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Nonvascularized Iliac Crest Autograft for Wrist and Hand Reconstructions: A Report of Two Clinical Cases and Literature Review

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Learning Point of the Article:

Non-vascularized iliac crest autograft is a reliable, single-stage solution for restoring anatomy and function in selected hand and wrist bone defects.

Abstract

Introduction: Bone defects of the hand and wrist may result from trauma or tumor resection and represent a reconstructive challenge due to the complex anatomy and functional demands of this region. Autologous bone grafting is commonly used to restore bone stock and preserve hand and wrist function.

Case Report: Two patients with distal radius and carpal bone defects were treated using non-vascularized iliac crest autograft. Patient 1 sustained a high-energy motorcycle accident resulting in an open distal radius fracture with significant metaphyseal bone loss, managed with definitive osteosynthesis and iliac crest autografting. Patient 2 presented with a locally aggressive midcarpal bone tumor; following wide resection, the defect was reconstructed through carpal arthrodesis using the same autograft. At final follow-up, both patients were pain free and able to perform full activities of daily living.

Conclusion: In selected cases, non-vascularized iliac crest autograft allows effective reconstruction of hand and wrist bone defects, providing stable bone healing, pain relief, and satisfactory functional outcomes.

Keywords: Iliac crest autograft, hand and wrist reconstruction, bone defects, distal radius fracture.

Introduction

Hand and wrist bony defects can occur after trauma or be secondary to a specific disease, either by a tumor, infection, or idiopathic avascular necrosis. The complex anatomy of the hand and wrist represents a challenge for the orthopedic surgeon as to restore the size and shape of the defect and reestablish the normal kinematics of the joints [1].

Autologous bone grafts have been used for several years to replace hand and wrist bony defects. Choosing the right graft to restore the anatomy in the distal upper limb depends on several factors. Bone characteristics, including shape, size, and structural properties, past surgeries, or trauma around the defect, can influence the local conditions and affect the graft choice. In addition, we should provide the minimal donor site morbidity [2,3].

Iliac bone crest graft in hand surgery reconstruction was first described by Wilson and Lance in 1965 [4]. It was defined as a safe option with a low rate of clinical complications, having adequate biomechanical properties and fibrocartilage ability [5].

We present immediate bone autografting in two patients with secondary hand and wrist bone defects in different clinical scenarios, where iliac crest autograft was used to reconstruct the

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Author's Photo Gallery


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Figure 1: X-rays of the right distal radius open fracture with a significant loss of the meta-epiphyseal bone in anterior-posterior (a) and lateral (b) views. The defect measured was approximately 36.7 × 23.6 mm.

anatomy. Functional outcomes were recorded, including the Visual Analog Scale (VAS) score at rest to measure pain intensity, the disabilities of the Arm, Shoulder, and Hand (quick DASH) score, and the patient-rated wrist evaluation (PRWE) score. Subsequently, a brief literature review will be conducted based on the two clinical cases.

Methods

We present a 37-year-old male patient (Patient 1) with a right distal radius open fracture (Gustilo and Anderson grade IIIA) [6] after a high-energy motorcycle accident. Radiographs showed a complex distal radius fracture with a significant meta-epiphyseal bone loss (Fig. 1a and b). The defect was measured as 36.7 × 23.6 mm. Despite an unaffected radial styloid, part of the scaphoid facet was affected, together with a major defect at the lunate facet. Primary surgery consisted of stabilization with an external fixator (Fig. 2a and b), and 8 days after the accident, the patient underwent definitive osteosynthesis with an iliac crest bone graft to fill the meta-epiphyseal defect (Fig. 3a and b). At 2-year follow-up, bony fusion was achieved, with the patient presenting a slight depression within the lunate facet area (Fig. 3c and d). An acceptable range of motion was observed (flexion 85°, extension 30°, complete prono-supination), with a VAS score of 1, quick DASH score of 15.9, and PRWE of 30.5. This patient presented no limitations for daily living activities, including recreational sports.

A 68-year-old male patient presented to us with a left midcarpal bone tumor originating from the trapezoid bone with more than 1 year of evolution (Fig. 4a and b). The clinical behavior and magnetic resonance imaging were consistent with a locally aggressive bone tumor, with a core needle biopsy showing features supporting osteoblastoma diagnosis (Fig. 4 c, d and e). After discussion at the bone tumor multidisciplinary meeting, we promoted a tumor-wide resection, which caused a significant bone defect (30.7 × 27.2 mm). As such, our reconstructive strategy was based on a carpal arthrodesis (lunate-hamate-second and third metacarpal) using an iliac crest autograft (Fig. 5a and b). With almost 2 years of follow-up, bony fusion was achieved, with the patient presenting a moderate wrist motion (15° of flexion, 20° extension, complete prono-supination), no finger movement restriction, VAS score of 0, quick DASH score of 15.9, and PRWE of 24, being able to perform all daily living activities.

