Arthroscopic Radial Head Implant Removal and Resection

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Abstract: Displaced radial head fractures are treated with open reduction and internal fixation using implants. Failure of fixation may occur in the presence of comminution and in multifragmentary fractures; open surgical approaches are necessary for removal of the implants and radial head resection. Arthroscopic radial head resection has been described as a minimally invasive and effective treatment for failed radial head fracture fixation; however, periarticular adhesions and prominent implants add to the complexity and technical difficulty of the procedure. The described technique uses 3 portals for adhesiolysis, implant removal, and radial head resection. Resection is performed in stages; smaller-diameter instruments are used to gain and improve access, and larger resectors are used subsequently. Adequacy of resection is assessed arthroscopically and with biplanar imaging. The arthroscopic technique avoids the need for an open surgical approach and prevents subsequent morbidity. In addition, the rehabilitation time is shorter and patient satisfaction is high.

Radial head fractures may be isolated or associated with elbow dislocations. Displaced or comminuted radial head fractures are usually treated with operative fixation, and associated fractures and ligament ruptures are treated simultaneously.[1] Incongruous reduction or late radial head collapse and subsequent arthrosis may predispose to progressive elbow pain and stiffness; in such cases, removal of the fixation implant and resection of the radial head are necessary.[2] Previous extensive surgery for associated ruptures and fractures may result in capsular stiffness, and this adds to the complexity and technical difficulty of the procedure.[3-6]

The purpose of this report is to describe an arthroscopic procedure for resection of the radial head and removal of the fixation implants. This technique involves initial capsular excision and circumferential radial adhesiolysis to permit visualization and to gain working space. Thereafter, a combination of small and large resectors is used to identify and loosen the implants for removal.

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Technique

The preoperative imaging is studied, and the number and position of implants are noted (Fig 1). The procedure is performed with the patient in the lateral decubitus position; the shoulder is flexed to 90°, and the elbow is flexed to 90°. The upper arm is placed on an elbow support, and an upper limb tourniquet is used at a pressure of 220 mm Hg. Routine medial and lateral elbow arthroscopy portals are marked, and a 30° arthroscope (2.9 mm × 160 mm; ConMed Linvatec, Largo, FL) is used for diagnostic arthroscopy[7-9] (Fig 2). The key steps and surgical pearls of the technique are summarized in Tables 1 and 2, respectively, and the steps are demonstrated in Video 1.

Step 1: Diagnostic Elbow Arthroscopy

The elbow joint is insufflated with 20 mL of saline solution by a needle placed through the posterolateral "soft spot." An anteromedial portal is placed approximately 1 cm anterior and proximal to the medial epicondyle and is the primary viewing portal throughout the procedure.[7] Additional anterolateral and direct lateral (accessory anterolateral) portals are created for instrumentation.[8,9] Gravity fluid inflow is used to achieve adequate distension. The articular surfaces of the radial head and capitellum are inspected; cartilage damage is assessed, and prominent implants are identified.

Step 2: Capsulotomy and Adhesiolysis

A 3-mm small-joint shaver blade (Arthrex, Naples, FL) is introduced into the elbow joint through the

