CASE REPORT

Proximal humeral allograft in a trauma setting

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Abstract

Proximal humeral allografts are usually reserved for reconstruction of the shoulder in a neoplastic setting. To our knowledge it has never been described for use in a trauma setting.

In this case report, we present a 30-year-old man involved in a motor vehicle accident (MVA) in 2007. He is right-hand dominant and employed as a driver. He presented initially to a peripheral hospital, and he sustained what seems to be a right floating shoulder injury with clavicle, scapula and proximal humeral fractures. He was operated there and underwent excision of the proximal humerus.

Subsequently he presented to us and a staged procedure was performed. Initially, the clavicle was plated and, six weeks later, he underwent reconstruction with a proximal humeral allograft. All rotator cuff muscles were re-attached and the allograft was secured with cement and an intramedullary nail.

We present his pre-op and post-op pictures as well as the function achieved. We also present a brief review of the literature.

Introduction

Proximal humeral allograft reconstruction is a procedure in which a cadaver humerus is shaped and used to replace a pre-existing defect in a patient. It is reserved for patients who have intra-articular pathology of the gleno-humeral joint and where the glenoid is still preserved.

There have been several publications on its outcomes in patients undergoing this procedure for tumour reconstruction in limb-sparing surgery. However from our extensive literature search it has never been described in a trauma setting. This is mainly because the need for a humeral allograft in trauma is such a rare occurrence. Modern prostheses and implants usually suffice for most fractures.

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SAOA poster award, Congress 2008, 2nd prize

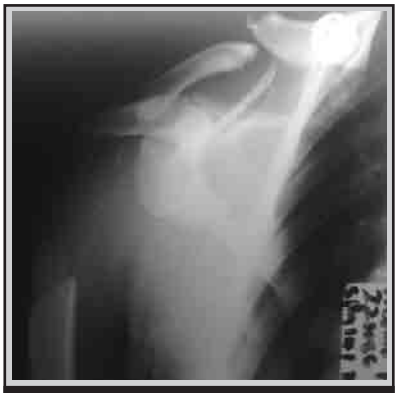

Figure 1: AP view of defect following initial surgery at a peripheral centre

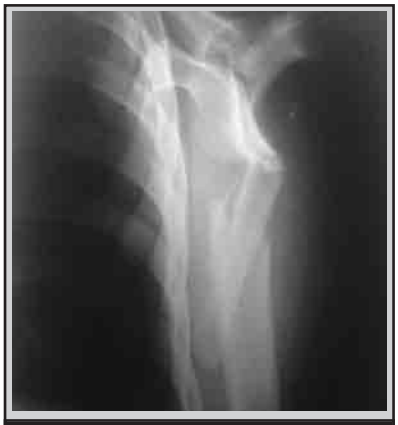

Figure 2: Lateral view of patient's shoulder

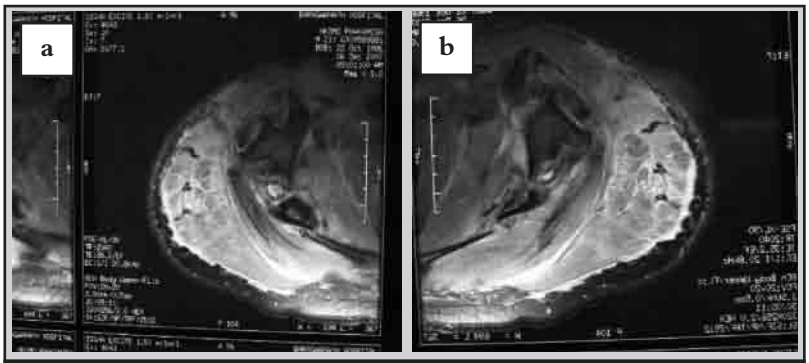

Figure 3a&b: MRI scan of shoulder showing intact rotator cuff

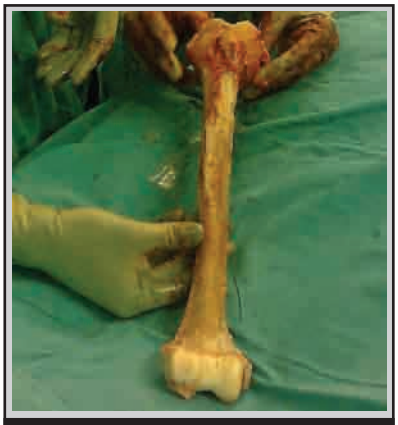

Figure 4: Fresh frozen humeral allograft

Figure 5: Humeral head showing preserved rotator cuff attachments

He had sustained a proximal humeral shaft fracture, a mid-shaft clavicle fracture and a minimally displaced fracture of the glenoid neck

Case report

A 30-year-old male who is right-hand dominant and employed as a driver was involved in a motor vehicle accident (MVA) in June 2007. He was initially taken to a peripheral hospital for treatment. Among other injuries he also sustained what seemed to be a floating shoulder on the right side. He had sustained a proximal humeral shaft fracture, a mid-shaft clavicle fracture and a minimally displaced fracture of the glenoid neck (*Figures 1 and 2*).