Discussion

In recent decades, advances in the treatment of hand and wrist bone defects have significantly influenced how surgeons approach these injuries, especially with a growing trend towards limb preservation, even in cases of substantial defects [7,8].

Non-vascularized iliac crest autograft has been described as an efficient and reliable procedure to fill bone defects in hand and wrist surgery [9]. Iliac crest bone grafts are a rich source of growth factors with a wide surface area, allowing bone formation and fast incorporation into the host site. It is relatively

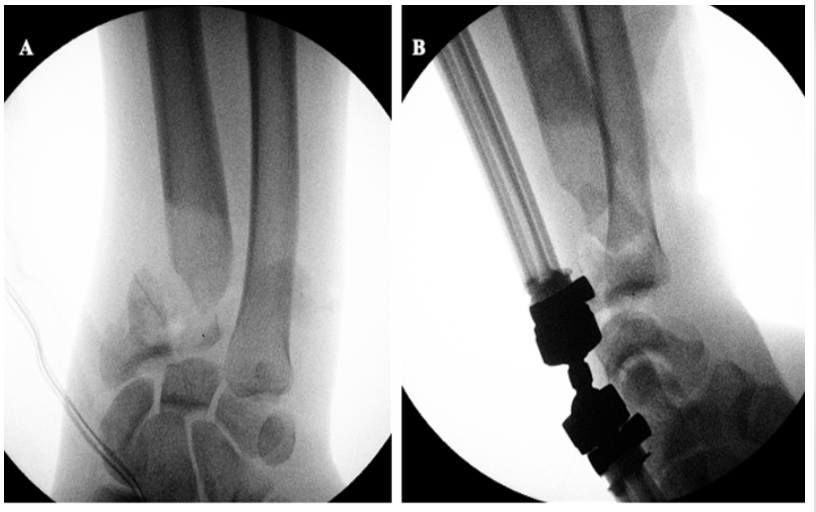

Figure 2: Intra-operative X-rays of the distal radius fracture primary stabilization using an external fixator. Anterior-posterior (a) and lateral (b) views.

