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CASE REPORT

Reconstruction of Metacarpal Bone with Giant Cell Tumour by Metatarsal Bone: A Rare Case

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ABSTRACT

Giant cell tumour (GCT) of the metacarpal bone is rare, and it behaves more aggressively with a higher recurrence rate as compared to other long bones. Modalities such as bone curettage with or without bone grafting, ray amputation, or wide resection and reconstruction have been described as surgical management for this condition. Wide resection (en block) is often preferred as it has a lower recurrence rate among the rests. Reconstruction techniques options available include vascularised or non-vascularised fibular graft, iliac crest strut graft with loss of metacarpophalangeal joint function or with metatarsal substitution resulting in a more preserved function of the hand. This case report is about a 15-year-old teenager girl with a giant cell tumor of her left second metacarpal bone, which was confirmed with a plain radiograph and magnetic resonance imaging. This case report focuses the operative technique of the metacarpal reconstruction using the third metatarsal bone. The aim was to preserve hand function and cosmesis while achieving good local control of the disease without compromising the lower limb function. The transfer of osteoarticular ligamentous complex of the third metatarsal bone for the reconstruction of the second metacarpal bone defects is a possible operative procedure that provides good cosmetic and excellent functional outcomes while not compromising the donor's foot function.

INTRODUCTION

Giant cell tumor (GCT), also known as osteoclastoma, is a relatively rare, benign osteolytic and locally aggressive tumor

(Gachhayat et al., 2019). GCT accounts for approximately 5 percent of the primary bone tumors, and the local recurrence rate tendency is considerably high (Tarun et al., 2016). It is common in the metaphyseal and epiphyseal region of the long bones; however, it may happen in the small bones of the feet and hand or the axial skeleton. GCT of the bone in hand provides some degree of possibility of pulmonary metastasis (Gachhayat et al., 2019). Giant cell tumor is commonly seen in young adults at the age of 20 to 40 years old. Giant cell tumor of the metacarpal has some different features from the long bones. It behaves more aggressively, involving the entire metacarpal bone and soft-tissue extension, and the recurrence rate is higher compared to the involvement of the long bones even after an adequate wide surgical resection performed. There is a wide pathology that is similar to the expensile lytic appearance of the bone lesion radiologically. Therefore, aneurysmal bone cyst, multiple myeloma, bone metastasis, chondroblastoma should be included in the differential diagnosis (Saikia et al., 2011).

Varieties of surgical treatment are already described in the literature, including curettage alone, curettage with bone grafting or with bone cementing, ray amputation, and en bloc resection with reconstruction[1]. The aim of the treatment of a giant cell tumor involving the metacarpal bone is to achieve adequate local control while maintaining acceptable gross and fine hand function and cosmesis (Beaton et al., 2001).

In this case, there was successful transplantation of third metatarsal bone along with the osteoarticular ligamentous complex to replace the second metacarpal bone of the left hand, where the tumour was involved. This technique allows us to maintain the functionality of the metatarsophalangeal joint of the hand while providing excellent local control.

CASE PRESENTATION

A 15-year-old girl presented with an 18-month history of pain and diffuse swelling over the left index finger at the metacarpal region (her non-dominant hand). The swelling was painless initially; however, the pain started after she sustained a low impact injury over her left hand. The pain had restricted the movement of the second metacarpophalangeal joint of the left hand. She had no history of any significant loss of appetite and weight loss.

On general physical examination, the swelling measured about 4.5cm x 3cm over the second metacarpal bone of the left hand. It had a well-demarcated margin, and the mass was not attached to the overlying skin structure, firm, and tender on palpation (Figure 1). The restriction in the movement of the second metacarpophalangeal joint due to pain led to disruption in daily activities.

