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Technical Note

Glenohumeral Osteoplasty Augmented Therapy (G.O.A.T.): A Novel Modification of the Comprehensive Arthroscopic Management Procedure Incorporating Biological Augmentation for the Arthritic, Contracted Shoulder

Sedeek Mosaid FRCS (Tr & Orth)[1*], Alun Yewlett FRCS (Tr & Orth)[1], Charles Corbin FRCS (Tr & Orth)[1], Paul Lee MD PhD FRCS (Tr & Orth)[1]

[1]Department of Trauma and Orthopaedic Surgery, United Lincolnshire Teaching Hospitals NHS Trust, Lincoln LN2 5QY, United Kingdom.

***Corresponding Author:** Sedeek Mosaid, Department of Trauma and Orthopaedic Surgery, United Lincolnshire Teaching Hospitals NHS Trust, Lincoln LN2 5QY, United Kingdom.

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Abstract

Glenohumeral osteoarthritis (GHOA) in younger patients presents a clinical challenge, as total shoulder arthroplasty carries an increased risk of revision. Arthroscopic joint-preserving procedures such as the comprehensive arthroscopic management (CAM) procedure provide symptom relief, but long-term durability remains variable. This Technical Note describes the glenohumeral osteoplasty augmented therapy (G.O.A.T.) technique, a modification of the CAM procedure incorporating a three-layer biological augmentation strategy. The procedure is performed in the beach-chair position using standard posterior, anterior and accessory posterior portals. The operative sequence comprises glenohumeral inspection, capsular release, focused inferomedial humeral osteoplasty, subchondral microfracture, collagen scaffold application and intra-articular micro-fragmented adipose tissue (mFAT) injection. The G.O.A.T. technique integrates established mechanical joint-preservation components with biologically plausible adjuncts within a single procedure. The biological rationale for each augmentation layer is supported by preclinical and limited clinical evidence. No clinical outcome data are reported. Prospective studies with validated outcome measures are required to determine the clinical effectiveness and durability of this combined approach.

Keywords: Glenohumeral Osteoarthritis; Arthroscopy; Osteoplasty; Biological Augmentation; Micro-Fragmented Adipose Tissue

Introduction

Glenohumeral osteoarthritis (GHOA) is a degenerative condition characterised by progressive articular cartilage loss, subchondral bone remodelling, osteophyte formation and secondary capsular contracture, resulting in pain, restricted range of motion and functional impairment [1]. In younger patients, the disease is frequently secondary to prior instability, fracture or inflammatory arthropathy, and its management presents a unique clinical challenge [2].

Total shoulder arthroplasty (TSA) remains the gold-standard treatment for end-stage GHOA. However, its use in younger and more active patients is associated with accelerated polyethylene wear, glenoid component loosening and higher revision rates [2,3]. Patients younger than 65 years who undergo primary TSA have a 3.4-fold increased risk of revision, underscoring the adverse impact of younger age on implant survival and clinical outcomes [3]. These limitations have driven increasing interest in joint-preserving strategies that may delay or potentially avoid arthroplasty in selected patients.

Arthroscopic management has emerged as an intermediate option for GHOA [4]. Early studies demonstrated that arthroscopic debridement preserves joint congruity and residual joint space, providing symptom relief in selected patients [5–7].

The inferior humeral osteophyte, often described as the “goat’s beard” osteophyte, is a characteristic feature of GHOA (Figure 1A). This lesion serves as a radiographic indicator of disease severity and a clinically relevant contributor to inferior capsular abutment, restricted range of motion, mechanical impingement and potential axillary nerve compression. Resection of this osteophyte has underpinned the development of osteoplasty-based arthroscopic preservation techniques [5,6,8].

Among these, the comprehensive arthroscopic management (CAM) procedure is the most established, combining debridement, inferior osteophyte excision, capsular release and adjunctive procedures where indicated. Although CAM and similar techniques can improve pain and function in appropriately selected patients, their durability remains variable, particularly in more advanced disease [4–7]. The 10-year survival rate of the CAM procedure has been reported at approximately 63% [9].