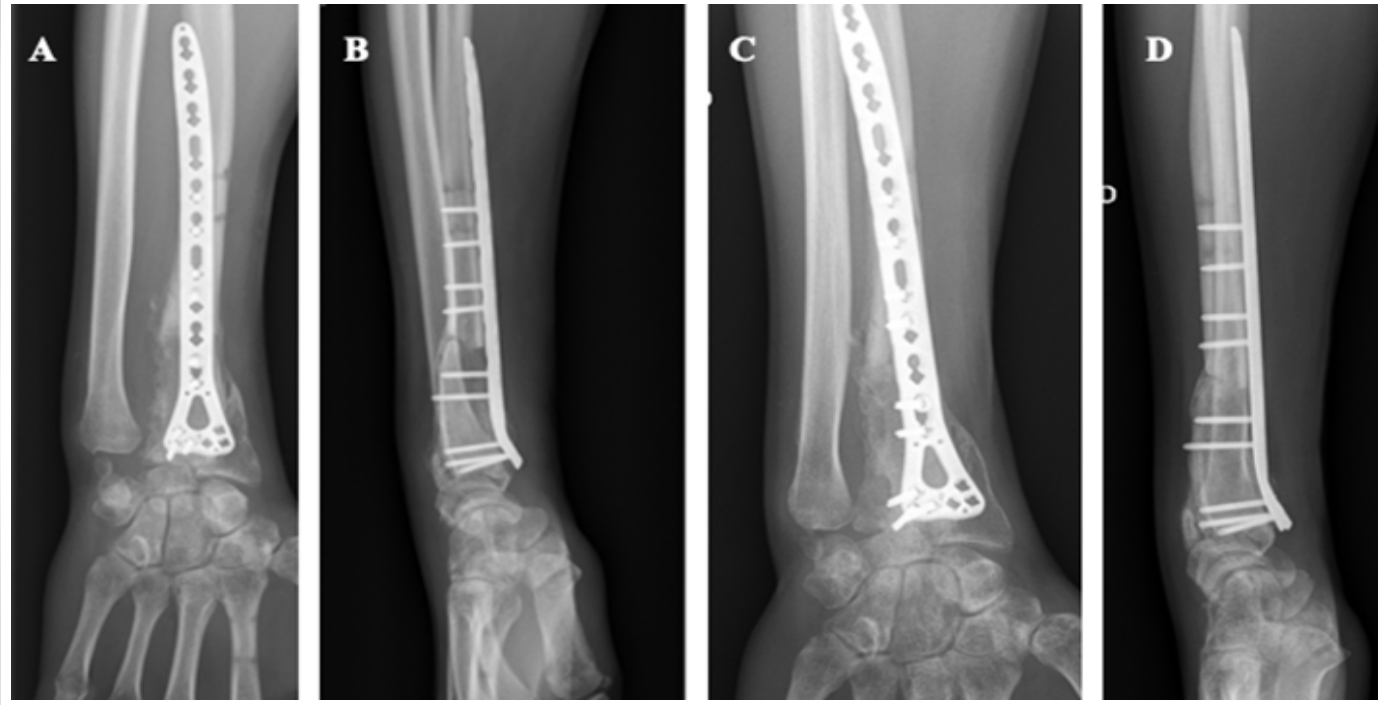

Figure 3: Anterior-posterior (a) and lateral (b) X-ray views 3 months after definitive distal radius fracture osteosynthesis with iliac crest bone graft. Equivalent X-rays presenting anterior-posterior (c) and lateral (d) views 2 years after definitive fixation.

easy and rapid to harvest a generous amount of bone with limited donor site morbidity [10,11]. Sen and Miclau reviewed the advantages of using iliac crest bone graft and suggested that it is the most cost-effective graft, especially to treat non-unions, due to unique osteogenic, osteoinductive, and osteoconductive characteristics [10]. Mehta et al., compared the intrinsic stem cell-like properties of the iliac crest and distal radius bone grafts and concluded that the iliac crest bone graft demonstrated a higher fibroblast colony-forming unit capacity and an increased capability to undergo both osteogenesis and adipogenesis [11].

Despite the well-known advantages of vascularized bone grafts, such as faster integration, less bone resorption, and better fracture healing potential, literature reports similar functional outcomes including pain and joint range of motion, compared with non-vascularized bone grafts when approaching limited bone defects [9,12]. Vascularized grafts might be advantageous in bigger defects although the literature is not consistent with the size limit for which these autografts are recommended. Some studies suggest a threshold of 5 cm, others between 6 and 7 cm [12,13]. Clarkson et al. studied 27 patients who underwent wrist arthrodesis after resection of a giant cell tumor of the distal radius using a vascularized free fibular graft or a non-vascularized structural iliac crest autograft. They concluded that although both techniques were effective

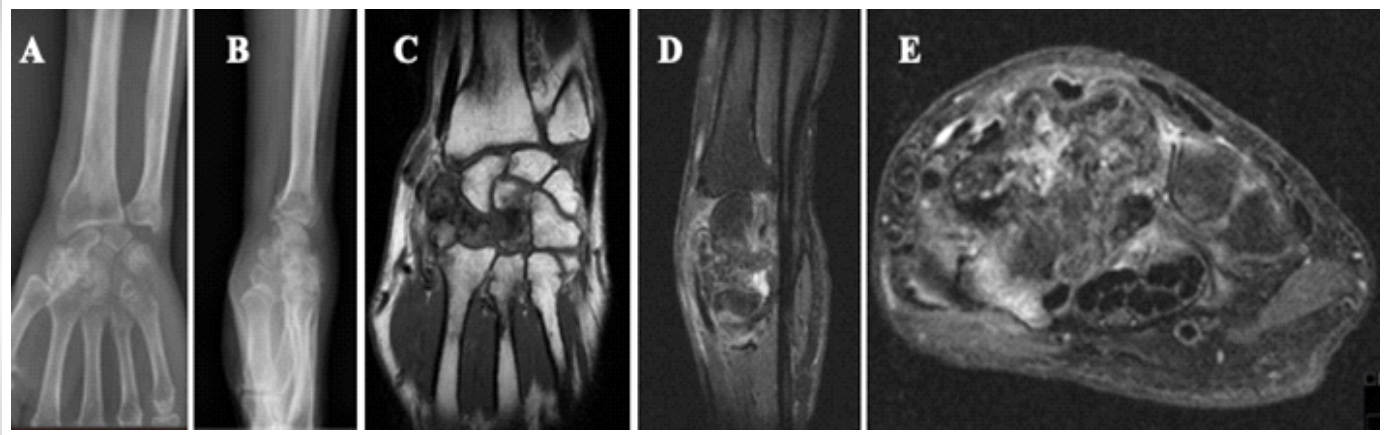

Figure 4: Anterior-posterior (a) and lateral (b) X-ray views presenting a locally aggressive carpal bone tumor; T1-weighted coronal image showing a bone tumor within the trapezium, trapezoid, and capitate areas (c); T1 fat-saturation-weighted sagittal (d) and axial (e) images of the same tumor and anatomical relations.