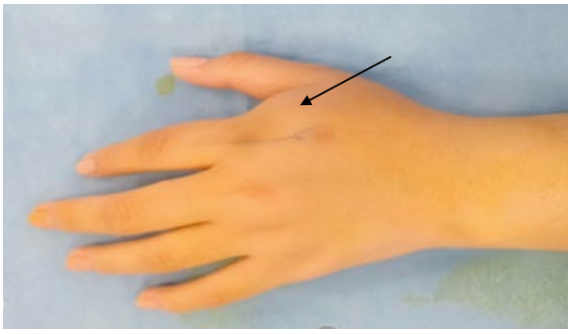

Figure 1 Pre-operative photograph of hand showing swelling in the region of the second metacarpal (arrow)

The plain radiograph showed an expansile lytic lesion, multiple bony septa with soap-bubble appearance involving the entire second metacarpal bone of the left hand. Significant cortical expansion and thinning over the second metacarpal bone was seen (Figure 2). In the non-contrasted magnetic resonance imaging of the left hand revealed a well-defined lobulated lesion in the second metacarpal bone with no evidence of infiltration to surrounding soft tissue or extension beyond the adjacent joints (Figure

3 in T1 imaging, Figure 4 in T2 imaging). The patient's routine laboratory parameters showed no abnormalities.

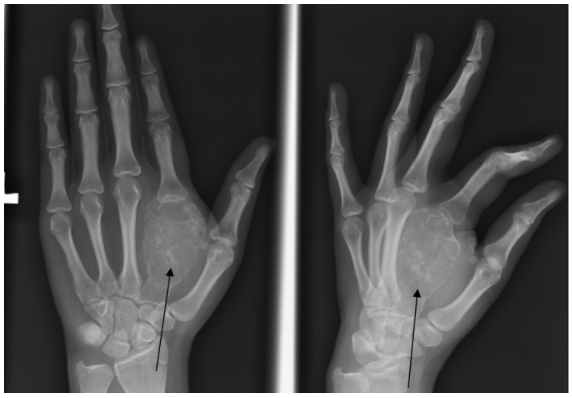

Figure 2 Antero-posterior (right) and oblique (left) view of the left hand revealing an expansile, lytic lesion with soap bubble appearance over the entire second metacarpal bone with thinning of the cortex (Arrow pointed).

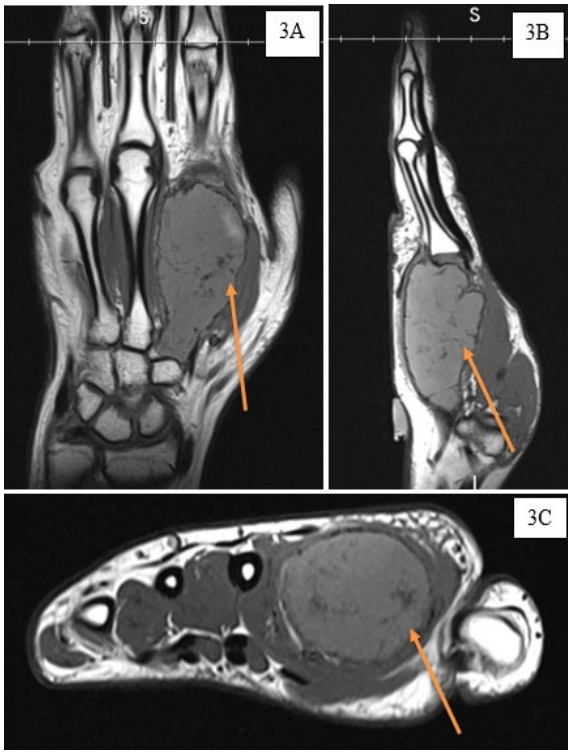

Figure 3 (Right). Pre-operative MRI. T1 coronal view (A), sagittal view (B), and transverse view (C) images were showing an isointense expansile lesion over the entire metacarpal bone of second metacarpal bone.

