Technical Note

Dynamic Assessment of Shoulder and Patellofemoral Pathology Using Limited-Volume Gas Arthroscopy

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Summary: Subtle instability problems of the glenohumeral joint and patellofemoral joint are difficult to assess and accurately diagnose with current methods of preoperative imaging and physical examination. A simple technique is described that provides objective information for diagnosing dynamic problems of the shoulder and patellofemoral joint. Limited-volume gas arthroscopy avoids many of the potential risks and complications of pressure-based gas arthroscopy. In addition to assessing joint dynamics, it allows for initial arthroscopic inspection of joints during open surgical cases, eliminating the additional morbidity and expense of fluid arthroscopy. Objective intraoperative assessments of completed reconstructions can also be made to insure that stabilizing procedures are adequate but not overzealous. The technique requires no special equipment, adds little time to an arthroscopic procedure, and requires only basic arthroscopic skills. **Key Words:** Shoulder instability—Anterior knee pain—Patellofemoral instability—Gas arthroscopy—Impingement syndrome—Rotator cuff repair.

Appropriate treatment of dynamic problems of the shoulder and knee requires objective information. Accurate diagnostic assessment of patients with shoulder pain or anterior knee pain due to occult instability may be elusive. Although magnetic resonance imaging may show secondary clues of instability such as labral tears or bone changes in the posterior humeral head, these findings may be absent in many patients. Shoulder pain caused by subacromial impingement in patients without rotator cuff pathology remains an almost purely clinical diagnosis.[1] Likewise, computed tomography or magnetic resonance imaging findings in patients with patellofemoral instability who present with anterior knee pain may be normal or inconclusive.[2] Intraoperative assessment with traditional fluid-based arthroscopy is limited because of the effect of the fluid environment, particularly when a pump is used. In many cases a careful preoperative history and physical examination may be the only guide to appropriate surgical treatment. A simple and safe application of gas arthroscopy is described that allows for intraoperative assessment of dynamic problems of the shoulder and the patellofemoral joint.

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SURGICAL TECHNIQUE

Shoulder

The patient is positioned in the beach chair position. A standard posterior shoulder portal is made being careful to cut only the skin, and a blunt trochar is inserted directly into the subacromial space. Sweeping of the cannula should be minimized and done very gently to avoid bleeding. The arthroscope is inserted and once adequate visualization of the coracoacromial ligament is confirmed 15 to 20 cm^3 of air is injected into the cannula side port, which is then sealed. After the subacromial space is fully inspected, the impingement maneuver is performed and the path of the rotator cuff is studied as it glides under the acromion and coracoacromial ligament. The severity of subacromial impingement is evaluated and the location of the affected areas are identified. If an acromioplasty is to be performed, bleeding can be minimized by placing an 18-gauge spinal needle into the location of the lateral portal and injecting epiniphrine solution (1: 100,000) into the common areas of known bleeding under direct vision (coracoacromial ligament, periosteum under acromion, subacromial fat, and anterolateral corner of acromion). The arthroscope is now removed.

The arthroscope and cannula are now cleaned to remove any blood along the outside or the inside of the cannula and then replaced into the posterior portal and gently directed into the glenohumeral joint. Once intra-aarticular placement is confirmed, 30 cm^3 of air is injected into the glenohumeral joint. A routine diagnostic assessment is then completed. Forward traction is now applied to the arm and anterior translation is assessed for pathological laxity. The arm is now taken into the position of abduction and external rotation and again assessed for abnormal translation and mechanics. Finally, the impingement maneuver is repeated looking for signs of internal impingement or other types of soft tissue impingement.

If open surgery has been planned, the arthroscope is removed and the routine open procedure is begun. Once the open procedure is completed, a postsurgical assessment can be carried out. The adequacy of a glenohumeral stabilization can be verified to assure adequate stability and avoidance of over-tightening. A rotator cuff repair can be inspected to assure adequate coverage. Finally, the subacromial space can be reinspected to confirm adequate decompression by repeating the impingement maneuver under direct vision. The total volume of air for the procedure should be limited to 100 cm^3 to avoid potential complications as described below.

