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ORIGINAL ARTICLE

# Evaluation of delayed diagnosis of osteoid osteoma in adolescents and young patients with hip pain

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## ABSTRACT

**Objectives:** This study aims to evaluate delayed diagnosis of osteoid osteoma (OO) in pediatric patients with hip pain and to identify the diagnostic challenges and errors encountered during this period.

**Patients and methods:** Between May 2010 and July 2022, a total of 18 patients (11 males; 7 females; median age: 12 years; range, 6 to 20 years) with a confirmed diagnosis of OO were retrospectively analyzed. Demographic, clinical, and radiographic data were recorded. The time from symptom onset to diagnosis was calculated for each patient. The date of radiological diagnosis was accepted as the time of diagnosis.

**Results:** The median time from symptom onset to diagnosis was 12 months. Right-sided involvement was observed in 61.1% of cases. The most common lesion location was the femoral neck (61.1%), and 66.7% of cases had intra-articular lesions. A limping gait was observed in 61.1% of patients. Additionally, 33.3% of cases reported atrophy of the thigh muscles and/or lower extremities. Night pain was present in 83.3% of cases. A total of 72.2% of cases had a diagnostic delay exceeding six months. Half (50%) of the patients required more than five visits to healthcare providers before receiving an accurate diagnosis.

**Conclusion:** The diagnostic delays for OO located in the hip region can be seen in among children and young adults, primarily due to misdiagnosis and reliance on inconclusive initial imaging findings. To minimize such delays, clinicians should maintain a high index of suspicion, particularly in patients with persistent, unexplained hip pain, and consider imaging studies. Pain lasting over three weeks warrants further diagnostic evaluation in this patient group.

***Keywords:*** Adolescent, delayed diagnosis, hip, osteoid osteoma, pain.

Osteoid osteoma (OO) is a benign bone tumor predominantly affecting individuals under 20 years of age, with a male predominance.[1] It is classified as a Stage 2 lesion according to the Musculoskeletal Tumor Society (MTS) staging system. While OO is relatively common among bone tumors, its intra-articular localization, particularly around the hip joint, is rare and often underdiagnosed in cases of hip pain in adolescents and children.[1-3]

The incidence of acute non-traumatic hip pathology in children is reported as 148.1 cases per 100,000 person-years, with transient synovitis being the most common diagnosis (76.2/100,000). Other differential diagnoses include Perthes disease and juvenile idiopathic arthritis.[4] Tumors, although rare, should also be considered in the differential diagnosis of unexplained hip pain. Nocturnal pain and a dramatic response to non-steroidal anti-inflammatory drugs (NSAIDs) can serve as critical diagnostic clues for OO.[4,5] However, due to the atypical symptoms of the tumor itself and its overlap with post-traumatic or sports-related injuries, misdiagnosis or delayed diagnosis is common.

Radiographic imaging remains the primary diagnostic tool, particularly for lesions in long bones. Computed tomography (CT) can provide more detailed visualization, particularly for

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intra-articular lesions, while magnetic resonance imaging (MRI) can overemphasize surrounding edema, leading to diagnostic challenges.[6-8] Misdiagnosis and delayed recognition are often observed in pediatric patients, as OO lesions may mimic other conditions, particularly when associated with referred pain or atypical imaging findings.[9,10]

In the present study, we aimed to evaluate delayed diagnosis of OO in pediatric patients with hip pain and to identify the diagnostic challenges and errors encountered during this period.

## PATIENTS AND METHODS

This single-center, retrospective study was conducted at Adnan Menderes University, Faculty of Medicine, Department of Orthopedics and Traumatology between May 2010 and July 2022. Patients diagnosed with OO or those who were diagnosed and admitted to our center for treatment were included. Medical data of the patients were obtained from the hospital database. Inclusion criteria were as follows: patients diagnosed with OO during the study period based on radiological imaging and clinical history and who underwent either radiofrequency ablation or open surgery with pathological confirmation; patients aged ≥20 years; and the presence of OO in the iliac bone, femoral neck, trochanteric region, or subtrochanteric region (up to 5 cm below the lesser trochanter). Those with insufficient radiological evidence to confirm the OO diagnosis and those with incomplete hospital data were excluded from the study. Initially, a total of 75 OO patients were identified. Among these, 21 patients met the age and nidus localization criteria. However, three patients were excluded due to insufficient clinical history and radiological findings. Finally, a total of 18 patients (11 males; 7 females; median age: 12 years; range, 6 to 20 years) were included in the study. Written informed consent was obtained from the patients and/or their parents or legal guardians. The study protocol was approved by the Adnan Menderes University, Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (date: 26/10/2022, no: 2022/035). The study was conducted in accordance with the principles of the Declaration of Helsinki.

