Technical Note

Technique for Arthroscopic-Assisted Reduction and Cannulated Screw Fixation for Coronal Shear Fractures of the Distal Humerus

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Abstract: Several articles have described arthroscopic fixation of coronal shear fractures of the distal humerus. However, not all of them have used purely arthroscopic techniques. In this Technical Note we describe another technique for intra-articular distal humeral fracture fixation using arthroscopy alone. Standard proximal anteromedial, proximal anterolateral, and posterolateral viewing portals are established with soft spot portal for reduction. During intra-articular examination, the fragment involving the capitellum and the trochlea as 1 piece is detected. Closed manipulative reduction under anesthesia is conducted with distraction, varus force, and gradual elbow extension. After closed reduction, reduction of the fragment more precisely under arthroscopic visualization using probe and elevator is performed. The fragment is temporarily fixed using 2 Kirschner wires from posterior direction. Anatomic reduction is confirmed with an image intensifier. Screw guide pin is inserted posteroanteriorly under image intensification, and a headless compression screw is placed over each wire. We describe a safe, reproducible, and minimal invasive technique for the arthroscopic treatment of coronal shear fractures of the distal humerus.

Various options for the treatment of distal humeral fractures have been previously reported, such as closed reduction and immobilization,[1] open reduction and internal fixation,[2-5] and elbow arthroplasty for cases that are not amenable to fixation in a select population. Arthroscopic reduction and percutaneous screw fixation for the treatment of simple fracture have also been described in several studies.[6-8]

Van Tongel et al.[9] described several fractures around the elbow joint that can be managed by arthroscopy technique, such as coronoid fractures; lateral condyle fractures; capitellum fractures; and coronal shear fractures of the distal humerus, which is a 2-part radial head fracture. In addition to these, arthroscopy can be used for valgus instability assessment before the decision of open repair or reconstruction. One recent study reported all-arthroscopic treatment for the terrible triad can provide an excellent safety profile.

Dubberley et al.[2] classified capitellum and trochlea fractures as fractures of the capitellum with or without the involvement of the lateral trochlear ridge (type 1), or fracture involving both the capitellum and trochlea as 1 piece (type 2), or as separate pieces (type 3). Each type was then further subclassified as either the absence (subtype A) or presence (subtype B) of posterior condylar comminution. Some studies highlighted the integrity of the posterior condyle of the distal humerus as a consideration to proceed with arthroscopy fixation.[2,4] Thereby arthroscopy technique is with limitation for Dubberley subtype B fractures.

There are several advantages that can be gained from arthroscopic technique in fracture fixation,

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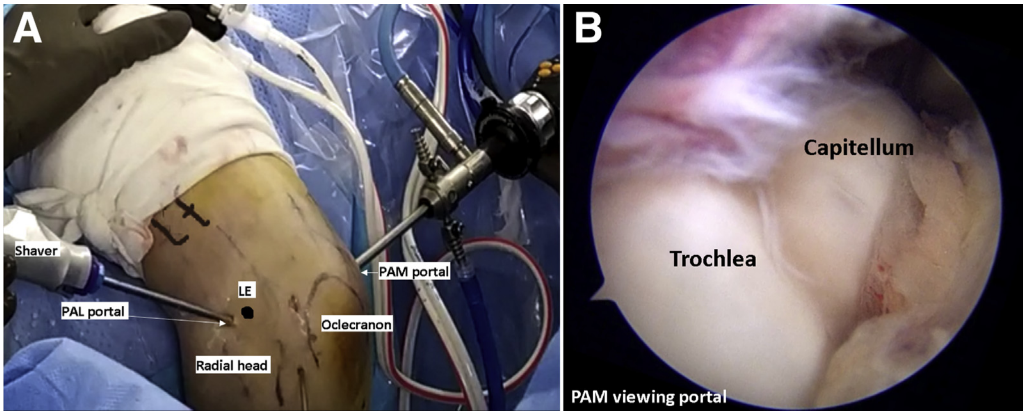

