Dry Arthroscopy of the Elbow

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Abstract: Dry arthroscopy is attractive because it affords an unsurpassed clarity of view and minimizes swelling. The elbow is a challenging joint to assess arthroscopically; however, dry arthroscopy has some particular benefits in the elbow. The primary benefit is the quality of the tissue definition, but dry arthroscopy also increases the working time for surgery by reducing swelling and results in less postoperative discomfort for the patient. With dry arthroscopy, all joint surfaces are covered in synovial fluid, which reflects light, to provide a clearer image of the joint surfaces and depth of field. The air-fluid interface provides an uninterrupted appreciation of the synovial recesses and tissue perfusion. This article describes the technique and indications for dry elbow arthroscopy, which will allow other surgeons to reap the benefits of dry arthroscopy without the need for special equipment or changes in their basic technique.

Elbow arthroscopy is usually performed using fluid inflow regulated by gravity or a pump. With an extended surgical time, considerable soft-tissue swelling and extravasation of fluid can occur, placing neurovascular structures at risk and risking compartment syndrome.

To our knowledge, dry arthroscopy has not been described in the elbow; however, it is becoming popular in the wrist, in which both diagnostic and therapeutic procedures can be performed.[1] In patients with shoulder instability, some authors advocate that initial assessment of the capsulolabral structures should be performed dry, to prevent fluid distension exaggerating the pathology.[2] Dry endoscopy is routinely used in the thoracic and abdominal cavities with air insufflation. Dry endoscopy has been described for extra-articular procedures around the elbow, including ulnar nerve decompression/transposition, distal biceps repair, and olecranon bursectomy.[3-5] We have developed a technique to perform dry elbow arthroscopy by application of skills developed in wrist arthroscopy and dry endoscopy. This article outlines the current indications, advantages, and technical aspects of dry elbow arthroscopy.

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The authors report that they have no conflicts of interest in the authorship and publication of this article.

Received January 8, 2015; accepted March 5, 2015.

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2212-6287/1526/$36.00
http://dx.doi.org/10.1016/j.eats.2015.03.006

Surgical Technique

We routinely perform dry elbow arthroscopy in every case that would have required "wet arthroscopy" in the past.

Setup

Surgery is performed with the patient under general anesthesia, in the lateral decubitus position, with a sterile tourniquet applied. A list of required instruments is given in Table 1.

Procedure

The joint is insufflated with air using a 20-mL syringe through the soft spot formed by the radial head, lateral epicondyle, and olecranon. This moves the capsule and overlying neurovascular structures away from the joint as it is entered with a trocar. A proximal-superior-medial viewing portal is created 2 cm proximal to the medial epicondyle and just anterior to the medial intermuscular septum. Only the skin is incised to avoid inadvertent cutaneous nerve injury, and the joint is entered using a blunt trocar. Dissection through the joint capsule with an artery clip is avoided because this creates a large capsular perforation and allows dissipation of air into the extra-articular tissues. A 4.0-mm, 30° arthroscope (Karl Storz, Tuttlingen, Germany) is inserted. If visualization is poor but entry into the joint is confirmed by visualization of the articular cartilage,

Table 1. Equipment Required for Dry Arthroscopy of Elbow

Equipment	Essential or Desirable
Sterile tourniquet	Desirable
Low-profile arm support	Essential
4.0-mm cannula with 2 inlet taps	Essential
30° arthroscope	Essential
4.0-mm shaver with variable suction control	Essential
Radiofrequency ablation probe	Desirable
Arthroscopic retractors (right-angled retractors and mini-Homan retractors)	Essential
Irrigation fluid	Essential
Metallic narrow-bore outflow cannula	Desirable

the joint is insufflated with 20 mL of room air through the inlet on the arthroscope sheath. The inlet tap is closed after insufflation to minimize air dissipation. The lateral capsule is identified, and a lateral working portal is created by an inside-out technique. Standard arthroscopic instruments are introduced through this working portal. A complete diagnostic assessment of the anterior compartment is performed, followed by treatment of intra-articular pathology as necessary.

Attention is then turned to the posterior compartment. A midline posterior viewing portal 2 cm proximal to the olecranon tip is created. A posterolateral working portal is made 2 cm lateral to the viewing portal using an outside-in technique. It can be difficult to obtain a view in the posterior compartment until the soft tissue is cleared from the olecranon fossa. This is performed using a shaver through the working portal. Once the view improves, air is used to maintain the working space as described for the anterior compartment. The posterolateral and posteromedial gutters are viewed, and the presence of instability is assessed by applying varus and valgus forces in pronation, supination, flexion, and extension. Gapping of the ulnohumeral articulation or the drive-through sign, in which the arthroscope can be "driven" into the anterior compartment, is indicative of instability (Video 1). More commonly, soft-tissue lesions such as plicae are debrided in the posterior compartment, as are posterior osteophytes that may cause impingement in extension. At the end of the procedure, the posterior and anterior compartments are thoroughly irrigated to clear any residual debris and reduce the chance of infection.