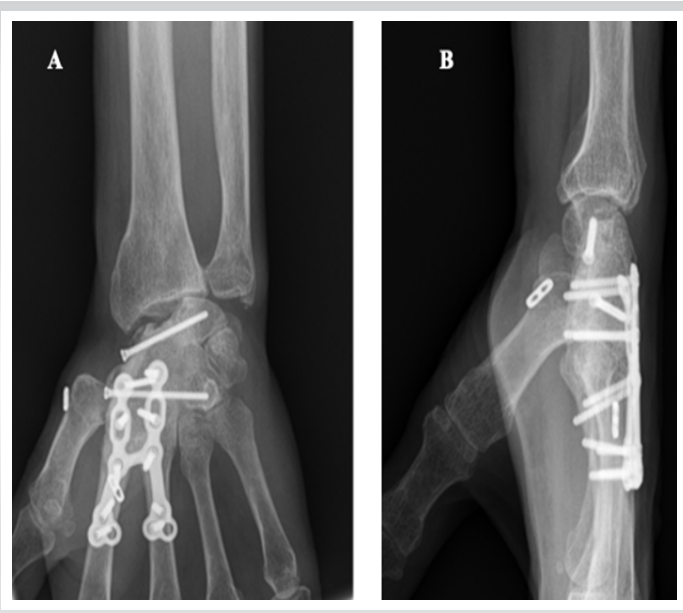

Figure 5: Anterior-posterior (a) and lateral (b) views of X-rays at final follow-up after tumor resection and carpal arthrodesis (lunate-hamate-second and third metacarpal) using an iliac crest autograft.

regarding wrist functional outcomes, vascularized free fibular transfer should be considered only when a major skin defect is anticipated, allowing the inclusion of a vascularized skin paddle, or when the osseous defect is longer than 10 cm [14]. Furthermore, a systematic review by Allsopp et al. concluded that there was insufficient data to establish a relationship between the length of the graft and the need for vascular supply [15].

Furthermore, surgical and post-operative complications related to vascularized bone graft techniques must be considered, which favor non-vascularized bone grafts when treating small defects, such as the ones usually occurring within the wrist and hand [16,17]. Ebad Ali et al. performed a systematic review reporting functional outcomes of reconstruction after resection of bone tumors with both types of autografts. Although reporting quicker bone union and earlier recovery with vascularized grafts, functional outcomes remained the same in both groups, considering pain, range of motion, load-carrying abilities, and other social activities [18].

In both our cases, the graft allowed us to restore the anatomy of the upper limb, restoring the length and stabilizing the distal radial and carpal structures, with a pain-free result. The choice for an iliac crest autograft to reconstruct the distal radius defect in Patient 1 was based on the ability to provide fast restoration of the anatomic configuration, in the best possible way. The major handicap for this strategy relied on the absence of cartilage to replace the lost lunar articular surface. Nonetheless, there are limited options to provide a better reconstruction, namely with a fresh osteo-cartilaginous allograft, which is hard to obtain in our daily practice. Taking all together, the iliac crest graft and its intrinsic characteristics were favorable to bone consolidation and a stable osteosynthesis, which were paramount in this scenario.

In similar fashion, the limited defect presented by patient 2 after tumor resection was well reconstructed using an iliac crest autograft. Hand anatomic configuration was immediately restored, and despite the carpal fusion, there was an opportunity to maintain partial motion of the radio-carpal articulation. At the same time, a fast hand and wrist grip strength recovery, with no pain, was achieved.

Immediate surgical reconstruction with bone autograft is recommended; in both cases, we chose a single-stage approach [19]. Primary osteosynthesis and immediate cortico-cancellous bone grafting are a reliable option to restore anatomy and preserve bone length (keeping muscles and ligaments under normal tension), thus reducing the risk of contracture and providing decent cosmetic and functional results [20,21]. For both cases that was the strategy followed, which was always supported by a stable osteosynthesis, that provided minimal post-operative period casting, and early rehabilitation[2.1]. This fact is particularly important, since it will facilitate early return to work, reduce medical expenses, and minimize patient financial burden.

Conclusion

Non-vascularized bone graft from the iliac crest is a safe, reliable, and reproducible option to treat hand and wrist bone defects in different clinical scenarios. In addition, iliac crest autografts have a low rate of donor site morbidity, allowing fast osteointegration and mechanical stability.

Clinical Message

Non-vascularized iliac crest autograft is an effective single-stage option for selected hand and wrist bone defects, allowing anatomical restoration and functional recovery.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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