Fig 1. Lateral decubitus position with left elbow with proximal anteromedial viewing portal. (A) Arthroscopic shaver is introduced through the working portal (proximal anterolateral portal). (B) Arthroscopic view shows the fragment involving capitellum and trochlea. (LE, lateral epicondyle; PAL, proximal anterolateral; PAM, proximal anteromedial.)

which include less soft tissue trauma with superior maintenance blood supply, improved visualization, and ability to identify associated lesions. We describe a Technical Note for arthroscopy management of coronal shear fracture of the distal humerus (Video 1).

Surgical Technique

Patient Setup and Preparation

The patient is positioned on the operating table in the lateral decubitus under general anesthesia. The arm is secured on a padded bolster with shoulder abducted to 90° and elbow flexed 90° allowing the hand to hang freely. After skin preparation and draping, a sterile tourniquet is applied and inflated to 250 mm Hg after limb exsanguination. The water pump is set at 30 mm Hg.

Portal Establishment and Arthroscopic Assessment

A 20-mL normal saline solution is injected to distend the elbow joint using an 18-gauge needle through the "soft spot" (i.e. midlateral portal).

The proximal anteromedial portal is established at 2 cm proximal to the medial epicondyle and 1 to 2 cm anterior to the medial intermuscular septum using a blunt trocar and a Wissinger rod. A 4.5-mm 30° arthroscope is used for the diagnostic arthroscopy of the elbow joint. The anterior elbow is examined and a proximal anterolateral portal is created using the inside-out technique. The arthroscopic shaver is then used to remove the hematoma allowing clear visualization of the fragment (Fig 1). Manipulative reduction under arthroscopic visualization by distraction varus force and gradual elbow extension is performed (Fig 2). The fragment is repositioned with an arthroscopic periosteal elevator in 90° elbow flexion.

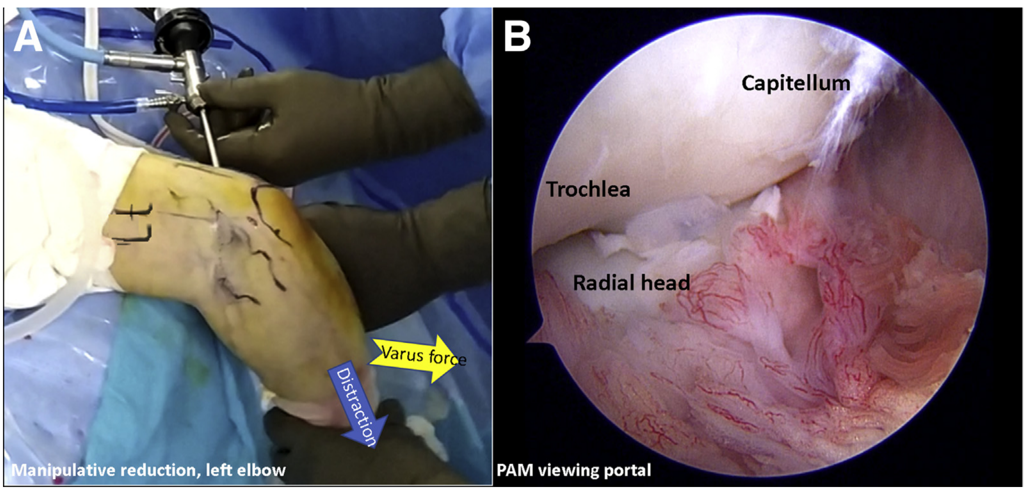

Fig 2. An attempt at closed manipulative reduction for the left elbow in the lateral decubitus position. (A) Manipulative reduction by distraction varus force and gradual extension under arthroscopic visualization. (B) Arthroscopic view of the anterior elbow chamber with the arthroscope in the proximal anteromedial portal shows fragment involving both capitellum and trochlea as 1 piece after manipulative reduction. (PAM, proximal anteromedial.)