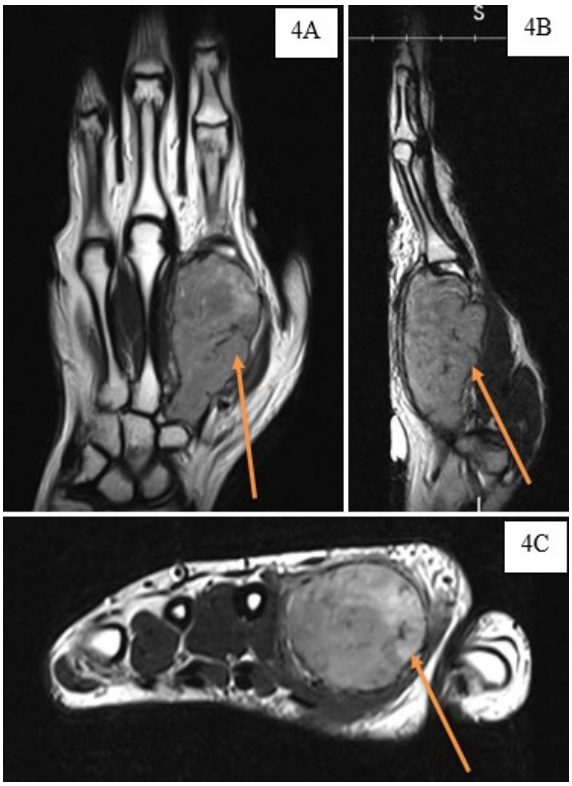

Figure 4 (Left). Pre-operative MRI. T1 coronal view (A), sagittal view (B), and transverse view (C) images were showing an expansile lesion with mixed-signal intensity.

This patient underwent en bloc resection of the tumor of the second metacarpal bone by the dorsal approach. While excising the affected bone, the distal half portion of the metacarpophalangeal joint capsule, collateral ligaments, and the whole volar plate were preserved. Subsequently, disarticulation was done at the carpometacarpal joint level. The third metatarsal bone of the left foot was harvested together with the collateral ligaments and capsule of its metatarsophalangeal joint. The metatarsal bone was osteotomised (Figure 5) according to the planned desired length for the recipient site (Figure 6). The ligaments, together with the capsule of the donor metatarsal, were plicated to their corresponding recipient ligaments and capsule to reconstruct back the metacarpophalangeal joint, providing stability to the reconstructed joint. It was further augmented with 1.3mm anchor suture. A mini

locking plate 2.0mm was used and was cut distally to form into V-shaped end to achieve intermetacarpal fusion between the base of the second and third metacarpal bones of the left hand.

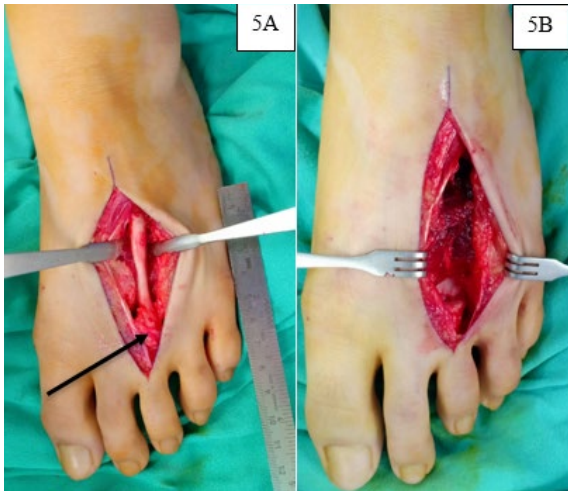

Figure 5 5A showing the left third metatarsal bone is osteotomised at the level of proximal 1/3 at the desired level, and the metatarsal head was harvested along with the capsule and the collateral ligaments (Black arrow). 5B showing the wound of the left foot after the extraction of the third metatarsal bone.

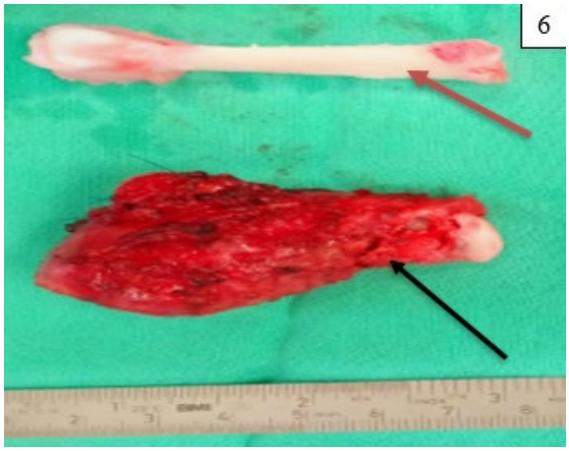

Figure 6 The donor metatarsal bone from the left foot (red arrow) with the preservation of the capsule and collateral ligaments. The proximal metatarsal bone was osteotomised at the level of the desired length. The affected second metacarpal bone (black arrow) resected entirely.

A single Kirschner-wire was inserted at the reconstructed metacarpophalangeal joint as a splint to immobilized the reconstructed joint and to facilitate the healing of the joint (Figure 7). The left foot surgical site hemostasis secured and was able to oppose the surgical wound with a drain which was removed one day postoperatively. A below elbow volar slab was applied after the fixation for two weeks while the Kirshner-wire was removed at four weeks to allow a progressive range of motion exercise.

