

# Arthroscopic Biological Total Shoulder Resurfacing: An Alternative Surgical Technique and Treatment Option for Arthritic Shoulder Pain in Young to Middle-aged Adults

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**Abstract:** Glenohumeral shoulder arthritis seems to be growing in prevalence, especially in the younger population below 50 years old. This may be due to multiple factors such as heredity, trauma, iatrogenic postsurgical changes, and high vocational and recreational demands. These factors increase the risk and incidence of glenohumeral osteoarthritic degeneration as we age. This arthritic degradation of the articular surfaces in the shoulder leads to symptoms of loss of mobility, pain, and functional limitation. The surgical treatment for glenohumeral arthritis in the young to middle aged, active adult has been the source of controversy and debate within the orthopedic community. A relatively new surgical procedure, arthroscopic biological total shoulder resurfacing, has the potential to provide significant pain relief and improve functional outcomes while allowing for return to high-level activity without the restrictions and complications that accompany other surgical interventions. This article will discuss in detail the surgical technique, rationale, and postoperative care of this biological resurfacing technique.

**Key Words:** osteoarthritis, arthroscopic, biological, shoulder, resurfacing

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There is significant debate in the orthopedic community regarding the optimal surgical treatment of end stage glenohumeral joint (GHJ) arthritis in the young to middle age adult population following failure of nonoperative care. Several studies have established that conventional total shoulder arthroplasty provides significant pain relief and improved shoulder function when performed on older adults with osteoarthritis (OA). However, mid-term and long-term results of this procedure when performed on younger patients with shoulder OA have not been shown to be very successful.<sup>1–7</sup> The strenuous physical demands imparted by patients of this age demographic lead to poor prosthetic durability. Beyond a total shoulder arthroplasty, there are other surgical treatment options available to address GHJ OA in young, active adults. However, many of these procedures have yielded inconsistent and/or unsatisfactory outcomes with a limited amount of long-term data available. A new surgical procedure has recently been introduced into the orthopedic landscape designed to specifically address GHJ OA in this population.<sup>8</sup>

Arthroscopic biological total shoulder resurfacing (ABTSR) with fresh osteochondral allografts, has been performed in limited manner as an alternative for young to middle age, highly active patients with end stage GHJ arthritis. ABTSR

alleviates the pain and disability associated with GHJ OA in a minimally invasive manner, which allows for quicker recovery and earlier return to functional and recreational activity. The short-term outcomes of this procedure have shown promising results with regard to improved pain levels and shoulder motion.<sup>8</sup> Ideal candidates for the ABTSR are young to middle age, active adults with good preoperative shoulder function, that present with primarily symptomatic glenohumeral OA (without deformity and minimal osteophyte formation) after failure of nonoperative treatment. Other criteria required for consideration of this procedure include adequate healing potential and postoperative compliance. Relative contraindications may include the following criteria: workers' compensation cases, non-compliance, infection, significant contracture, joint or bony deformity, and/or any other medical condition that would inhibit postsurgical healing and recovery. This article will provide a detailed description of the entire surgical procedure including: allograft preparation, implantation, surgical rationale, and technique. Postoperative care and rehabilitative guidelines will also be provided.

## PROCEDURE

On the date of surgery, the patient is seen by anesthesia and given a preoperative interscalene regional block. Dose appropriate IV antibiotics are administered for prophylaxis within 1 hour of the incision being made. After the patient is transported to the operative suite and placed in the beach chair position, the involved upper extremity is prepped and draped in the normal sterile manner. A standard posterior portal is created with a scalpel and a blunt trocar and cannula is placed into the GHJ. The camera is inserted into the joint to visualize and examine the integrity of the joint structures. Direct anterior and anterolateral portals are created through the interval using an outside-in technique after the portals have been localized with a spinal needle. This standard anterior portal will need to be enlarged 2 to 3 cm to pass the humeral guide and for graft implantation. Arthrex (Naples, FL) is currently the only company that has the Osteochondral Autograft Transfer System (OATS) platform and instrumentation available for the procedure performed for this case. Cannulas are then placed in through the portals and a shaver is used to debride the labrum and articular surfaces.