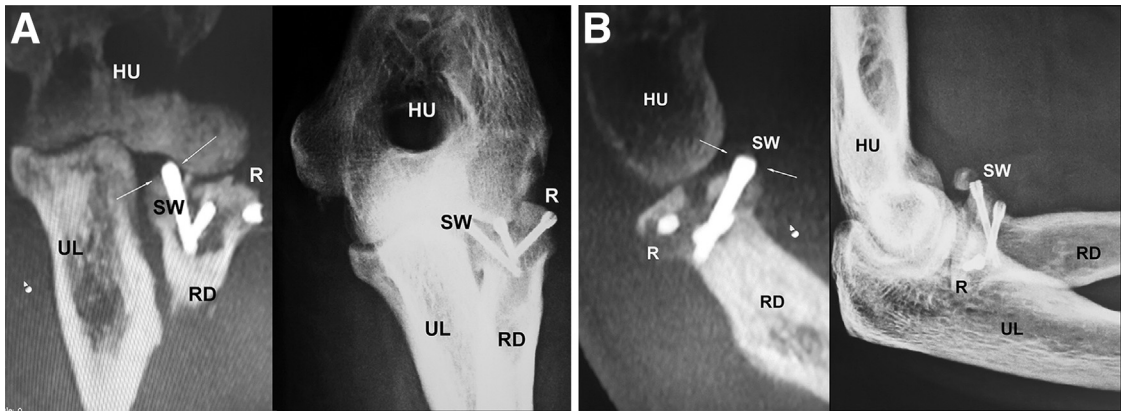

Fig 1. (A) A coronal computed tomography scan (on left) and anteroposterior radiograph (on right) show a collapsed radial head (R) and prominent implants (SW, arrows). (B) A sagittal computed tomography scan (on left) and lateral radiograph (on right) show an incongruent articular radial head surface (R) and a prominent screw (SW, arrows). (HU, distal humerus; RD, radial shaft; UL, ulna.)

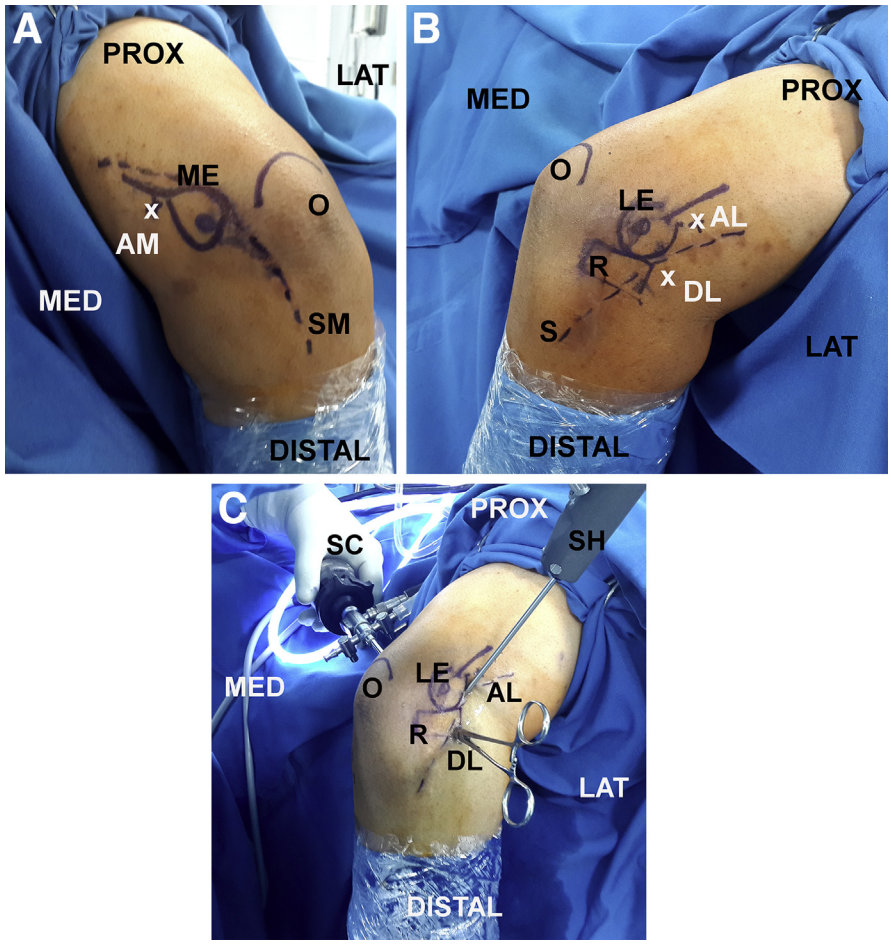

Fig 2. (A) A standard anteromedial (AM) elbow arthroscopy portal (x) is shown in a right elbow in the lateral decubitus position. The portal is placed 1 cm anterior and proximal to the medial epicondyle (ME). The medial scar (SM) from previous surgery is marked (dashed line). (B) Standard lateral elbow arthroscopy portals (x) are shown in a right elbow in the lateral decubitus position. The anterolateral portal (AL) is placed 1 cm anterior and proximal to the lateral epicondyle (LE). The direct lateral portal (DL) is placed anterior to the radial head (R) at the level of the radiocapitellar joint. The lateral scar (S) from previous surgery is marked (dashed line). (C) The arthroscope (SC) is placed in the anteromedial portal throughout the procedure. A right elbow is shown in the lateral decubitus position. Preliminary adhesiolysis is performed using a shaver (SH) through the anterolateral portal (AL). The precise position of the direct lateral portal (DL) is ascertained using an outside-in technique, and the capsular entry is dilated using a hemostat. (LAT, lateral; MED, medial; O, olecranon; PROX, proximal; R, radial head.)