### Data collection and assessment

The radiological findings of the included patients were first reviewed and evaluated through hospital records. The study was conducted by recording the data documented in the hospital system, including patient history and pathology reports.

During data collection, data such as the patient's age at the time of disease onset, medications used, comorbid conditions, onset of initial symptoms, and the medical specialties consulted, and all examinations performed on patients until the diagnosis was made were recorded. Additionally, it was noted whether the patients previously traveled outside their city for treatment and whether they received any misdiagnoses.

The time from symptom onset to diagnosis was calculated for each patient. For this purpose, the date of radiological diagnosis was accepted as the time of diagnosis, rather than the date of histopathological confirmation. This choice was made, as the interval between radiological and histological diagnosis may vary significantly depending on physician workload and patient-related factors.

Hip joint radiographs were retrospectively re-evaluated for OO findings. The exact location of the lesion was determined in the CT scans performed on the patients. Furthermore, data were collected on pain localization, the presence of night pain, the most intense pain experienced by the patients, and whether the pain decreased with medication use.

### Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). The normality of the data distribution was assessed using the Shapiro-Wilk test. Descriptive data were presented in mean ± standard deviation (SD), median and interquartile range (IQR; $25^{th}$-$75^{th}$ percentiles) or number and frequency, where applicable. For comparisons between the groups, the Mann-Whitney U test was used for non-parametric data. A $p$ value of $<0.05$ was considered statistically significant.

## RESULTS

The demographic and baseline characteristics of the patients are summarized in Table I. Right-sided involvement was observed in 61.1% of cases. The most common lesion location was the femoral neck (61.1%), and 66.7% of cases had intra-articular lesions.

The most common symptoms and their frequencies are summarized in Table II. A limping gait was observed in 61.1% of patients. Additionally,

**TABLE I**
Clinical and demographic characteristics of the patients (n=18)

| | n | % | Median | Min-Max |
|---|---|---|---|---|
| Age at diagnosis (year) | | | 12 | 6-20 |
| Sex | | | | |
| Male | 11 | 61.1 | | |
| Right-side involvement | 7 | 38.9 | | |
| Lesion location | | | | |
| Femoral neck | 11 | 61.1 | | |
| Iliac bone | 3 | 16.7 | | |
| Intertrochanteric | 3 | 16.7 | | |
| Subtrochanteric | 1 | 5.6 | | |
| Lesion type | | | | |
| Intra-articular | 12 | 66.7 | | |
| Extra-articular | 6 | 33.3 | | |

33.3% of cases reported atrophy of the thigh muscles and/or lower extremities.

Night pain was present in 83.3% of cases. While 55.6% of the patients reported generalized pain that was not localized to the pathological site in the extremities, 44.4% described localized pain in the hip, which was the site of pathology. A total of 72.2% of patients experienced dramatic pain relief with NSAID use. The median value for duration from symptom onset to diagnosis was 12 (range, 1 to 48) months. Additionally, 72.2% of cases had a diagnostic delay exceeding six months (Tabe II).

The median number of physicians consulted for diagnosis was 5 (range, 2 to 10). A total of 50% of patients visited more than five physicians before receiving the correct diagnosis. All patients received analgesic treatment at least once with non-specific preliminary diagnoses, such as soft tissue trauma or myalgia. Seven patients were given incorrect diagnoses other than hip pain/diseases. To exclude incorrect initial diagnoses, a total of 11 additional examinations were performed combined with hip imaging. Two patients underwent blood tests, three underwent knee X-rays, three underwent lumbar MRI, one underwent sacroiliac ultrasonography (USG). The initial diagnoses investigated in these patients were rheumatological disease, patellofemoral pain, lumbar disc herniation, sacroiliitis, scoliosis, and intrapelvic pathology, respectively (Table III).