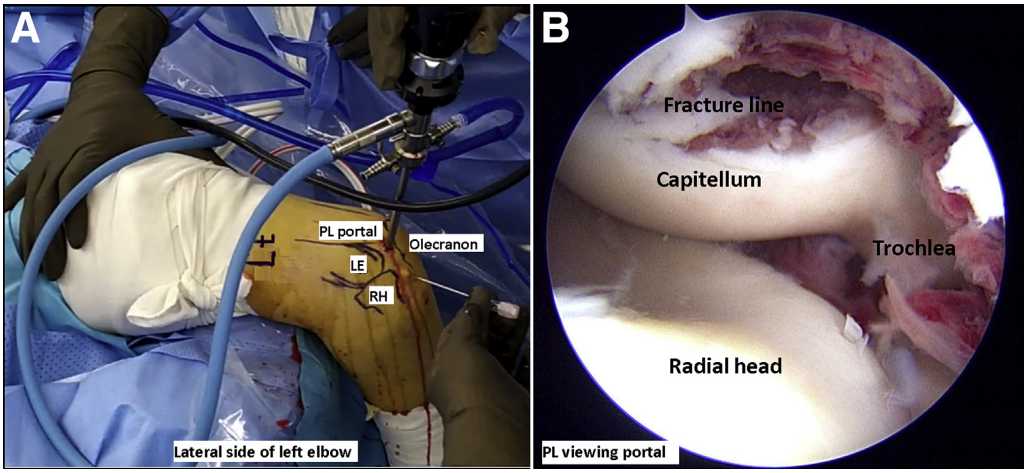

Fig 3. Switching the arthroscope into posterior compartment of left elbow in the lateral decubitus position provides detailed view of the fracture gap and the radiocapitellar joint. (A) Lateral side of the left elbow in 90° flexion. (B) Arthroscopic view of the posterior elbow chamber reveals the fragment involving capitellum and trochlea from the posterolateral viewing portal after manipulative reduction. (LE, lateral epicondyle; PL, posterolateral; RH, radial head.)

Because the visualization from the proximal anteromedial portal is unsatisfactory, the posterolateral portal is established to allow viewing through the posterior compartment. The posterolateral portal provides a better visualization that allows us to observe the fracture line in 90° elbow flexion (Fig 3). The posterolateral gutter is debrided with shaver to allow the "transjoint visualization." After this, the arthroscope is moved to the midlateral portal, which provides a detailed view of the radiocapitellar joint including the fracture line. A probe is placed into the posterior elbow joint through the posterolateral portal to maintain the reduction (Fig 4) along with the periosteal elevator from the anterolateral portal. While being compressed by the periosteal elevator, the fragment is then temporarily fixed with two 1.2-mm retrograde Kirschner wires. An image intensifier is used to confirm anatomic reduction (Fig 5). Two percutaneous guide pins for 2.4-mm headless compression screws (DePuy Synthes) are inserted retrogradely under the direct control of an image intensifier and arthroscopic image (Figs 6 and 7). Reduction is checked with a probe during a full range of motion of the elbow and rotation of the forearm. Full arthroscopic examination for associated lesions is performed to rule out associated lesions. Anteroposterior and lateral elbow plain radiographs are taken at the end of the procedure to confirm fixation (Fig 8).

Postoperative Rehabilitation

After immobilization in a long-arm splint for 1 week, the patient begins active range of motion exercises.

