Technical Note

Arthroscopically Assisted Humeral Head Decompression for Avascular Necrosis: Lateral Cortical Perforation Technique

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Abstract: Avascular necrosis (AVN) of the humeral head is debilitating condition that, when left untreated, can progress to humeral head collapse and end-stage arthritis of the glenohumeral joint. Core decompression is widely regarded as a first-line surgical treatment for early-stage AVN, and when performed on the appropriate patient, core decompression is an effective treatment for improving symptoms and preventing progression and humeral head collapse. This article discusses operative indications and presents a relatively simple and effective arthroscopic method for core decompression of humeral head avascular necrosis.

Introduction

Avascular necrosis (AVN) of the humeral head is an uncommon but debilitating condition that requires prompt recognition and management.[1] The humeral head is the second most common site affected by AVN, behind the femoral head.[2,3] However, since the glenohumeral joint is less congruent and bears less weight than the hip joint, humeral head AVN can often go unrecognized for a prolonged period as the pathology worsens.[4] Without treatment, patients with humeral head AVN progress to humeral head collapse on an average of 6 years after the onset of pain.[2]

Many causes of humeral head AVN have been described, including trauma, corticosteroid use, alcohol abuse, sickle cell disease, rheumatologic and endocrine disorders.[1,5,6] While the exact pathophysiology of atraumatic AVN is unknown, the common pathway is hypothesized to progress through a disruption in the blood supply, causing ischemia, increased intraosseous pressure and ultimately cell death.[7,8] A sclerotic rim forms around the necrotic bone as the body attempts to repair itself by partially resorbing the necrotic tissue and generating new bone on the old trabeculae.[7,9] This process results in inflammation and subchondral fractures, which may progress to articular surface collapse if left untreated.[7]

The severity of humeral head AVN can be designated into stages, as described by the Cruess classification.[4,10] The Cruess Classification (Table 1) is a radiological classification staged from normal radiographic appearance to complete collapse of the humeral head with adjacent glenoid degenerative changes.[10] This classification system is useful for quantifying disease progression, as well as to guide treatment. Several surgical options have been proposed for the management of humeral head AVN based on the extent of joint involvement. Patients with early-stage, precollapse AVN of the humeral head are candidates for joint-preserving procedures, such as core decompression.

Although recent studies have questioned its effectiveness, core decompression remains the gold standard surgical treatment for early stage AVN of the humeral head.[3,8,11] Core decompression is thought to treat AVN through reduction of the subchondral bone marrow pressure and promotion of neovascularization, thereby allowing the body to form new healthy bone.[7] The procedure is typically performed percutaneously using a small-diameter drill or Steinman pin, advanced under

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Table 1. Creuss Classification for Humeral Head Avascular Necrosis

Stage	Classification
Stage I	Normal appearance on plain radiographs, changes seen on MRI only
Stage II	Sclerosis and osteopenia on radiographs, humeral head sphericity preserved
Stage III	Crescent sign on radiographs, subchondral fractures
Stage IV	Flattening and progressive collapse of the humeral head with joint space narrowing
Stage V	Degenerative arthrosis of both the humeral head and glenoid

fluoroscopy. The perforation starting point is repositioned to achieve multiple passes through the lesion.[7,12] The purpose of this paper is to discuss indications and describe a technique used by the senior author (L.D.F.) for core decompression of humeral head AVN.

Surgical Technique

Preoperative magnetic resonance imaging (MRI) and plain films are reviewed to localize the area of osteonecrosis for planned decompression (Figs 1 and 2). Following induction of anesthesia, the patient is positioned in the beach chair position, and the operative extremity is prepared and draped in sterile fashion. The bony landmarks of the shoulder are then palpated and marked for portal placement. Diagnostic arthroscopy is completed using a 30° arthroscope with a standard posterior viewing portal and an anterior working portal. The arthroscopic technique is illustrated in Video 1. The glenohumeral joint is examined for disease staging, and the humeral head is inspected and probed to assess for subchondral support or degenerative changes (Fig 3). Any intra-articular pathology is addressed at this point.