**TABLE II**
Symptoms and their frequency in patients

| Symptoms | n | % | Median | Min-Max |
|---|---|---|---|---|
| Limping | 11 | 61.1 | | |
| Atrophy | 6 | 33.3 | | |
| History of trauma | 2 | 11.1 | | |
| Pain | | | | |
| Hip pain (localized to pathology) | 8 | 44.4 | | |
| Unlocalized pain | 10 | 55.6 | | |
| Pain at night | 15 | 83.3 | | |
| Relief with NSAIDs | 13 | 72.2 | | |
| Duration from symptoms to diagnosis (month) | | | 12.0 | 1.0-48.0 |
| Delayed diagnosis >6 months* | 13 | 72.2 | | |

NSAIDs: Nonsteroidal anti-inflammatory drugs.

**TABLE III**
Misdiagnosis of patients and imaging methods used during diagnosis

| Variables | n | % | Median | Min-Max |
|---|---|---|---|---|
| Number of doctors consulted for diagnosis | | | 5 | 2-10 |
| Number of patients who consulted more than five doctors | 9 | 50.0 | | |
| Medical specialties consulted before diagnosis | | | | |
| Orthopaedics | 17 | 94.4 | | |
| Pediatrics | 14 | 77.8 | | |
| Physical therapy | 3 | 16.7 | | |
| Other | 4 | 22.2 | | |
| Misdiagnosis | | | | |
| Growth pain | 5 | 27.8 | | |
| Disc herniation | 3 | 16.7 | | |
| Patellofemoral pain | 3 | 16.7 | | |
| Rheumatic diseases | 2 | 11.1 | | |
| Sacroiliitis | 1 | 5.6 | | |
| Intrapelvic pathology | 1 | 5.6 | | |
| Scoliosis | 1 | 5.6 | | |
| Intramuscular injection pain | 1 | 5.6 | | |
| Bone marrow edema | 2 | 11.1 | | |
| Synovitis | 2 | 11.1 | | |
| Avascular necrosis | 1 | 5.6 | | |
| Patients who traveled out of province for diagnosis/treatment | 15 | 83.3 | | |
| Patients who traveled out of province more than twice | 6 | 33.3 | | |
| Over-imaging methods used until diagnosis | | | | |
| X-ray | 26 | | | |
| Magnetic resonance imaging scan | 8 | | | |
| Ultrasonography | 1 | | | |
| Findings of hip X-rays | | | | |
| Typical (lytic nidus and surrounding sclerosis) | 4 | 22.2 | | |
| Atypical (absence of nidus lysis or surrounding sclerosis) | 11 | 61.1 | | |
| Almost normal | 3 | 16.7 | | |

Six patients were found to have misdiagnoses related to hip pain. Five of them were diagnosed with growing pains and one was diagnosed with gluteal injection pain. Misdiagnoses and their frequencies, excluding non-specific diagnoses such as soft tissue trauma or myalgia, are listed in Table III. The most frequently recorded misdiagnosis was growth pain.

The majority of patients (83.3%) traveled outside their province for diagnosis or treatment. Among these, six patients travelled outside their province more than twice to seek a diagnosis (Table III).

All patients had at least one radiograph, CT, and MRI showing the hip. Hip radiographs of the patients were retrospectively re-evaluated for OO findings. In four patients, there was lysis in the nidus area and sclerosis around it, which is considered typical for OO. Three appeared almost normal (n=2 with small nidus in the iliac bone and n=1 with nidus in the femoral neck). The remaining 11 patients had atypical findings on radiographs. In these radiographs, either the lysis in the nidus area was not prominent or sclerosis around the nidus was not prominent (Table III).

The first cross-sectional imaging examination of the hip was MRI in 16 patients, followed by CT in two patients. An MRI was also performed in two patients who initially underwent CT scans to support the diagnosis.

In 14 of the initial MRI examinations performed on the hip, bone tumor or OO was reported as a differential diagnosis and, then, CT was performed. However, in the other two MRI reports, non-tumor

diagnoses such as bone marrow edema, synovitis, and avascular necrosis were reported. One of these patients had a CT scan after another MRI, and the other had three additional MRIs performed at different time points, followed by CT.

The total number of radiological examinations performed on the patients was found to be 89. The number of imaging studies are summarized in Table III. Accordingly, the median number of imaging examinations per patient was 4.9, while 1.9 of these examinations were found to be overexaminations.