Technical Pearls

Technical pearls are summarized in Table 2.

Maintaining Working Space. To maintain safe visualization during elbow arthroscopy, it is necessary to keep the anterior soft tissues away from the bony structures. We achieve this by manual air insufflation, using a 20-mL syringe to maintain capsular distension. When entering the joint, we use a blunt trocar immediately after the skin incision and advance it through the capsule in one motion. This minimizes the size of the capsular perforation and air escape into the soft tissues. After injecting air through the 3-way valve on the arthroscope, we turn the valve off to minimize slow loss of air. Suction is necessary to clear debris and blood on occasion, but it must be used carefully. Uncontrolled suction results in collapse of the joint and loss of visualization; however, low-pressure intermittent suction is beneficial.

We frequently use retractors. These are either standard right-angled retractors or flat retractors, such as mini-Hohmann retractors (Innomed, Savannah, GA). No specific or custom equipment is required. The retractors are inserted either through the viewing portal alongside the arthroscope or through an accessory portal. The assistant retracts the capsule manually, which maintains the working space.

Maintaining Visualization. Aside from collapse of the joint space, visualization can be affected by condensation (fogging) of the arthroscope and by blood and debris adhering to the end of the arthroscope. If present, fogging settles as the case proceeds. This is due to an initial temperature mismatch between the joint and arthroscope. Wiping the lens with an alcohol swab or

Table 2. Pearls and Pitfalls of Procedure

	Reason
Pearls	
Do not use artery clip to open capsule	Allows air to dissipate into soft tissues
Use low-pressure air to insufflate joint	Expands working space safely
Use intermittent low-pressure suction	Prevents collapse of working space
Point shaver blade away from camera	Prevents coating of camera with debris
Use irrigation with radiofrequency probe	Avoids heating of chondral surfaces
Use retractors liberally	Helps maintain safe working space
Use intermittent irrigation and suction	Efficiently clears bony debris
Irrigate joint at end of procedure	Minimizes infection risk
Pitfalls	
Avoid performing aggressive suction	Collapses working space and draws in neurovascular structures
Avoid making multiple passes when entering joint	Allows air to dissipate into soft tissues
Avoid using air insufflation in acute fractures	May predispose to air embolus due to exposed vascular surfaces

immersing the arthroscope in warm saline solution before starting the procedure minimizes fogging. Blood, debris, and condensation on the lens can also be removed by wiping the lens on the intra-articular soft tissues, which avoids removal of the arthroscope. To reduce contamination of the lens, shavers or burrs should be pointed away from the lens when in use. Short bursts of irrigation and suction on the shaver are very useful to rapidly clear the visual field and maintain a dry environment.

Using Radiofrequency Probes. A common concern with dry arthroscopy is the use of radiofrequency devices or cautery. If used, we recommend a low setting and short pulses of activity. This should be accompanied by frequent irrigation and suction to prevent overheating of the cartilage. When radiofrequency probes are used in a dry environment, smoke generation occurs. If excessive, opening the valve on the arthroscope and balloting the soft tissues will dissipate the smoke. These maneuvers act as a bellows to pump smoke out of the joint.

Discussion

We now routinely perform all elbow arthroscopies dry. Depending on the technical demands of the procedure, we do use fluid in the latter part of the case, although the need for this is decreasing with experience. We have not had any postoperative complications related to using a dry technique.

Advantages of Dry Arthroscopy

Tissue Definition. The key benefit of dry arthroscopy is the quality of tissue definition. Figure 1 shows the view achieved during a diagnostic arthroscopy. Subtle areas of synovitis and chondral damage, as well as partial ligament tears, are more obvious when dry. This is because the articular surfaces remain coated with synovial fluid, which reflects light at the air-fluid interface. This provides greater detail of the tissue surface. With wet arthroscopy, fluid also coats the articular surfaces but there is no air-fluid interface to reflect light. This means the finer detail is not appreciated. Figure 2 shows comparative views of dry and wet arthroscopy during diagnostic and therapeutic arthroscopy.

Reduced Intra-articular Pressure. Wet arthroscopy distends the soft tissues and compresses the capillary vessels. Dry arthroscopy does not compress these vessels, allowing a greater appreciation of synovitis, which can be underestimated when wet. During wet arthroscopy, extensive synovitis may obscure visualization because of the fluid effect (Fig 3).