He could not give us an indication as to why he had to undergo a proximal humeral resection at the peripheral hospital.

He subsequently presented to Helen Joseph Hospital in December 2007 with a painless flail right upper limb. He was unable to use the arm in any activity of work or daily living. Clinically, it did not seem that he had brachial plexus injury as all nerves were assessed as functional except the suprascapular nerve that does not have a peripheral sensory component.

Part of the pre-operative planning included an MRI scan to assess the integrity of the rotator cuff (*Figure 3*). The MRI revealed the infraspinatus and subscapularis folded in on the glenoid. The rotator cuff was remarkably preserved. His deltoid also seemed preserved. EMG/nerve conduction study was not considered because of the normal findings in the clinical examination.

A decision to do a staged procedure was made. Initially he underwent an open reduction and internal fixation of his clavicle with a six-hole locking plate. After an uneventful procedure he returned in February 2008 for the second stage of the procedure which involved the reconstruction of his proximal humerus.

A requisition for a fresh frozen full cadaver humerus was made (*Figure 4*). The donor humerus had to match the approximate size of our patient and had to be a right-sided humerus.

Figure 6: Patient supine with previous surgical incision

Figure 7: Humeral allograft shaped to match defect

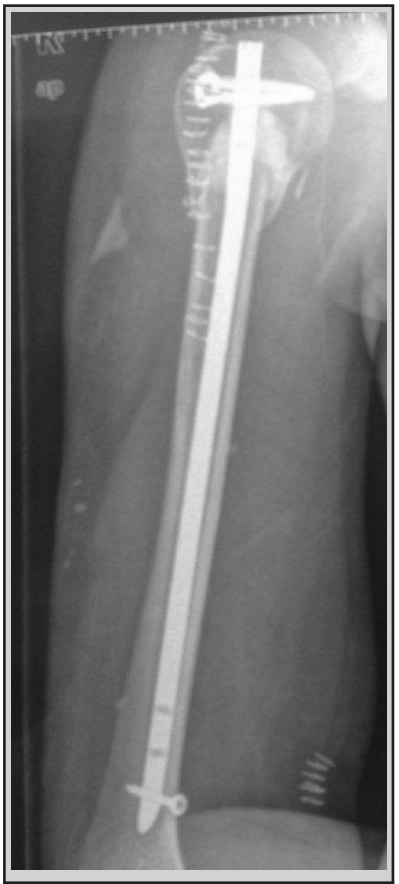

Figure 8: Allograft in place with cement and an intramedullary nail with spiral blade

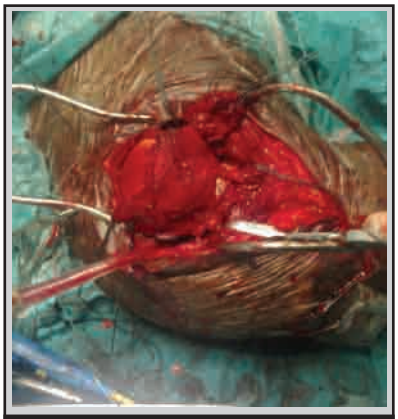

Figure 9: Rotator cuff re-attached

Figure 10: Allograft in place

It was also imperative that the allograft would be supplied with the rotator cuff attachments to facilitate re-attachment (*Figure 5*).

The patient was positioned supine and draped. The previous surgical incision was used (*Figure 6*). Thereafter, the delto-pectoral interval was identified.

Intra-operatively, the individual rotator cuff muscles were identified and isolated with non-absorbable sutures. The defect of the humerus was identified and the humeral allograft was then shaped according to this defect to fit in with the humeral shaft (*Figure 7*). The allograft was secured to the humeral shaft with cement and an intramedullary nail. The nail extended through the entire medullary canal. In addition, a spiral blade which locked into the nail, was passed through the humeral head (*Figure 8*). It was important to obtain the correct version of the donor humeral head to the recipient humeral shaft.

The rotator cuff muscles were re-attached using non-absorbable sutures (*Figures 9 and 10*).

The rotator cuff and capsule were reattached in a position of 30° of external rotation. The proportional cover of the head of humeral allograft by the donor and recipient tendons was in favour of the latter. The deltoid was preserved and the skin approximated. A drain was placed for a period of 24 hours and the patient immobilised in a sling post-operatively.

Immediate post-operative radiographs were satisfactory (*Figure 8*). The patient made an uneventful recovery with no immediate complications. He was discharged on a rehabilitation programme to strengthen the rotator cuff and deltoid.

At the six-week follow-up he presented with some superficial wound sepsis which was treated with iodine dressings. At the six-month follow-up (*Figures 11 and 12*) the patient was very satisfied with the procedure and his range of movement. He was able to achieve 30° of external rotation, 30° of forward elevation and 10° of abduction (*Figure 12*).

