2: The physical examination revealed pain in the left elbow accompanied by limited ROM but no open wounds.

Case 3: The physical examination revealed swelling and pain in the right elbow accompanied by limited ROM but no open wounds.

Laboratory examinations

No obvious abnormalities were observed in the preoperative examinations.

Imaging examinations

Case 1: Radiographs revealed a right humerus shaft fracture and right capitellar fracture (Figure 1A and B). A computed tomography scan revealed a right humerus shaft fracture and right capitellar and trochlea fractures (Figure 1C and D).

Case 2: Radiographs revealed left capitellar and trochlea fractures (Figure 2A and B). A computed tomography scan revealed left capitellar and trochlea fractures accompanied by a left olecranon avulsion fracture (Figure 2C and D).

Case 3: Both radiographs and a computed tomography scan revealed right distal humerus fractures, including lateral epicondyle, capitellum, and trochlea fractures (Figure 3A-D).

FINAL DIAGNOSIS

Case 1

The final diagnosis was coronal shear fractures of the right distal humerus (type 3A according to Dubberley *et al*[7]) and a right humerus shaft fracture.

Case 2

The final diagnosis was coronal shear fractures of the left distal humerus (type 3B according to Dubberley *et al*[7]) accompanied by a left olecranon avulsion fracture.

Case 3

The final diagnosis was coronal shear fractures of the right distal humerus (type 2B according to Dubberley *et al*[7]) accompanied by a lateral epicondyle fracture.

TREATMENT

Case 1

The examination performed after anesthesia showed that the affected elbow joint was not unstable in varus or valgus. The extended lateral approach was used in ORIF, and then, lateral epicondyle osteotomy was performed. The lateral epicondyle was mobilized distally along with the origins of the common wrist and digit extensor muscles and the lateral collateral ligament to provide ideal visualization of the distal humerus articular surface, thereby allowing the fracture fragments to be anatomically reduced under direct vision and the screws to be placed in the anterior-posterior direction. During surgery, fragmentation of the articular surface was noted, and both the capitellum and lateral trochlea were involved as separate fracture fragments. The fracture fragments were reduced and temporarily fixed with K-wires. First, six screws were placed as follows with countersinking: Five screws were placed in the anterior-posterior direction, and the remaining screw was placed in the distal-proximal direction. Then, a K-wire was inserted for bone stabilization. Finally, two lag screws were used to stabilize the osteotomy region. The right humerus shaft fracture was also treated by ORIF. Passive activities were encouraged starting on the second day after surgery.

