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(CASE REPORT)

Plantar osteochondroma of the metatarsal bone: A case report and brief literature review

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Abstract

Osteochondromas are the most common benign bone tumors, typically arising from the metaphysis of long bones during skeletal development; however, their occurrence in the small bones of the foot, particularly the metatarsals, is exceedingly rare. We report the case of a 32-year-old female who presented with a seven-month history of a slowly enlarging, firm plantar mass and progressive mechanical pain along the medial arch of the left foot. Radiographic and cross-sectional imaging demonstrated a sessile osteochondroma arising from the plantar-medial aspect of the second metatarsal neck, exhibiting the pathognomonic corticomedullary continuity with the host bone and an 8-millimeter cartilaginous cap without aggressive features.

Following multidisciplinary tumor board review, the patient underwent marginal en bloc excision through a plantar-medial approach, resulting in complete resolution of symptoms at twelve months postoperatively. Histopathological and molecular studies confirmed the benign nature of the lesion and definitively excluded its principal mimickers, including bizarre parosteal osteochondromatous proliferation.

This case illustrates that osteochondroma should be considered in the differential diagnosis of chronic plantar foot pain in adults, even in the absence of hereditary multiple exostoses. It further emphasizes the indispensable role of multimodal imaging, multidisciplinary evaluation, and meticulous surgical planning in achieving safe and durable functional recovery.

Keywords: Osteochondroma; Planter; Metatarsal; Cartilaginous cap; Solitary

1. Introduction

Osteochondromas represent the most frequently observed benign bone tumors, typically occurring at the metaphyseal sites of long bones. [1] Nevertheless, the occurrence of such tumors in the short tubular bones of the foot is exceedingly uncommon, particularly in the plantar-medial portion of a metatarsal neck. [2]

Lesions on the plantar side are especially difficult to diagnose and manage. [3] As the plantar surface sustains primary loads during ambulation, even relatively small benign bony masses may cause considerable mechanical pain, inability to wear shoes, and difficulties with gait. [4,5,6] Diagnostically, these lesions may be easily overlooked or mistaken for more common plantar conditions. [2,6] Moreover, differential diagnosis with aggressive surface lesions, including

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periosteal chondromas, Nora's lesions, and low-grade parosteal osteosarcomas, poses special challenges in radiology and histopathology. [7]

We report this case to highlight the diagnostic dilemma posed by the uncommon location of osteochondroma, demonstrate the usefulness of multiplanar imaging in establishing the pathognomonic corticomedullary continuity, and describe the multidisciplinary strategy needed for a successful outcome without a preoperative biopsy.

2. Case Presentation

2.1. Clinical Presentation

A healthy 32-year-old female presented with a 7-month history of a slowly enlarging, firm mass along the plantar arch of her left foot. She initially noticed a vague, pressure-like discomfort only when wearing thin-soled shoes, which she managed by switching to stiff-soled sneakers and using over-the-counter metatarsal pads. Over the three months prior to her visit, the pain worsened to a sharp, pinching sensation during push-off in gait, forcing her to stop walking altogether. She sought medical attention after developing a mild limp and the inability to wear closed-toe shoes due to direct pressure on the now-palpable bony protrusion.

2.2. Physical Examination, History, Labs, and Differential Diagnosis

On physical examination, the patient stood with visible offloading of the left forefoot. Palpation of the plantar-medial arch revealed a hard, non-mobile, non-tender osseous prominence just proximal to the second metatarsal head. There was no warmth, erythema, or overlying skin changes. The range of motion of the second metatarsophalangeal joint was mildly restricted in plantarflexion, with a palpable "block" sensation. No neurological deficits or vascular compromise were noted. The patient denied any personal history of hereditary multiple exostoses, though a paternal uncle had a single known osteochondroma of the distal femur. Routine laboratory studies, including complete blood count, inflammatory markers (ESR, CRP), and serum alkaline phosphatase, were all within normal limits.

Radiographs of the left foot were obtained first, followed by CT and MRI. The imaging demonstrated a sessile osteochondroma arising from the plantar-medial aspect of the second metatarsal neck, with flawless corticomedullary continuity between the host bone and the lesion. The cartilaginous cap measured up to eight millimeters in thickness on the T2 fat-sat sequence, appearing hyperintense without aggressive features. (**Figure 1 A, B, C, D, E**) The clinical differential diagnosis included a bizarre parosteal osteochondromatous proliferation (Nora's lesion), a periosteal chondroma, and a florid reactive periostitis. The radiologic differential diagnosis also included a solitary osteochondroma (favored given the direct marrow continuity), a subungual-type exostosis (excluded by location), and a low-grade parosteal osteosarcoma (considered due to the lobulated contour but rejected due to intact cortical continuity and absence of soft-tissue invasion).