A synovectomy may be performed to allow for better visualization and to inspect for joint contractures and capsular thickening. If necessary, capsular release(s) may be required by utilizing a thermal wand 1 cm off the glenoid in the typical circumferential manner. Once the releases are completed and the interval is opened, the instruments are withdrawn. The scapula is stabilized with one hand and gentle joint manipulation may then be performed with the other hand to improve shoulder mobility and range of motion (ROM). If the patient had preoperative signs of impingement and symptomatic acromioclavicular joint arthritis, a subacromial decompression

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and distal clavicle excision may be performed. The rotator cuff is then inspected on both the articular and bursal sides. If there is long head of the biceps tendon pathology, a subpectoral tenodesis may be performed.<sup>9</sup> The mini-open biceps tenodesis is preferred over an arthroscopic tenodesis so it will not interfere the biological graft procedure. The arthroscope is then placed back into the posterior GHJ to prepare the joint for implantation of the fresh allografts. This is when the anterior portal will be slightly enlarged with a scalpel to accommodate the humeral guide and eventually, the grafts.

### HUMERAL PREPARATION

The targeting guide is centered on the humeral head and is incrementally increased in size until the majority of the arthritic area is covered by the guide (Fig. 1). The guide sleeve is placed down to the skin laterally and a small incision is made to accommodate the cannula.

Caution is exercised to make sure the direction of the cannula does not injure the axillary nerve, which is located 7 cm inferior to the lateral edge of the acromion. A hemostat is taken and spread down to the bone of the lateral humeral cortex so that the axillary nerve is not harmed. A recently developed blunt trochar is now available to be placed through the cannula, down to the surface of the humeral head protecting the nerve. The metal cannula is then placed down to the bone followed by a 2.4-mm guide pin which is drilled through the lateral humerus until it reaches the center of the guide on the humeral head visualized through the scope. A grasper is inserted through the anterior portal to grasp the pin as the guide is removed (Fig. 2). A 5.5-mm cannulated reamer is drilled over the pin into the joint. The reamer is removed and the pin is maintained in the head with the grasper. The transhumeral sleeve is placed over the pin, at that time the pin is removed, leaving just the sleeve. The sleeve will remain for most of the procedure. Next, a 10-mm flip cutter (Arthrex) is used to ream, in a retrograde manner, ~3 mm of bone centrally as the transhumeral sleeve is slightly backed up. The 20 or 25-mm retrograde humeral reamer is used, depending on the size of the humerus and area to be reamed. The humeral reamer is placed through the interval portal, using a grasper, and then connected onto the retro pin (Fig. 3). The retro pin is placed through the transhumeral sleeve



**FIGURE 2.** Grasping of the guide pin after the pin had been drilled through the humerus. [full color online](#)

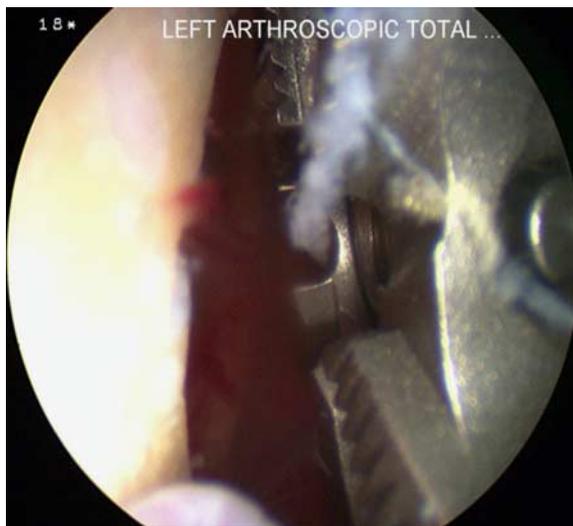
by spinning the pin with the drill until it catches the reamer. These have to be lined up in the joint to connect. The sleeve is backed up about 5 to 7 mm and the humerus is reamed in a retrograde manner with a lateral pulling force (sometimes anterior or posterior) until the peripheral edge of the reamer is flush against the bone on the humerus. This allows for a fixed depth of 7 mm. The center coupling mechanism on the humeral reamer swivels, so a change in the direction of force on the reamer may be required to prevent leaving an elevated side. A grasper is then inserted through the anterior portal to stabilize the humeral reamer as the retro pin is reversed, this will disengage the reamer. These steps are now repeated in 5-mm reamer increments up to 40 mm, if needed, until the affected arthritic area is fully removed from the humerus (Fig. 4).

