Article published online: 2026-02-15

An Innovative Technique to Preserve Elbow Function During Replantation of an Amputation Near the Elbow Joint in an Infant

Hari Venkatramani[1] Jayaramaraju Dheenadhayalan[2] Shruthi Chandrasekar[1]
Chengazhacherril Baby Romy[1] Praveen Bhardwaj[3] Shanmuganathan Raja Sabapathy[1]

[1] Department of Plastic, Hand and Microsurgery and Burns, Ganga Hospital, Coimbatore, Tamil Nadu, India
[2] Department of Orthopedics, Ganga Hospital, Coimbatore, Tamil Nadu, India
[3] Department of Hand and Microsurgery, Ganga Hospital, Coimbatore, Tamil Nadu, India

Address for correspondence Hari Venkatramani, MBBS, MS, MCh, DNB, EDHS, Department of Plastic, Hand and Microsurgery and Burns, Ganga Hospital, Coimbatore 641043, Tamil Nadu, India (e-mail: drhari@gmail.com).

Indian J Plast Surg

Abstract

Bone shortening is performed during replantation of major crush avulsion amputations. It ensures fixation of healthy bone ends, helps avoid vein, nerve grafts, and additional soft tissue procedures, thereby reducing ischemia time. When amputations occur near joints, bone shortening may lead to joint loss. A 12-month-old infant suffered amputation just proximal to the articular surface of the humerus. The humerus fragment was small for any stable fixation and any shortening of the proximal segment would offer a vastly different cross section for rigid fixation. To preserve elbow joint, a 3 cm of humerus segment was osteotomized from the proximal segment. The resected bone segment was fixed as a free bone graft to the humeral distal articular surface with Kirschner wires. A 3-cm further shortening was done in the proximal segment and fixed to the distal side. The free bone segment survived as graft with bone union at both sides with joint preservation.

Keywords
► major replantation
► pediatric replant
► elbow preservation

Introduction

Replantation of major crush, avulsion amputations is a challenge due to the risks of high morbidity. Acute complications are related to the ischemia time, and late complications to infection. Infection is avoided by radical debridement and excision of avulsed soft tissue, muscles and neurovascular structures. Bone shortening, as an integral step of the procedure, narrows the gap and facilitates primary repair of structures, avoiding procedures for additional soft tissue cover, thereby reducing ischemia time.[1] In amputations close to the joints, bone shortening results in loss of the joint. In a child, the functional loss could be severe.[2]

We report a technique that helped to preserve elbow function in a 1-year-old child following amputation close to the articular surface of the humerus.

Case Report

A 1-year-old child crawled into the power loom machine in a village where home and work environments are together. The child was brought to us 2.5 hours after the injury with a well-preserved amputated part. The amputation appeared to be around the elbow joint (►**Fig. 1**), and there were no other injuries to the child or the part. Radiographs revealed that

DOI https://doi.org/10.1055/s-0046-1816057.
ISSN 0970-0358.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Fig. 1 Avulsion amputation of the right upper limb at the distal arm level, very close to the elbow joint.

Fig. 2 X-ray of the part shows a small distal fragment of the humerus in the amputated part.

Fig. 3 Three cm of bone osteotomized and used as a free bone graft and fixed to the distal end of the humerus using two Kirschner wires.

the amputation was just proximal to the articular surface of the humerus (►Fig. 2).

Post-debridement, there was a need for bone shortening for primary repair of structures. To preserve the elbow joint, a 3-cm segment of bone was osteotomized from the proximal end and fixed to the articular surface with two 1.25-mm Kirschner wires (K wires), to avoid splintering of the tiny distal segment, thus also reconstructing the joint (►Fig. 3). The attached segment was planned to serve as a free bone graft. To enable primary repair of structures, the proximal segment was further shortened by 3 cm. The bone ends were fixed with a five-hole adult distal radius plate (►Fig. 4). The steps are illustrated by a line diagram (►Fig. 5).

The brachial artery, cephalic vein, another cutaneous vein, median, ulnar and radial nerves were repaired. The biceps and triceps were repaired at the musculotendinous level with 3–0 prolene sutures. The skin could be closed primarily. To minimize the effects of ischemia, the limb was covered with glove bags containing ice and wrapped with bandage throughout the procedure, except at the operation site. The total ischemia time was 7.5 hours. Since the fingers were flexible and most of the ischemia time was cold, fasciotomy was not done. The limb was immobilized in an above elbow cast for 3 weeks. It was then changed to an above-elbow slab, retained for another 3 weeks with intermittent passive motion exercises of the wrist and fingers.

