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Review Article

An Approach to Joint Pain in Paediatric Patients: A Comprehensive Review

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Abstract:

Joint pain in paediatric patients is a common but diagnostically challenging issue, with causes ranging from benign self-limiting conditions to serious diseases that may result in long-term disability. This review addresses a structured diagnostic approach to joint pain in children, covering infectious, inflammatory, traumatic, and neoplastic causes. Key diagnoses include septic arthritis, juvenile idiopathic arthritis (JIA), Lyme arthritis, and malignancies such as leukaemia and osteosarcoma. A detailed history and physical examination are essential for identifying underlying conditions, distinguishing benign causes from emergencies. Infectious causes require urgent consideration, especially septic arthritis, which risks rapid joint destruction. Inflammatory conditions like JIA are common chronic arthritides in children and need timely referral for rheumatologic assessment. Malignancies and traumatic causes also warrant careful attention to avoid delayed diagnosis. Laboratory investigations—including complete blood counts, inflammatory markers (ESR and CRP), and autoantibodies (ANA and RF)—help support diagnoses. Imaging studies, particularly radiography, ultrasound, and MRI, are pivotal for assessing trauma, inflammation, and marrow involvement. Targeted approaches for specific conditions, such as joint aspiration in septic arthritis and serological testing for Lyme arthritis, are discussed. Advances in biomarkers, imaging, and biologic therapies—especially TNF inhibitors and interleukin blockers—are highlighted as emerging tools in diagnosing and managing paediatric joint pain, offering promising avenues for early diagnosis and personalised care.

Key words: Paediatric joint pain, juvenile idiopathic arthritis (JIA), septic arthritis, Lyme arthritis, paediatric rheumatology, paediatric arthritis

Introduction:

Joint pain in paediatric patients is a frequent clinical issue, posing diagnostic challenges due to the broad differential diagnoses that range from benign, self-limiting causes to severe conditions that can result in long-term disability. Accurate diagnosis and timely intervention are crucial to manage conditions such as juvenile idiopathic arthritis (JIA), where delayed treatment can lead to chronic joint damage and functional impairment.[1,2] Differentiating between inflammatory, infectious, traumatic, and mechanical causes of joint pain requires a structured approach, as joint pain in children often presents with atypical symptoms compared to adults, such as irritability and difficulty moving the limb.[3] This review aims to outline the diagnostic approach to paediatric joint pain, emphasising the importance of comprehensive history, physical examination, and relevant investigations in determining the underlying aetiology.

Differential Diagnosis

The differential diagnosis of paediatric joint pain is extensive and includes both common and rare conditions. Joint pain in children can generally be categorised into inflammatory, infectious, traumatic, neoplastic, and mechanical causes. Table 1 outlines the major causes within these categories, highlighting key clinical features for each.

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1. Infectious Causes

Infections such as septic arthritis and osteomyelitis must be urgently considered in children presenting with joint pain, particularly if accompanied by systemic symptoms such as fever and malaise.[4,5] Septic arthritis, most frequently caused by Staphylococcus aureus, can lead to rapid joint destruction if not treated promptly.[6] Lyme arthritis, though less common, should be considered in endemic areas, especially if there is a history of tick exposure.[7] Viral infections, including parvovirus B19 and Epstein-Barr virus, can also manifest with transient joint pain and should be distinguished from bacterial causes based on clinical and laboratory findings.[8]

2. Inflammatory and Autoimmune Disorders

Juvenile idiopathic arthritis (JIA) is the most common chronic inflammatory arthritis in children, with subtypes that vary in clinical presentation and severity.[9] Symptoms may include joint swelling, stiffness, and limited range of motion, which are typically worse in the morning. Other autoimmune conditions, such as systemic lupus erythematosus (SLE) and dermatomyositis, should also be considered, particularly if joint pain is associated with rashes, fatigue, or systemic involvement.[10,11] Early recognition and referral to a paediatric rheumatologist are essential for optimal outcomes.

3. Traumatic Causes

Trauma is a frequent cause of joint pain in children and can range from acute injuries, such as sprains or fractures, to overuse injuries commonly seen in young athletes.[12] A thorough history, including details about recent physical activities or specific injuries, can often clarify the cause. Chronic repetitive stress may lead to conditions such as osteochondritis dissecans or patellofemoral pain syndrome, particularly in active adolescents.[13]

4. Neoplastic and Haematological Disorders

Though rare, malignancies such as leukaemia or bone tumours may initially present with joint pain. In leukaemia, bone pain is often generalised and may be associated with systemic symptoms like fatigue, pallor, and unexplained bruising.[14] Bone tumours, including osteosarcoma and Ewing sarcoma, should be considered in cases of persistent, localised pain, especially if accompanied by swelling.[15,16]

Table 1: Common Causes of Joint Pain in Paediatric Patients

Category	Condition	Clinical features
Infectious	Septic arthritis	Fever, acute onset, erythema, warmth, tenderness
	Lyme arthritis	Monoarthritis, history of tick exposure, endemic areas
Inflammatory	Juvenile idiopathic arthritis (JIA)	Chronic joint pain, morning stiffness
	Systemic lupus erythematosus (SLE)	Joint pain, rash, systemic symptoms
Traumatic	Fracture	Acute pain, history of trauma, limited mobility
	Osteochondritis dissecans	Chronic knee pain, adolescent athletes
Neoplastic	Leukaemia	Bone pain, systemic symptoms, pallor
	Osteosarcoma	Persistent localised pain, swelling