Table 1. Key Steps of Procedure

Diagnostic elbow arthroscopy should be performed to determine the severity of radial head and capitellar damage. Intra-articular adhesions are assessed, and any other associated pathology is noted and treated.
Intra-articular adhesions are excised until a clear working space is obtained. Adhesions along the circumference of the radial head are resected to gain pronation and supination.
Superficial scar tissue debridement exposes the prominent implants. The screws are loosened by using a 3-mm burr to excise peri-implant bone. A grasper is used through a 4.5-mm cannula to withdraw the loosened screws.
The radial head is resected using a 4-mm burr. Resection is carried down to the cortical bone of the distal radial shaft.
The peripheral cartilage rim is excised in small parts, using a combination of punches, graspers, and shavers. The surrounding annular ligament and ligamentous regions are left undisturbed.
Adequacy of resection is confirmed arthroscopically by measuring a distance of approximately 8 to 10 mm between the radius and the capitellum. Biplanar imaging is useful to document the completion of resection.
Early mobilization is necessary to prevent re-formation of adhesions and subsequent recurrence of stiffness.

anterolateral portal and is used to perform a circumferential radial adhesiolysis. The direct lateral portal is useful for circumferential access to radial head adhesions. The lateral and anterior capsules are excised, and intra-articular adhesions are debrided. Next, radiocapitellar adhesions are resected, and adhesions between the radial head and annular ligament are excised. (Fig 3). A meticulous adhesiolysis restores range of motion and provides working space for further implant removal and radial head resection.

Step 3: Implant Removal

After creation of adequate working space, a 4-mm burr (Arthrex) is used through the direct lateral portal, and the superficial articular surface is debrided. A switching stick is used as a retractor through the anterolateral portal to assist visualization and working (Fig 4). Damaged cartilage and scar tissue over the radial head are resected, and the implants are identified. Loose headless screws are withdrawn from the bony bed using an angled arthroscopic probe. Screws that are well fixed to the bone are "excavated" by peri-implant bony resection using a 3-mm small-joint burr (Arthrex). A 4.5-mm metal cannula (Smith & Nephew, Andover, MA) is inserted through the anterolateral portal, and a 2.9-mm grasper (Acufex; Smith & Nephew) is used to withdraw the screws from the joint (Fig 5).

Step 4: Radial Head Resection

A 4- or 5-mm burr (Arthrex) is used to resect the radial head. The 2 lateral portals permit adequate access to all regions of the radial head. The peripheral cartilage rim is difficult to excise with a burr and is usually excised piecemeal at the end of bony resection.

Table 2. Technical Pearls for Key Steps of Procedure

Steps	Pearls
Portal creation	Fluid insufflation is necessary prior to portal creation. This distends the joint and increases the distance of vital neurovascular structures from the elbow joint.
	A 2.9-mm arthroscope (4-mm sheath) is used throughout the procedure.
	Lateral portals are created using an outside-in technique with an 18-gauge spinal needle. This helps to place the instrument trajectory in the precise position.
	The direct lateral portal is aimed at the level of the articular surface of the radial head.
Adhesiolysis	The surgeon should start with a 3-mm shaver blade using a combination of anterolateral and direct lateral portals.
	Lateral capsule resection should not extend posterior to the mid axis of the radial head and capitellum to avoid resection of the lateral ligamentous complex.
	The anterior capsule should be resected with caution to prevent iatrogenic neurovascular complications.
	The annular ligament is adherent to the radial head and should be dissected circumferentially off the bone.
Implant removal	The screws should be visible in their entirety.
	Peri-implant burring should be performed to loosen the screws.
	Use of a 2.7- or 2.9-mm grasper is necessary to withdraw the screw through the 4.5-mm cannula.
	Radial head resection should not proceed prior to implant removal. Inadvertent burring of the metallic implant releases metallic particle debris into the joint and may lead to particle-related inflammatory response in the postoperative period.
Radial head resection	Sufficient space is created by performing adhesiolysis and debridement.
	A 4-mm burr is ideal for rapid resection of the radial head.
	The surgeon should start with the central bone and proceed to the periphery.
	The peripheral cartilage rim is removed piecemeal once bony resection is adequate.
Adequacy of resection	An 8- to 10-mm space between the radius and capitellum can be measured using a 4-mm burr through the direct lateral portal. A space equal to 2 burr widths is indicative of sufficient resection.
	Biplanar imaging is mandatory. A posterior and medial shelf of bone may persist and should be resected further.