Knee

The patient is placed in a supine position and a tourniquet is applied and inflated to 300 mm Hg. An anterolateral portal incision is made in the skin only. The arthroscope is introduced into the patellofemoral joint with the knee extended; 60 mL of saline is injected into the side port and then aspirated. This step is repeated as many times as necessary until the effluent is clear. Suction is then placed on the side port and the cannula is gently swept into the medial and lateral gutters, notch, and medial, and lateral compartments to suck out all residual fluid; 50 cm^3 of air is then injected into the side port which is then sealed. Patellofemoral instability is then assessed with manual pushing of the patella. Patellofemoral tracking can then be assessed by taking the knee through a full arc of motion. If an open patellofemoral realignment is planned, the arthroscope is removed and the open procedure is begun. Reassessment of patellofemoral tracking and stability can then be checked as needed throughout the procedure to confirm the adequacy of the repair.

DISCUSSION

Arthroscopy utilizing a gas medium was first described in 1921 by Bircher[3] and was popularized by Henche in the 1970s.[4,5] The classically described advantages are improved clarity and the ability to make a more realistic assessment of joint surface pathology.[4-6] A more recent advantage is the ability to use lasers that require a gas medium.[7] Most described techniques use a carbon dioxide medium and require a pump that maintains a constant gas pressure of 50 to 100 mm Hg. Gas-related complications resulting from the use of a pump are common and include subcutaneous emphysema and, more rarely, gas embolism.[6,8-10] When using a pump, carbon dioxide is preferable because of its solubility in the blood stream, which is five times greater than that of air.[8] However, the use of gas medium has been limited in North America.[4] This may be attributable to the cost and unfamiliarity of the equipment as well as the risk of gas-related complications.

Johnson[11] described using room air for joint distention as a means to increase the field of vision and to control bleeding, because of the drying effects of air on bleeding surfaces. His technique was described primarily as an adjunct to arthroscopic shoulder procedures. A 60-cm^3 syringe was used and two volumes of room air were placed into the shoulder. He reported no complications of infection, air embolism, or subcutaneous emphysema.

The limited-volume air technique has a number of technical advantages over the pressure-based gas techniques. There is no special equipment or associated costs. There is a minimal need for added operative time, as the technique is technically quite simple. By limiting the total volume of air to 100 cm^3, the complication of subcutaneous emphysema is eliminated and the potential for clinically significant gas embolism is minimized. Two deaths caused by an air

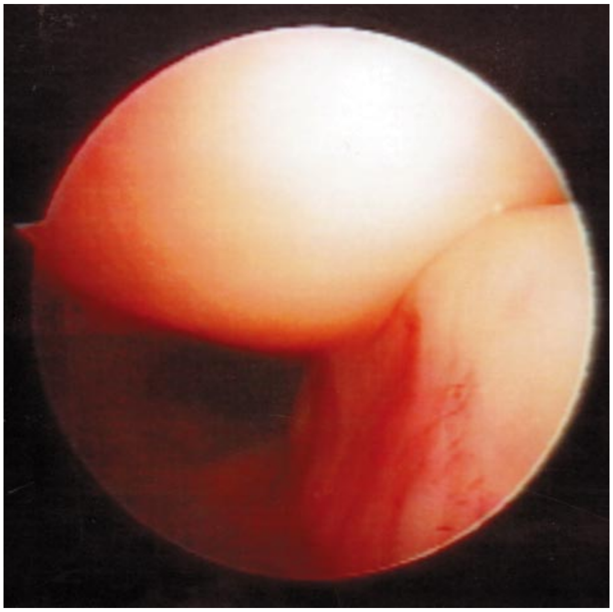

FIGURE 1. View of the patella from an anterolateral portal. Manual pressure is being exerted over the medial aspect of the patella. Note that the central ridge of the patella is overhanging the lateral edge of the lateral femoral condyle.