2.3. Multidisciplinary Tumor Board Discussion and Management Decision

The multidisciplinary tumor board, comprising a musculoskeletal radiologist, orthopedic oncologist, pathologist, and a foot and ankle surgeon, reviewed the case with the detailed CT and MRI findings. The discussion centered on two key questions: first, whether the thickness of the cartilaginous cap warranted concern for malignant transformation; and second, whether the patient's mechanical symptoms justified surgical excision rather than conservative management. The radiologist emphasized that the cap was uniformly thin, lacked irregular margins, and showed no adjacent soft-tissue mass or edema beyond mild adventitial bursitis. The orthopedic oncologist noted that although symptomatic plantar osteochondromas are rare, the persistent gait disturbance and shoe intolerance indicated functional impairment.

The team unanimously agreed that the lesion was unequivocally benign and that no biopsy was required prior to treatment. The consensus management decision was a planned marginal excision of the osteochondroma through a plantar-medial approach, with intraoperative care to protect the medial plantar nerve and the flexor tendons. The recommended next step was to schedule the patient for elective surgical excision with a three-week postoperative period of protected weight-bearing.

2.4. Special Studies, Pathology, Immunohistochemistry, and Molecular Studies

Intraoperatively, the exostosis was exposed and found to have a glistening, pearly white cartilaginous cap. The lesion was excised en bloc at its base, preserving the underlying host cortical bone of the second metatarsal. Gross pathology showed a lobulated osseous stalk capped by hyaline cartilage. Histologic examination revealed mature trabecular bone

with fatty marrow continuity into the stalk, overlaid by benign hyaline cartilage arranged in columns perpendicular to the underlying bone. The chondrocytes were small, uniform, with single nuclei and no binucleation or pleomorphism. The cartilage cap showed a well-defined tidemark and lamellar bone formation at the zone of provisional calcification. No atypical mitotic figures, necrosis, or myxoid change were identified. (**Figure 2 A, B, C**)

Immunohistochemistry (IHC) was not clinically indicated for diagnostic confirmation, but routine stains (H&E) were supplemented with S100 protein, which highlighted the benign chondrocytes in a diffuse, non-atypical pattern. Molecular studies were performed for completeness and showed no evidence of *EXT1* or *EXT2* mutations, ruling out hereditary multiple exostoses in this sporadic presentation. Fluorescence in situ hybridization (FISH) was negative for rearrangements involving *USP6*, effectively excluding a bizarre parosteal osteochondromatous proliferation.

Following three weeks of protected weight-bearing after the excision, the patient noted progressive pain relief as the wound healed and subsequently initiated physical therapy. At the 12-month postoperative visit, the patient reported being able to walk comfortably and to wear shoes with greater ease.