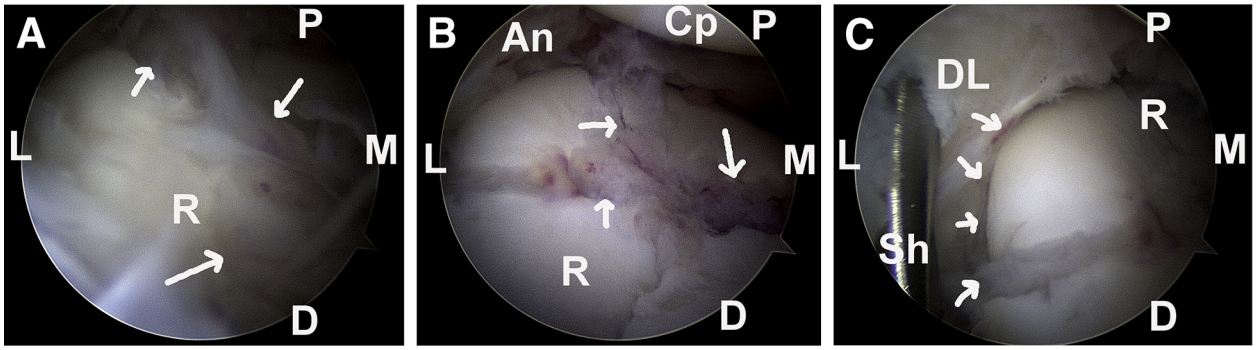

Fig 3. Articular surface of right radial head (R). (A) The radial head is deformed and covered with scar tissue. Areas of cartilage loss (arrows) are seen. (B) The scar tissue has been excised, and the incongruous articular surface is clearly visible. Fibrous tissue between the fracture segments (arrows) is excised, and the superficial surface is debrided to expose the implants. The capitellum (Cp) appears normal. (C) The recess (arrows) between the radial head and annular ligament is cleared of adhesions. The shaver (Sh) is seen in the direct lateral portal (DL). (An, annular ligament; D, distal; L, lateral; M, medial; P, proximal.)

Step 5: Peripheral Rim Excision

The cartilage rim is excised with a combination of punches, graspers (Acufex; Smith & Nephew), and small-joint shavers (Arthrex). Loose pieces of the rim may persist as loose bodies, and meticulous removal is crucial (Fig 6). Adequacy of resection is confirmed by (1) arthroscopic visualization of an adequate radiocapitellar space, which usually equates to 2 breadths of a 4-mm burr; (2) arthroscopic visualization of the cortical borders of the radial shaft that is distal to the resected radial head; and (3) fluoroscopic visualization of resection of the entire radial head (Figs 7 and 8).

A bulky dressing and sling are used in the postoperative period for 2 to 3 days. The rehabilitation protocol involves early passive and active range-of-motion exercises (weeks 1 through 6) and simultaneous gradual strengthening. Achievement of full range is dependent on the initial severity of the problem and may vary from 4 to 8 months. Light work is permitted after 6 weeks, and a return to heavy work is permitted only after 3 months (Fig 9).

Discussion

Arthroscopic radial head resection has been described before, and the results of this procedure have been comparable with those of the traditional open surgical approaches.[10-13] Wijeratna et al.[13] evaluated 15 patients who underwent arthroscopic radial head excision for elbow trauma; they suggested that the arthroscopic technique had similar results to open excision and was safe and reliable. Menth-Chiari et al.[12] analyzed the outcomes of arthroscopic radial head excision in 12 patients with post-traumatic arthritis or rheumatoid arthritis; they found that the procedure was effective in