## DISCUSSION

In the present study, we evaluated the duration between symptom onset and diagnosis in patients with OO and investigated the frequency of misdiagnosis and the number of diagnostic tests performed. We believe that understanding these factors can enhance the accuracy and timeliness of diagnosis, ultimately leading to improved patient outcomes. Our study findings revealed that the median time from symptom onset to diagnosis was 12 months. Nocturnal pain was reported by 83% of patients, while only 44% experienced pain localized to the lesion site. Additionally, 55% of patients described pain radiating to a distant site from the lesion. According to these findings, we conclude that clinicians should be cautious when evaluating pediatric and adolescent patients with non-specific or referred pain around the hip and knee, as osteoid osteoma may not always present with pain localized to the lesion site. Awareness of atypical pain patterns can help reduce diagnostic delays.

Osteoid osteoma is a rare cause of hip pain, and due to its low prevalence, it is often not considered as a primary diagnosis by clinicians.[4] Pain is the most frequently reported symptom in these patients. Initially, the pain is intermittent and occurs during the day, but as the disease

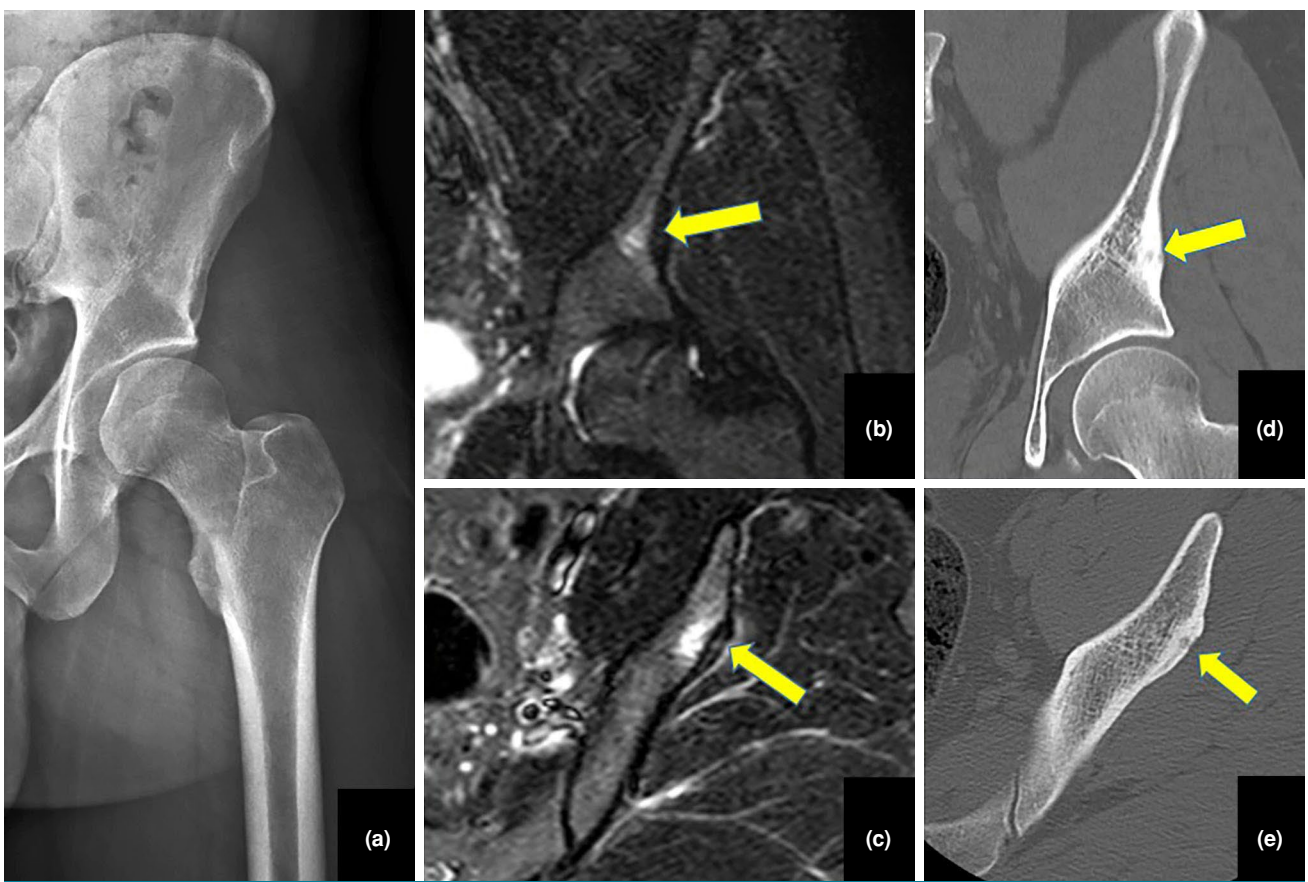



**FIGURE 1.** Radiological images of a case with a nidus in the proximal femur. **(a)** Plain radiograph of the left hip. **(b)** Coronal MRI image showing the nidus. **(c)** Axial MRI image showing the nidus. **(d)** Coronal CT image showing the nidus. **(e)** Axial CT image showing the nidus.
Arrows: Indicate the nidus. Yellow arrows indicate the nidus; MRI: Magnetic resonance imaging: CT: Computed tomography.

