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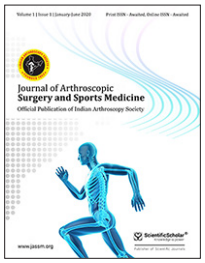

Shoulder *Review Article*

Recent advances and future trends in shoulder arthroscopy

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ABSTRACT

Shoulder arthroscopy has evolved significantly over the past decade. Treatment algorithms have evolved in sync with results from cadaveric, biomechanical, and clinical studies, and newer minimally invasive and biomechanically proven surgical techniques have replaced suboptimal procedures. Advances in arthroscopy have influenced three key aspects of shoulder problems: Anterior instability, rotator cuff tears, and osteoarthritis. A new frontier of "endoscopic" extra-articular procedures has evolved and these procedures have convincingly replaced traditional open surgeries. The current evidence suggests a growing trend for arthroscopic procedures in joint preservation and restoration.

Keywords: Shoulder arthroscopy, Latarjet procedure, Rotator cuff, Biceps autograft

INTRODUCTION

Shoulder arthroscopy has evolved significantly over the past decade. Basic science studies have provided vital insights into pathoanatomy of common disabling injuries and failure mechanisms of surgical procedures. Treatment algorithms have evolved in sync with results from cadaveric, biomechanical, and clinical studies, and newer minimally invasive and biomechanically proven surgical techniques have replaced suboptimal procedures. Innovations in medical devices have led to the development of newer biomaterials and delivery devices and biomechanically superior fixation implants. Advances in surgical skills and technical expertise have led to a new frontier of endoscopic extra-articular procedures that have convincingly replaced traditional open surgeries. This article presents a summary of the most recent advances in shoulder arthroscopy and futuristic trends in management of common shoulder problems.

SHOULDER ARTHROSCOPY PROCEDURES

Advances in arthroscopy have positively influenced three major shoulder problems: Anterior instability, rotator cuff tears, and osteoarthritis.

Anterior glenohumeral instability

Arthroscopic management of shoulder instability has undergone a paradigm shift after introduction of the concept of significant glenohumeral bone defects.[1,2] Several recent clinical and biomechanical studies have challenged the standard definition of "critical" glenoid bone

loss of 25%. Recent clinical and biomechanical studies have reported a high failure rate of arthroscopic repair with "subcritical" bone loss ranging from 13.5% to 17% and biomechanical studies have redefined critical loss as 15% of the largest anteroposterior width of glenoid for defects perpendicular to the superoinferior glenoid axis.[3-5] Cadaveric analysis of sequential changes in glenoid geometry with progressive bone loss suggests that a significant change in glenoid area and arc length occurs between glenoid width loss between 10% and 20%, and a significant change in glenoid version (retroversion to anteversion) is seen with glenoid bone loss over 20–30%.[6] This analysis is supported by biomechanical data that show a decrease in stability even with glenoid bone loss as small as 2 mm (7.5%) of the glenoid width. It is recommended that bony restoration should be performed whenever bone loss exists and particularly for defects that are in line with the superior-inferior axis of the glenoid.[7]

Decision-making algorithms for anterior instability have undergone modifications based on the newer clinical and basic science studies. The interrelationship of glenoid and humeral defects (glenoid track concept) has evolved and two subgroups of on-track lesions (peripheral-track and central-track lesions) have been suggested. Peripheral-track lesions with the Hill-Sachs occupancy ≥75% resulted in significantly worse outcomes without recurrent instability events when assessed with a disease-specific quality of life questionnaire.[8] The Glenoid Track Instability Management Score (GTIMS) incorporated the glenoid track concept into the instability severity index score and the study found that the GTIMS could possibly more accurately predict failure after arthroscopic Bankart repair and therefore could be used to identify patients better suited for a Latarjet procedure.[9] An "integrated algorithmic approach" based on sequential alteration of several glenoid geometry parameters suggested that glenoids with defects up to 10% of widest anteroposterior diameter were not significantly different from those of normal glenoids, and therefore, soft-tissue repairs were recommended for this subgroup.[6,10] The significance of 10% glenoid defect was further highlighted in a recent study that analyzed a statistical model of anatomic risk factors to predict recurrent instability after primary arthroscopic capsulolabral repair; the analysis demonstrated a 7.5 times increased risk of failure with glenoid bone loss more than 10% and this was also the largest contributor to post-operative failure in the statistical model.[11]

