Case Report

Avascular necrosis of the proximal humerus: a novel indication for the use of osteochondral allograft transplantation in the shoulder: Case report

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ABSTRACT

Osteochondral allograft (OCA) transplantation is an increasingly available biologic treatment option for a range of intraarticular aetiologies. To our knowledge, no prior publication has documented the use of this technology to treat a lesion of the proximal humerus secondary to avascular necrosis (AVN). We describe our experience treating a 42-year-old female executive with idiopathic AVN of the proximal humerus with a fresh osteochondral allograft. Computed tomography (CT) at 3 months post-op showed full bony incorporation and a restored native joint contour. Over the initial 7 months post-operatively, she reported continued improvements in pain and function as measured by quick Disabilities of the Arm, Shoulder, and Hand (DASH) scores. She was discharged from physical therapy after 6 months, reporting no rest pain, full active and passive range of motion, and unrestricted occupational and recreational activity.

The case

- 42-year-old female executive with idiopathic avascular necrosis (AVN) of the right proximal humerus treated with a fresh osteochondral allograft (OCA).
- Post-operative computed tomography (CT) at 3 months showed full bony incorporation of the graft and a restored native joint contour.
- 7-month follow-up showed no rest pain, full active and passive range of motion (ROM), unrestricted occupational and recreational activity, and continued improvements in pain and function as measured by quick DASH.

Lesson learnt

- Osteochondral allograft (OCA) transplantation is an effective treatment modality for avascular necrosis (AVN) of the proximal humerus.
- The effective use of OCAs reflects the potential for continued progress at the crossroads of medical science and orthopaedic care.

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1. Introduction

Osteochondral allograft (OCA) transplantation is a surgical procedure in which viable, mature hyaline cartilage and subchondral bone from a screened donor are applied to restore chondral or osteochondral pathologies. The usefulness of this biologic treatment approach stems from its ability to restore functionality and stability to diseased joints while avoiding artificial joint replacement or non-anatomic techniques. The use of OCA is considered a standard of care where available and well-described for knee and ankle pathology. Its use on the shoulder is less well documented.

A review of the English language literature has shown that the use of OCA in the shoulder has been limited to the following indications: reverse Hill-Sachs lesions [1–5], Hill-Sachs lesions [6–10], pain pump chondrolysis [5], osteoarthritis/degenerative changes [11], glenohumeral instability [5,12–14], osteochondritis dissecans [8,15], radio-frequency chondrolysis [5,16], glenoid lesion [17], iatrogenic injury [8], and prominent suture anchor [5,18]. The case presented here represents a never-before-reported indication for OCA in the shoulder, specifically avascular necrosis (AVN) of the proximal humerus.

AVN, sometimes referred to as aseptic necrosis or ischaemic bone necrosis, may manifest as a painful, debilitating disease with several possible underlying aetiologies. The widely accepted view is that AVN arises from a reduction in subchondral blood supply [19]. Shah et al. [20] categorised the various causes of this reduced blood supply into six main categories: direct cellular toxicity (e.g., chemotherapy, radiation therapy, smoking, etc.), extraosseous arterial fracture (e.g., hip dislocations, femoral neck fractures, iatrogenic post-surgery, congenital arterial abnormalities, etc.), extraosseous venous (e.g., venous abnormalities, venous stasis, etc.), intraosseous extravascular compression (e.g., haemorrhage, elevated bone marrow pressure, fatty infiltration of bone marrow, bone marrow edema, etc.), intraosseous intravascular occlusion (e.g., sickle cell crises, coagulopathies, etc.), and multifactorial [20]. The most common articular location for AVN is in the hip (proximal femora), but it is described to occur as well in the distal femora, proximal tibia, distal tibia, talus, and proximal humerus (humeral head) [19].

Traditionally, surgical treatment of AVN in the shoulder has included core decompression to salvage tissue prior to articular compromise. Alternatively, in the setting of joint surface collapse, either partial or total joint arthroplasty can be performed, and in cases involving severe periarticular compromise, reverse total shoulder arthroplasty or shoulder arthrodesis can be performed [21]. In this manuscript, we describe, to our knowledge, the first reported case of OCA used to treat AVN in the proximal humerus.