The arthritic glenohumeral joint constitutes a biologically adverse environment that impedes intrinsic repair. Osteoarthritic cartilage demonstrates reduced proteoglycan content, chondrocyte apoptosis and an inflammatory synovial milieu dominated by interleukin-1β and tumour necrosis factor-α, which together impair the joint’s natural reparative capacity [10].

Glenohumeral osteoplasty augmented therapy (G.O.A.T.) is a novel arthroscopic joint-preserving surgical procedure that addresses both the mechanical and biological limitations of existing treatment strategies for GHOA. Its defining features include targeted inferomedial humeral osteoplasty with restoration of the inferior humeral contour (Figure 1B), the use of two posterior portals to improve access to the inferior humeral head, reduced reliance on sustained traction in stiff arthritic shoulders, and a structured three-layer biological augmentation strategy (Figure 2).

The aim of this Technical Note is to describe the G.O.A.T. procedure, outlining its technical steps and biological rationale as a joint-preserving strategy for GHOA.

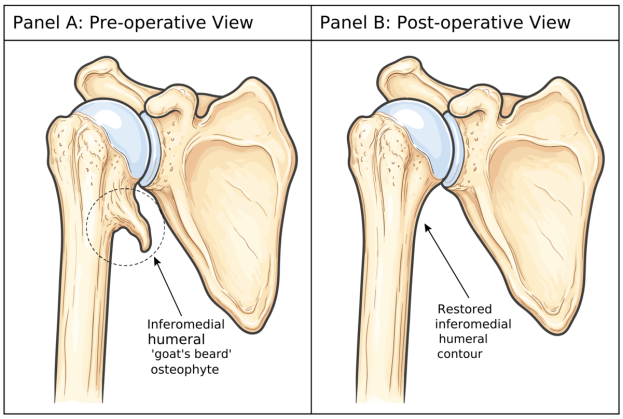


Figure 1. Schematic illustration of the glenohumeral joint demonstrating the inferomedial humeral “goat’s beard” osteophyte and the result of focused osteoplasty. (A) Pre-operative view showing the inferomedial humeral osteophyte (dashed circle) and the target area for osteoplasty. (B) Post-operative view showing the restored inferomedial humeral contour following focused inferomedial osteoplasty. Representative schematic illustration; does not depict an individual patient.

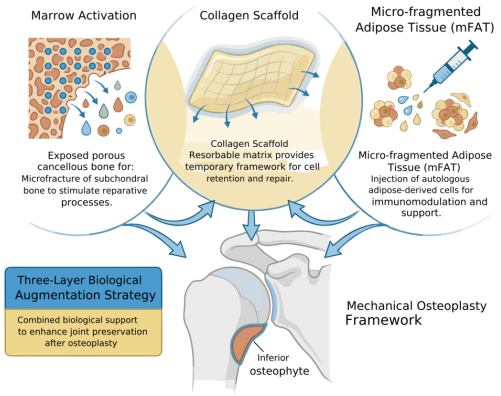


Figure 2. Schematic representation of the three-layer biological augmentation strategy of the glenohumeral osteoplasty augmented therapy (G.O.A.T.) technique. The three biological components — subchondral marrow activation by microfracture, resorbable collagen scaffold application and micro-fragmented adipose tissue (mFAT) injection — are applied sequentially following mechanical inferomedial osteoplasty. The collagen scaffold provides a temporary resorbable matrix for cell retention and local reparative support. mFAT delivers autologous adipose-derived stromal cells for paracrine immunomodulation. Representative schematic illustration; does not depict an individual patient.