progresses, it shifts to a nocturnal pattern and becomes persistent. Occasionally, the OO located in the hip joint can even cause knee pain. This finding suggests that, in adolescents with unexplained persistent knee pain but normal knee radiographs, OO should not be overlooked as a potential diagnosis.[11,12]

The anatomical location of the OO lesion is another critical factor which influences the diagnostic process. Szendroi et al.[12] reported that the diagnostic delay was significantly longer in intra-articular lesions (22.6 months) compared to extra-articular locations (8.5 months). In this series, two patients with intra-articular nidus experienced also a delay in diagnosis despite a hip MRI being performed. The MRI reports of these two patients were reported non-tumor diagnoses such as bone marrow edema, synovitis, and avascular necrosis.

In terms of diagnostic imaging, X-ray, MRI, and CT were the most frequently used modalities, respectively. Our patients underwent a median number of 4.9 radiological examinations before receiving a definitive diagnosis, and 1.9 of these examinations were found to be overexaminations.

Imaging modalities play a crucial role in early diagnosis which, in turn, significantly shortens the treatment cycle and improves the patient's quality of life.[13] While there are limited comparative data in the literature, this finding highlights the necessity of thin-section CT scans for accurate nidus identification. In our series, all patients who underwent CT were diagnosed with OO. However, it may not be easily diagnosed, particularly on hip X-rays (Figure 1). In our series, the rate of patients who could easily be diagnosed with OO on hip X-rays was 22.2%, while the radiographs were almost normal in 16.7% of the patients. The remaining 61.1% of the patients had atypical radiological findings.

Furthermore, it is well established that OOs, including those not visible on plain radiographs, can be detected using bone scintigraphy. However, in this retrospective study, bone scintigraphy was not performed in any of the patients. Clinical data combined with CT and MRI imaging were found to be sufficient for the radiological diagnosis of OO in all cases, and radiological findings were entirely consistent with histopathological confirmation.[14]

Georgoulis et al.[15] evaluated 20 patients diagnosed with OO and found that the median diagnostic delay was 11.5 months, primarily due to misdiagnosis followed by arthroscopic surgeries. They emphasized that the misdiagnosis was often attributed to atypical symptoms and radiographic findings, which led to misdiagnoses such as tendinitis, chondromalacia patella, and meniscal syndrome. They also noted that a variety of unnecessary treatments, including assistive walking aids, knee braces, intra-articular injections, and arthroscopy, were applied before the correct diagnosis was made. In another study, May et al.[9] reported that three patients in their series underwent operations with incorrect diagnoses and that the median value of diagnostic delay was six months. In our study, while 83.3% of the patients received at least one incorrect diagnosis, no patients underwent operations due to incorrect diagnoses, and the median value of diagnostic delay was found to be 12 months.

As in the study of Georgoulis et al.,[15] the most frequent misdiagnosis was growth pain in our study. In contrast, May et al.[9] reported that the most common misdiagnosis in their cohort was femoroacetabular impingement (FAI). Growth pain is more common in the adolescent population, as younger patients are more likely to report intermittent pain associated with skeletal growth, while FAI is typically observed in adults with more chronic hip conditions. This disparity underscores the importance of recognizing OO in adolescents with unexplained persistent pain and normal radiographs.[10]

In childhood, hip and knee joint pain can arise from various pathologies such as FAI,[10] Legg-Calvé-Perthes disease,[16] slipped capital femoral epiphysis (SCFE),[17] developmental dysplasia of the hip,[18] or septic arthritis.[4] These conditions pose significant diagnostic challenges. One of the key clinical clues for OO diagnosis is the presence of a characteristic pain pattern, nocturnal pain which responds well to NSAIDs. Asking patients about this specific pain pattern can significantly narrow the differential diagnosis and accelerates the diagnostic process. Given that this is a simple, rapid, cost-effective, and non-invasive clinical question, incorporating it into routine musculoskeletal evaluations can facilitate earlier recognition and reduce unnecessary delays.[19] Future studies should explore the statistical reliability of this question as a screening tool to further validate its diagnostic value.