2. The Case

A 40-year-old right-handed dominant female executive was referred to orthopaedic care after more than three years of right shoulder pain and dysfunction. The causative event was reported to be a direct blow sustained in a fall while playing basketball. Her symptoms were exacerbated by overhead activity and reaching forward and moderately relieved by rest. Initial physical examination showed slight ipsilateral peri-articular atrophy and asymmetry compared to the non-dominant left (uninvolved) shoulder. Full active and passive range of motion was noted, as was tenderness to palpation at the posterior lateral glenohumeral area. Initial radiographs showed no visible osseous abnormality. A magnetic resonance imaging (MRI) study indicated AVN of the central humeral head surface with minimal changes or compromise of the articulation of the shoulder joint (Fig. 1a).

The initial treatment plan was non-operative (conservative), consisting of extensive physical therapy, activity modification, and non-narcotic pain medication as needed. The patient maintained ROM, but pain and disability continued to reduce capacity for healthful activity. A second MRI after 9 months showed progression of AVN with minor joint surface collapse and cartilage surface involvement (Fig. 1b). Surgical care was recommended, and the patient elected to undergo ambulatory surgery involving the transplant of viable (fresh) OCA to restore the joint surface after debridement of the non-viable osteochondral pathology.

2.1. Surgical technique

Prior to the patient’s arrival in the operating room (OR), anaesthesia provided an ultrasound-guided interscalene nerve block, placing a catheter to deliver 0.2% ropivacaine. The procedure was done with the patient supine in the beach chair position. After adequate general anaesthesia using a 20 mcg/kg/min propofol (Diprivan) infusion, a surgical pause allowed the operative shoulder to be identified, examined, and found to have no evidence of motion compromise. This upper extremity was then prepped and draped in a standard sterile surgical environment.

Fig. 1. a & b. Serial pre-operative MRIs of the right shoulder. (a) An MRI from 2019 shows an initial diagnosis of avascular necrosis with minimal collapse. (b) MRI from 2020 shows disease progression with collapse and cartilage fragmentation.
fashion after proper padding and positioning were complete. Arthroscopic evaluation proceeded via a standard posterior portal and identified Grade IV, International Cartilage Repair Society (ICRS) chondral changes to the central humeral head (2.5 x 2.5 cm or 6.25 cm²).

Several resultant loose osteochondral bodies were removed via arthroscopic instruments, and no evidence of adjacent glenoid surface pathology (no kissing lesion) or other soft tissue pathology was noted. The arthroscopy fluid was evacuated and the instruments removed. Surgical attention was turned to the arthrotomy. Prior to the open incision, the OCA humerus tissue was examined and found to be defect-free. It was measured to assure that the maximum transplant tissue size and contour were compatible with the treatment of a 6.25 cm² lesion.

A standard deltopectoral arthrotomy was undertaken, exposing the area of injury. This required the takedown of the proximal lateral subscapularis tendon, which was repaired during closure with 2 x 5-0 Fastin RC (Smith & Nephew; Hertfordshire, UK) suture anchors at the proximal lesser tuberosity.

Removal of the damaged joint area provided a bed of cancellous bone surrounded by 100% cartilage, characterized as grade 0. This was accomplished as follows: A central guide pin was placed at a right angle to the articular surface, and a 25 mm “cookie cutter” was used to outline the treatment area from healthy adjacent cartilage. A 25 mm drill then applied to the damaged tissue and taken to a depth of approximately 6 mm. The debride was removed with vacuum suction and serial dilution. A 0.045 mm K wire was used to provide several small holes at the base of the prepared cylinder to allow bleeding from some sclerotic bone in the area.

The transplanted specimen was taken from the analogous area of the donor allograft. The graft was cut using a 25 mm cylindrical drill and prepared to a congruous depth (6 mm) with an oscillating saw at a right angle to the articular surface. Irrigation during cutting reduced the heating of the instruments to minimise the potential for tissue damage. Pulse lavage with vacuum suction was used to wash the cut OCA to remove any residual tissue elements prior to transplant. The bed of the accepting site was then accessed via external rotation of the arm and placement of retractors to expose the humeral surface. The cut allograft core was then inserted by gentle thumb pressure to a flush level across 100% of the contacting perimeter. The joint was irrigated, and the subscapularis was repaired as described as part of a layered wound closure.