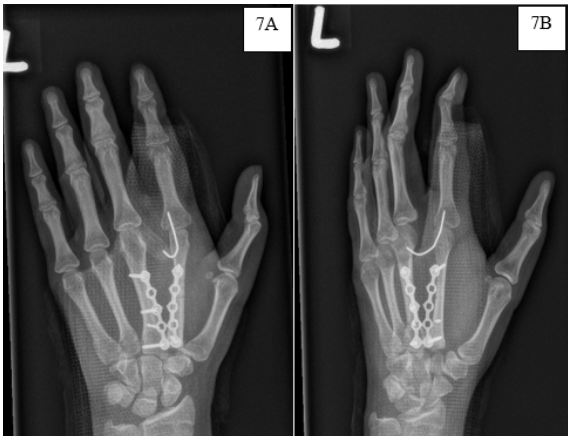

Figure 7 Plain radiograph of left the hand post-operation (7A, anteroposterior view; 7B, oblique view). A modified V-shaped mini-plate was used for fusion between the donor metatarsal and the third metacarpal. A Kirshner wire inserted over the second metacarpal-phalangeal joint.

Histopathological study of the excised second metacarpal bone confirmed the diagnosis. Multinucleated osteoclastic giant cells scattered diffusely and intermingled with fibroblast and small blood vessels; mature bony trabeculae were seen peripherally microscopically (Figure 8).

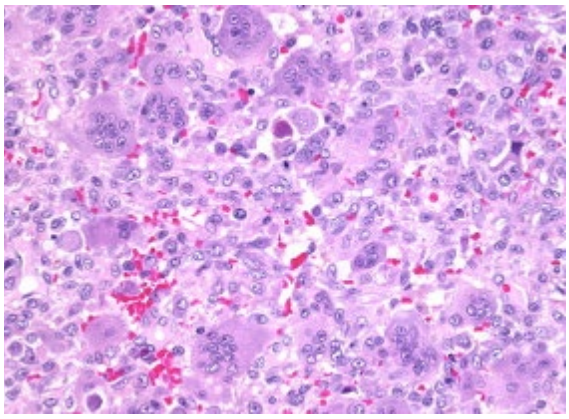

Figure 8 H&E stain microscopic stain showing numerous multinucleated giant cells scattered the entire stroma in the background of mononuclear cells.

At 3 months after surgery, the range of motion was almost full and pain-free. A thorough examination of the hand showed that 20 degrees of flexion deficit with full extension of the metacarpophalangeal joint and the range of motion of metacarpophalangeal joint were 0–70 degrees in active movement and 0 – 80 degrees in passive movement (Figure 9). The patient was assessed using DASH outcome measure[4] and achieved 30 points, which represents mild disability.

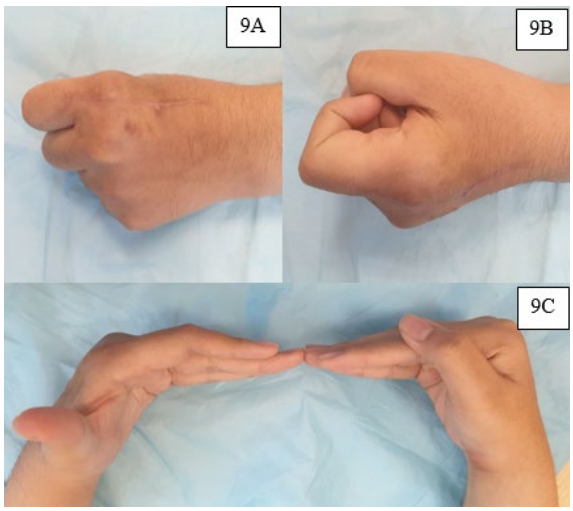

Figure 9 9A, 9B, 9C state the functional status of the left hand at three months follow-up

The patient was able to perform well with ease in spherical, hook, cylindrical, power tool, pinch, and tripod grasping. The patient also was able to ambulate, stand and run well with a well-healed surgical scar of the left foot donor site. No local and metastasis detected during follow-up.

