JSES Reviews, Reports, and Techniques 2 (2022) 250–253

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Allograft reconstruction of olecranon after traumatic bone loss: a case report

Mahala F. Walker, BS[a], Srinath Kamineni, MD[b,*]

[a]University of Kentucky College of Medicine, Lexington, KY, USA
[b]Department of Orthopedic Surgery, Elbow Shoulder Research Center, University of Kentucky College of Medicine, Lexington, KY, USA

ARTICLE INFO

Keywords:
Olecranon
Allograft
Bone extension
Ulna
Triceps
Nonunion

Level of evidence: Level IV; Review

Despite 2.2 million bone allografts conducted annually, their complication rate remains high, with recipients incurring infection, fracture, instability, and failure to incorporate. Nonunion rates in massive bone allografts—a bone segment ≥5 cm in length that also contains the total circumference of replaced bone—have been documented as high as 50%. However, if early complication can be avoided, a 75% success rate at 20 years postoperatively has been reported. Nonmassive allografts may yield decreased nonunion rates, as massive bone allografts must overcome a greater metaphyseal to diaphyseal incorporation rate and osteoconduction may not ensue beyond the bone periphery. The patient in this case is a 23-year-old male demonstrating absent bone in the right olecranon process of the ulna without attachment of the triceps brachii after a motorbike accident. The patient underwent olecranon allograft reconstruction with triceps brachii tendon reattachment. Four and a half years after allograft reconstruction of the right olecranon, the patient presents with minimal symptoms. However, he reports occasional aching at the site of injury. His current active arc of sagittal motion was 20°-130°, and pronation-supination was 70°-80°. His triceps strength was 4/5 Medical Research Council grade. Radiographic evaluation revealed a well-incorporated graft with a recontoured olecranon tip. Overall, this report demonstrates that operations involving a nonmassive allograft about the olecranon process may display minimal side effects in comparison to massive allografts, specifically regarding nonunion. Furthermore, this operation allows for improved range of motion after bone loss, allowing the patient to partake in activities of daily living.

The first bone allograft was conducted by Macewen in 1878 as an attempt to treat humeral infection.[5,19] The use of allografts in the field of orthopedic surgery has grown tremendously since, with more than 2.2 million bone allografts conducted annually.[7] Various allografting techniques, including impaction grafting, allograft-prosthesis composite, and cortical strut allografting, have been used to treat massive bone loss after tumor resection, failed arthroplasty, or traumatic injury, with the latter being less reported.[7,8,11,13,18] Despite the procedure's high risk of failure, overcoming early complications has demonstrated a success rate of 75% over 20 years, following review of more than 800 allograft transplants of various types and locations.[4,6,10,13]

In addition to risks such as infection, fracture, osteoarthritis, and instability, failure of massive allografts to fully incorporate into the host bone is common.[1,11,13,17] Massive bone allografts are bone segments ≥5 cm in length *and* also consist of the total circumference of a replaced bone.[4] Studies have indicated massive allograft nonunion rates to be approximately 17%; however, Min et al report nonunion of allograft-prosthesis composites of the proximal femur to be as high as 50%.[4,6,7,15] Delloye et al report the rate of incorporation of the metaphyseal junction of graft occurs at a rate twice that of the diaphyseal junction, demonstrating variation in the biology of graft healing. However, the extent of incorporation failure proceeds beyond incorporation rate variance. Comprehensive osteoconductive incorporation of graft bone with host bone rarely occurs beyond the peripheral interfaces, leaving the volumetric majority of graft bone unincorporated.[4] We were unaware of any definition for nonmassive allograft reported in the literature. For the purpose of this report, we defined the nonmassive allograft as any allograft not meeting both conditions stated in the Delloye et al definition for massive allograft.[4] Nonmassive allografts were less documented in the literature, and therefore, their outcomes and complications, for example, incorporation, have been poorly

Institutional review board approval was not required for this case report.