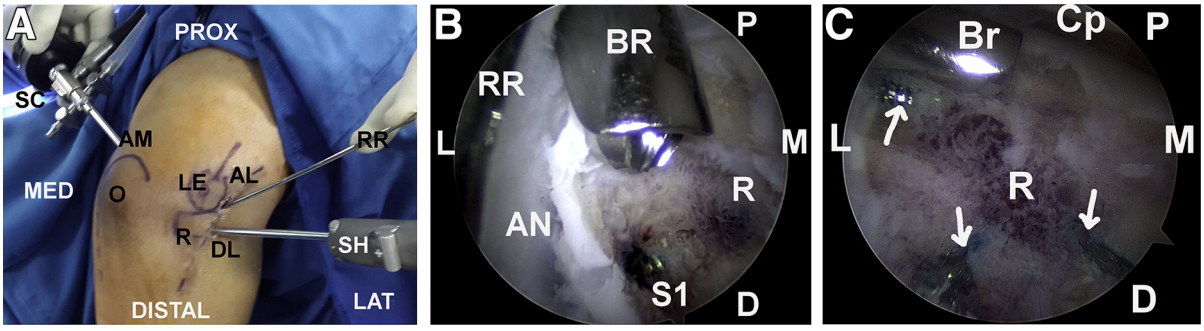

Fig 4. (A) External view of the retraction maneuver. A right elbow is shown in the lateral decubitus position. A switching stick (RR) is placed in the anterolateral portal (AL) and is used to retract the anterior capsule. This creates working space for the shaver through the direct lateral portal (DL). The arthroscope (SC) is placed in the anteromedial portal (AM) throughout the procedure. Preliminary adhesiolysis is performed using a shaver (SH) via the anterolateral portal (AL). (LAT, lateral; LE, lateral epicondyle; MED, medial; O, olecranon; PROX, proximal; R, radial head.) (B) Internal view of the retraction maneuver. The switching stick (RR) is seen holding the anterior capsule out of the field of visualization. Superficial debridement of the radial articular surface (R) is performed using a burr (BR) through the direct lateral portal. Debridement is continued until the fixation screws (S1) are exposed. (AN, annular ligament; D, distal; L, lateral; M, medial; P, proximal.) (C) Internal view of the debrided radial head (R). Debridement is performed using a burr (Br) through the direct lateral portal. Three headless screws (arrows) are exposed, and their location is identified. This step also creates working space between the radial head (R) and capitellum (Cp) for further resection. (D, distal; L, lateral; M, medial; P, proximal.)