Gross finger movements through long flexor action were recorded at 3 months. The K-wires were removed at 3 months, and elbow passive flexion exercises were initiated. The intrinsic muscle function recovery was noted at 4 months. Active elbow flexion against gravity was seen at 5 months. At 1.5 years, although a proper sensory evaluation

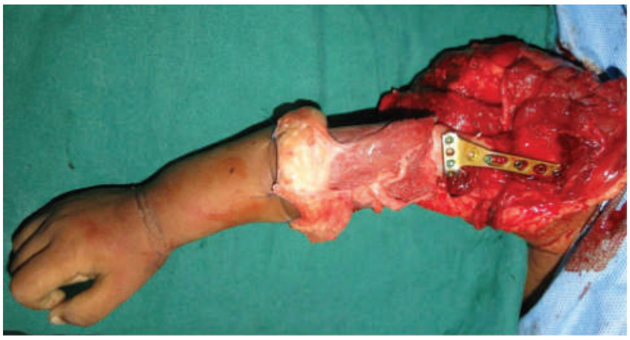

Fig. 4 Three cm further shortening of the proximal humerus was done to allow primary repair of vessels, nerves and tendons.

could not be done, the child was found to have protective sensation. No bite marks or trophic ulcers were present.

At 2 years, when the flexors and the intrinsics recovered, there was tightness of the long flexors of the middle and ring fingers, it was corrected by fractional lengthening of the flexors and a plication of the extensors.

Seven years post-replantation, radiographs show good bone union (►**Fig. 6**). The elbow showed a flexion deformity of 30 degrees with flexion possible up to 90 degrees (►**Fig. 7**). Sensations are normal with a 2 Point Discrimination of 4 mm. The Parent proxy Pediatric Outcomes Data Collection Instrument tool was administered. The upper extremity domain score was 67/100. He could perform all his daily activities without much assistance.

Discussion

Experience has proved that replantation of major crush avulsion amputations is a worthwhile endeavor and, when successful, yields gratifying results, particularly in children.[3] One of the key components of major replantation is bone shortening, which is usually done on both sides. When the amputation is near the joint, the shortening is preferentially done on the side away from the joint.[4,5] In this case, shortening of the proximal stump would have caused difficulty in fixing the humerus with a small cross-sectional area to the wider distal segment with the articular surface. The distal end is triangular with posterior, anteromedial, and anterolateral surfaces, but as it goes proximally, it becomes more circular. We had a tiny distal end, and if 3 to 4 cm in an infant is shortened, then we will have a smaller circular cross-sectional area contacting a triangular area, and a significant part of the distal part will not have a bone contact, and also be of a different shape. Further, the distal segment with the articular surface was too short for plate fixation.

To address these concerns, we decided to get a segment of bone from the proximal side and fix it with the distal articular fragment. It could be held well together with two K wires. Further proximal shortening converted an elbow-level amputation to a lower third arm replantation and made the skeletal fixation simpler. The step was taken on the premise that the nonvascularized bone segment would survive as a free graft in a child.[6] It is open to question if that would be successful in an adult, but the principle could be worth using in demanding circumstances, even in adults.

The case also illustrates the excellent nerve recovery potential in children and underscores the importance of attempting replantation in children. Major replantations usually need secondary procedures for enhancing function. In our child, the secondary surgery required was to correct the mild ischemic contracture of the deep flexor muscles of the middle and ring fingers.[7,8] Our efforts at intraoperative cooling the amputated part has succeeded except at the core. In the mildest form of ischemic contracture, the flexor digitorum profundus muscles of the middle and ring are affected, as in this child. Fractional lengthening of the involved muscles gave excellent results.