*Corresponding author: Srinath Kamineni, MD, Department of Orthopaedic Surgery, University of Kentucky, 740 S. Limestone, Lexington, KY 40536, USA.
E-mail address: srinathkamineni@gmail.com (S. Kamineni).

https://doi.org/10.1016/j.xrrt.2021.12.006
2666-6391/

understood. Even more uncommon was the use of moderate-sized allografts at hemiarticular locations such as the olecranon.[11] However, the limited information that exists on postoperative outcomes of graft incorporation at the proximal ulna has been optimistic.[2,3,10,11]

We present a case report describing a nonmassive olecranon bone allograft in a young patient enduring traumatic bone loss after a motorbike incident. A final postoperative evaluation was completed 4.5 years after the allograft.

Case report

A 23-year-old male presented to the emergency department with right elbow pain after sustaining a motorcycle incident. Initial radiographic examination demonstrated absent bone in the right olecranon process of the ulna, and the triceps brachii was not attached (Fig. 1). The patient underwent irrigation, débridement, and attempted triceps reattachment at an outside hospital. The mean Mayo Elbow Performance Score (MEPS) was 45 (pain: 15, range of motion: 15, stability: 0, function: 15). One month after the initial presentation, when the posterior skin had recovered, the patient was referred for reconstructive surgery. With infection hematological indices being normal, the patient was scheduled for a right olecranon allograft reconstruction and triceps reattachment.

Preoperatively, the patient was administered 2 gm of IV antibiotics (patient weight >80 kg), underwent general anesthesia, and was positioned supine with the arm flexed across the chest, supported by a towel roll. The previous dorsal incision was used and extended 3 cm proximally and distally. Full thickness skin flaps were raised, and the ulnar nerve was identified proximal to the elbow and was neurolysed 10 cm proximally and to the first motor branch distally by removing the transverse cubital ligament entirely. Because of the prior triceps injury and attempted repair at the outside hospital, a triceps-reflecting anconeus pedicle approach was used to mobilize the triceps while preserving the maximum structural material available.[16] The triceps-reflecting anconeus pedicle approach was conducted by removing the anconeus in continuity with the triceps to the olecranon fossa level. The triceps tendon displayed several areas of heterotopic bony callus within its traumatized structure, which were carefully removed. Once the triceps was mobilized and the débridement complete, the remnants of the posterior olecranon were visible. The scarred posterior capsule was excised, and the anterior capsule was stripped from the anterior humerus to promote soft tissue mobility. No structurally relevant olecranon bone was salvageable proximal to the bare area. The coronoid process was intact. At this time, the triceps was completely tenolyzed from the proximal extent of the olecranon fossa and up to 10 cm proximal of the olecranon fossa, allowing for excursion. A step cut was then created, entering the bare area and exiting the proximal subcutaneous border of the host ulna, to receive a reciprocally contoured fresh frozen proximal ulna allograft. It should be noted the fresh frozen allograft was selected as opposed to a fresh osteochondral graft based on previous experience in a similar case. The surgeon determined the need to perform a secondary extension because of extension-based subtle incongruence of the olecranon made the need for fresh cartilage less important than stable triceps insertion. Fine contouring, to achieve maximal contact, was performed with a burr. The allograft was positioned and secured with four 3.2 mm lagged titanium screws (Fig. 2). A subcutaneous plate was not considered at this time because of poor soft tissue. The host triceps was then reattached to the olecranon allograft bone using 2 running locking #2 braided polyester suture into bone tunnels. It was noted that the allograft-host articulation posteriorly was marginally imperfect because of graft morphology and prevented terminal extension due to the incongruence. The flexor and extensor masses were reconnected, side to side, to the triceps at the epicondylar level with #1 synthetic absorbable suture. The ulnar nerve was then repositioned posterior

