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Osteoid Osteoma of the Occipital Condyle in Adolescents: Surgical Resection Under Navigation

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ABSTRACT

This article reports a 12-year-old male with occipital condyle osteoid osteoma, presenting with neck pain and limited motion, unresponsive to conservative treatment. CT revealed a right condylar lesion. Surgical excision via a right paramedian suboccipital incision achieved complete recovery, confirmed by pathology and 3-month follow-up.

1 | Introduction

Osteoid osteoma, a benign osteoblastic tumor, shows highly variable clinical manifestations and anatomical locations. It accounts for about 10%–12% of all benign bone tumors [1, 2]. Patients with osteoid osteoma develop it between 5 and 24 years old, with male incidence around three times that of females [3]. The treatment of spinal osteoid osteoma has three problems: delayed diagnosis, accurate localization, and ensuring complete resection [4]. Osteoid osteoma is typically treated for its associated persistent pain. Clinically, it manifests as intermittent nocturnal pain exacerbation, with pain in some patients relievable by aspirin or NSAIDs [5]. The recurrence or persistence rate of osteoid osteoma after surgical treatment is 4.5% [6]. In recent years, percutaneous ablation of the nidus has partially replaced surgical resection [7]. In the past, reports on osteoid osteoma of the occipital condyle were extremely limited [8, 9]. This paper reports a case of osteoid osteoma in the occipital condyle removed via the far-lateral approach. Intraoperative use of a navigation-guidance system enhanced resection accuracy and safety.

2 | Case History

A 12-year-old male patient presented to our department with intermittent neck pain and restricted movement. The pain was particularly severe in the morning and when he tilted his head backward, while it was alleviated by neck flexion. Three months ago, following a comprehensive evaluation, a local hospital recommended conservative treatment initially, yet the pain persisted. Preoperative imaging studies indicated a space-occupying lesion in the right occipital condyle (Figure 1A–E). Cranial computed tomography (CT) showed a round-like, inhomogeneous hyperdense shadow in the right occipital condyle, with visible calcification. The lesion was approximately 14 mm in diameter, and its CT value ranged from 107 to 511 HU.

Yiji Li and Mingquan Liu contributed equally to this study as co-first authors.