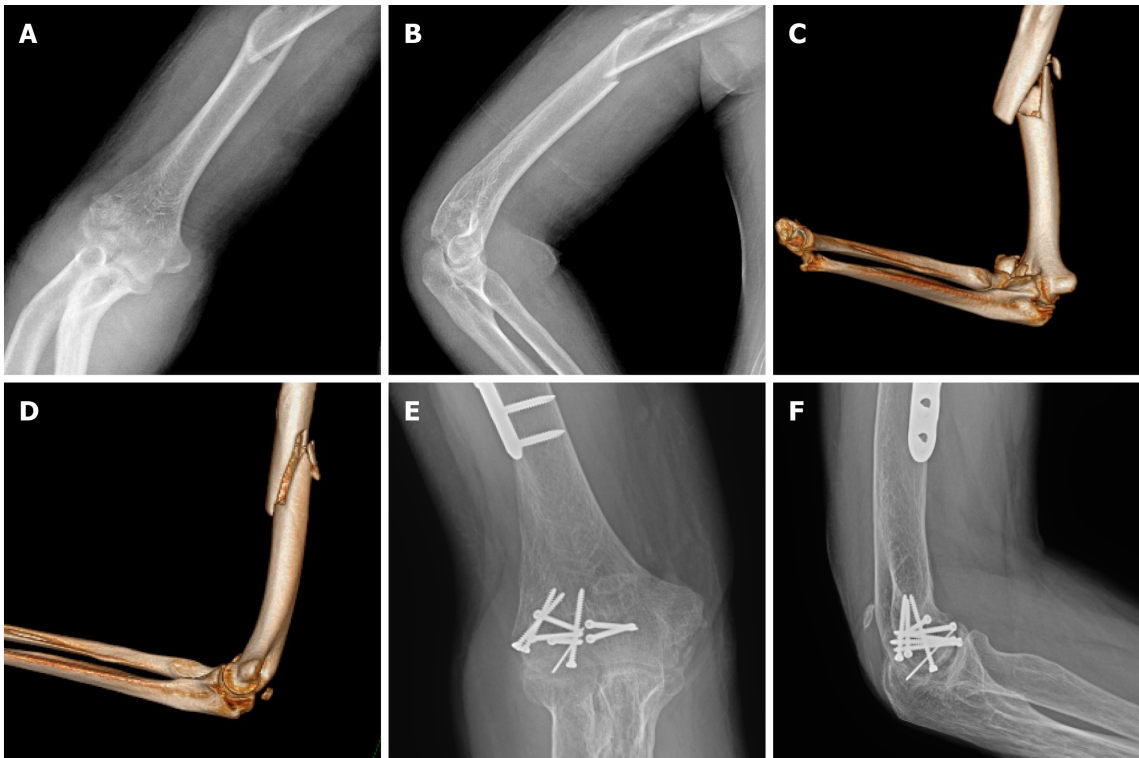


Figure 1 Imaging examinations performed before and 12 mo after surgery. A-D: Preoperative radiographs and computed tomography scan showed a type Dubberley 3A fracture and a right humerus shaft fracture; E and F: Radiographs taken 12 mo after surgery showed union without osteonecrosis.

Case 2

The examination after anesthesia showed that the elbow joint was not unstable in varus or valgus. As in the first case, the extended lateral approach was used in ORIF, and then, lateral epicondyle osteotomy was performed. During surgery, we noted that the fracture involved the capitellum, medial trochlea, and posterior aspect of the lateral condyle. The fracture fragments of the capitellum and trochlea were sequentially reduced and temporarily fixed with K-wires; then, final fixation was performed by placing screws in the anterior-posterior direction and in the distal-proximal direction. All screws were inserted with the screw head buried beneath the articular surface. Three K-wires were retained. Finally, the posterolateral plate of the distal humerus was used to fix the osteotomy region and the fracture of posterior aspect of the lateral condyle at the same time. Regarding the olecranon avulsion fracture, after elevating the lateral aspect of the triceps from the distal humerus and the proximal olecranon, we removed the free fracture fragments and repaired the triceps tendon with two absorbable rivets. Passive activities were encouraged starting on the second day after surgery.

Case 3

The examination after anesthesia showed that the elbow joint was unstable in varus but not unstable in valgus. The extended lateral approach was used in ORIF, and a lateral epicondyle fracture was noted. The origins of the lateral collateral ligament and the common extensor muscles were attached to the fracture piece, as in the lateral epicondyle osteotomies performed in the two cases above. During surgery, a large fracture fragment consisting of the capitellum and the medial trochlea was seen, and it was reduced and temporarily fixed with K-wires. Then, screws were placed in the anterior-posterior direction and in the lateral-medial direction for fixation. Finally, the fracture piece of the lateral epicondyle was reduced and fixed with a posterolateral plate of the distal humerus. Passive activities were encouraged starting on the second day after surgery.