A sling and abduction pillow were placed to support the arm during recovery from the interscalene continuous infusion nerve block (72 hours). The post-operative recommendations included sling protection for six weeks and intermittent (daily) passive motion exercises without limitation to weightbearing. Active external rotation was permitted after motor and sensory functions returned. Active internal rotation without resistance for subscapularis protection was permitted at six weeks and increased to resistance at 12 weeks. Periscapular strengthening was encouraged from post-operative day one to maintain scapulothoracic kinetics. At 12 weeks, the rehabilitation plan changed to focus on restoring the functional deficits from the long pre-surgical period of reduced activity. This part of the recovery was permitted after a proximal humeral CT scan of the treated shoulder confirmed allograft bone incorporation had occurred and healing was felt to be adequate to allow unrestricted activity.

2.2. Outcome

A computed tomography (CT) scan obtained at 12 weeks post-operatively indicated full bony incorporation and a subchondral contour that was congruous with native tissue. This was interpreted as reflecting a fully restored native joint articulation (Fig. 3). At 7-months post-operation, the patient has no rest pain and full active and passive ROM of the shoulder joint.

Fig. 2. Pre- and post-operative Quick DASH scores.

Fig. 3. Computed tomography (CT) of the right shoulder 3 months post-operatively shows full graft incorporation and restored native joint contour.
The patient-reported outcome metric “quick DASH,” a validated 11-item self-reported questionnaire, was used to measure patient function and satisfaction at baseline and follow-up intervals. As evidenced in Fig. 2, the patient’s quick DASH scores improved across the treatment and recovery, trending favourably. Some associated disuse atrophy of the periaricular musculature attributed to pre-operative dysfunction resulted in associated rotator cuff tendinosis, initially limiting early rehabilitation. Nonetheless, effective rehabilitation improved her capacity as the tendinosis resolved, and the patient was successfully discharged from physical therapy at six months. The patient has been subsequently “lost to follow-up” despite multiple efforts to contact her for the purposes of obtaining longer term follow up.

3. Discussion

Osteochondral allograft (OCA) transplantation represents an increasingly available and effective biologic treatment modality for a variety of joint conditions. The most common locations for OCA treatment are the knee and ankle, with the shoulder being less well-described joint for its application. The various indications for the use of OCA in the shoulder are also less well described, as we recently reported in a systematic review of reports in the English language describing the use of OCA in the shoulder. To summarize this review, there are reports of using OCA to treat reverse Hill-Sachs lesions [1–5], Hill-Sachs lesions [6–10], pain pump chondrolysis [5], osteoarthritis/degenerative changes [11], glenohumeral instability [5,12–14], osteochondritis dissecans [8,15], radiofrequency chondrolysis [5,16], glenoid lesion [17], iatrogenic injury [8], and prominent suture anchor [5,18]. This review found no reported or documented cases of avascular necrosis in the shoulder as the primary indication for the use of OCA. As AVN is well described in other joints and the use of OCA transplantation in the proximal shoulder had been previously conducted by the senior author, we felt it important to provide a case example as a precedent.

To our knowledge, the case presented now formally adds to the list of pathologic conditions (or indications) for which the use of OCA can be therapeutically effective. Avascular necrosis of the humeral head is a painful and potentially debilitating condition with various etiologies (when identifiable, many cases are felt to be idiopathic), and it often manifests in the young. This case report illustrates a biologic treatment approach to avascular necrosis of the humeral head using an OCA to restore articular anatomy, thus yielding a novel therapeutic option that can help avoid arthroplasty approaches in this population.

4. Conclusion

This report describes a unique indication for the use of OCA in the shoulder: avascular necrosis of the proximal humerus. It illustrates an example of the effectiveness of OCA in the management of a difficult-to-treat shoulder condition, particularly in a young, active patient. As well, it reflects the continued progress at the crossroads of medical science and orthopaedic surgical care.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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