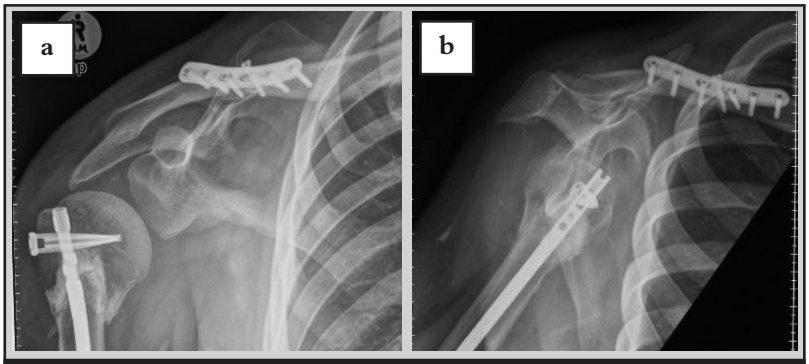

Figure 11a&b: AP and lateral view of shoulder at six months following surgery

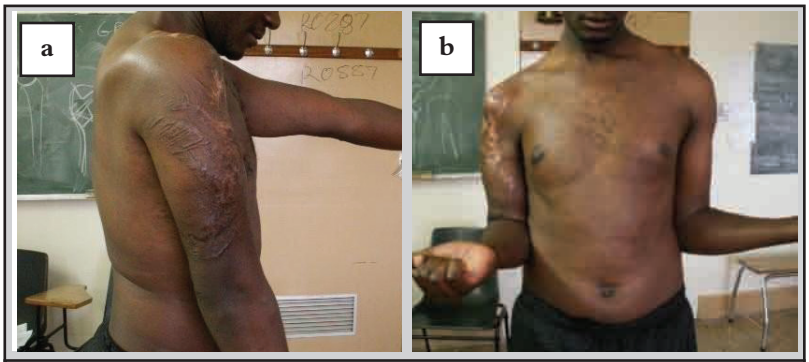

Figure 12a&b: Post-operative range of movement at six months

This limited range of active movement indicates weak rotator cuff muscles, and the patient was encouraged to continue rehabilitation. He was unable to return to his pre-morbid level of activity but had a better outcome compared to after his first surgical procedure.

Discussion

Proximal humeral allograft reconstruction is a very challenging procedure. The main aims of this procedure are to replace the articular surface, to retain sufficient muscle to be able to position the arm in space and to restore length of the arm.[1] Restoration of length is also important to enable the upper limb muscles around the shoulder to function at the correct tension. It is also vital to improve shoulder function as well as to preserve elbow and hand function.[2] Another challenge to the surgeon is to obtain a correct version of the prosthesis and tension on the rotator cuff to restore internal and external rotation to a functional range.

Alternatives for patients with proximal humeral defects include the use of a prosthesis.[3-5] However, this prosthesis has to be custom-made to compensate for the defect of the proximal humeral shaft. With a prosthesis there is a risk of stress shielding at the humeral-prosthesis interface,[3] and there are no anatomical attachment sites for the rotator cuff.[4,5] These attachments provide for greater stability and restoration of function. Also the allograft provides for a more natural and anatomical fitment.[4] There is also the question of longevity of a prosthesis especially if used in a young patient.[1]

Another alternative is to perform an arthrodesis of the shoulder.[1,3,5] With the arthrodesis either an autograft or allograft is still required to compensate for the osseous defect. A vascularised or free fibular graft is used and this is associated with all the morbidities related to the donor site, e.g. peroneal nerve damage. The fibula, along with its proximal articular cartilage, can also be used to recreate an articular surface; however the range of movement achieved is unsatisfactory.[1]

A fibular allograft can also be used but this carries the same risks and side effects of a proximal humeral osteoarticular allograft.[1]

There is also an inherent high risk of fracture of these fibula grafts even though an autograft has a better chance of being incorporated.

The movement in patients with an arthrodesis then shifts from a gleno-humeral articulation to the scapulothoracic one. O'Connor *et al* in their case series found that these patients had a superior range of movement compared to patients undergoing a proximal humeral replacement with a prosthesis or a spacer.[3]

A spacer can also be used but these patients do not regain shoulder function.[3]

The osteoarticular allograft with attached tendons however can also have a number of complications. These include the risk of disease transmission, non-union and bone resorption.[4] The allograft is also at risk for fracture and it is preferable to use fixation that spans the entire length of the bone.[1] Furthermore, the recipient tendons might not heal to the donor tendons as the blood supply of the bone bed where the tendons are attached is precarious. There is also a high rate of infections in these patients.[1] There is usually an initial host response to the graft, which walls off the graft and creates a dead space which forms a nidus for bacteria. Other factors which play a role are that usually these procedures are long and involve extensive dissection which could predispose to infection.[1]

The main aims are to replace the articular surface, to retain sufficient muscle to be able to position the arm in space and to restore length of the arm

Another complication that was noted in the literature is a high rate of subchondral fracture and collapse. O'Connor *et al* have suggested an allograft-prosthesis composite.[3,5] There may be more literature produced on this in the future.

However it is vital to reiterate that all of this work has come from patients with tumour reconstruction who are very different from trauma patients. The main aim in tumour patients is to ensure that all pathological tissue is removed.

Trauma patients have a higher functional demand and different expectations.

Conclusion

Although this type of humeral fracture is a rare occurrence, it is still wise for the trauma surgeon to consider an osteoarticular allograft as an option in a patient with massive bone loss injuries.

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