The overall evidence favors three key surgical procedures in anterior instability:

Arthroscopic Bankart repair combined with remplissage procedure

In a systematic review of the treatment of subcritical glenoid bone loss, the addition of a Hill-Sachs remplissage procedure to anterior labral repair demonstrated favorable rates of recurrent instability and a negligible loss of external rotation when compared with isolated Bankart repair.[12] At a minimum 10-year follow-up analysis, Bankart repair combined with remplissage showed better functional results (mobility and stability scores) than Bankart repair only without the limitations of pain and restriction of motion.[13] Finally, a concomitant remplissage procedure did not correlate with subjective patient dissatisfaction.[14] Newer remplissage techniques involve trans-tendon double-pulley techniques and specialized remplissage knots (double-barrel remplissage) and a tripod-pulley technique [Figure 1].[15-17]

Open bone grafting procedures

A prospective randomized study analyzed the Latarjet and iliac crest bone graft transfer procedures for the treatment of anterior shoulder instability with glenoid bone loss and found no difference in clinical and radiologic outcomes.[18] Recent basic science studies have analyzed the restorative possibilities of Latarjet procedures (classic and congruent-arc modifications) and distal clavicular autograft (DCA) procedure for instability-related anterior glenoid bone loss.[6,19] The classic Latarjet and DCA were suitable for glenoid defects of 20–25% and the congruent-arc Latarjet corrected all articular parameters even in 30–40% defects.

Arthroscopic bone grafting procedures

Open glenoid grafting can now be performed with arthroscopic techniques; several arthroscopic bone grafting procedures have emerged recently and mid-term results are encouraging [Figure 2]. Development of specialized instrumentation and graft fixation devices (cortical button and screws) has made these procedures safe and reproducible. A biomechanical evaluation of graft fixation techniques found that cortical button and screw fixation techniques exhibited comparable biomechanical strength for coracoid bone block

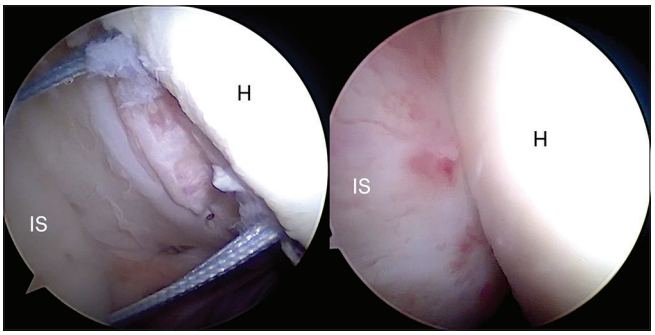

Figure 1: A double-barrel remplissage technique is demonstrated. Trans-tendon anchors are inserted into the Hill-Sachs lesion (left image) and a sliding self-retaining double-pulley knot (double-barrel knot) is used to approximate the infraspinatus into the humeral defect (right image). H: Humeral head, IS: Infraspinatus.

fixation.[20] A more recent analysis suggested that the cortical button fixation did not resist direct loads to the graft as much as traditional screw fixation; however, bony damage to the surrounding anatomy was more extensive in screw fixation.[21] In a clinical study, button fixation for Latarjet showed higher rates of recurrent dislocation compared to screw fixation.[22] Newer techniques include arthroscopic iliac crest grafting, implant-free J-bone grafting, and arthroscopic congruent-arc Latarjet procedure.[23-25] A multicenter analysis of learning curves showed that surgical time in arthroscopic Latarjet significantly reduced after 20 cases; however, complication rates did not decrease over this time.[26]

Rotator cuff tears

The treatment of rotator cuff tears has undergone changes in the recent past and arthroscopic management of massive and potentially irreparable tears has evolved by innovations in three key areas:

Rotator cuff repairs and healing

Bioinductive scaffolds and arthroscopic delivery techniques are emerging technologies that may enhance healing potential of partial and massive rotator cuff tears. In a preclinical canine model, biological scaffolds augmented healing of articular-sided partial-thickness supraspinatus tears when compared with debridement, and decellularized human dermal allograft and amnion matrix cord scaffolds were found to have advantages over the bovine collagen patch.[27] A 2-year follow-up of large and massive rotator cuff repairs that were augmented with a bioinductive collagen scaffold patch suggested 96% radiological healing rate and no adverse events attributed to the implant.[28] In a multicenter prospective study, use of a bioinductive collagen scaffold was found to be safe and effective for intermediate- to high-grade partial-thickness rotator cuff tears of the supraspinatus tendon.[29]

Rotator cuff repair and autograft augmentation

Biceps autograft augmentation of the repaired rotator cuff has been used to recreate the superior capsular restraint and for simultaneous cuff augmentation during repair. In a large series of massive and potentially irreparable tears, the proximally attached long head of biceps tendon was used as an autograft in specific cases to augment poor quality tissue in posterosuperior tendons.[30] In a recent study, structural and clinical outcomes of three surgical techniques for massive posterosuperior tears (double-row repair, transosseous-equivalent repair with absorbable patch reinforcement, and Superior Capsular Reconstruction (SCR) with biceps autograft) were analyzed; at 24 months, the infraspinatus tendon remained healed in three-fourths of the repair group and the patch augmented group and in 100% of the biceps autograft group.[31] Biomechanical evaluation of the biceps autograft for SCR found that the biceps autograft with appropriate distal insertion on the greater tuberosity recentered the humeral head on the glenoid and provided stability in cuff deficiency [Figure 3].[32]

Superior Capsular Reconstruction

Arthroscopic superior capsular reconstruction (SCR) has gained popularity and several techniques with different reconstruction tissues are currently in use. Clinical outcomes using a dermal allograft at 2 years have shown successful outcomes in 72%; graft failure was found in 16%; and revision to replacement was necessary in 12% of patients.[33]

A review of clinical outcomes comparing fascia lata autograft and human dermal allograft in arthroscopic SCR

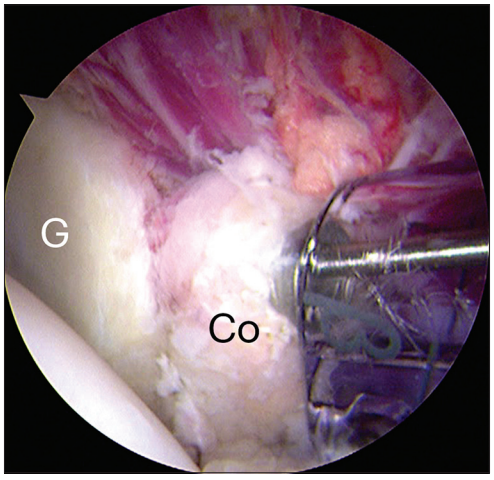

Figure 2: Arthroscopic Latarjet procedure is shown. G: Glenoid, Co: Coracoid.

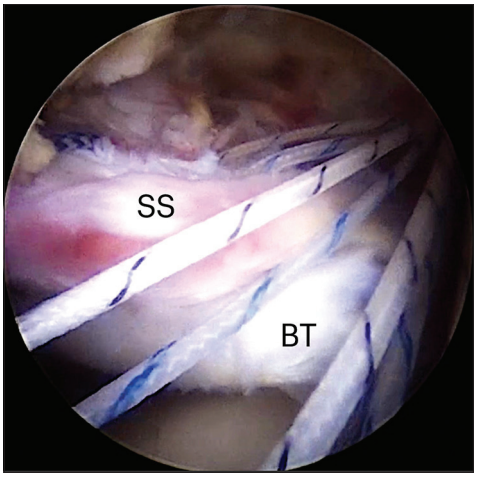

Figure 3: Arthroscopic superior capsular reconstruction and cuff augmentation using the biceps autograft are demonstrated (SS: Supraspinatus, BT: Long biceps tendon).