### GLENOID PREPARATION

To initiate the glenoid preparation phase of the procedure, a glenoid guide is placed through the anterior portal with a grasper onto the central bare area. The guide is then connected to the transhumeral sleeve. The humerus is manipulated to gain



**FIGURE 1.** Centering of the targeting guide over the humeral head articular defect. [full color online](#)

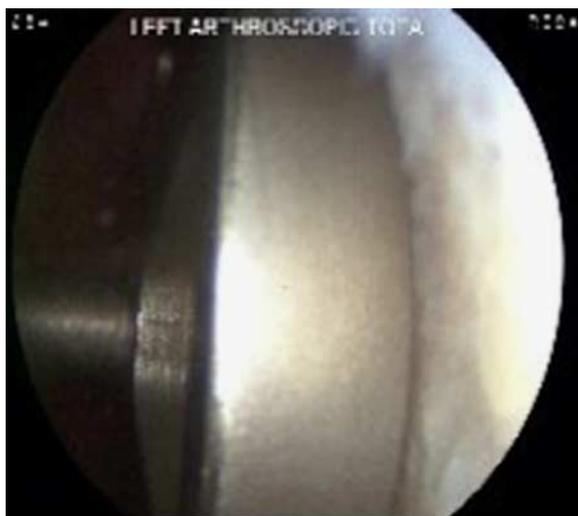


**FIGURE 3.** The connection of the humeral reamer onto the retro pin. [full color online](#)



**FIGURE 4.** Humerus following the reaming procedure in preparation for graft placement. [full color online](#)

straight alignment onto the glenoid. Next, a 2.4-mm pin is drilled through the sleeve, into the center of the glenoid guide to a depth of 10 mm. The pin and guide are removed, maintaining the transhumeral sleeve. The retro pin is placed through the sleeve and connected onto a glenoid reamer, which is placed through the anterior portal. The glenoid reamers come in sizes of 18, 20, or 22 mm depending on the coverage area. This is performed with a grasper in the same manner as with the humeral reamer. The retro pin is then connected to the glenoid reamer, this is also performed in the same manner as with the humeral reamer. However, this time an antegrade ream depth of 5 mm is established after placing the small, central post on the glenoid reamer into the predrilled hole. This will help center the reamer. The glenoid is reamed down until the peripheral rim of the reamer is flush on the bone (Fig. 5). Again, the reamer connection to the pin does swivel and force may have to be applied in different directions to fully seat the reamer. This is important to prevent an elevated side which would ultimately



**FIGURE 5.** The glenoid is reamed down to depth of 5 mm. [full color online](#)

interfere with seating of the graft. The pin and reamer are then disengaged, as described prior with the humeral reamer, and taken out of the joint with a grasper. Any debris is then removed with a shaver (Fig. 6).