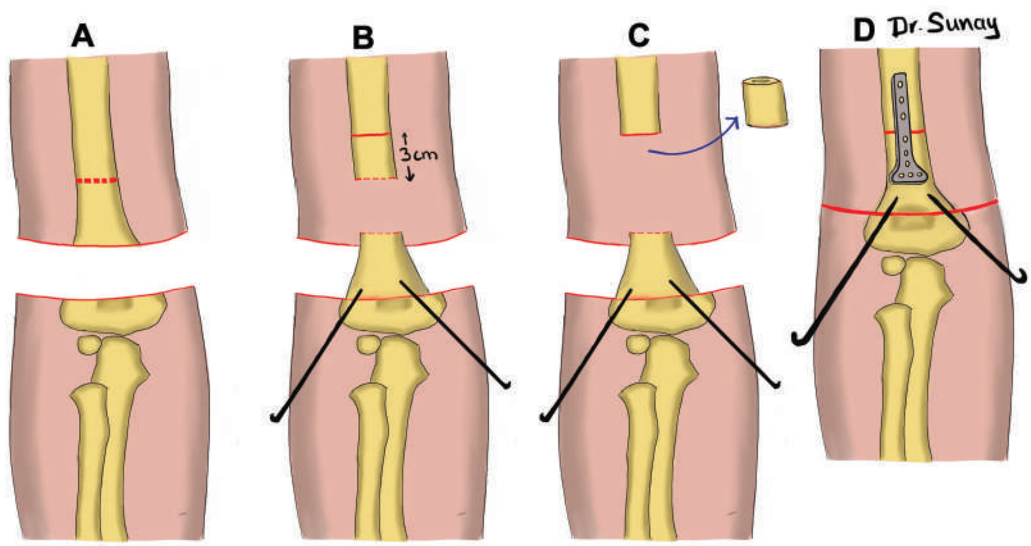

Fig. 5 Line diagram to illustrate the technique of skeletal fixation. (**A**) Level of amputation with a small part of the distal humerus in the amputated part. (**B**) Three cm of humerus osteotomized at the amputation level and sourced as a free bone graft. (**C**) Free bone graft attached to the humeral articular surface and further 3 cm of humerus segment excised and discarded. (**D**) Fixation of the ends to facilitate primary repair of vessels and nerves.

Fig. 6 Seven-year follow-up radiograph showing good bony union and preserved elbow joint.

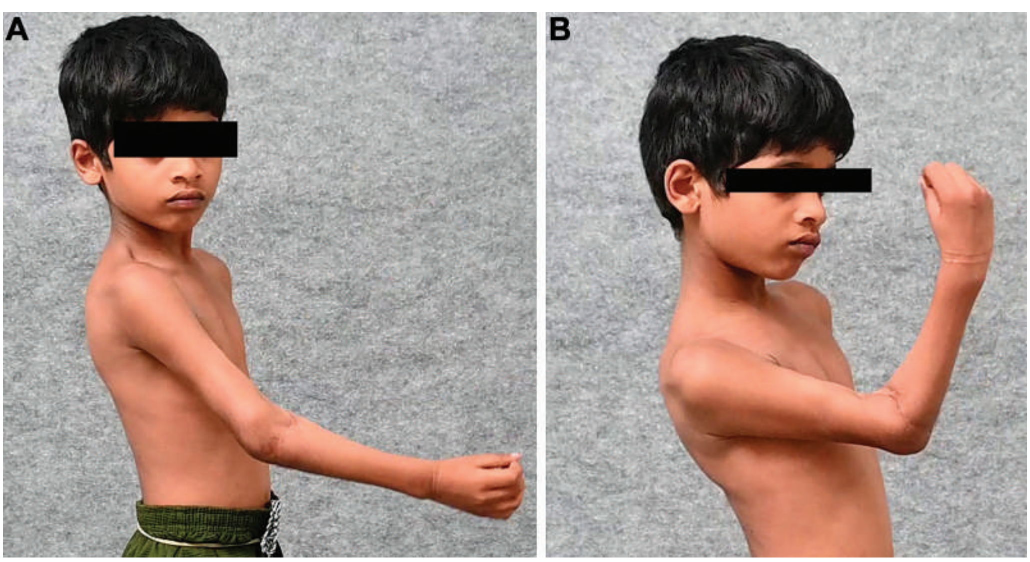

Fig. 7 (**A, B**) Range of movement at the elbow at 7-year follow-up.

Conclusion

Functional elbow joint preservation is possible during replantation of amputations close to the joint by using the adjacent segment of bone from the proximal segment as a bone graft and further proximal shortening to facilitate primary repair of structures. This technique also helps in easier, stable fixation of bone. The bone graft survives well, resulting in primary bone union on either side of the graft.

Conflict of Interest
None declared.

References

1 Sabapathy SR, Venkatramani H, Bharathi RR, Bhardwaj P. Replantation surgery. J Hand Surg Am 2011;36(06):1104–1110
2 Prem H. Physeal injuries in children. Surgery (Oxf) 2017;35(01): 10–17
3 Taghinia AH. Pediatric replantation and revascularization. Hand Clin 2019;35(02):155–178
4 Sun Z, Liu G, Kanakaris NK, Li T, Wu X, Giannoudis PV. Acute shortening of upperextremity in orthopaedic patients: a scoping review. Eur J Trauma Emerg Surg 2025;51(01): 225
5 Sabapathy SR, Venkatramani H, Bharathi RR, Dheenadhayalan J, Bhat VR, Rajasekaran S. Technical considerations and functional outcome of 22 major replantations (The BSSH Douglas Lamb Lecture, 2005). J Hand Surg Eur Vol 2007;32(05): 488–501
6 Kaewpornsawan K, Eamsobhana P. Free non-vascularized fibular graft for treatment of large bone defect around the elbow in pediatric patients. Eur J Orthop Surg Traumatol 2017;27(07): 895–900
7 Fufa D, Lin CH, Lin YT, Hsu CC, Chuang CC, Lin CH. Secondary reconstructive surgery following major upper extremity replantation. Plast Reconstr Surg 2014;134(04):713–720
8 Sabapathy SR, Bhardwaj P. Secondary procedures in replantation. Semin Plast Surg 2013;27(04):198–204