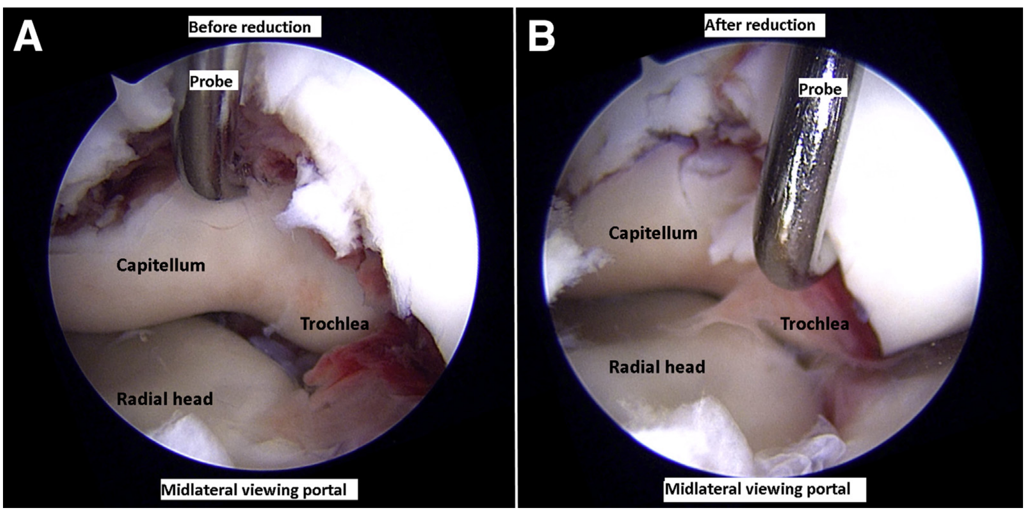

Fig 4. Arthroscopic view of the same left elbow in the lateral decubitus position shows fragment from midlateral portal; a probe was inserted through the posterolateral portal to complete the reduction along with the periosteal elevator from proximal anterolateral portal. (A) Displaced fragment before reduction and (B) well-reduction fragment after that.

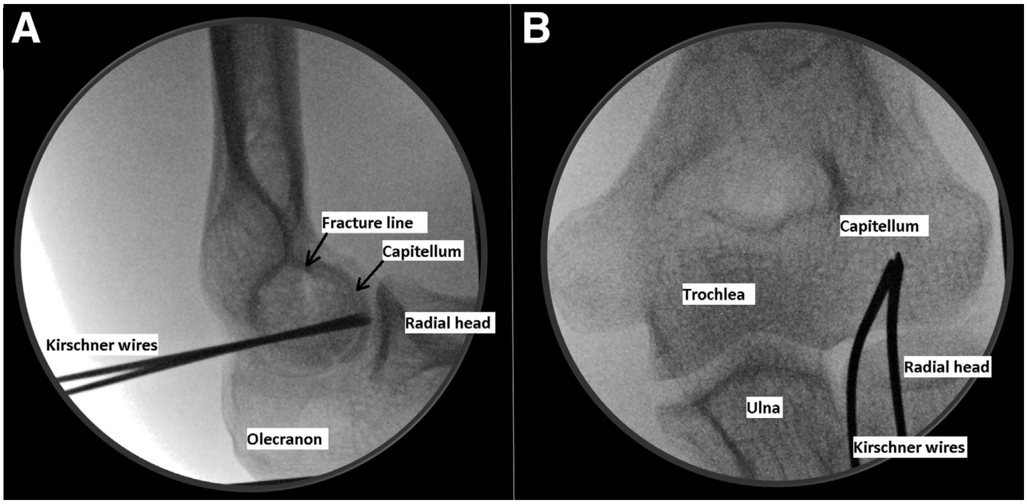

Fig 5. The left elbow radiographs show well-reduction fragment, which is provisionally fixed with two 1.2-mm retrograde Kirschner wires using an image intensifier. (A) Lateral view and (B) anteroposterior view.