We have noticed that fluid distension causes the capsule to become capacious, whereas air will not overdistend it. This may alter the surgeon's perception of

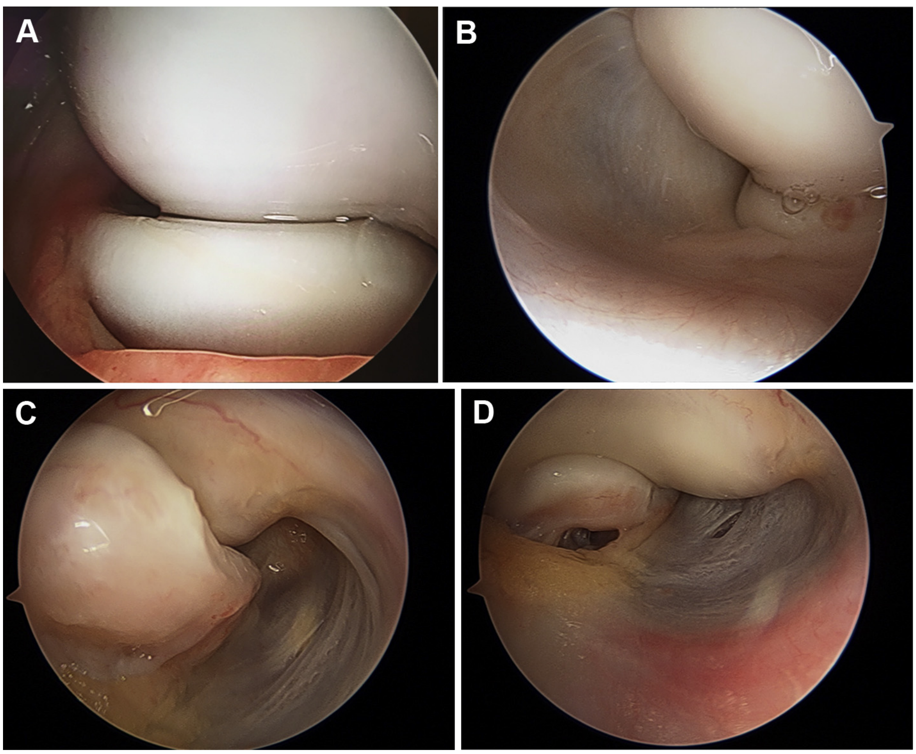

Fig 1. Dry diagnostic arthroscopy of anterior compartment. (A) Radiocapitellar articulation viewed from anteromedial portal. The articular surfaces are coated in synovial fluid. Light reflects more readily at the air—synovial fluid interface to give a clear, vibrant image. (B) Lateral capsule and radiocapitellar joint viewed from anteromedial portal. Air distension expands the working space and tensions the capsule, which can be seen clearly. Bubbles on the surface of the synovial fluid can be seen from the air distension. (C) Medial capsule and coronoid process viewed from anterolateral portal with elbow flexed. The hammock-like anatomy of the capsule is displayed, as is the bony detail of the coronoid process and trochlea. (D) Panoramic view of anteromedial aspect of joint with elbow extended. The vascular markings of the capsule are seen with clarity that cannot be achieved when using air distension.