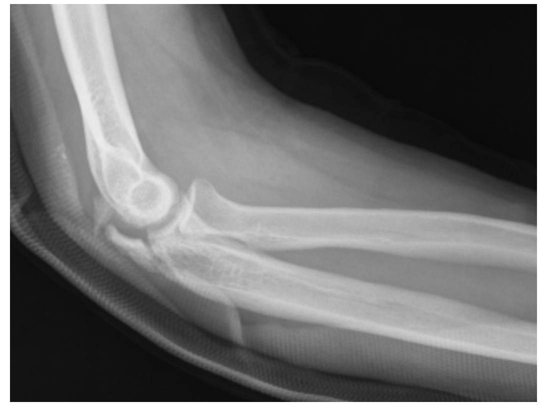

Figure 1 Initial radiograph of 23-yr-old male patient demonstrating absence of the olecranon process.

Figure 2 Initial postoperative radiograph of the olecranon process allograft demonstrating allograft secured with four 3.2 mm titanium screws in a lagged combination of allograft and autograft.

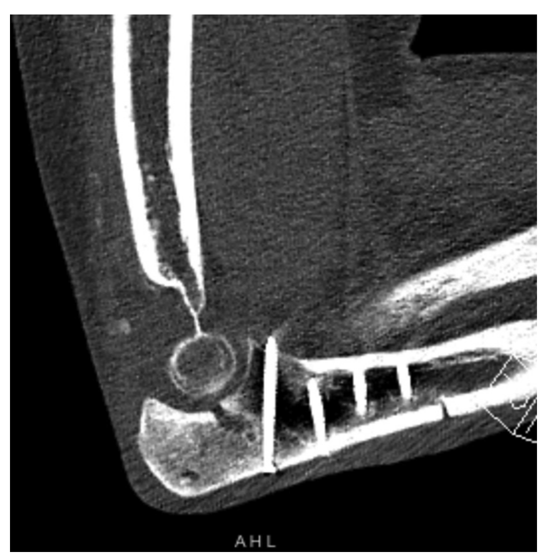

Figure 3 CT scan at 4 months demonstrating 60%-70% interface healing.

Figure 4 Final 4.5-yr follow-up of extension and flexion.

Figure 5 Final 4.5-yr follow-up of pronation and supination.

Figure 6 4.5-yr postoperative radiograph of the incorporated olecranon process allograft demonstrating a stable recontoured olecranon process tip.

to the medial epicondyle and was noted to be tension-free in elbow flexion and stable. A routine lavage and closure were performed and the arm splinted in full extension.

The postoperative course was uneventful. Two weeks postoperatively, no problems were reported, sutures were removed, and the patient was placed in a long arm cast. Physical therapy was requested for the patient at 3 weeks. At 10 weeks, the range of motion was 45°-130° sagittal motion, and the triceps functioned well against gravity and achieved 4/5 strength. The patient was released to return to work with a 0.45-0.9 kg weight restriction. Computed tomography of the patient's right elbow, at 4 months, demonstrated 60%-70% surface area healing of the allograft, as seen in Figure 3.

The residual 45° extension deficit due to posterior abutment remained and was symptomatically difficult for the patient. Hence, at 6 months, a right elbow arthroscopic anterior capsulectomy and posterior partial olecranon tip resection were performed, with the retention of 50% of the posterior articular facets. This allowed on-table full extension, with minimal residual incongruence. There was an uneventful postoperative course with physical therapy.

Four and half years after allograft reconstruction, clinic follow-up revealed minimal symptoms, with only occasional aching at the injury site. MEPS was 100 (pain: 45, range of motion: 20, stability: 20, and function: 25). His active arc of sagittal motion was 20°-130° (Fig. 4), pronation-supination was 70°-80° (Fig. 5), and triceps strength was 4/5 Medical Research Council grade. Radiographic evaluation revealed a well-incorporated graft with a recontoured olecranon tip (Fig. 6). Because of his olecranon remaining attached to his triceps from both a palpatory and functional standpoint, the patient had returned to his job as a box mover lifting boxes of 50-75 kg in weight without restriction, 10 months after the reconstruction.