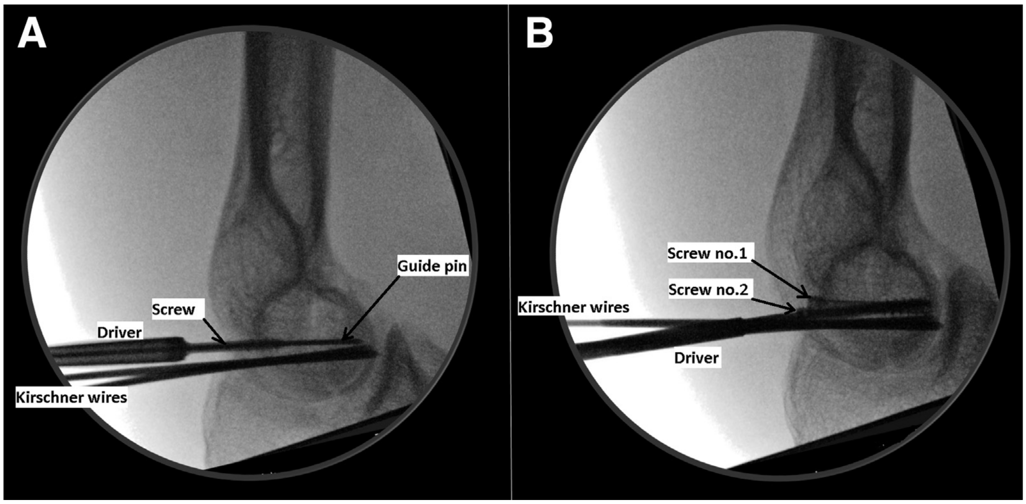

Fig 6. Fracture fixation of the left elbow with headless compression screw under image intensifier. A screw is placed over each wire: (A) first screw, (B) second screw.

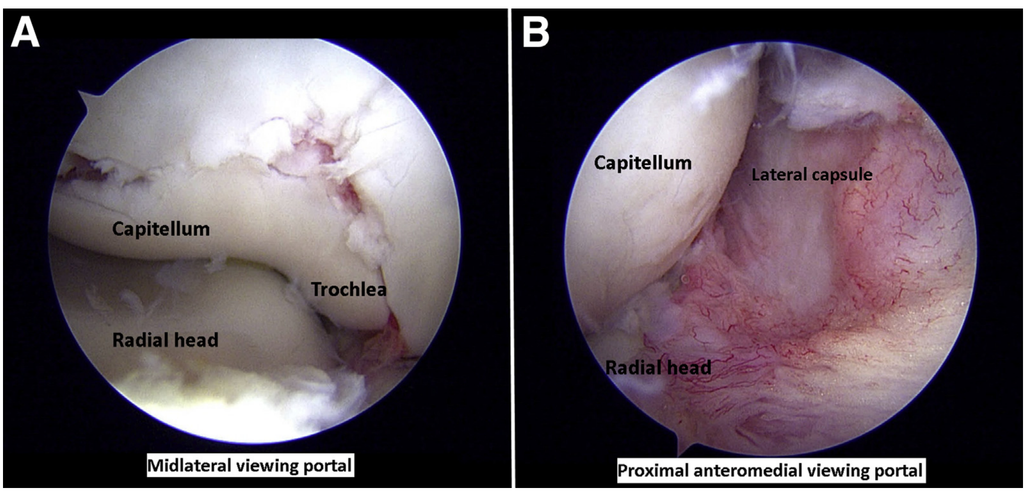

Fig 7. Arthroscopic views of the left elbow in the lateral decubitus position after fixation. (A) The posterior view through the midlateral portal reveals articular congruency of distal humerus. (B) The anterior view of the same elbow via the proximal anteromedial portal shows lateral capsule intact.