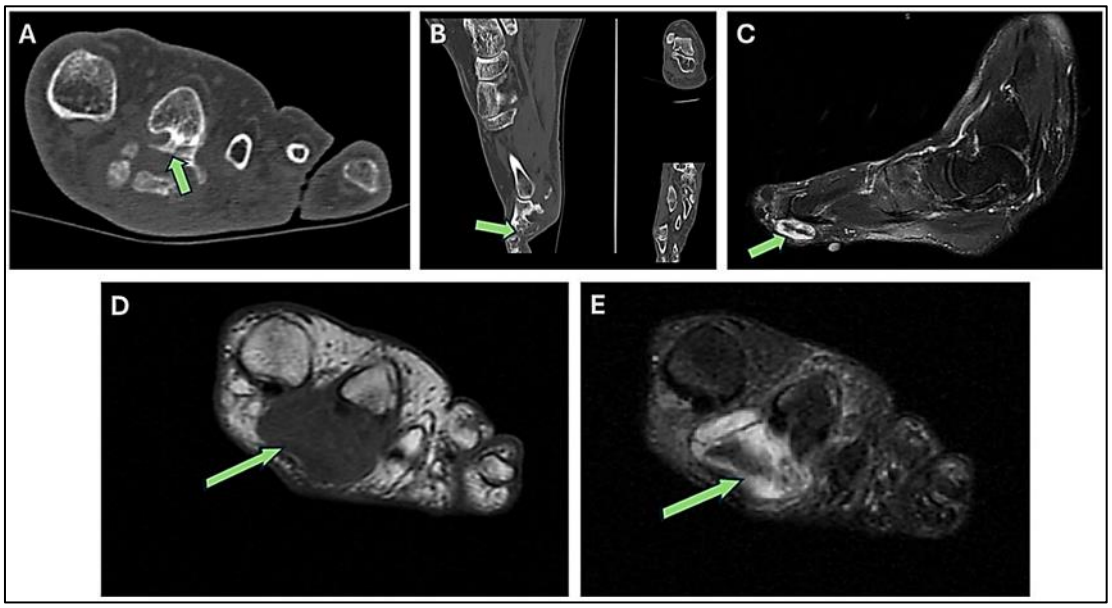
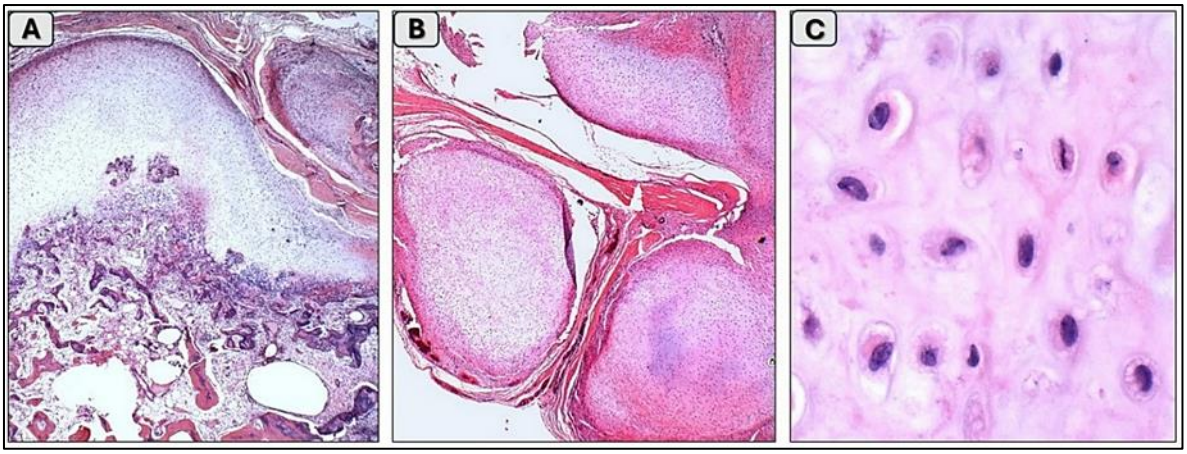


Figure 1 Radiographic images of planter osteochondroma

The imaging demonstrated a sessile osteochondroma (Green arrow) arising from the plantar-medial aspect of the second metatarsal neck, with flawless corticomedullary continuity between the host bone and the lesion. The cartilaginous cap measured up to eight millimeters in thickness on the T2 fat-sat sequence, appearing hyperintense without aggressive features

- **1A:** Axial CT
- **1B:** Multiplanar reconstruction CT (Axial, sagittal, and coronal)
- **1C:** Sagittal T2
- **1D**: Axial T1
- **1E**: Axial T2



2A: Low-power view showing a lobulated osseous stalk capped by hyaline cartilage (H&E X20); **2B:** Intermediate power view showing lobules of hyaline cartilage (H&E X40); **2C:** High power view showing small, uniform chondrocytes with single nuclei and no binucleation, atypical mitosis, or pleomorphism (H&E X60)

Figure 2 Microscopic features of planter osteochondroma

3. Discussion

3.1. Background (History, epidemiology, risk factors, and WHO classification):

Osteochondroma is formally classified by the 2020 World Health Organization (WHO) fifth edition as a benign chondrogenic tumor, representing the most prevalent primary benign osseous neoplasm and accounting for 20% to 50% of all benign bone tumors and approximately 9% of all bone tumors combined. [8,9,10]

Pathophysiologically, the lesion is believed to arise from displaced growth plate cartilage that undergoes endochondral ossification beneath the periosteum, producing a bony projection capped by hyaline cartilage. [9,11] The defining pathognomonic feature is the uninterrupted continuity of the lesion's cortical and medullary bone with the underlying host bone. This finding is both diagnostically confirmatory and distinguishes osteochondromas from their principal mimickers. [10,11]

Solitary osteochondromas predominantly affect the metaphysis of the distal femur (approximately 30%), proximal tibia (15–20%), and proximal humerus (10–20%), with roughly 75% of all lesions presenting before the age of 20 years and a recognized male predominance. [9,11] Involvement of the foot and ankle is uncommon, representing approximately 10% of all cases, and localization specifically to the metatarsals is exceedingly rare, with only sporadic case reports documented in the literature. [12,13] Approximately 85% of osteochondromas present as solitary, sporadic lesions, while the remaining 15% occur in the context of hereditary multiple exostoses (HME), an autosomal dominant syndrome arising from loss-of-function mutations in the EXT1 and EXT2 tumor suppressor genes, which encode glycosyltransferases essential for heparan sulfate proteoglycan synthesis. [9,14]