Discussion

This case supports the existing literature demonstrating the utility of allografts in treating bone loss due to tumor resection, arthroplasty failure, and traumatic injury about the elbow.[3,8,9,10,11,12,13,14] This treatment option allows for avoidance of earlier alternatives to bone loss, such as custom arthroplasty or amputation, while providing a means to improve range of motion, minimize pain, and restore activities of daily living.[8] Thirteen allograft-prosthesis composites for failed total elbow arthroplasty were described by Mansat et al.[14] Over an average of 42 months, the mean MEPS improved from 23 points preoperatively to 67 points postoperatively. Preoperative arc of flexion was recorded as an average of 87°, which increased to 97° postoperatively (average extension of 28°, average flexion of 125°). Forearm rotation increase was also noted (average protonation of 72°, average supination of 72°).[14] Strut allograft reconstructions of the proximal ulna have also been documented in revision total elbow arthroplasty.[9] Twenty-one patients were followed for an average of 4 years, with a mean MEPS improvement of 45 points. The pain score was the most robustly impacted variable, increasing from 9 to 32 postoperatively. Stability and activities of daily living scores also improved. Regarding graft incorporation, 14 patients had grade 4 incorporation (76%-100% incorporation), 5 patients had grade 3 incorporation (51%-75%), 3 patients had grade 2 incorporation (26%-50%), and no patients had grade 1 or grade 0 incorporation.[9] A case report by Lee described impaction grafting of cancellous allograft for failed total elbow arthroplasty presenting with bone loss. Cancellous bone graft was used to restore bone volume at the distal humerus and proximal ulna.[12] Mankin et al report favorable outcomes in cases of tumor resection, using various allografting techniques in over 800 transplant procedures, with success rates of >75%.[13]

Allograft use after traumatic bone loss is less reported. Jaffe et al refer to traumatic major bone loss as “one of the most difficult treatment problems confronting the orthopedic surgeon.”[8] In an analysis of 11 allografts for traumatic bone loss, it was suggested that this surgical technique is useful in young patients facing articular deficit.[8] Our study supported this concept since our patient demonstrated enhanced range of motion and strength, decreased pain, and returned to his manual occupation as a box lifter with minimal sequelae.

In a review of 25 patients undergoing reverse shoulder–allograft prosthesis composite at the proximal humerus, the allograft-host junction demonstrated incorporation in 96% of the cases.[2] In another study of 23 patients receiving elbow allografts (1 olecranon allograft, 6 distal humerus allografts, and 16 total elbow allografts including ligamentous aspects), only one nonunion was reported.[3] A single nonunion was also reported in another study of 19 elbow allograft patients, and a case report found incorporation of humeral and ulnar allografts in a 69-year-old being treated for twice-failed total elbow arthroplasty.[10,11] This case demonstrates the ability of a “nonmassive” osteoarticular allografts, used for traumatic olecranon osteoarticular loss, to heal the graft periphery to the host bone, and achieve functional range of motion, strength, and joint stability. Although these findings are not conclusive in the use of nonmassive allografts about the olecranon, they are in accordance with the limited studies published on outcomes of graft incorporation at the proximal ulna.

Conclusion

Further research is necessary to conclude an optimal treatment for traumatic loss of the olecranon process. Currently, insufficient data exist regarding nonmassive allografts at hemiarticular locations, specifically among the adolescent and young adult demographic.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.
Patient consent: Obtained.