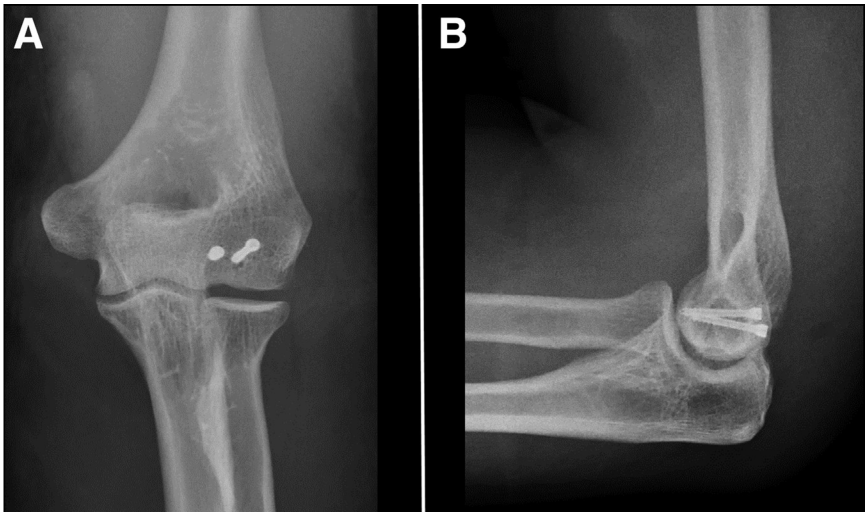

Fig 8. (A, B) Postoperative radiographs of coronal shear of distal humerus fracture fixation show correct alignment of the left elbow and articular congruency.

Discussion

This Technical Note describes a step-by-step arthroscopic technique to treat a coronal shear of a distal humerus fracture. Despite the various options for the treatment of coronal shear of a distal humerus fracture, arthroscopic technique may have a role when some conditions apply.

Holt et al.[10] stated that the criterion for arthroscopic management in articular distal humerus fractures is capitellum fracture without comminution. Arthroscopic