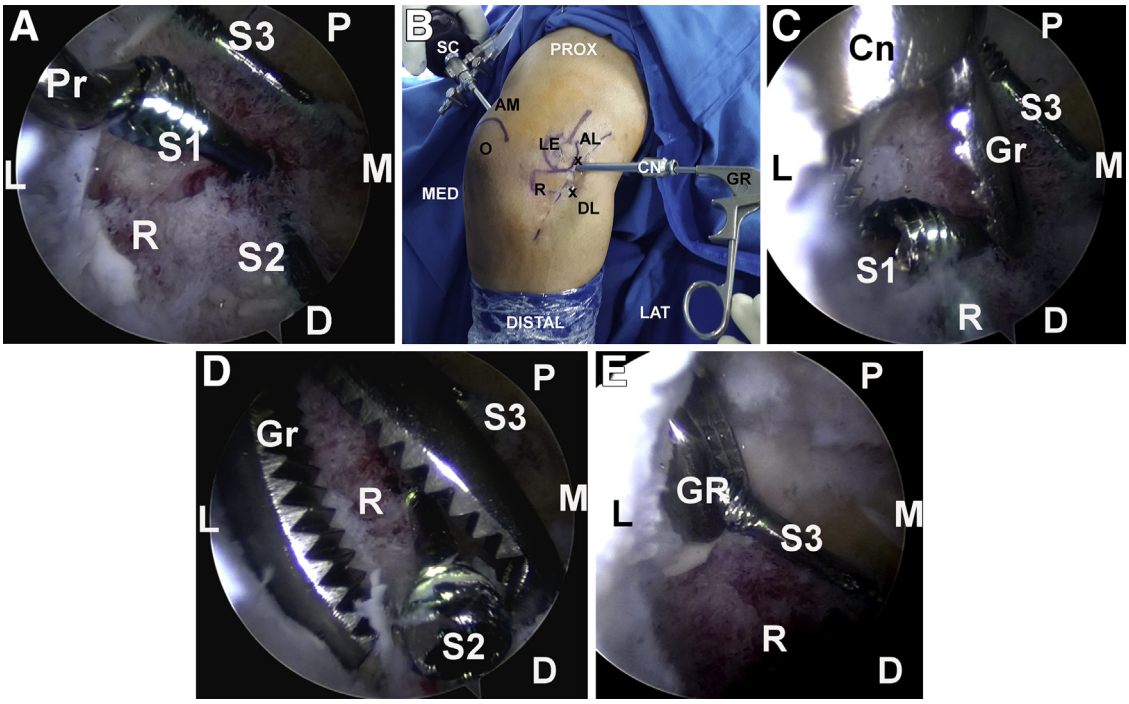

Fig 5. (A) The right radial head (R) is debrided, and the implants are identified. The first screw (S1) is loosened using an angled probe (Pr) passed through the anterolateral portal. The probe tip engages the screw end, and the screw is maneuvered out of the bone for further removal. (D, distal; L, lateral; M, medial; P, proximal; S2, second screw; S3, third screw.) (B) External view of implant removal. A right elbow is shown in the lateral decubitus position. A cannula (CN) is placed through the anterolateral portal (AL). A grasper is introduced through the cannula and is used to withdraw the implants. Arthroscopic visualization (SC) is performed through the anteromedial portal (AM). (DL, direct lateral portal; LAT, lateral; LE, lateral epicondyle; MED, medial; O, olecranon; PROX, proximal; R, radial head.) (C-E) Internal views of implant removal step. The 2.9-mm grasper (Gr) passes through the 4.5-mm cannula (Cn) and is used to withdraw the first screw (S1) from the radial head bone (R). Similarly, the second screw (S2) and third screw (S3) are withdrawn after being sufficiently loosened. (D, distal; L, lateral; M, medial; P, proximal.)

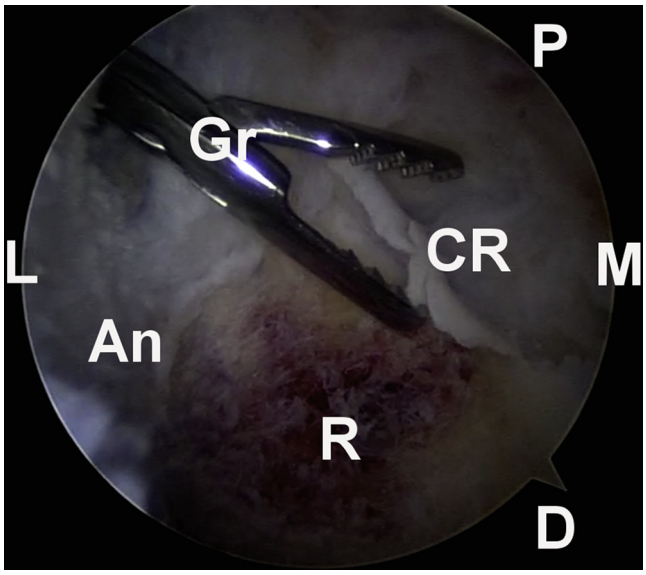

Fig 6. Peripheral cartilage rim (CR) excision of the radial head is performed piecemeal. The grasper (Gr) is seen entering the joint through the direct lateral portal and excises the rim fragment. The radial head bone (R) is completely excised to create a space of 8 to 10 mm between the radius and capitellum. (An, annular ligament; D, distal; L, lateral; M, medial; P, proximal.)

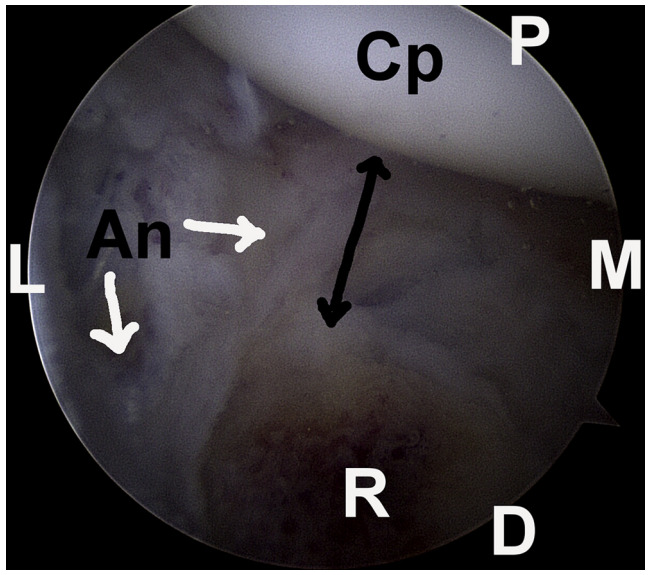

Fig 7. Arthroscopic assessment of adequate radial head excision is performed by measuring the space (black arrow) between the radius (R) and the capitellum (Cp). The intact annular ligament (An) is seen circumferentially (white arrows) in continuation with the capsule and the radial head remnant. (D, distal; L, lateral; M, medial; P, proximal.)