In the current study, we identified a case of Familial Mediterranean Fever (FMF) where hip pain was initially attributed to an FMF flare-up, leading to prolonged NSAID treatment without further diagnostic evaluation. As the pain persisted,

the patient was later diagnosed with sacroiliitis, and subsequent imaging revealed an OO nidus in the ilium. This case highlights the importance of considering alternative diagnoses in FMF patients presenting with persistent joint pain, as not all joint pain episodes may be directly related to FMF flares.

Since OO does not present with specific physical examination findings, it is of utmost importance to assess the distinctive examination features of differential diagnoses, such as disc herniation, with care. Additionally, certain conditions can be excluded by analyzing their characteristic pain patterns. To illustrate, FMF typically follows a course of exacerbations and remissions, whereas OO is characterized by continuous and progressively worsening pain. This distinction can aid in differentiating between the two conditions.

Our findings suggest that the lack of typical symptoms in OO, inconsistency between clinical and radiological findings, and the absence of a trauma history may discourage physicians from ordering additional MRI/CT scans, ultimately contributing to diagnostic delay. However, in patients presenting with bone pain, the first imaging modality of choice should be plain radiography. However, its sensitivity may be reduced in specific locations such as the spine, femoral neck, and small bones of the hands and feet. Osteoid osteoma typically appears as an oval or round radiolucent area measuring less than 1.5 to 2 cm, often with a central calcification.[20,21] A sclerotic rim usually surrounds the nidus, with the intensity of sclerosis being more prominent in cortical lesions compared to those located in the metaphyseal or epiphyseal regions.[20] Notably, reduced sclerosis is frequently observed in femoral neck lesions. While CT is nearly 100% diagnostic for OO,[20] it is superior to both radiography and MRI in confirming the presence of a nidus. When MRI is used as the initial imaging method, excessive perinidal edema may lead to misdiagnosis.[8]

In patients whose symptoms persist despite pain management, reassessment should be performed if there is no improvement within three weeks. Even if radiographs are interpreted as normal, MRI should not be avoided, as it provides higher sensitivity in detecting early-stage lesions. Particularly, fluid-sensitive MRI sequences remain the most sensitive imaging modality for identifying small OO lesions and other tumor-like conditions. Increased clinical suspicion and appropriate imaging selection can prevent diagnostic delays and improve treatment outcomes.[22]

Although histopathological confirmation remains the gold standard for definitive diagnosis, preoperative identification of OO is mainly based on clinical features such as nocturnal pain relieved by NSAIDs and characteristic radiological findings. These criteria are critical for surgical decision-making and are widely accepted in clinical practice, particularly in retrospective studies where histopathological data may not be available.

Nonetheless, this study has some limitations. First, the retrospective design may have led to missing or incomplete patient data, particularly in symptom reporting. Additionally, the relatively small sample size limits the generalizability of our findings, and larger, prospective studies are needed for further validation. As this is a single-center study conducted in a tertiary care center, the results may not be fully representative of different healthcare settings or geographic populations. The variability in imaging modalities and diagnostic approaches across patients may have introduced inconsistencies in the diagnostic process. Furthermore, while the characteristic pain pattern and NSAID response are critical diagnostic clues, patient-reported symptoms can sometimes be inaccurate, potentially affecting the reliability of this clinical feature. Despite these limitations, our study provides valuable insights into the diagnostic challenges of OO and highlights the need for early suspicion and appropriate imaging in patients with unexplained joint pain.

In conclusion, the diagnostic delays for OO located in the hip region can be seen in among children and young adults, primarily due to misdiagnosis and reliance on inconclusive initial imaging findings. To minimize such delays, clinicians should maintain a high index of suspicion, particularly in patients with persistent, unexplained hip pain, and consider MRI or thin-slice CT, even when plain radiographs appear normal. Additionally, the characteristic pain relief with NSAIDs should be considered an important diagnostic clue, as a positive NSAID response can help to distinguish OO from other musculoskeletal conditions early in the diagnostic process.

**Data Sharing Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Author Contributions:** Investigation, data collection, writing-review & editing: F.T.O.; Methodology, formal analysis, data curation, writing-original draft, project administration: G.O.K.; Conceptualization, visualization, resources, writing-review & editing, supervision: E.C.

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