DISCUSSION

GCT of bone comprises 20 percent of benign bone tumours. It is commonly seen in young adults between 20 to 40 years. It occurs more predominantly in females, unlike most of the other bone tumours which show male predominance. GCT of the bone affecting the hand is rare and is usually detected and diagnosed at an advanced stage with extensive bone destruction with the high recurrent rate (Matev et al., 2012). The phalanges and metacarpals are the usual site of the origin in hand. Detailed clinical evaluation, imaging studies, and histopathological investigation are required to obtain an accurate diagnosis.

GCT of bone is a distinctive neoplasm of undifferentiated cells. It is not a tumour comprising of proliferating osteoclasts or precursors of osteoclasts. The cytokine environment coupled with tumourigenic gene expression leading neoplastic GCT stromal cells a failure to differentiate into osteoblasts. The stromal cells induce a chain of osteoclastogenesis by the recruitment of osteoclasts precursors and supplying pro-osteoclastogenic cytokines (Kim et al., 2012). Pain is the chief symptom, which is related to bony destruction leading to mechanical insufficiency. A mass can be seen occasionally when the tumour progresses outside the bone or cortical destruction.

The typical radiological finding of giant cell tumors includes a well-defined lytic lesion. It is usually eccentrically located in the meta-epiphyseal region of the long bone; however, it tends to affect the central portion of the

bone when present in the hand. No periosteal reaction is seen in GCT, and the cortex is thinned (McEnery et al., 1999). Matev et al. (2012) classified it into three grades: Grade 1 shows cortical involvement minimally; Grade 2 has bulged and thinned cortex of the affected bone, whereas Grade 3 presents with the breaching of the involved cortex with soft tissue extension. Computed tomography (CT) and magnetic resonance imaging (MRI) is vital in staging and evaluating of giant cell tumour of bone. MRI proves to be more potent than CT in case of any cortical breach and soft tissue extension and also useful in detecting the fluid level, which is typical for an aneurysmal bone cyst (ABC) as its differential diagnosis (Matev et al., 2012).

Various treatment modalities were discussed and described in the literature, such as bone curettage with or without bone grafting, ray amputation, and en bloc resection with reconstruction of the affected bone. In grade 1 or 2 of GCT of bone, the standard proposed treatment modalities such as intralesional curettage and packing the cavity with bone graft; however, intralesional curettage is no longer recommended as it carries a high recurrent rate up to 90 percent (Williams et al., 2010). In grade 3 GCT of bone, en bloc resection is advocated to reduce the recurrent risk. A more technically demanding surgical treatment modality was described by Kotwal PP et al. in the year 2008 by using vascularized joint transfer for the giant cell tumor management (Kotwal et al., 2008).

As the GCT of the hand is aggressive, en bloc resection is the preferred method to prevent the recurrence. Several modalities were described in the reconstruction of the removed metacarpal bone; autografting with metatarsal bone, vascularized or non-vascularized fibular graft, silicone end prosthesis and iliac crest graft. Al Bayati MA et al. (2017) recommended the autotransplant of metatarsal bone for the destruction of the metacarpal bone with GCT with satisfactory function and cosmoses. Saikat (2016) also used the metatarsal bone to replace the GCT metacarpal bone with promising functional results.

In this case, en bloc resection of second metacarpal bone with autograft replacement was used to prevent the high recurrent rate of GCT of bone in hand without compromising much of the hand functionality and cosmetic appearance. The reconstruction of metacarpophalangeal joints involving an osteoarticular ligamentous complex of metatarsal transfer by suturing the capsule and ligaments of the donor's bone to the proximal phalanx is being presumed that the synovial membrane of the proximal phalanx would provide ample nutrition to the cartilage of the transferred metatarsal head to guarantee its survivability.

The usage of miniplate for the fusion of the carpometacarpal joint was unable to achieve as the patient's trapezoid bone was too small for the miniplate fixation. Therefore, the fusion was achieved by modifying the miniplate into the V-shaped plate and the fuse inter-metacarpal without compromising the cascade and the function of the hand. We described this technique as despite it being more technically demanding, the outcome in terms of function and cosmosis outweigh the previous treatment modalities (Maini et al., 2011).

CONCLUSION

The transfer of osteoarticular ligamentous complex of the third metatarsal bone for the reconstruction of the second metacarpal bone defects is a possible operative procedure that provides good cosmetic and excellent functional outcomes while not compromising the donor's foot function.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this article.

CONSENTS

Written informed consent was obtained from the patient to publish the case with its related pictures. A copy of the written consent is available for review by the Chief Editor.

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