Hemi-Fibular Grafting for Metacarpal Giant Cell Tumor – Surgical Technique

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Learning Point of the Article:
Hemi-fibular grafting an innovative method for the reconstruction of bone defect due to excision of giant cell tumor of metacarpal bone has been discussed in this article

Abstract

Introduction: Giant cell tumor (GCT) of small bones of hand is no so uncommon, especially in the metacarpals. Considering the aggressive behavior in the metacarpals, en bloc resection is often required. Following resection, reconstruction techniques available include tricortical iliac grafting, vascularized or non-vascularized fibular grafting, or metatarsal grafting. We present an innovative surgical technique for the management of such bone defects.

Case Report: A 14-year-old girl presented with pain and swelling over the dorsum of the right hand for 2 months which was progressively increasing in size. The range of movements of the metacarpophalangeal (MCP) joint was normal. Radiological evaluation showed a lytic lesion with a well-defined margin over the metaphyseal region of the second metacarpal without articular involvement. The lesion was diagnosed as GCT on biopsy. Reconstruction of bone loss was managed by hemi-fibular grafting technique which involves selective osteotomy of the anterior half of the middle third of the fibula for the reconstruction of bone loss. This new technique ensures a renewable source of autograft with good incorporation at the recipient site with good hand function despite maintaining the esthetic appearance of the hand. Lesion being very aggressive had two episodes of recurrence at 2–3 years of post-operative period which was excised.

Conclusion: This case illustrates the management of aggressive GCT of metacarpal bone by excision and reconstruction with hemi-fibular grafting technique. Hence, hemi-fibular grafting can be considered as an innovative technical substitute to the traditional methods of autograft harvesting with good regenerative potential at the donor site and better incorporation rates at the recipient site providing good functional results.

Keywords: Giant cell tumor, hemi-fibular graft, metacarpal GCT.
We planned for wide excision of the metacarpal region sparing the MCP joint and reconstruction with hemi-fibular grafting. Through the dorsal approach, the lesion was exposed and the normal level of the bone was identified. Excision of the lesion followed by extended curettage with hydrogen peroxide was performed to ensure no residual tumor cells were left in the graft bed. The MCP articular cartilage with a flake of cancellous bone was preserved to maintain the joint function.

**Case Report**

A 14-year-old girl presented with pain and swelling over the dorsum of the right hand for 2 months, which was progressively increasing in size. The range of movements of the metacarpophalangeal (MCP) joint was normal. Radiological evaluation showed a lytic lesion with a well-defined margin over the metaphyseal region of the second metacarpal without articular involvement, as shown in (Fig. 1). Diagnosis by tissue biopsy came out to be GCT.

**Surgical technique**

We planned for wide excision of the metacarpal region sparing the MCP joint and reconstruction with hemi-fibular grafting. Through the dorsal approach, the lesion was exposed and the normal level of the bone was identified. Excision of the lesion followed by extended curettage with hydrogen peroxide was performed to ensure, no residual tumor cells were left in the graft bed. The MCP articular cartilage with a flake of cancellous bone was preserved to maintain the joint function.

The graft was harvested from the middle third of the ipsilateral fibula, as illustrated in (Fig. 2). The length of the graft required was measured and harvested from the anterior half of the fibula leaving the thicker posterior half in situ to help in earlier weight-bearing of the donor limb. The graft is placed in the recipient
Clinicoradiological evaluation at final follow-up showed improved range of movement and function based on Michigan Hand Function Score compared to the initial pre-operative status which deteriorated with each recurrence and improved later on at the final follow-up at 4 years, as shown in (Table 1). No evidence of distant metastasis was noted from computed tomography chest and bone scan until recent follow-up. The patient was under regular follow-up in view of the aggressiveness of the lesion, notorious for recurrence.

Graft showed good incorporation on radiological analysis, as shown in (Fig. 3) during follow-up. The patient had improvement in range of movement and hand functions post-surgery during follow-up, as shown in (Fig. 4). Donor fibula has regrown fully despite sustaining a stress fracture at 3 months follow-up.

At 2 years follow-up, the patient developed mass in the first web space which was tissue diagnosed as tumor recurrence and surgical excision was done. At 3 years follow-up, the patient developed a mass at the MCP joint which was also tissue diagnosed as tumor recurrence. Surgical excision of the lesion, along with the removal of the plate followed by fusion of the metacarpophalangeal joint, was done, as shown in (Fig. 5). The patient was symptom-free since the last recurrence till now at 4 years of follow-up.

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Discussion

Although the technique of free fibular grafting was introduced in the 20th century [9], there was controversy regarding its successful fusion outcome compared to vascularized fibular grafting [10, 11]. Despite all the critical comments, the technique has been established in various studies as a reliable method of reconstruction of segmental and hemi-cortical bone defects following tumor resection [12].

Utilizing the technique of free fibular grafting and modifying it by harvesting only the anterior half of the fibula, we developed this technique of hemi-fibular grafting for the management of bone loss in the management of GCT of small bones of the hand. Saikia et al. [2] treated two such patients with metacarpal GCT by ray amputation in one and wide resection and tricortical iliac crest bone grafting in the other. Another study involving three patients utilized methodology, such as curettage, cryosurgery, and cementation [3]. Our method reduces the need for amputation, reduces the morbidity associated with the above-mentioned procedures.

We performed selective osteotomy of anterior half of the fibula for the reconstructive purpose and retained the posterior cortical structure to aid in the transfer of 7.12% of the load transfer that normally takes place across an intact fibula preventing any significant biomechanical changes due to the grafting procedure [13]. Free fibular grafting attains the vascularity from the perforating vessels from the graft bed; hence, preparation of the recipient site remains a key step to get a successful integration of the graft to the host bone [14]. By bisecting the graft, the surface area of the graft in contact with the graft bed is increased to facilitate integration.
We use graft from the middle third of the fibular for four reasons: First, to prevent injury to the common peroneal nerve from procedures involving proximal third fibula. Second, to prevent injury to the superficial peroneal nerve distally. Third, the middle third graft harvest reduces the alteration in the contact area stress and crest value stress of the tibiotalar joint [13]. Finally, various anatomical studies have demonstrated that the nutrient artery for fibula was located away from the middle third region in 80% of the cases resulting in safer grafting procedure, precluding vascular compromise to the donor bone [15, 16]. The added advantage of the procedure is that the donor bone regenerates from the periosteal sheath from the posterior strut resulting in a renewable source of autograft for future needs.

This method of grafting has certain limitations. This method is not applicable to weight-bearing joints and in procedures involving the reconstruction of large bone defects which are beyond the scope of the procedure described. Large studies with a greater number of cases are needed in the future to validate the surgical procedure for wider acceptability as a common reconstructive option in a similar scenario.

**Conclusion**

This case illustrates the aggressive GCT of metacarpal bone managed by excision and reconstruction of bone defect with hemi-fibular grafting. Hence, hemi-fibular grafting can be considered as an innovative technical substitute to the traditional methods of autograft harvesting with good regenerative potential at the donor site and better incorporation rates at the recipient site providing good functional results.

**Clinical Message**

This case report illustrates the hemi-fibular grafting technique as a reconstruction method for the management of bone loss arising from the excision of GCT involving small bones of the hand.

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