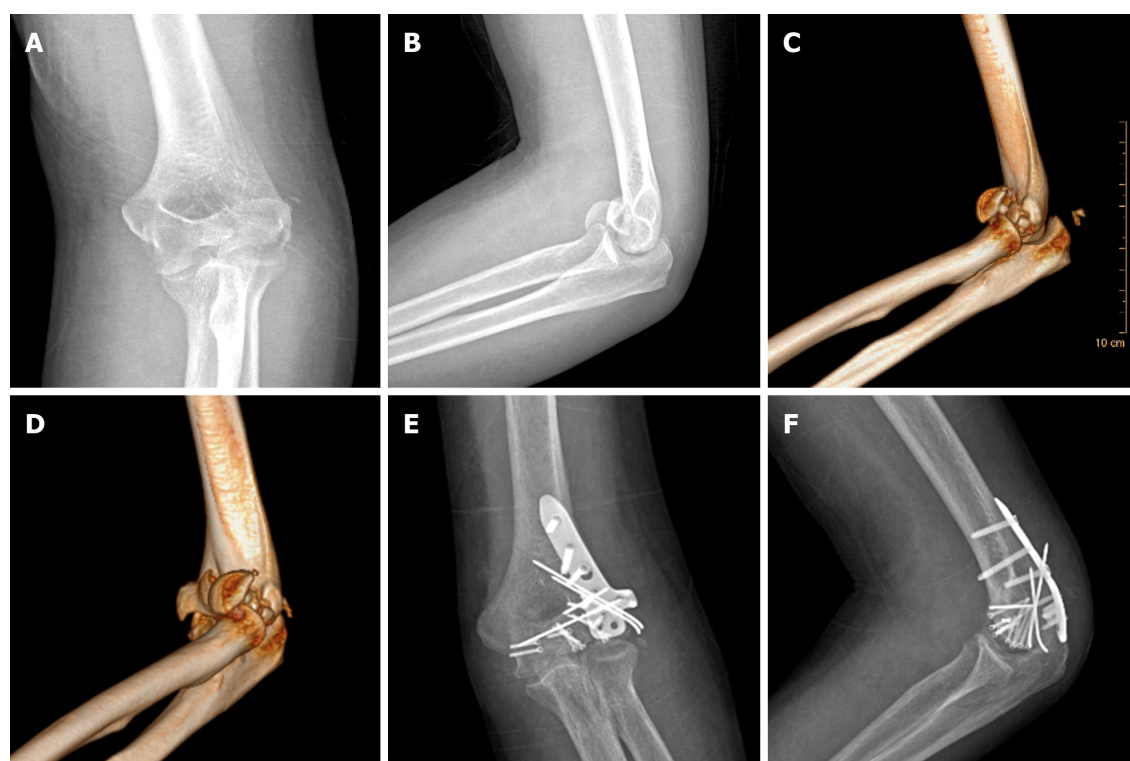


Figure 2 Imaging examinations performed before and 5.5 mo after surgery. A-D: Preoperative radiographs and computed tomography scan showed a type Dubberley 3B fracture accompanied by a left olecranon avulsion fracture; E and F: Radiographs taken 5.5 mo after surgery showed union without osteonecrosis.

OUTCOME AND FOLLOW-UP

Case 1

At 12 mo after surgery, radiographs showed union without osteonecrosis (Figure 1E and F). At the 33-mo follow-up, the postoperative elbow ROM values were as follows, without pain or instability: Extension 33°, flexion 147°, pronation 86°, and supination 90°. The Mayo elbow performance score (MEPS) was 95 points (excellent), and the disability of the arm, shoulder, and hand (DASH) score was 10 points.

Case 2

At 5.5 mo after surgery, radiographs showed union without osteonecrosis (Figure 2E and F). At 6 mo after surgery, the patient underwent hardware removal because of prominent implants, and during the second surgery, two K-wires and one loose screw were removed. At the 12.5-mo follow-up, the postoperative elbow ROM values were as follows, without pain or instability: Extension 21°, flexion 133°, pronation 78°, and supination 90°. The MEPS was 100 points (excellent), and the DASH score was 1.7 points.

Case 3

At 16 mo after surgery, radiographs showed union without osteonecrosis (Figure 3E and F). At the 20-mo final follow-up, the postoperative elbow ROM values were as follows, without pain or instability: Extension 0°, flexion 128°, pronation 82°, and supination 90° (Figure 4). The MEPS was 100 points (excellent), and the DASH score was 0 points.