Fluoroscopy is then used to localize the area of necrosis seen on preoperative imaging and triangulate the proposed incision. An incision is then made over the proximal humerus, and an 8.0-mm cannula and trocar (8.0-mm Clear Trac Cannula, Smith & Nephew, Inc., Memphis TN) are inserted bluntly down to the bone surface. The cannula is held firmly on bone to prevent any soft tissue interposition, and the trocar is removed from the cannula. Prior to insertion, the rubber seal may also be removed from the top of the cannula to permit larger instrument passage. A 2.4-mm Steinman pin is then inserted through the cannula to the bone surface and further advanced, under fluoroscopy, to the center of the osteonecrosis (Fig 4). A cannulated 8-mm reamer is then used over the Steinman pin, with controlled reaming through only the lateral cortex of the humerus. The reamer is then removed leaving the guide pin in place (Fig 5). Through the 8-mm cortical window, the Steinman pin is repeatedly redirected under fluoroscopy throughout the area of osteonecrosis to remove multiple cores of bone.

Once adequate decompression is completed, the arthroscope may again be used to confirm that the articular surface was not violated. All instruments are then removed, the decompression incision is then thoroughly irrigated to remove any bone debris and closed using interrupted nylon suture. Suggested technique details and precautions are listed within Table 2.

Discussion

Core decompression is generally regarded as the first-line surgical option for low-grade AVN of the humeral head.[3] Following this procedure, the overall success rate is high in terms of pain relief and improved function in the appropriate patient.[13] However, the success rate decreases with worsening disease stage. When examining results following core decompression, LaPorte et al. found 94% successful outcomes for stage I disease; however, this decreased to 88% for stage II, 70% for stage III, and only 14% for stage IV.[13] Additional studies have found similar results with decreasing effectiveness in higher-stage disease.[3,11,12]

Treatment and outcomes of humeral head AVN are predominantly determined by disease severity, and

Fig 1. Anterior-posterior, scapular and axillary views of the right shoulder on plain film radiograph demonstrate subchondral sclerosis.

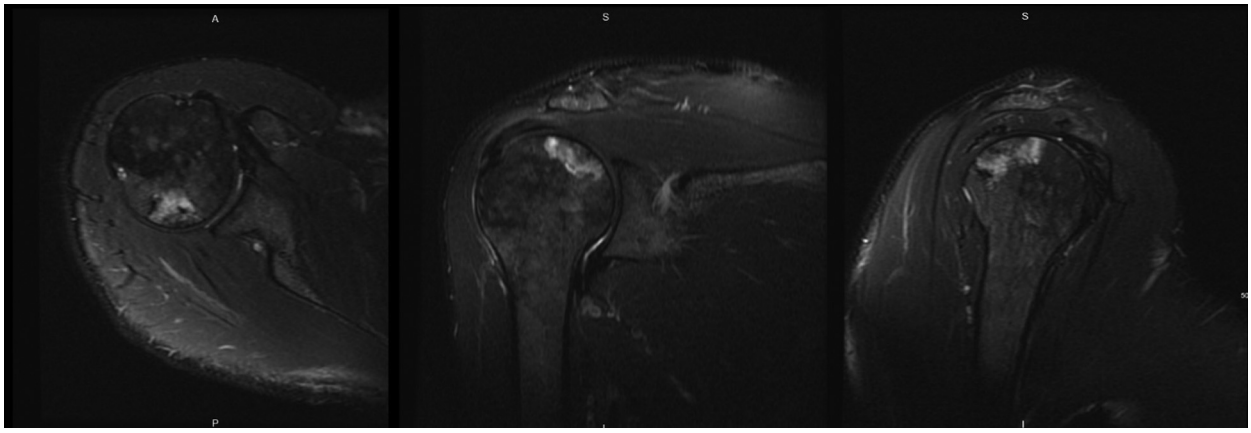

Fig 2. Axial, sagittal and coronal images from a T2 weighted magnetic resonance imaging scan of the right shoulder demonstrate an area of osteonecrosis without humeral head collapse.

therefore, disease staging is critical.[7] In early-stage osteonecrosis, stage I and stage II, core decompression is indicated to attempt to reverse the early radiographic changes and prevent progression and collapse. In addition to core decompression, arthroscopy may often be added with stage II or stage III disease. With late-stage osteonecrosis, stage IV and stage V, the bony changes are irreversible and shoulder arthroplasty is indicated.[7]