### GRAFT PREPARATION

The ABTSR requires use of fresh osteochondral allografts for transplantation on both articulating surfaces. Fresh allografts are preferred over frozen samples because of the potential for diminished cell viability in the frozen products. Preoperatively, we obtain shoulder radiographs of the operative side with marker balls. This is sent to the tissue bank (where the grafts are obtained) and a search is initiated for a matching donor. Once the donor graft is obtained through a tissue bank, it is thoroughly tested and examined for diseases. The graft is soaked in an antibiotic blend and refrigerated in a nutrient-rich media to preserve chondrocyte viability. Though graft viability has shown to be preserved for up to 45 days in this manner, fresh osteochondral allografts are typically released after 14 days of culture monitoring.<sup>10</sup> The chondrocyte viability is best if utilized within 21 days from date of harvest.

The humeral graft is size matched to within 2 mm of the patient's humeral head diameter, however, the glenoid graft is not size matched. One can use a proximal medial tibial plateau or a distal tibial plafond graft. Both have a concave surface that closely resembles the glenoid articular surface. The proximal medial tibial plateau is preferred because it contours to match the glenoid surface better. However, distal tibial plafond grafts are much more readily available. The freshly cut glenoid allograft will usually require some trimming of undulations around the edges of the graft articular surface with a scalpel.

Either the humeral or glenoid grafts may be prepared first with each graft being size matched. The available humeral sizes in the Osteochondral Autograft Transfer System range from 20 to 40 mm (in 5 mm increments). The available glenoid sizes are 18, 20, and 22 mm. Size restriction of the grafts are due to the system used for the procedure. Both allografts are initially irrigated off with copious amounts of sterile saline when removed from their packaging. The glenoid donor graft (medial tibial plateau or distal tibia) is placed on the stand. The graft is

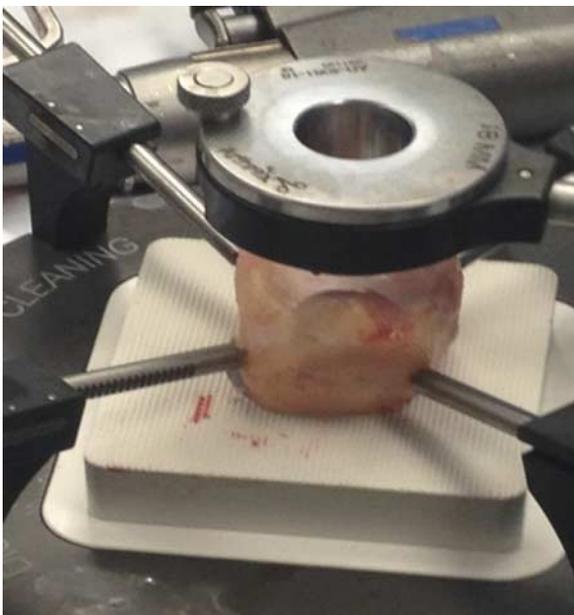


**FIGURE 6.** Glenoid after reaming procedure in preparation for graft placement. [full color online](#)



**FIGURE 7.** Tibial plafond is secured as the desired grafting surface position is determined. [full color online](#)

secured with 4 peripheral pins after attaining the desired position (Fig. 7). The sized matched guide is placed on the articular side of the donor graft in the surgeon's preferred position in effort to obtain the best graft surface (Fig. 8). Although in the guide, the size specific core reamer is used to drill the graft to a depth of at least 10 to 15 mm (Figs. 9, 10). An assistant will typically be utilized to hold the drill guide in place. The pins holding the graft are removed, and a flat saw is required to cut the graft in line with the articular surface for a graft depth of 15 to 20 mm to be safe. The graft is placed in the guide (articular side facing the guide) and is cut through a slot with a flat saw to a graft depth of 5 mm while stabilized with manual pressure (Fig. 11). The graft is set on the back table in a moist sponge (Fig. 12) and the humeral graft is then prepared in a similar manner. The graft size is chosen on the basis of the last humeral



**FIGURE 8.** The 20-mm glenoid reaming guide is positioned parallel to the desired articular surface of the allograft. [full color online](#)



**FIGURE 9.** The 20-mm glenoid core reamer is used to cut the glenoid allograft to a depth of at least 10 to 15 mm. [full color online](#)

reamer used when preparing the humeral head. The only difference is that when preparation of the humeral graft is complete, the central bone side is reamed down in a concave manner with a round reamer. This is performed with another guide to prepare a uniform curved graft depth of 7 mm. Two holes are now drilled in the center of the graft about 5 to 7 mm apart and a #2 FiberWire (Arthrex), is passed through the holes using the stiff end of a Fiberstick (Arthrex).