DISCUSSION

Coronal shear fractures of the distal humerus are rare injuries, accounting for 6% of distal humeral fractures and 1% of elbow fractures[1]. With the development of digital imaging and computed tomographic scans, the complex nature of these fractures is now better understood[4,8]. These fractures are technically challenging to manage due to their small size, associated osteochondral fragments, and propensity to displace, and they can result in limited elbow motion. Compared to surgical treatments,

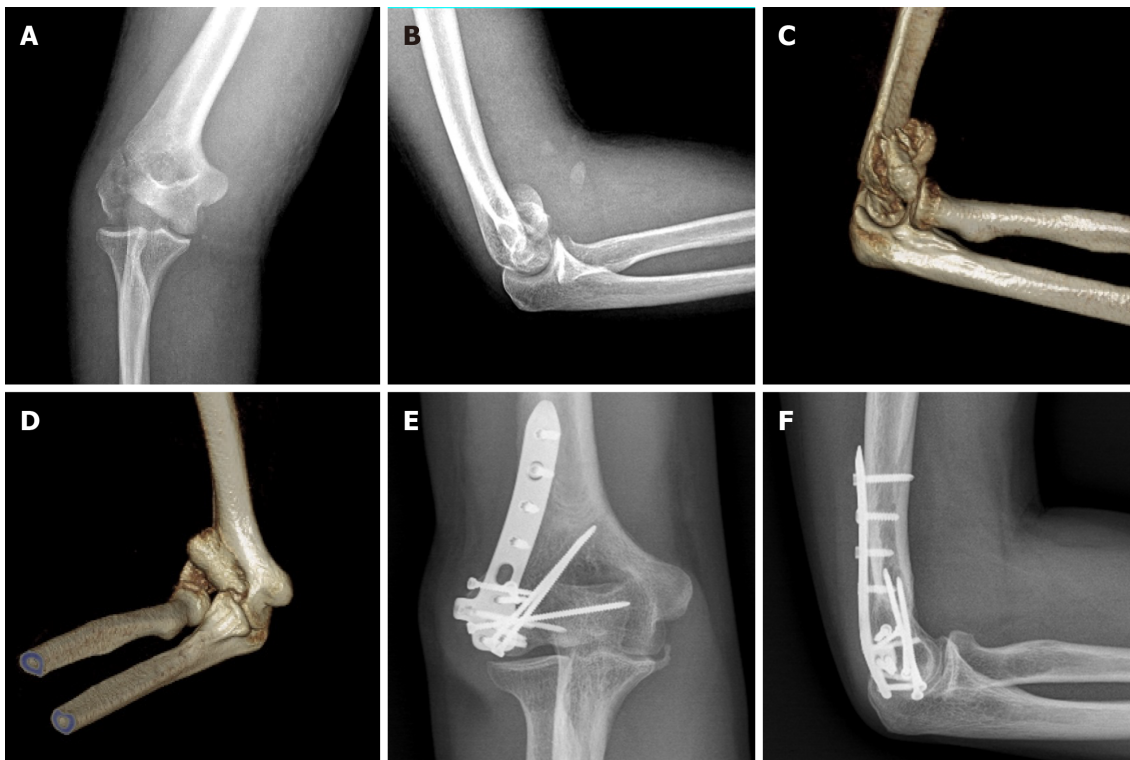


Figure 3 Imaging examinations performed before and 16 mo after surgery. A-D: Preoperative radiographs and computed tomography scan showed a type Dubberley 2B fracture accompanied by a lateral epicondyle fracture; E and F: Radiographs taken 16 mo after surgery showed union without osteonecrosis.



Figure 4 Elbow range of motion 20 mo after surgery.

nonsurgical treatments are often associated with worse results and more complications, such as elbow stiffness, traumatic arthritis, chronic pain, and joint instability[11-13]. The surgical treatments available include ORIF[2-10], arthroscopic surgery[14,15], fragment resection[16,17], and elbow joint replacement[18,19]. Currently, ORIF has become the preferred treatment because it provides anatomical

reduction, stable internal fixation, and early motion. However, the limited surgical window and associated osteochondral fragments make it difficult to obtain stable internal fixation to allow early motion. Therefore, it is essential to choose a suitable surgical approach that provides direct visualization of fracture fragments and facilitates anatomical reduction of the fracture fragments to achieve good outcomes.

The common surgical approaches include the anterolateral approach, posterior olecranon osteotomy approach, and extended lateral approach. Some surgeons choose the anterolateral approach[2,3], which starts from the space between the biceps brachii and brachioradialis. The anterolateral approach provides access to trochlear fragments and facilitates anatomical reduction in the fragment without the need for lateral collateral ligament complex (LCLC) release or olecranon osteotomy, but it is difficult to stabilize the fractures with posterior comminution *via* this approach alone. Therefore, ORIF through the anterolateral approach is suitable for Dubberley type A fractures. However, the surgical dissection of this approach is relatively cumbersome, given the risk of neurovascular injury to the structures of the fossa cubitalis.