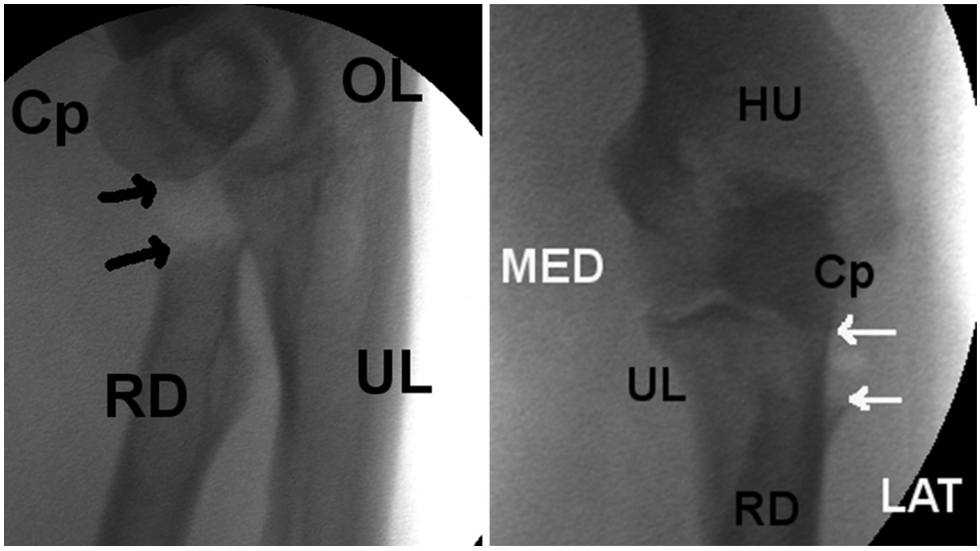

Fig 8. Biplanar oblique imaging of the elbow joint shows adequate resection space (arrows) between the radius (RD) and capitellum (Cp). (HU, distal humerus; LAT, lateral; MED, medial; OL, olecranon; UL, ulna.)

Fig 9. Range of motion at follow-up shows nearly complete flexion and rotation of the elbow and forearm.

Table 3. Advantages and Pitfalls of Technique

Advantages
The arthroscopic technique avoids the need for an open surgical approach and its subsequent morbidity. Only 3 portals are required for effective and complete management.
In cases in which ligament repairs have been performed, the open approach can compromise the healed ligament. Arthroscopic resection protects the repair, and early mobilization can be initiated.
An arthroscopic approach ensures an adequate adhesiolysis, and this facilitates a rapid gain in range of motion.
The annular ligament is preserved and prevents instability of the proximal radius. Soft-tissue preservation may also help to prevent proximal migration of the radius.
The rehabilitation time is shorter. Range-of-motion exercises are initiated in the first postoperative week, and a sling is not used thereafter.
Pitfalls
Neurovascular complications are possible, and adhesiolysis should proceed with caution. A thorough knowledge of anatomy and experience in elbow arthroscopy are necessary.
Inadequate resection is possible and results in persistent stiffness and painful forearm rotations. Biplanar imaging should be performed to ensure adequate resection.
Excessive resection results in proximal radial instability and is difficult to treat. This should be avoided by measuring the resection as described.
Screws should be removed carefully. A loose screw may migrate to an inaccessible site, and an open approach may be required to remove it thereafter.
Early initiation of range of motion is necessary to prevent re-formation of adhesions and recurrent stiffness.

relieving elbow stiffness and pain. Similarly, Bornu et al.[3] reported good outcomes of arthroscopic release and radial head resection in 12 patients with elbow joint arthritis.

Arthroscopic resection of the radial head is a difficult procedure with a steep learning curve. Capsular hypertrophy and intra-articular adhesions that occur from previous extensive surgery result in elbow stiffness, and this reduces the intra-articular working space for resection. The presence of fixation implants adds to the technical difficulty; these implants need meticulous removal before resection to avoid the risk of losing the implant in the deeper recesses of the complex anatomy of the elbow joint. The technical steps described in this report permit minimally invasive implant removal and bone resection. In addition, the adhesiolysis described is crucial to achieving the desired improvement in range of motion and pain relief. The overall advantages and pitfalls of the procedure are summarized in Table 3.

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