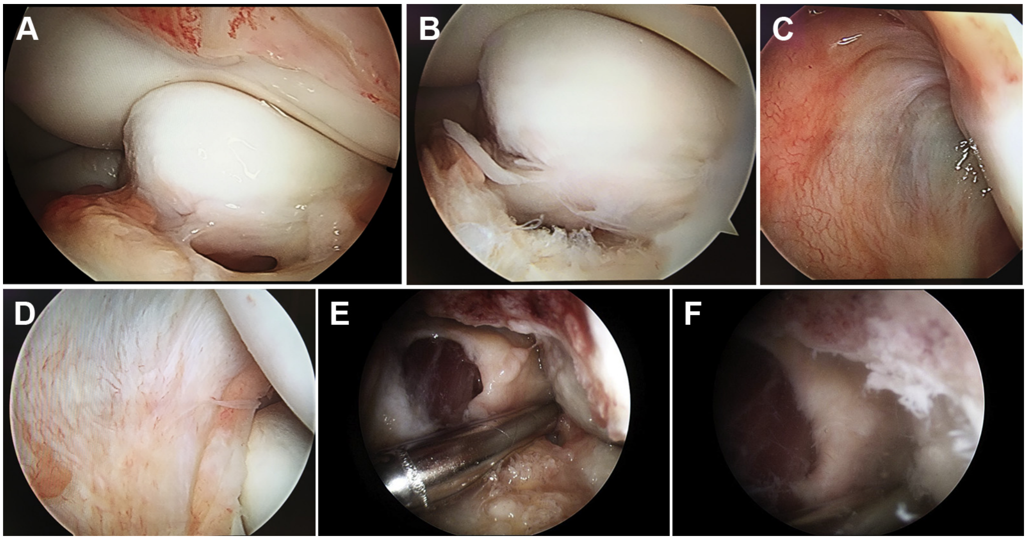

Fig 2. Comparative views of dry and wet arthroscopy. (A) Dry and (B) wet views of coronoid process and trochlea. In the dry view, the articular surface is clear and vibrant, whereas in the wet view, it is dull in comparison. (C) Dry and (D) wet views of lateral capsule. During dry arthroscopy, the striations and detail of the capsule are superior and the light can be seen reflecting off of the soft tissues coated in synovial fluid. (E) Dry and (F) wet views of osteocapsular release of anterior compartment. In the dry view, the muscle, capsule, bone, and articular cartilage all look crisp and clear, whereas in the wet view, the image is cloudy because of debris floating in the fluid.

capsular and ligamentous laxity, although this entity is difficult to quantify.

Swelling. Dry surgery results in less swelling. With wet arthroscopy, there is progressive swelling, which limits the "working time" for safe surgery. The swelling compromises visualization and can lead to extravasation. With dry arthroscopy, there is no swelling or extravasation, and it therefore increases the safe working time. This is particularly valuable for surgeons in the early part of their learning curve for elbow arthroscopy, when swelling and time are limiting factors.

Conversion to Open Surgery. Conversion to open surgery is easier after dry arthroscopy. The fluid extravasation accompanying wet arthroscopy compromises the soft tissues and makes it more difficult to identify the anatomic planes during dissection.

Rehabilitation. In our experience, reduced postoperative swelling after dry arthroscopy translates into patients having less pain and allows quicker mobilization and rehabilitation postoperatively.

The advantages and disadvantages of dry and wet arthroscopy are compared in Table 3. There are some potential concerns with air distension, which must be respected, such as the risk of an air embolus. Positive-pressure gas distension was the initial method of joint distension during the early years of arthroscopy, without a significant incidence of air emboli. Air emboli are rare, given the number of arthroscopic and endoscopic procedures performed on a daily basis. In particular, abdominal and thoracic endoscopy is performed with greater volumes of gas, without a tourniquet and in a field in which a greater number of veins are exposed. The minimum volume of air required to cause a minor, asymptomatic air embolus is 50 mL.[6]

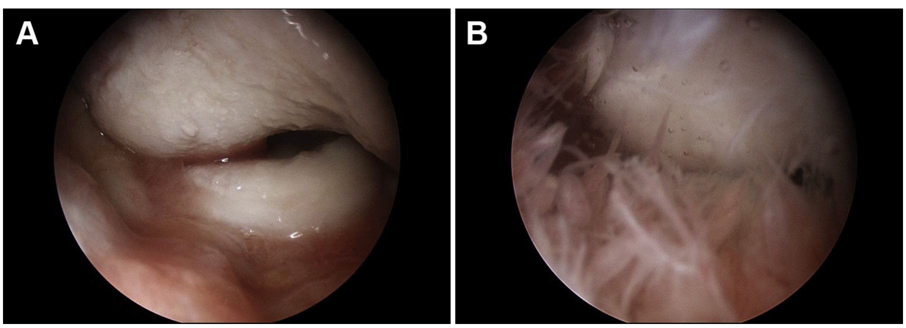

Fig 3. Images from a patient with osteoarthritis of the elbow and anterior compartment synovitis. (A) When dry, the synovitis is visible but not obstructive; (B) however, with fluid distension, the synovitic tissue floats up and obscures the view.

Table 3. Advantages of Dry and Wet Arthroscopy

Dry arthroscopy	
	Better tissue definition (joint surfaces, synovial reflections, and perfusion)
	Decreased risk of swelling, fluid extravasation, and compartment syndrome
	Easier conversion to open surgery
	Retention of external landmarks
	"Truer" understanding of tissues and their pathology
	Less postoperative swelling and discomfort
	Less expensive
Wet arthroscopy	
	Familiar technique
	Sustained fluid distension and visualization of joint
	Continuous irrigation of debris
	Cooling effect to joint
	Floating of synovium and loose bodies (this can be a disadvantage)

Thus, by never injecting greater than 20 mL at a time, the risk is minimized. Finally, in the lateral position, the elbow does not lie significantly above the level of the heart, which means the air within the joint is not under greater pressure than the venous pressure. In view of the serious nature of air emboli, we advise that mechanical air insufflation should not be used for this procedure.

Dry arthroscopy of the elbow is new, but there is considerable evidence from the wrist of its superiority over wet arthroscopy. On the basis of our experience, we would urge other surgeons to try this technique because they will find the improved tissue definition valuable to their practice and pathoanatomic understanding of intra-articular elbow conditions.

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