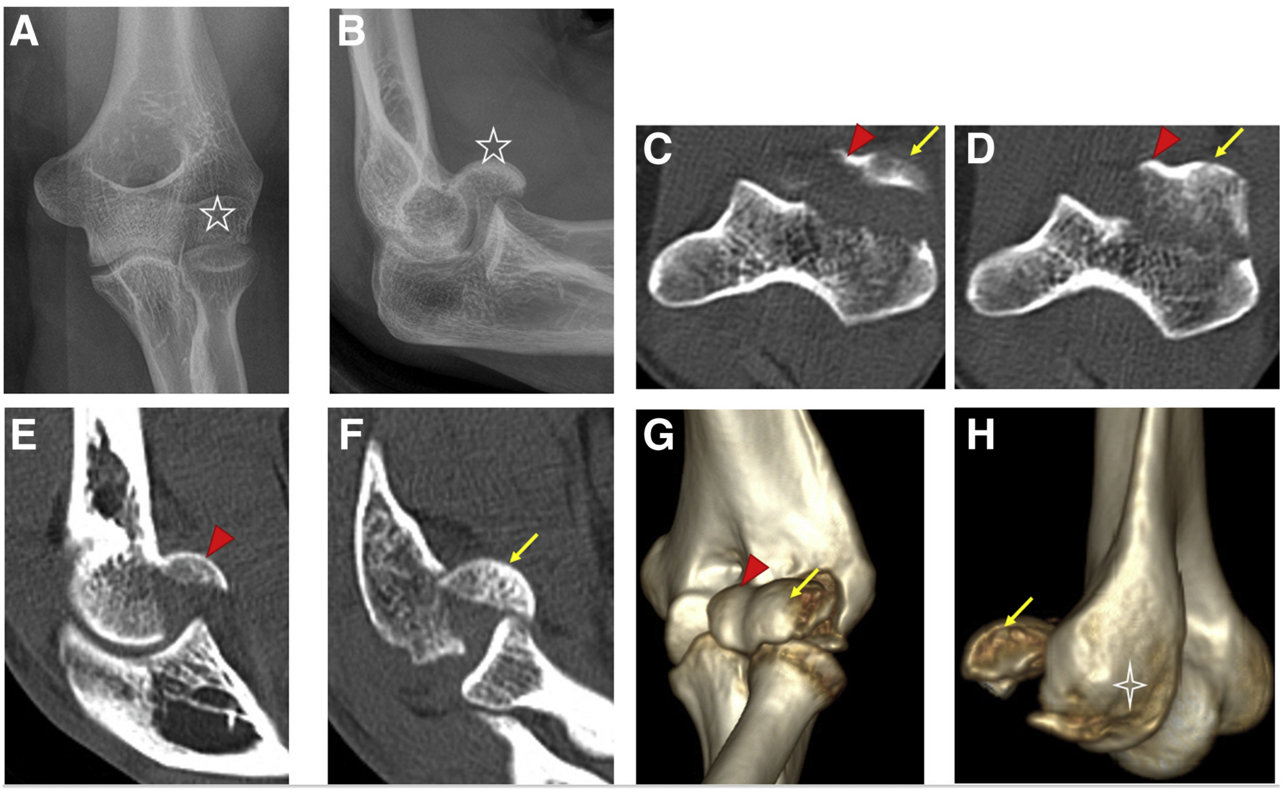

Fig 9. (A, B) Preoperative radiographs of coronal shear of distal humerus fracture fragment (star) and (C-G) computed tomography scans of the left elbow show a fracture of both the capitellum (arrow) and the trochlea (arrowhead) as 1 piece (Dubberley type 2A fracture). (H) Three-dimensional computed tomography image shows intact posterior condyle of distal humerus (diamond).

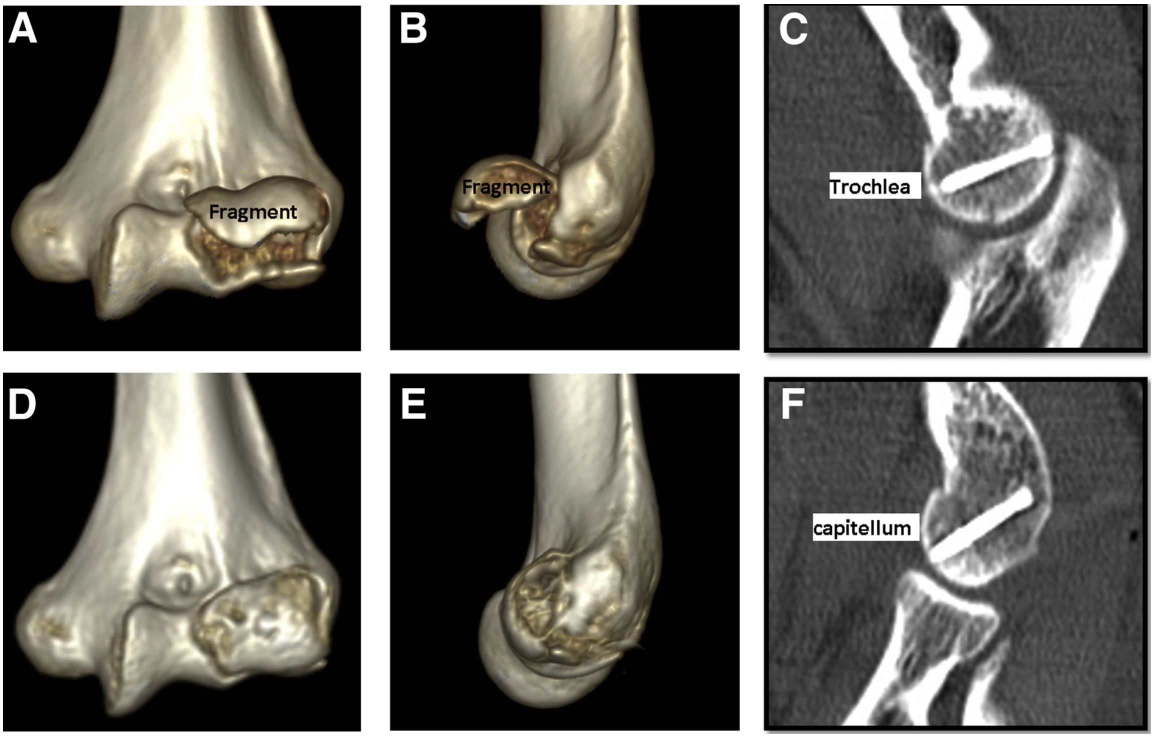

Fig 10. Computed tomography images of the left elbow of a 30-year-old male patient. (A, B) Preoperative images show a fracture of both the capitellum as 1 piece (Dubberley type 2A fracture). (C-F) Postoperative computed tomography image shows acceptable distal humerus reduction state.