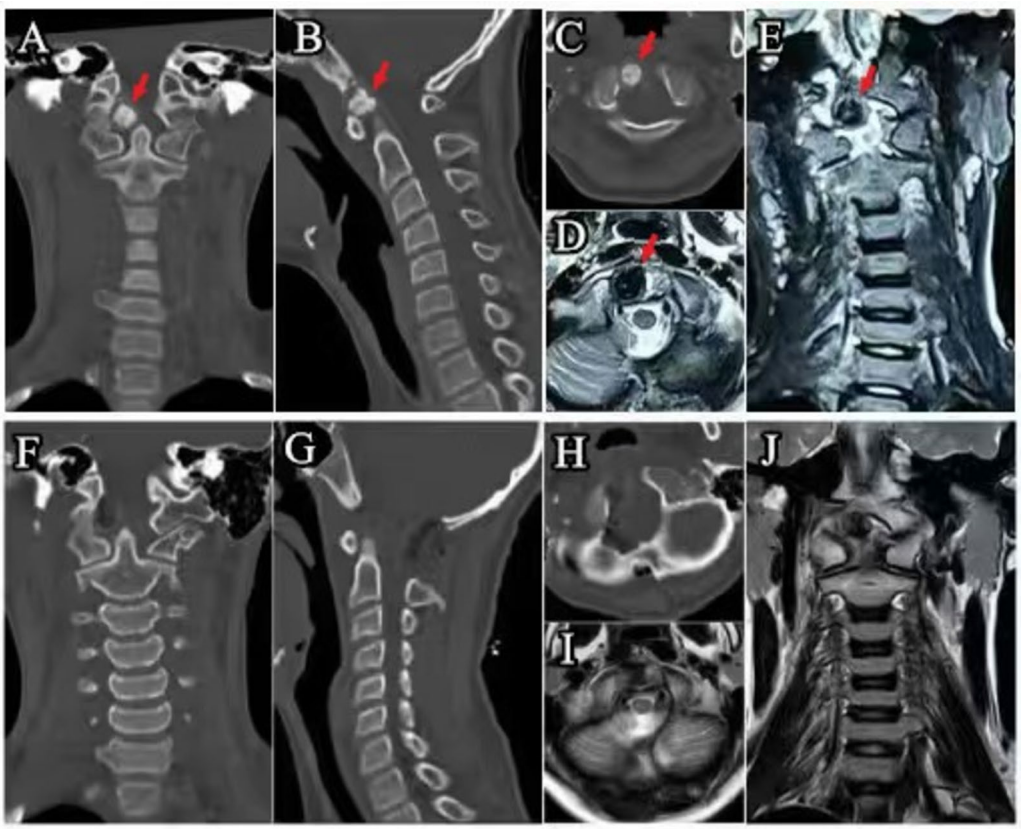

FIGURE 1 | Preoperative imaging data for a patient with osteoid osteoma included CT scans (A–C) and MRI (D–E), which revealed the tumor located in the right occipital condyle. Postoperative CT scans (F–H) and a 3-month postoperative MRI (I, J) indicated satisfactory tumor resection.

Considering the patient's lack of response to conservative treatment, we ultimately proceeded with surgical intervention. Following general anesthesia, electrophysiological monitoring electrodes were attached to monitor the right posterior cranial nerves. The patient was axially turned and placed in the prone position. Data were input, and the Remebot was used for positioning. A right-angled suboccipital posterior median incision was made, extending from the superior nuchal line to the spinous process of C2 and laterally to the medial mastoid. Under the microscope, the right posterior arch of the atlas was removed, and the right vertebral artery's intracranial entry point was dissected. Intraoperative navigation guided the surgical approach. The tumor was found closely associated with the hypoglossal nerve, with unclear bone margins and poor blood supply. The lesion was resected piecemeal, preserving the atlanto-occipital joint.

3 | Differential Diagnosis

3.1 | Osteoid Osteoma

Osteoid osteoma of the occipital condyle is more common in adolescents or young adults, typically presenting with nocturnal pain that responds well to nonsteroidal anti-inflammatory drugs (NSAIDs). Imaging-wise, CT is the gold standard for diagnosis, revealing a radiolucent nidus less than 1.5 cm in diameter surrounded by a reactive sclerotic ring. MRI shows enhancement of the nidus and surrounding bone marrow edema. Pathologically, osteoblasts are seen surrounding the osteoid matrix with a few osteoclasts.

3.2 | Giant Cell Tumor of Bone

Giant cell tumor of the occipital condyle is rare, predominantly affecting adults aged 20–40 years, and presents with localized pain and swelling, potentially accompanied by pathological fractures. Imaging reveals an eccentric, expansile, lytic lesion with well-defined borders but no sclerotic rim ("soap bubble" appearance), often invading soft tissues. Pathologically, it is characterized by numerous multinucleated giant cells evenly distributed among mononuclear stromal cells.

3.3 | Fibrous Dysplasia

Fibrous dysplasia of the occipital condyle can be monostotic or polyostotic, typically starting in childhood or adolescence, often asymptomatic or presenting with slowly progressive bone deformity. Imaging features include a "ground-glass" density, expanded and thinned cortex, with no nidus or sclerotic ring. Pathologically, immature bone trabeculae are scattered within a fibrous matrix, lacking multinucleated giant cells.

3.4 | Bone Metastasis

Metastases to the occipital condyle are more common in middle-aged and elderly individuals, with primary sites often being breast, lung, or prostate cancer. Clinical presentation includes severe, persistent pain (worsening at night), potentially accompanied by pathological fractures or nerve compression. Imaging shows lytic or blastic changes with indistinct borders and no nidus. Pathologically, malignant cells such as adenocarcinoma or squamous cell carcinoma, consistent with the primary tumor, are seen, distinctly different from the benign osteogenic lesions of osteoid osteoma.

4 | Pathological Result and Outcome

Postoperative pathological examination reveals cancellous bone tissue under the microscope, with irregular trabeculae in some areas. There is proliferation of osteoblastoma with varying density, along with a small number of multinucleated osteoclasts. Osteoid osteoma is highly suspected (Figure 2).

The patient was discharged on postoperative day 8 without any neurological impairment. Three months after the operation, the patient experienced no pain during neck movement. The postoperative CT review demonstrated satisfactory tumor resection (Figure 1F–J).

5 | Discussion

Osteoid osteoma is a benign tumor that has a latent course [10]. Relevant studies indicate that osteoid osteoma is characterized by a well-circumscribed osteolytic nidus typically measuring less than 1 cm in diameter. Surrounding this, the degree of marginal sclerosis varies according to its anatomic location. Histologically, the nidus comprises an irregular lattice of osteoid trabeculae with diverse levels of calcification, embedded within a highly vascularized, cellular stroma [11]. This type of lesion typically manifests as localized pain, which may intensify with movement. Conversely, the pain may also subside with movement [12].