Indications and Contraindications

Inclusion criteria

The G.O.A.T. technique is indicated for patients aged 35 to 60 years with symptomatic primary or secondary GHOA confirmed on plain radiographs and/or magnetic resonance imaging who remain symptomatic despite at least 6 months of structured non-operative treatment. For the purposes of this technique, a minimum glenohumeral joint space of 2 mm on a true anteroposterior radiograph was selected as a threshold to ensure sufficient residual cartilage to support biological augmentation. This threshold represents a technique-specific criterion rather than an established standard. Additional inclusion criteria include preserved joint congruity and willingness to comply with postoperative rehabilitation. The presence of a radiographically visible inferomedial humeral osteophyte (“goat’s beard” deformity) is considered a favourable feature supporting the indication for osteoplasty.

Exclusion criteria

Patients are excluded if they demonstrate end-stage or structurally non-preservable disease, including joint space less than 2 mm, advanced posterior glenoid erosion, static posterior subluxation, severe rotator cuff tear arthropathy, morbid obesity or significant medical comorbidities precluding safe anaesthesia or rehabilitation

Contraindications

The use of biological augmentation materials, including micro-fragmented adipose tissue (mFAT) or collagen scaffolds, is contraindicated in the presence of active infection within the joint or elsewhere in the body, consistent with standard exclusion criteria for intra-articular biological therapies. Active inflammatory arthropathy with uncontrolled synovitis creates a catabolic intra-articular environment that is likely to diminish the regenerative capacity of biological augmentation.

Surgical Technique

Patient positioning and setup

The patient is positioned in the beach-chair configuration under general anaesthesia with an interscalene nerve block. Standard skin preparation and draping are performed. Bony landmarks including the acromion, acromioclavicular joint, coracoid process and posterior soft spot are identified and marked. Examination under anaesthesia is conducted to assess active and passive range of motion. The glenohumeral joint is distended to enhance visualisation and create adequate working space [11].

Portal strategy

A key aspect of this technique is the dual posterior portal configuration, comprising a standard posterior viewing portal and an accessory posterior working portal. This approach is tailored to the arthritic, contracted glenohumeral joint, where access to the inferomedial humeral head is challenging. The workspace is primarily created through the strategic placement of portals rather than sustained traction [11,12].

The standard posterior portal is established using conventional arthroscopic landmarks and serves as the main viewing portal. The accessory posterior portal is the primary working portal, created under arthroscopic visualisation using spinal needle localisation. This approach achieves a direct posterior-to-inferomedial trajectory to the osteophyte, enhancing access to the calcar-adjacent region and enabling safer burr orientation along the inferior humeral arc during osteoplasty [6,13].

The axillary nerve is the principal structure at risk. Cadaveric studies have demonstrated that the axillary nerve is closest to the glenoid rim between the 5:30 and 6:30 clock-face positions, at a distance of 10–25 mm in a neutral arm position. The arm should be maintained in abduction–neutral rotation to maximise the distance between the inferior glenoid and axillary nerve [14].

The anterior portal, created via the rotator interval, is used as required to address residual anterior–inferior osteophytes not accessible from posterior portals.

Capsular release

Capsular release is performed in a stepwise fashion. First, the anterior capsule is released using a radiofrequency ablation device or arthroscopic scissors through the anterior portal, while the arthroscope is in the posterior portal. In the present technique, the anterior release is performed prior to the posterior release, as it facilitates external rotation of the shoulder and thereby improves visualisation for the subsequent posterior work. This sequence differs from the original CAM description, which commences with the posterior release [6]. In patients with large inferomedial osteophytes, the gain in external rotation may be limited by the osteophytes themselves.

The posterior release begins at the posterosuperior capsule at the 10 o'clock position and proceeds inferiorly to the 6 o'clock position, maintaining a safe distance from the axillary nerve [15,16].

Once the posterior capsule is addressed, the inferior capsule is released to treat contracture in the inferior pouch, moving from the posterior–inferior to the anterior–inferior capsule whilst remaining within the capsular tissue and avoiding the quadrangular space. These combined releases should enable a nearly full passive range of motion intraoperatively [15–17].

Focused inferomedial osteoplasty

Through the accessory posterior working portal, a motorised burr is introduced and incremental inferomedial osteoplasty is performed. Resection is confined to the inferior articular margin and directed at the inferomedial humeral "goat's beard" osteophyte. Bone is removed in a controlled manner until a smooth inferior humeral contour is restored and the mechanical prominence eliminated (Figure 1B).