for irreparable rotator cuff tears suggested significant and clinically important improvements in clinical outcomes in both groups; however, the graft tear rate was found to be high (fascia lata autograft 5–32% and human dermal allograft 20–75%.).[34]

Glenohumeral arthritis

Arthroscopic procedures for joint preservation in severe glenohumeral osteoarthritis (GHOA) have shown favorable outcomes and should be considered in appropriately selected young and active patients. Arthroscopic glenoid resurfacing using a dermal allograft was found to be a safe option in younger patients with an acceptable rate of revision to prosthetic arthroplasty (23%) at short-term to midterm follow-up.[35] These results are similar to the previous studies that reported successful outcomes in two-thirds of patients who underwent this procedure.[36] In another study, the comprehensive arthroscopic management (CAM) procedure for GHOA showed 76.9% survivorship rate at a minimum of 5 years postoperatively. Further studies are necessary to evaluate long-term outcomes and durability after joint preserving procedures [Figure 4].[37]

ANESTHESIA AND POSITIONING IN SHOULDER ARTHROSCOPY

Several studies have evaluated the risk involved with shoulder arthroscopy in the beach chair position. Intravenous general anesthesia and controlled hypotension in the beach chair position (65°) were found to affect cerebral blood flow and cerebral oxygenation; the incidence of cerebral desaturation events was 25% and there were no neurological deficits.[38] In another study, pre-operative interscalene brachial plexus (BP) block and advanced age were risk factors associated with symptomatic hypotensive bradycardic events in the beach chair position.[39] The beach chair position angle was shown to affect cerebral oxygenation, and there was a linear decline in cerebral oxygenation as the position angle increased.[40] The current recommendations suggest that beach chair and lateral position are safe and successful methods for patient positioning in shoulder arthroscopic procedures without conclusive evidence of superiority of one position to the other.[41]

EMERGING FRONTIERS IN SHOULDER ARTHROSCOPY

Endoscopic extra-articular procedures

Shoulder "endoscopy" is a new and emerging frontier in arthroscopy and involves surgical procedures in extra-articular regions of the shoulder. The procedures are technically challenging and potential iatrogenic complications are possible.

Brachial plexus endoscopy

Lafosse *et al.* have described an all-endoscopic technique for infra- and supraclavicular brachial plexus (BP) neurolysis and have reported significant functional improvements in the selected patients suffering from non-specific neurogenic thoracic outlet syndrome.[42] The authors suggest that endoscopy may be an advantageous tool in selected cases of BP nerve sheath tumors and have further reported an all-endoscopic resection of an infraclavicular BP schwannoma.[43]

Endoscopic proximal humeral plate removal

Implant removal after proximal humerus fracture fixation can be performed endoscopically and may be combined with arthrolysis.[44,45] These techniques involve endoscopic dissection in the subdeltoid and upper arm region and have several advantages over conventional open removal of implants [Figure 5].

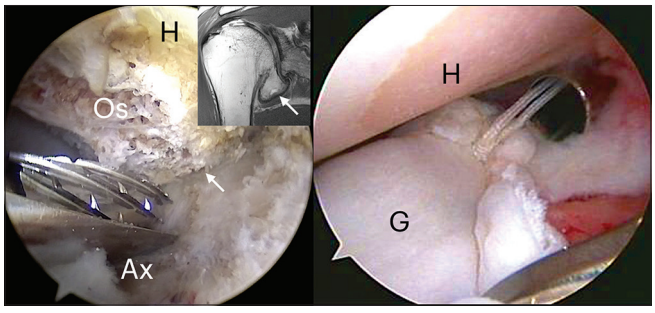

Figure 4: Arthroscopic options in glenohumeral osteoarthritis are demonstrated. Glenohumeral debridement and large osteophyte (OS) resection (arrows, left image) are combined with release of the axillary pouch capsule (Ax). Arthroscopic biological resurfacing is performed using a dermal allograft (G, right image) (H: Humeral head). (Right image: Courtesy Joe de Beer, used with permission).