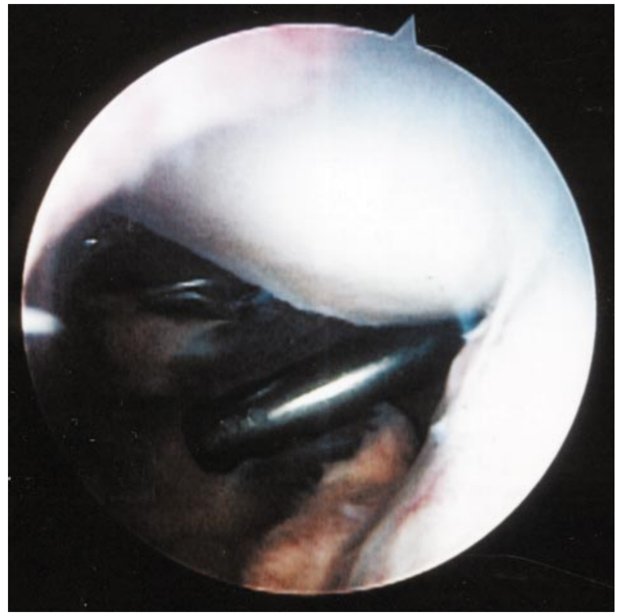

FIGURE 3. View of the patella from an anterolateral portal in a water medium. Manual pressure is being exerted over the medial aspect of the patella.

embolus have been recently reported in separate case reports.[9,10] In one case, the volume of air injected was in excess of 300 cm^3 and the initial bolus of 300 cm^3 was injected at the beginning of the procedure. In the second case, the amount of air injected was not reported and it was unclear whether a pump was used for insufflation. Both cases involved fresh fractures and findings at autopsy showed tracking of air through the venous sinusoids that was thought to have originated from the fracture site.[9,10] The technique described here limits the total volume to 100 cm^3 and the

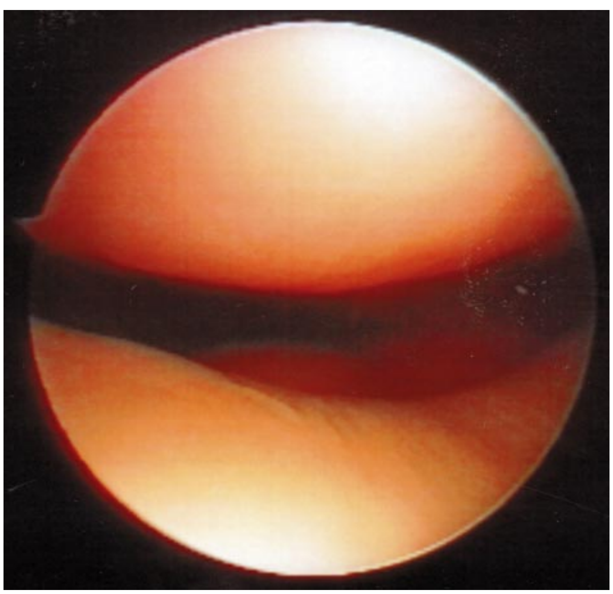

FIGURE 2. View of the same patella several seconds later when the pressure is released and the patella is now centered in the trochlear groove.

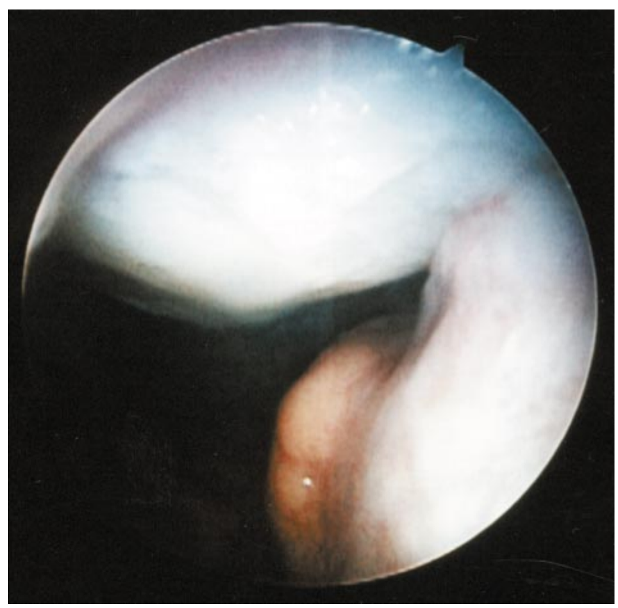

FIGURE 4. Exact view of the patella shown in Fig 3 in an air medium with the same amount of pressure being exerted over the medial aspect of the patella. Note that the apex of the patella is more laterally displaced than in Fig 3.