Although the majority of osteochondromas are asymptomatic, those arising in weight-bearing regions, such as the plantar surface of the foot, can cause significant morbidity by mechanically compressing adjacent tendons, nerves, and soft-tissues, ultimately necessitating surgical intervention. [9,12]

3.2. Comparative Analysis of Our Case with Existing Literature, and What Have We Learned from This Case?

The occurrence of a solitary osteochondroma on the plantar surface of a metatarsal in a skeletally mature adult is an exceptionally rare clinical entity, and a review of the published literature reveals only a small number of analogous cases, the majority of which involve pediatric or adolescent patients. Alhuzaimi et al. reported an intermetatarsal osteochondroma in a 10-year-old boy who presented with a 2-year history of dorsal foot pain refractory to conservative treatment, with radiographic findings demonstrating a bony mass extending from the medial cuneiform to the first metatarsal, resulting in intermetatarsal widening. [12] Similarly, Laliotis described two distinct solitary osteochondromas involving the first metatarsal and medial cuneiform in a 13-year-old athlete, both of which required surgical excision to relieve plantar pain and restore sporting function. [13] These pediatric cases share the fundamental diagnostic and surgical principles outlined in our report; however, the presentation in our 32-year-old patient is notably

distinct, as new symptomatic growth of an osteochondroma after skeletal maturity is atypical, and any enlargement in an adult should prompt heightened vigilance for malignant transformation. [11,13]

A central diagnostic lesson from this case concerns the assessment of the cartilaginous cap. According to the established literature, a cap thickness exceeding 2 centimeters in adults is considered highly suspicious for secondary transformation to chondrosarcoma. In contrast, a cap below this threshold, as observed in our patient at 8 millimeters, is consistent with benign behavior. [11,14] Nevertheless, the multidisciplinary tumor board appropriately scrutinized this measurement, given that the lesion was located in an atypical site and the patient was a skeletally mature adult. This deliberate approach reflects an important clinical red flag: the anatomic location of a lesion, not merely its cap thickness, should govern the threshold for multidisciplinary review. The successful exclusion of bizarre parosteal osteochondromatous proliferation (Nora's lesion) via negative FISH for USP6 rearrangement and the confirmation of true medullary continuity on imaging further illustrate the diagnostic precision required when evaluating parosteal ossifying lesions in the acral skeleton. [7]

From a management perspective, this case reinforces the consensus that symptomatic pedal osteochondromas warrant surgical excision rather than prolonged conservative observation when functional impairment is present. The marginal en bloc excision performed in our case, with careful preservation of the medial plantar nerve and flexor tendons, resulted in complete symptom resolution at twelve months, consistent with the favorable outcomes reported in analogous cases in the literature [12,13]

The case further highlights that the primary indication for surgery in metatarsal osteochondromas is not the concern of malignant transformation, which carries a risk of less than 1% in solitary lesions, but rather the profound mechanical impairment imposed by the lesion's plantar location. [14] For future clinical practice, this case advocates a low threshold for including osteochondroma in the differential diagnosis of any firm, bony plantar mass, even in adult patients without a family history of HME. It underscores the indispensable role of a structured multidisciplinary tumor board in guiding management decisions for rare osseous foot lesions.

4. Conclusion

This case presents a rare instance of a symptomatic plantar osteochondroma arising from the second metatarsal neck in a skeletally mature adult, adding a valuable contribution to the limited literature on metatarsal osteochondromas. The principal value of this report for the medical community lies in its demonstration that osteochondroma, though uncommon in the foot, must be considered in the differential diagnosis of any firm, progressive plantar mass in an adult, irrespective of the absence of hereditary multiple exostoses.

This case further illustrates that a structured, multidisciplinary tumor board approach integrating musculoskeletal radiology, orthopedic pathology, orthopedic oncology, and foot and ankle is essential for navigating the complex differential diagnosis of parosteal ossifying lesions and determining the optimal surgical strategy. Ultimately, complete marginal excision with meticulous protection of plantar neurovascular structures remains the definitive treatment, offering durable symptom relief and full functional restoration, as evidenced by our patient's complete recovery at twelve months.

Compliance with ethical standards

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All authors make the following declarations:

- Payment/services information: All authors have declared that they received no financial support from any organization for the submitted work.

- Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might be interested in the submitted work.

Statement of informed consent

Informed consent for the publication of this case was obtained from the patient.

Data access statement

All relevant data are included in the paper.

Author contributions

All authors contributed equally to producing this manuscript.

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