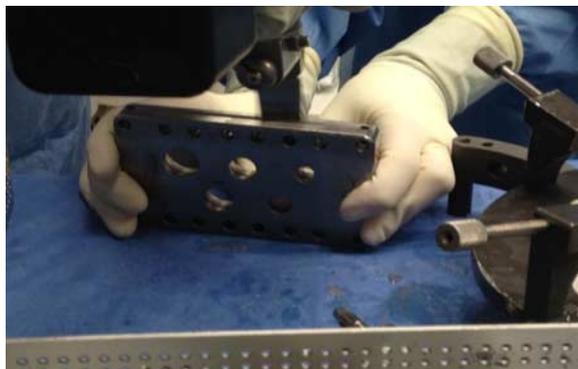
The free ends exit on the bone side of the graft and are then used to pass the graft into the reamed humeral side. The sutures are moved back and forth in a sawing motion while holding the graft secure until the FiberWire suture sits below the articular surface of the graft. This ensures that the suture will not be elevated above the cartilage surface after passage and implantation of the humeral graft. The graft is placed on the back table (Fig. 13), along with the glenoid graft, in a moist sponge. Again, the humeral graft size can be 25, 30, 35, or 40 mm in diameter and the glenoid graft size can be 18, 20, or 22 mm in diameter depending on the size needed.

## GRAFT IMPLANTATION

The glenoid graft is placed in an inserter with the articular side facing forward and then placed through the anterior portal.



**FIGURE 10.** The tibial plafond allograft for the glenoid after using core reamer. [full color online](#)



**FIGURE 11.** A flat saw is utilized to cut the graft in line with the articular surface while manual pressure is applied to the graft. [full color online](#)

The inserter is open on both sides to visualize the graft. A retro pin is placed down the humeral sleeve and connected onto a round impactor before the graft is placed into the joint. Once the graft is centered on the reamed glenoid surface, the impactor is used to seat the graft. The guide is removed once the graft is pushed out of the inserter onto the reamed glenoid. Final impaction is then performed with the glenoid impactor and once the grasper has been disengaged from the retro pin, the impactor is removed through the anterior portal. After the graft has been fully seated, 2 to 3 bioabsorbable poly-L-lactic acid chondral darts (Arthrex) may be passed through the humeral sleeve to provide additional graft fixation. This is left up to the discretion of the surgeon based on how secure the graft is press fit into the recipient site. If there are any sides of the graft elevated above the articular bed, they may gently be trimmed down with a shaver or burr (Fig. 14).

The humeral graft is now ready for placement into the joint. To place the humeral graft, a nitinol wire is taken through the humeral sleeve and passed out the anterior portal with a grasper. The free ends of the #2 FiberWire are placed through



**FIGURE 12.** Glenoid graft before implantation. [full color online](#)



**FIGURE 13.** Humeral graft utilized for joint resurfacing before implantation. [full color online](#)

the loop on the nitinol and then passed through the humeral tunnel. The humeral sleeve is removed and the suture is tensioned laterally, pulling the graft in through the anterior portal and onto the reamed humeral surface. The graft can be manually rotated with a finger through the anterior portal for optimal positioning before it is fully seated. A large round endobutton by Arthrex is used laterally after the free ends of the FiberWire are threaded through the eyelets. Once the humeral graft is passed and digital pressure is applied, the sutures can be tensioned and tied over the button laterally. The FiberWire sutures are tied down over the button on the lateral humeral cortex for additional fixation while the graft heals. The suture is then cut with an arthroscopic suture cutter leaving a small tail and the wounds are closed in a standard manner. Arthroscopic pictures of the GHJ before and after the procedure are shown (Figs. 15, 16). A sterile dressing is applied, a cryotherapy compress is positioned over the operative shoulder, and the UE is stabilized in an immobilizer. After the patient awakens from anesthesia, they are transferred to the Post-Anesthesia Care Unit for recovery. This surgery is usually performed as an outpatient procedure.