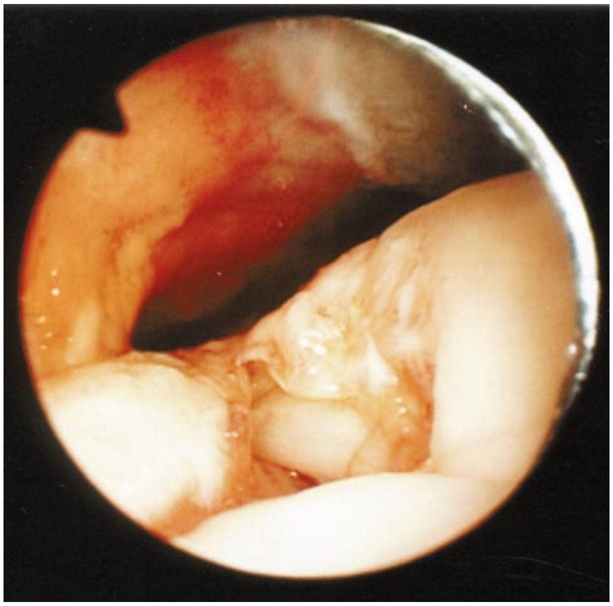

FIGURE 5. Full-thickness rotator cuff tear limited to the supraspinatus tendon.

FIGURE 7. View of the same glenohumeral joint with the shoulder reduced. The posterior lip of the glenoid is seen at the far left and the Hill-Sachs lesion is again shown.

technique is contraindicated in cases of fresh fractures. Volume restriction by limiting total volume to 100 cm^3 is in keeping with the recommendations by Kieser[8] in his 1992 review of complications of arthroscopic knee surgery. This low volume is similar to the volume of air routinely used by radiologists for air contrast studies for routine and computed tomography arthrograms.[12-15] Over 400 arthroscopic procedures have been performed by the author since 1996 using the limited-volume gas technique. There have been no complications of subcutaneous emphysema or cases of clinically apparent gas emboli.

There are a number of significant surgical and

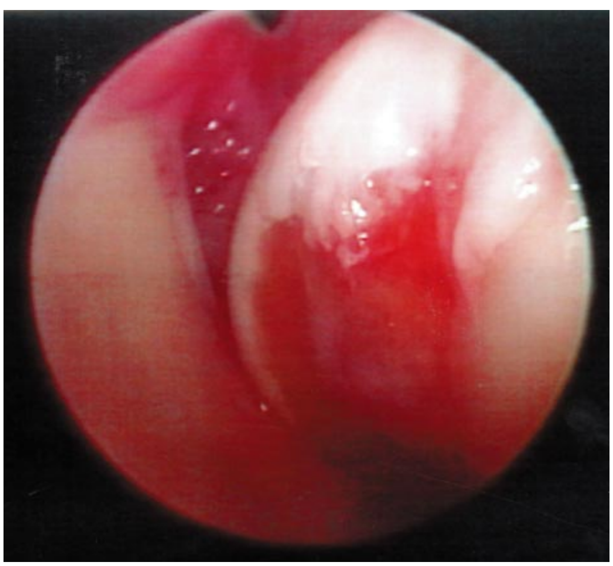

FIGURE 6. View of the glenohumeral joint from the posterior portal. The humeral head is dislocated anteriorly and a large Hill-Sachs lesion is well visualized and is straddling the anterior lip of the glenoid. There is no Bankart lesion present. Instability is due to capsular stretching.