The posterior olecranon osteotomy approach[4-7] has been used frequently in ORIF for coronal shear fractures of the distal humerus, because it can provide the widest exposure of the articular surfaces of the distal humerus[20,21]. This approach is especially suitable for capitellar and trochlea fractures combined with posterior comminution of the lateral or medial condyle. The disadvantages of the posterior olecranon osteotomy approach include the need for additional internal fixation of the osteotomy and the risk of complications related to osteotomy, such as olecranon pain, nonunion, delayed healing, malunion, and implant prolapse[7,22,23].

We prefer the extended lateral approach[7-10]. A skin incision that is centered on the lateral epicondyle and extended from the lateral column of the distal humerus to approximately 2 cm distal to the radial head is made. The common origin of the wrist and digit extensor muscles along with the anterior capsule is elevated anteriorly as a full-thickness sleeve. A continuous full-thickness anterior soft-tissue flap is created by connecting the distal Kocher space to the proximal exposed region. However, due to obstruction from the LCLC, this approach does not provide adequate visualization of the trochlear fragments or facilitate anatomical reduction of the fragments. In cases in which the fracture involves the trochlea, the LCLC may need to be released to provide adequate visualization of the trochlear fragments[7,10,24]. However, this additional procedure increases the risk of posterolateral rotatory instability due to laxity of the lateral collateral ligament[25]. Mighell *et al*[26] thought that release of LCLC would affect the blood supply of the capitellum, thus affecting fracture healing. Therefore, we performed lateral epicondyle osteotomy based on the extended lateral approach to provide ideal visualization of the medial trochlea fragments and permit direct reduction and screw placement in the anterior-posterior direction. Concerning screw fixation, the ideal direction of implantation is still controversial. Sano *et al*[6] showed that screws placed in the posterior-anterior direction fail to fix thin fragments because the threads do not completely pass through them. Additionally, given the cancellous screw's solid core and higher ratio of the outer-to-inner diameter, anterior-to-posterior screw insertion without countersinking may be more biomechanically robust than headless screws as well as countersunk anterior-to-posterior screws and posterior-to-anterior screws, although no direct comparisons have been made[27,28]. Matache *et al*[29] conducted an anatomical study and indicated that there is a nonarticulating zone for screw placement along the anterior aspect of the lateral trochlear ridge throughout the normal elbow ROM. The use of a partially threaded cancellous screw inserted anterior-to-posterior into this region without countersinking could theoretically improve the stability of some fractures that extend into the anterolateral aspect of the trochlea. Therefore, the lateral epicondyle osteotomy approach may be superior to the olecranon osteotomy approach regarding the direction of screw implantation.

In lateral epicondyle osteotomy, two hollow lag screws or the posterolateral plate of the distal humerus can be used for fixation. Regarding Dubberley type B fractures, the posterolateral plate of the distal humerus can simultaneously fix the osteotomy region and the fractured posterior aspect of the lateral condyle. The plate ensures firm internal fixation for early postoperative functional exercises and maximizes the motion of elbow joint function[8,30-32].

In conclusion, we report three cases of coronal shear fractures of the distal humerus treated by ORIF *via* the lateral epicondyle osteotomy approach and discuss the advantages and disadvantages of various surgical approaches. According to our management experience, the lateral epicondyle osteotomy approach is reliable and potentially useful for coronal shear fractures of the distal humerus. However, due to the limited number of cases and the short follow-up time in this study, additional high-quality clinical research needs to be conducted to verify the practicality of this

surgical approach.

CONCLUSION

The three patients had excellent functional results according to the MEPS. The average ROM was 118° in flexion/extension and 172° in pronation/supination. Only case 2 had one complication, which was implant prolapse. Our experience regarding the management of these three cases initially proved the effectiveness and safety of the lateral epicondyle osteotomy approach.

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