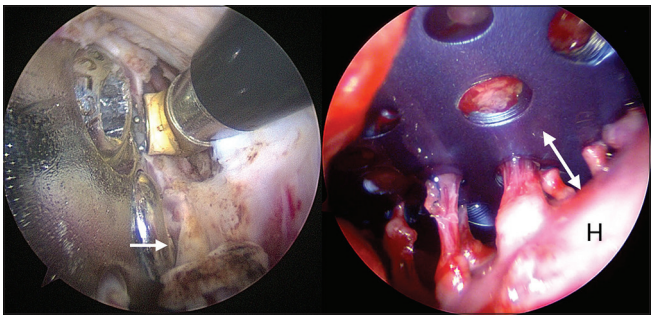

Figure 5: Endoscopic proximal humeral plate removal is shown. Careful dissection is performed in the subdeltoid and upper arm region and the axillary nerve (arrow, left image) is identified and protected. The plate is dissected off (arrows, right image) from the humeral head (h) and retrieved through a "plate portal" in the upper arm.

Scapulothoracic endoscopy

Scapulothoracic endoscopy and scapuloplasty can be performed using a new two-portal technique that uses intraoperative landmarks for accurate orientation.[46] Arthroscopic management of snapping scapula syndrome yields improvement in pain, crepitus, and range of motion in a majority of patients; however, most patients experience residual symptoms. Lower pre-operative mental status score, longer duration of symptoms, and greater age were associated with poorer outcomes [Figure 6].[47,48]

Tendon transfers

Endoscopic harvest and transfer of tendons (latissimus dorsi, teres major, and pectoralis minor) have been described by several authors and are a minimally invasive alternative to open surgery.[49-51]

Office-based needle arthroscopy

In-office needle arthroscopy is a new minimally invasive diagnostic procedure that allows the patient to actively participate in the diagnostic process and avoids the need for advanced imaging.[52] The technology has evolved for use during surgery and single-portal rotator cuff and labral repairs have been described.[53,54]

FUTURE TRENDS

Arthroscopic procedures and techniques are evolving at a rapid pace and current evidence suggests a future role for joint preservation and restoration procedures. Arthroscopic techniques like remplissage are safe and durable and likely to be commonly used to address larger Hill-Sachs lesions with minimal glenoid bone loss.[55] Arthroscopic bone grafting has shown technical and outcome advantages; however, the technique is limited by a steep learning curve and complications rates remain unaffected by surgical experience.[56] Bioinductive scaffolds have the potential to enhance healing rates of repaired tendons, and further clinical evaluation to assess their utility is necessary. SCR appears to be a solution to avoid prosthetic replacement in irreparable rotator cuff tears; however, graft thickness is crucial to achieve the desired results of the original procedure.[57] Mobilization and repair of potentially irreparable rotator cuff tears in combination with biceps autograft for augmentation is an attractive and cost-effective option, and the combination has the advantage of preserving the cuff and superior capsule.[58,59] Finally, joint preservation procedures for GHOA have stood the test of time and are likely to be adopted and evaluated further.[60]

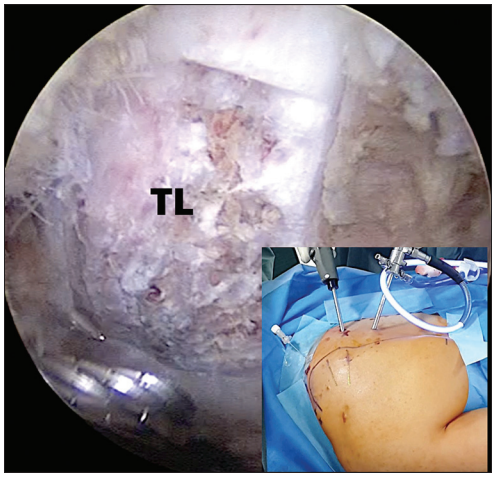

Figure 6: Scapulothoracic endoscopy is shown. Scapuloplasty and resection of the Luschka's tubercle (TL) are demonstrated. Inset image shows the portals and position for the procedure.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

The author certifies that he has no commercial associations (e.g., consultancies, stock ownership, and equity interest) that might pose a conflict of interest in connection with the submitted article. The senior author (DN Bhatia) retains the copyright to the images, videos, and content in this chapter.

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