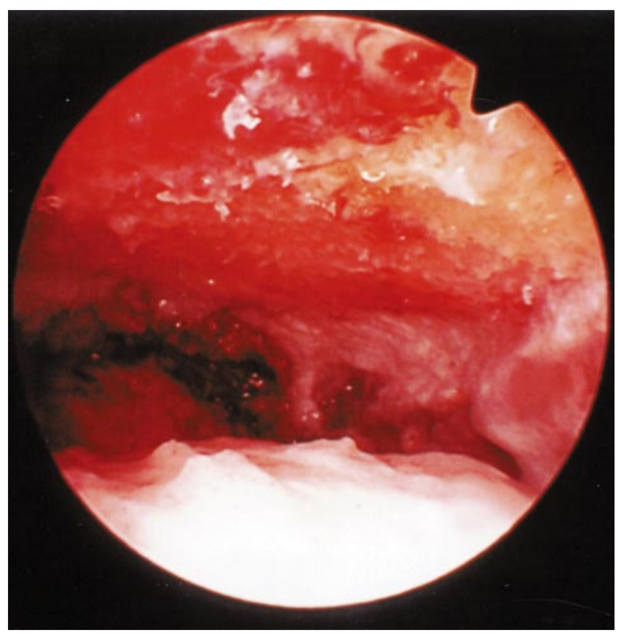

FIGURE 8. Completed acromioplasty with the arm held in abduction and internal rotation showing ample decompression of the subacromial space. The rotator cuff tendon is normal.

diagnostic advantages of the current technique that expand on the previous advantages of using a gas medium. The ability to assess dynamic pathology is important in cases of occult instability of the shoulder and patellofemoral joint. Many patients with occult instability as a cause of shoulder pain, particularly in an athletic population, may present with normal preoperative studies.[1] The limited-volume gas environment allows for an objective evaluation of the degree and pattern of instability in these patients. This is particularly useful in cases of patients with evidence of both impingement and capsular stretching when an intraoperative decision must be made regarding an optimum surgical plan. The same is true of patients with anterior knee pain who have normal preoperative study results yet show evidence of patellar instability intraoperatively (Figs 1 and 2). Although these assessments can be made in a fluid environment, the presence of fluid dampens the natural movements of the joint, thus making objective assessment more difficult and less useful (Figs 3 and 4).

The technique is a valuable adjunct to open surgery in many cases. Rotator cuff tear size can be assessed without disturbing the soft tissue with water distention (Fig 5) This allows for intraoperative decisions regarding surgical approach (classic open, mini-open, or arthroscopic) before committing to skin incision. Decisions regarding open versus arthroscopic shoulder reconstruction can also be made without disturbance of soft tissue planes (Figs 6 and 7). In addition, the expense and extra time in setting up a fluid-based procedure is eliminated.

In cases in which a reconstruction has been perforemed (glenohumeral stabilization or patellofemoral stabilization), the adequacy of the repair can be checked either before tying the sutures or after the repair has been completed. This provides an objective assessment of the adequacy of the repair. If subacromial impingement is being treated, the area and severity of the impingement can be visualized and the decompression can be assessed at the conclusion of the procedure (Fig 8). If the procedure is being recorded on videotape, valuable objective information is available on review during the follow-up period.

Finally, in rare cases, the technique can be applied to situations where the avoidance of the morbidity of multiple portals and fluid distention is desired. A pure diagnostic arthroscopy can be completed with a single portal. This may have application for athletes in midseason. Likewise, an arthroscopic biopsy for diagnosis or for chondrocyte retrieval can be completed with less time and morbidity than standard fluid arthroscopy.

CONCLUSION

A technique for using small amounts of air in routine arthroscopy is described. The primary advantages are the ability to see dynamic phenomena with less artifact than is possible with fluid and the ability to reduce the surgical morbidity associated with open surgical procedures. Prevention of gas-related complications is accomplished by adherence to a strict limitation of the use of no more than 100 cm^3 of air and avoidance of the technique altogether in cases of fresh fractures.

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