Glenohumeral arthroscopy is a useful adjunct to core decompression for humeral head AVN. Arthroscopy is helpful for staging and allows direct examination of the articular surface for sphericity or collapse.[14] In addition to staging, arthroscopy can be used to address associated pathology, such as removal of loose bodies or debridement of chondral flaps.[7,14] Other authors have additionally described a technique using arthroscopy and an ACL tibial guide to help localize the area of osteonecrosis for decompression drilling.[1,15]

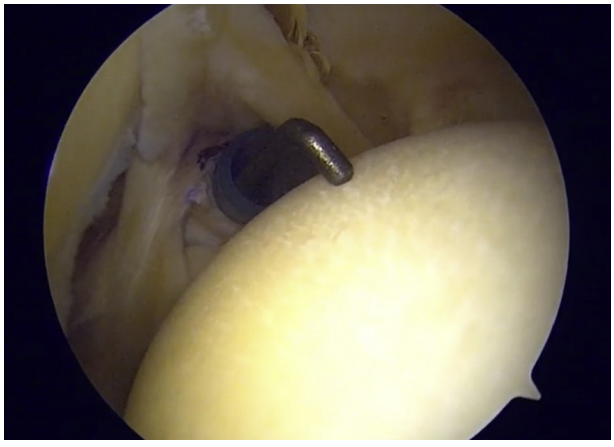

Fig 3. Intraoperative photograph demonstrates fluoroscopy placement in the beach chair position and instrumentation through an 8.0-mm arthroscopic cannula with seal removed.

The lateral cortical perforation technique described in this article offers a simple method for performing the decompression with several noted benefits. Iatrogenic injury to the axillary nerve is a devastating complication of surgical procedures to the shoulder.[16] The close proximity of the anterior branch of the axillary nerve places it at increased risk for injury during humeral head decompression. By using an arthroscopic cannula, the axillary nerve can be protected during instrument

Fig 4. For the right shoulder in beach chair position, viewed from the posterior glenohumeral joint portal, an arthroscopic probe from the anterior portal demonstrates no softening of the cartilage or collapse of the humeral head.

Fig 5. Fluoroscopic anterior-posterior image of the right proximal humerus, demonstrating Steinman pin positioned centrally within the area of osteonecrosis with larger 8.0-mm reamer, creating lateral cortical window.

passage and drilling. This method also avoids multiple stress risers in the lateral cortex of the proximal humerus. Creating a cortical window by reaming the near cortex with a larger diameter reamer prevents the need for multiple cortical perforations while allowing for redirection of the drill or Steinman pin to expand the area of decompression. Technique advantages and disadvantages are listed in Table 3.

With appropriate techniques, core decompression is a generally safe procedure with few reported complications.[13] In patients with early-stage disease, who have failed nonoperative treatments, the potential of preventing progression or delaying arthroplasty likely outweighs the risks. In these patients, arthroscopy is a useful adjunct to core decompression that can aid in staging and address associated pathology. The lateral cortical perforation technique further improves the procedure by protecting the axillary nerve from injury, limiting stress risers in the proximal humerus, and facilitating redirection of the Steinman pin.

Table 2. Pearls and Pitfalls for Arthroscopic Lateral Cortical Perforation for Humeral Head AVN

Pearls and Pitfalls
• Following removal of the trocar, the arthroscopic cannula must be held firmly on the lateral cortex of the humerus to prevent soft tissue interposition.
• Using intraoperative fluoroscopy and direct visualization on arthroscopy helps localize the area of necrosis and improve accuracy.
• Frequent fluoroscopy and tactile feedback must be used when drilling to prevent penetration of the articular surface.

Table 3. Advantages, Disadvantages and Limitations of Arthroscopic Lateral Cortical Perforation for Humeral Head AVN Decompression

Advantages, Disadvantages, and Limitations
Advantages
• Utilization of an arthroscopic cannula provides protection of the axillary nerve during drilling and instrument passage.
• Over reaming the near cortex and using a single cortical preformation limits stress risers in the lateral cortex of the proximal humerus.
• Arthroscopy allows for more accurate disease staging and can address intra-articular pathology.
Disadvantages and Limitations
• Triangulation and retrograde drilling of the area of necrosis can be technically challenging.
• Beach chair positioning can make fluoroscopic imaging more difficult.
• Use of a disposable cannula increases costs

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