References

1. Amirfeyz R, Stanley D. Allograft-prosthesis composite reconstruction for the management of failed elbow replacement with massive structural bone loss: a medium-term follow-up. J Bone Joint Surg Br 2011;93:1382-8. https://doi.org/10.1302/0301-620X.93B10.26729.
2. Boileau P, Raynier JL, Chelli M, Gonzalez JF, Galvin JW. Reverse shoulder-allograft prosthesis composite, with or without tendon transfer, for the treatment of severe proximal humeral bone loss. J Shoulder Elbow Surg 2020;29:e401-15. https://doi.org/10.1016/j.jse.2020.03.016.
3. Dean GS, Holliger EH 4th, Urbaniak JR. Elbow allograft for reconstruction of the elbow with massive bone loss. Long term results. Clin Orthop Relat Res 1997;341:12-22.
4. Delloye C, Cornu O, Druez V, Barbier O. Bone allografts: what they can offer and what they cannot. J Bone Joint Surg Br 2007;89:574-9. https://doi.org/10.1302/0301-620X.89B5.19039.
5. Gross TP, Cox QG, Jinnah RH. History and current application of bone transplantation. Orthopedics 1993;16:895-900.
6. Head WC, Berklacich FM, Malinin TI, Emerson RH Jr. Proximal femoral allografts in revision total hip arthroplasty. Clin Orthop Relat Res 1987;225:22-36.
7. Hoffman MD, Xie C, Zhang X, Benoit DS. The effect of mesenchymal stem cells delivered via hydrogel-based tissue engineered periosteum on bone allograft healing. Biomaterials 2013;34:8887-98. https://doi.org/10.1016/j.biomaterials.2013.08.005.
8. Jaffe KA, Morris SG, Sorrell RG, Gebhardt MC, Mankin HJ. Massive bone allografts for traumatic skeletal defects. South Med J 1991;84:975-82.
9. Kamineni S, Morrey BF. Proximal ulnar reconstruction with strut allograft in revision total elbow arthroplasty. J Bone Joint Surg Am 2004;86:1223-9. https://doi.org/10.2106/00004623-200406000-00015.
10. Kay RM, Eckardt JJ. Total elbow allograft for twice-failed total elbow arthroplasty. A case report. Clin Orthop Relat Res 1994;303:135-9.
11. Kharrazi FD, Busfield BT, Khorshad DS, Hornicek FJ, Mankin HJ. Osteoarticular and total elbow allograft reconstruction with severe bone loss. Clin Orthop Relat Res 2008;466:205-9. https://doi.org/10.1007/s11999-007-0011-8.
12. Lee DH. Impaction allograft bone-grafting for revision total elbow arthroplasty. A case report. J Bone Joint Surg Am 1999;81:1008-12.
13. Mankin HJ, Gebhardt MC, Jennings LC, Springfield DS, Tomford WW. Long-term results of allograft replacement in the management of bone tumors. Clin Orthop Relat Res 1996;324:86-97.
14. Mansat P, Adams RA, Morrey BF. Allograft-prosthesis composite for revision of catastrophic failure of total elbow arthroplasty. J Bone Joint Surg Am 2004;86:724-35. https://doi.org/10.2106/00004623-200404000-00009.
15. Min L, Tang F, Duan H, Zhou Y, Zhang WL, Shi R, et al. Cemented allograft-prosthesis composite reconstruction for the proximal femur tumor. Onco Targets Ther 2015;8:2261-9. https://doi.org/10.2147/OTT.S85788.
16. O'Driscoll SW. The triceps-reflecting anconeus pedicle (TRAP) approach for distal humeral fractures and nonunions. Orthop Clin North Am 2000;31:91-101.
17. Reintgen C, Gerlach E, King JJ. Surgical treatment of displaced olecranon fracture through a persistent physis: case report and review of the literature. Orthop J Sports Med 2019;7:2325967119881647. https://doi.org/10.1177/2325967119881647.
18. Rhee YG, Cho NS, Parke CS. Impaction grafting in revision total elbow arthroplasty due to aseptic loosening and bone loss. J Bone Joint Surg Am 2013;95:e741-7. https://doi.org/10.2106/JBJS.K.01737.
19. Tomford WW. Bone allografts: past, present and future. Cell Tissue Bank 2000;1:105-9.