The burr must remain on the bony osteophyte at all times and must not be directed inferiorly beyond the humeral neck to avoid injury to the axillary nerve [5]. Care should be taken to avoid excessive violation of subchondral bone or destabilising over-resection [18]. Intraoperative image intensification should be available to confirm the extent of resection.

Marrow activation

Full-thickness chondral defects of the humeral head or glenoid, identified during initial inspection and confirmed intraoperatively, are prepared for microfracture. The calcified cartilage layer is removed with a curette to expose the subchondral bone plate. A dedicated microfracture awl creates perforations at 3–4 mm intervals, to a depth of 3–4 mm, across the base of the defect in a systematic pattern from the periphery to the centre [19]. Adequate marrow activation is confirmed by the appearance of fat droplets and blood from the perforations after reducing arthroscopic pump pressure to allow marrow egress (Figure 2). Marrow activation in this context should be considered biologically plausible rather than validated cartilage restoration [19–21].

Collagen scaffold

A resorbable collagen scaffold may serve as an adjunctive matrix following mechanical decompression rather than functioning as a definitive resurfacing treatment. The proposed role of the scaffold is to provide a temporary collagen framework that facilitates the retention of biological material and supports local reparative processes (Figure 2) [22,23]. No established clinical studies have evaluated the use of a collagen scaffold in GHOA; its application in the shoulder is currently justified by evidence from other joints and the broader cartilage-repair literature [22–24]. Accordingly, within this technique, the use of a collagen scaffold is best characterised as a biologically plausible, extrapolated adjunct.

The scaffold is applied as a liquid through the anterior cannula with a dedicated applicator, then gels in situ. During this step, the arthroscopic pump is set to a low flow rate so that the scaffold can gel before normal irrigation resumes. A dry arthroscopy may be performed at this stage to facilitate accurate placement.

Micro-fragmented adipose tissue

In this technique, mFAT is used as a biological adjunct, distinguished from traditional applications as a structural resurfacing agent. Its proposed role relies on the biological activity of adipose-derived stromal vascular elements, which may offer paracrine signalling, immunomodulation and stromal support in the osteoarthritic glenohumeral joint (Figure 2).

Contemporary reviews characterise adipose-derived treatments for GHOA as promising but emphasise that the evidence base is limited, heterogeneous and predominantly low-level [25]. Small clinical series have reported improvements in pain and function after intra-articular mFAT injection, with one observational study demonstrating maintenance of benefit at 36 months in 65 patients with GHOA [25].

The mFAT injection is performed as the final intra-articular step, immediately prior to wound closure, as once introduced it obscures the arthroscopic view.

Postoperative Considerations

Following the G.O.A.T. procedure, the arm is placed in a sling for comfort, with the duration guided by intraoperative findings. Early controlled mobilisation is encouraged to minimise stiffness whilst protecting the treated joint surfaces and biologically augmented environment. A structured rehabilitation programme is commenced early, beginning with passive and active-assisted range of motion, before progressing to active motion, scapular control and functional strengthening. Progression is guided by pain, stiffness and tissue response, and is tailored according to the extent of osteoplasty, capsular work and biological augmentation performed [5–7]. No evidence-based rehabilitation protocol has been established specifically for combined biological augmentation in this setting, and the described approach is empirical. The stepwise procedural workflow is summarised in Figure 3.