management is not indicated for treating Dubberley subtype B fractures with posterior condylar comminution. To determine whether a candidate or not for an arthroscopic approach, we recommend a 3-dimensional computed tomography scan to routinely assess the absence or presence of posterior condylar fracture (Fig 9). When fractures involve the posterior aspect of the trochlea or the medial epicondyle as detected on computed tomography, open reduction and internal fixation is recommended to provide better exposure and good result.[4]

Several studies have reported the arthroscopic fixation of fractures of the capitellum.[6-8] Hardy et al.[7] reported successful results in a patient with a type 1A fracture by using 3 lateral portals, inserting a 3.5-mm cannulated screw anterolaterally followed by countersink in the articular capitellum cartilage. Mitani et al.[8] also reported successful results with headless screws inserted retrogradely after treating a type 1A fracture via a proximal anteromedial portal and anterolateral portal. Kuriyama et al.[6] reported 2 cases of a patient with type 1A fracture and another with a Dubberley type 3A fracture that were treated using proximal lateral and soft spot portals with headless screws inserted retrogradely. The author mentioned that an arthroscopic approach would be challenging when the capitellum and trochlear presented as separate fragments (type 3A).[6] In the current Technical Note 2 anterior portals (proximal anteromedial and proximal anterolateral portals) were used for debridement and posterolateral and midlateral portals to visualize the posterior elbow for the treatment of a Dubberley type 2A fracture with 2.4-mm headless cannulated screw inserted retrogradely (Figs 8 and 10). We recommend the midlateral portal as a viewing portal for better visualization in this specific type of fracture. The capitellum and trochlea fragments were still connected by the articular cartilage, which serves as an advantage to assist the reduction.

Arthroscopic surgery has the advantage of better cosmesis and less morbidity because of minimized soft tissue trauma. This technique also allows a precise evaluation of associated lesions, especially involving the medial joint that is perhaps limited by open surgery. In addition, arthroscopy technique may help the surgeon

Table 1. Technique Advantages and Disadvantages

Advantages	Disadvantages
Minimally invasive Preserves maximal blood supply Able to diagnose intra-articular pathology Removal of loose body if present Ensures articular reduction	High technical demand, requiring expert knowledge of elbow anatomy, and advanced elbow arthroscopy skills Inherent risks to the neurovascular structures

Table 2. Technique Pearls and Pitfalls

Pearls	Pitfalls
Proper selection of patients is important to ensure effective treatment.	Improper portal placement that results in limited viewing and difficult instrumentation, given the narrow working area.
The posterolateral portal provides better views for the capitellum fracture line when it is not seen from anterior portal.	Failure to remove blood in fracture site, if present, may make visualization and reduction difficult.
Manipulative reduction by distraction and varus force.	
Combined probe and periosteal elevator to reduce fragment.	
Inserted K-wire into the fragment used as a joystick to reduce and advance across the fracture line for provisional fixation.	

to have a better understanding of the morphology of the fracture line and fragment to ensure anatomic articular reduction (Table 1).

Arthroscopy-assisted reduction and cannulated screw fixation for coronal shear fractures of the distal humerus are challenging for several reasons. The narrow space of posterolateral elbow gutter intra-articular working area along with significant constraints of the radiocapitellar joint imposes limitations to visualization and restricts access to fragment reduction. However, evolving knowledge and technique of elbow joint arthroscopy allow effective and reproducible management of the coronal shear fractures of the distal humerus (Table 2). The current technique allows detailed visualization of the fracture line and lesser risk of inadvertent iatrogenic injury to the adjacent articular cartilage and other anatomic structures.

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