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Enchondroma: A Comprehensive Guide to a Common Benign Bone Tumor

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Abstract

Medication-related osteonecrosis of the jaw (MRONJ) is a challenging complication associated with antiresorptive and antiangiogenic medications. Traditional treatment approaches often involve extensive surgical interventions, which can be associated with significant morbidity. Recently, photobiomodulation (PBM) has emerged as a promising adjunct in MRONJ management, leveraging its anti-inflammatory, analgesic, and tissue regenerative properties. This review explores the synergistic use of PBM with minimal surgical interventions, highlighting its potential to promote healing while reducing treatment invasiveness. Clinical studies, biological mechanisms, and future perspectives on integrating PBM into MRONJ protocols are discussed.

Introduction

Enchondromas are among the most common benign bone tumors, accounting for 10–25% of all benign skeletal lesions [1]. These tumors arise from hyaline cartilage remnants in the medullary cavity, often discovered incidentally during imaging for unrelated conditions. Although benign, their clinical significance lies in their potential for complications, including pathological fractures and, in rare cases, malignant transformation into chondrosarcoma. Understanding the natural history and clinical implications of enchondromas is crucial for appropriate management. This article aims to provide a detailed guide to enchondromas, addressing their diagnosis, management, and recent advancements in the field [2].

Pathophysiology and Epidemiology

Enchondromas are thought to originate from aberrant cartilage growth during endochondral ossification. They commonly occur in the metaphyses of long bones, with the small bones of the hands and feet being the most frequently affected sites [3].

Epidemiology:

- Peak incidence: 20–40 years of age.
- No significant gender predilection.
- Associated syndromes: Ollier disease (multiple enchondromas) and Maffucci syndrome (enchondromas with hemangiomas) [4].

Clinical Presentation

- **Asymptomatic Lesions**: Most enchondromas are incidental findings.
- **Symptomatic Lesions**:
  - Pain or swelling due to tumor growth or pathological fracture.
  - Deformities, especially in cases of multiple enchondromatosis.
- **Red Flags for Malignant Transformation**: Persistent pain, lesion growth, and cortical destruction on imaging may signal malignancy [5].

Diagnosis

Imaging

- **X-Ray**: Enchondromas appear as well-defined, lytic lesions with chondroid matrix calcifications ("popcorn" or "rings and arcs" patterns).
- **MRI**: Useful for delineating lesion extent and evaluating associated soft tissue involvement. Characterized by high T2 signal due to cartilage content [6].
- **CT Scan**: Excellent for assessing calcifications and cortical integrity.
- **PET-CT**: Limited utility in distinguishing benign enchondromas from low-grade chondrosarcomas due to overlapping metabolic activity.

Histopathology

- Features: Hyaline cartilage lobules with minimal atypia, surrounded by reactive bone.
- Differential Diagnosis: Requires distinction from low-grade chondrosarcoma, particularly in cases with cellular atypia or invasive growth patterns [7].

Molecular and Genetic Analysis

- **IDH1/IDH2 Mutations**: Found in a significant proportion of enchondromas and low-grade chondrosarcomas, aiding in diagnosis and understanding tumorigenesis.

Treatment Approaches

Observation

- Indicated for asymptomatic lesions without concerning imaging features.
- Routine follow-up with imaging to monitor for growth or changes.

Surgical Intervention

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- **Indications**: Symptomatic lesions, fractures, deformities, or suspicion of malignancy [8].
- **Techniques**:
  - **Curettage**: Standard treatment for symptomatic lesions, often combined with bone grafting or cement filling.
  - **En Bloc Resection**: Reserved for lesions with aggressive behavior or concerning histological features.

Management of Complications

- Pathological fractures are managed with immobilization, followed by delayed curettage if necessary.

Prognosis and Follow-Up

- Most enchondromas have an excellent prognosis, with rare recurrence after complete surgical excision.
- **Follow-Up Protocols**:
  - Annual imaging for asymptomatic lesions [9].
  - Closer monitoring for syndromic cases (e.g., Ollier disease) due to higher malignancy risk.

Challenges in Diagnosis and Management

- **Distinguishing Enchondroma from Chondrosarcoma**: Overlapping clinical and imaging features necessitate a multidisciplinary approach involving radiologists, pathologists, and orthopedic oncologists.
- **Treatment of Multiple Enchondromatosis**: Balancing intervention for symptomatic lesions while minimizing unnecessary surgeries.

Recent Advances and Future Directions

- **Molecular Insights**: Targeting IDH mutations offers potential for novel therapeutic strategies.
- **Minimally Invasive Techniques**: Percutaneous procedures like radiofrequency ablation are being explored for symptomatic small lesions.
- **Artificial Intelligence in Imaging**: Machine learning algorithms are under investigation for improving diagnostic accuracy in distinguishing enchondromas from malignant lesions [10].

Conclusion

Enchondromas are common benign bone tumors with a generally favorable prognosis. Advances in imaging, histopathology, and molecular diagnostics have enhanced the ability to differentiate these lesions from malignancies, guiding appropriate management. A tailored, multidisciplinary approach remains the cornerstone of effective care, ensuring that patients receive the least invasive yet most effective treatment. Further research into molecular mechanisms and innovative treatment modalities holds promise for improving outcomes in complex or atypical cases.

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