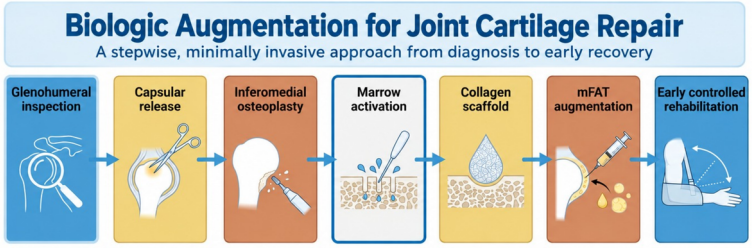


Figure 3. Procedural workflow of the glenohumeral osteoplasty augmented therapy (G.O.A.T.) technique. The operative sequence proceeds from glenohumeral inspection, through capsular release, focused inferomedial osteoplasty, subchondral marrow activation by microfracture, collagen scaffold application and intra-articular micro-fragmented adipose tissue (mFAT) augmentation, followed by early controlled rehabilitation. Representative schematic illustration; does not depict an individual patient.

Discussion

The G.O.A.T. technique represents an advancement of the CAM procedure, designed to address the biological limitations of purely mechanical arthroscopic joint preservation in GHOA [6]. The CAM procedure has demonstrated that combining humeral osteoplasty with capsular release and axillary nerve neurolysis can provide significant pain relief and functional improvement, particularly in young patients with advanced GHOA who might otherwise require arthroplasty [5]. A systematic review by Williams et al. confirmed that arthroscopic treatment of GHOA improves range of motion and patient-reported outcomes with minimal complications; however, conversion-to-arthroplasty rates remain highly variable, ranging from 4% to 42.4% [7].

The rationale for biological augmentation is based on the recognition that the arthritic glenohumeral joint constitutes a biologically adverse environment that impedes intrinsic repair [10]. Subchondral microfracture remains the most widely used marrow-stimulation technique for treating full-thickness chondral defects in the glenohumeral joint. Wang et al. reported a long-term success rate of 66.7% and significant improvements in patient-reported outcomes at a mean follow-up of 10.2 years in a case series of 17 shoulders [20]. However, the fibrocartilaginous repair tissue generated by microfracture alone is mechanically inferior to native hyaline cartilage and susceptible to progressive degradation, particularly under the high-contact-stress conditions of the glenohumeral joint [20].

The application of mFAT is supported by a growing body of evidence. Natali et al. reported significant improvements in the Constant–Murley score, visual analogue scale and simple shoulder test at 36-month follow-up in 65 patients with GHOA treated with intra-articular mFAT injection, with a patient satisfaction rate of 83.08% [25].

The mechanistic basis for mFAT efficacy is attributed to the paracrine anti-inflammatory and trophic signalling of adipose-derived mesenchymal stem cells, which suppress synovial inflammation, promote chondrocyte survival and stimulate extracellular matrix synthesis by secreting TGF-β, VEGF, IGF-1 and hepatocyte growth factor [25].

Limitations

This Technical Note describes a surgical technique and does not report clinical outcome data. The formal integration of all three biological layers within a single operative procedure represents a novel conceptual framework; whilst the biological rationale for each component is individually supported, the potential for additive benefit across the combined construct remains to be prospectively validated. From a practical standpoint, the mFAT harvest requires an additional operative step, extending the procedure time. These considerations underscore the importance of prospective clinical studies with standardised patient-reported outcome measures and a minimum 2-year follow-up to rigorously evaluate the safety, reproducibility and clinical efficacy of the G.O.A.T. technique.

Conclusion

The G.O.A.T. technique is a modified arthroscopic procedure that aims to preserve the joint in patients with an arthritic, stiff shoulder. It is based on evidence supporting inferior humeral osteoplasty, removal of the inferomedial humeral “goat’s beard” osteophyte and CAM-type arthroscopic treatment for GHOA. Key features include targeted inferomedial osteoplasty, the use of two posterior portals, reduced reliance on sustained traction, and the option to add biological support with marrow activation, mFAT and a collagen scaffold. Prospective clinical studies are required to confirm its effectiveness.

Declarations

Conflict of Interest: The authors declare no conflicts of interest with respect to the research, authorship and/or publication of this article.

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Ethical Approval: Not applicable. This manuscript describes a surgical technique and does not report a research study involving human participants or identifiable patient-level data.

Informed Consent: Not applicable. No individual patient information, images or identifiable clinical data are reported in this manuscript.

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