For this type of benign tumor, conservative treatment combined with close follow-up is viable [13]. However, many patients often experience severe and persistent pain [14]. Research has shown that this tumor expresses very high levels of prostaglandins, especially PGE2 and PG12. The locally high levels of these prostaglandins are thought to be the cause of severe pain in patients with this lesion. Prostaglandins probably cause pain in osteoid osteoma in two ways. Increased blood flow pressure might irritate nerve endings, or prostaglandins could directly stimulate them by reducing the pain threshold. Mungo et al.'s study on osteoid osteoma showed higher levels of cyclooxygenase (COX), the key enzyme in prostaglandin production [15]. Some patients respond to NSAIDs to a certain extent. However, to avoid long-term use or drug ineffectiveness, surgical treatment is still the preferred option.

In this case, the patient had been treated with NSAIDs at an external hospital before presentation, but with poor results. Generally, radiofrequency ablation is feasible only when the spinal cord and nerve roots are detached from the tumor, thus avoiding neurological complications [16]. Previous studies show that aspiration biopsy cannot enhance the diagnostic accuracy of spinal osteoid osteoma [17]. Hence, we finally chose open surgery. The posterior and posterolateral approaches, though simple, provide limited exposure and may require spinal cord traction. The anterolateral retropharyngeal approach is better for extensive exposure. The direct transoral pharyngeal approach is effective for midline tumors but less so for lateral or basal ones. After weighing these options, we selected the far-lateral approach for tumor resection. During the operation, we accurately located the position of the tumor under navigation and safely curetted the lesion, minimizing interference with the movement and anatomical structures [18]. As the tumor had a close connection with the hypoglossal nerve during the operation, performing a complete resection became quite challenging. Thus, under the microscope, we meticulously dissected the tumor from the nerve and excised it piece by piece. Post operation, the patient had no signs of hypoglossal nerve injury. At the 3-month follow-up, the patient reported no pain during head and neck movement.

6 | Conclusion

This article reports a case of osteoid osteoma in the occipital condyle of a 12-year-old male. As conservative treatment was ineffective, the tumor was excised via the far-lateral approach. Intraoperatively, it was found that the tumor was tightly adhered to the hypoglossal nerve, and the diagnosis was confirmed by

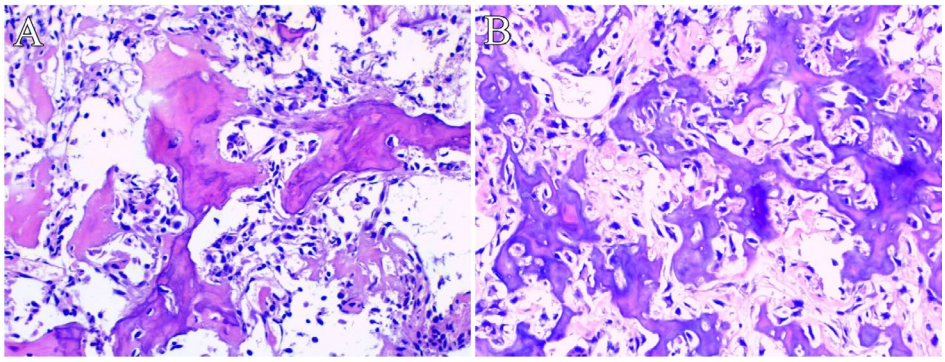

FIGURE 2 | Histopathological examination of the tumor tissue confirmed the diagnosis of osteoid osteoma.

postoperative pathology. The patient recovered well, and symptoms disappeared during the 3-month follow-up. With the aid of intraoperative navigation, the far-lateral approach can achieve precise and safe tumor resection, significantly improving the quality of the surgery. This case provides valuable reference for dealing with similar cases, indicating that choosing an appropriate surgical method has a remarkable effect on the treatment of such conditions.

Author Contributions

Yiji Li: conceptualization, writing – original draft. **Mingquan Liu:** writing – original draft. **Dongao Zhang:** resources, supervision. **Yinqian Wang:** resources, supervision. **Xingang Zhao:** supervision. **Kun Wu:** supervision. **Zijun Zhao:** resources. **Ze Ding:** resources. **Tao Fan:** conceptualization, writing – review and editing.

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The authors have nothing to report.

Ethics Statement

Ethical approval of the case report is not needed by the local ethical guidelines.

Consent

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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