### POSTOPERATIVE COURSE

ROM exercises are initiated as soon as the effects of pre-operative nerve block subside. The patient is instructed and



**FIGURE 14.** Arthroscopic picture of glenoid graft fixation. [full color online](#)



**FIGURE 15.** Preoperative arthroscopic picture depicting the extensive degenerative changes of the patient's glenohumeral joint surfaces. [full color online](#)



**FIGURE 17.** Radiograph taken during initial consultation exhibiting extent of glenohumeral joint degenerative changes.

prescribed shoulder pendulums and elbow, wrist and hand ROM exercises to be performed daily. The patient is seen in the office 1 week after surgery for their first postoperative appointment and radiographs are obtained to view the position of the grafts. Sutures are removed and steri strips are applied over the incisions. The patient is provided the postoperative rehabilitation protocol, designed by both authors, and physical therapy is initiated at the end of the first postoperative week. Therapy is typically prescribed for 3 times a week for the initial 6 weeks, and continued as needed, for 12 weeks following surgery.

Postoperative rehabilitation consists of gradual therapeutic progression with clinical care to avoid of any shear or compressive stress on the grafts. Extensive patient education is provided to assure compliance with these precautions and restrictions. Sling immobilization is prescribed for 2 weeks postoperatively with the patient gradually weaning from sling as tolerated. Shoulder ROM is progressed gradually once therapy begins and gentle strengthening is initiated at 4 weeks following surgery. No joint compression or weight bearing activities are initiated until 2 months after surgery to allow for adequate graft tissue healing and incorporation to occur. Preoperative radiographs are provided along with the 6-month postoperative radiographs to exhibit complete graft healing following ABTSR procedure (Figs. 17, 18).

The results of osteochondral allograft repair procedures (performed primarily in the lower extremity) have been

successful with relation to pain relief and functional improvement.<sup>11-16</sup> This evidence grants biological resurfacing strong consideration as the surgical treatment, if otherwise indicated, for GHJ OA in the younger patient population. In terms of future concerns regarding postoperative biological grafting procedures, we would also propose that the lack of weight bearing stress on the GHJ (in comparison to its lower extremity counterparts), would lead to even greater longevity and viability of the biological graft material. Another positive attribute of biological resurfacing pertains to the preservation of the glenohumeral bone stock and structural joint integrity in case a joint arthroplasty is deemed necessary later in life.

Early outcome studies conducted on postoperative ABTSR patients seem to be very promising. In the only published outcome study of patients following the ABTSR procedure, Dr Gobezie reported significant pain level reduction, improved



**FIGURE 16.** Postoperative arthroscopic picture of the glenohumeral joint surfaces after graft placement and repair. [full color online](#)



**FIGURE 18.** Radiograph taken 6 months after surgery demonstrating complete graft and surgical healing.

level of function, and stable graft placement (without signs of resorption) at time of 2-year follow-up.<sup>8</sup> This technically challenging arthroscopic procedure may first be performed as an open procedure until the surgeon gains more experience and comfort with the procedure. As with any surgical procedure, patient selection is one of the most important factors for best possible outcome. The lead author has performed this procedure in his practice with promising early results, similar to those reported by Dr Gobezie. Graft durability and survivorship will continue to require further evaluation with future research and follow-up studies. We hopefully will continue to see long-term prognosis and benefits of the ABTSR as more data are collected and outcome studies are published.

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