Initial Evaluation and History

A detailed history is crucial in evaluating joint pain in paediatric patients, as it can often direct clinicians toward specific diagnoses. The onset, duration, and nature of the pain are key elements to consider. Acute-onset joint pain, especially if accompanied by fever, raises suspicion for infections such as septic arthritis or osteomyelitis.[4, 5] In contrast, gradual onset of pain may suggest an inflammatory or autoimmune process, such as juvenile idiopathic arthritis (JIA).[1, 9]

The pain's location and pattern provide additional clues. For example, monoarticular pain typically suggests septic arthritis or trauma, whereas polyarticular pain may indicate systemic conditions like JIA or systemic lupus erythematosus (SLE).[3, 10] Night-time pain or pain that disrupts sleep is concerning and may signal malignancy, particularly leukaemia or bone tumours, such as osteosarcoma.[14-16] Any history of recent travel, insect bites, or exposure to endemic areas is relevant in diagnosing conditions like Lyme arthritis.[7]

Physical Examination

A thorough physical examination should assess for signs of joint inflammation, such as swelling, warmth, erythema, and reduced range of motion. Palpation of joints can reveal tenderness and help identify specific sites of pain, as in cases of osteomyelitis where pain may be localised over the affected bone.[5] Observing the child's gait and posture can reveal compensatory mechanisms and functional limitations related to joint pain.[17] During the examination, clinicians should assess for systemic signs, such as lymphadenopathy, hepatosplenomegaly, and skin changes. Rashes can be indicative of certain autoimmune conditions, such as the malar rash in SLE or the heliotrope rash in juvenile dermatomyositis.[10,11] Inflammatory arthritides, such as JIA, may present with joint swelling and stiffness that improves with activity.[9]

Laboratory Investigations

Laboratory tests are a valuable adjunct to clinical assessment, aiding in differentiating between infectious, inflammatory, and neoplastic causes. Commonly ordered tests include complete blood count (CBC), inflammatory markers (e.g., ESR, CRP), and specific serologic tests depending on the suspected diagnosis.[18]

- *CBC and Inflammatory Markers:* A CBC can identify leukocytosis in infections and anaemia or thrombocytopenia, which may indicate leukaemia.[14] ESR and CRP are elevated in most inflammatory and infectious conditions, though levels may vary based on the severity of inflammation.[19]
- *Autoimmune Markers:* For suspected autoimmune causes, tests such as antinuclear antibody (ANA) and rheumatoid factor (RF) may be indicated. ANA positivity is common in SLE, while RF can help confirm JIA in older children.[20, 21] However, clinicians should interpret these results carefully, as some markers may have limited specificity in children.
- *Infectious Workup:* If septic arthritis or osteomyelitis is suspected, blood cultures and joint fluid analysis are essential. Joint aspiration allows for synovial fluid analysis, which includes cell count, Gram stain, culture, and crystal analysis.[6] Elevated white blood cells in synovial fluid, particularly with a neutrophilic predominance, suggest bacterial infection.[22]

Imaging Studies

Imaging is often crucial in diagnosing paediatric joint pain. Plain radiography is usually the initial imaging modality, especially for trauma and infections. Radiographs can reveal fractures, joint effusions, or osteolytic lesions seen in osteomyelitis and malignancy.[23] For soft-tissue evaluation and more detailed imaging of bones, magnetic resonance imaging (MRI) is highly sensitive and useful in identifying marrow involvement in osteomyelitis or neoplastic lesions.[24] Ultrasound can also be a valuable tool in evaluating joint effusions and guiding joint aspiration, especially in younger children who may not tolerate MRI.[25] In cases where Lyme arthritis is suspected, ultrasound can reveal synovial thickening and effusion, which may prompt further serological testing in endemic regions.[7]

Table 2: Key Laboratory and Imaging Studies in Paediatric Joint Pain Evaluation

Investigation	Purpose	Indications
CBC	Identify anaemia, leukocytosis	Suspected infection or malignancy
ESR/CRP	Assess inflammation	Infection, inflammatory arthritis
ANA and RF	Detect autoimmune markers	Suspected SLE, JIA
Joint aspiration	Synovial fluid analysis	Septic arthritis, crystal arthropathy
Radiography	Initial imaging for fractures, effusion	Trauma, infection
MRI	Detailed soft -tissue and marrow imaging	Osteomyelitis, neoplasm
Ultrasound	Assess effusion, guide aspiration	Joint effusion, suspected septic arthritis

Specific Diagnostic Approaches by Condition

Given the broad differential diagnoses for paediatric joint pain, an individualised approach to each suspected condition is essential. Conditions such as septic arthritis, juvenile idiopathic arthritis (JIA), and malignancy each have unique diagnostic challenges and often require targeted investigations.

1. Septic Arthritis

Septic arthritis is a medical emergency in children due to the risk of rapid joint destruction and long-term disability.[4] The diagnostic gold standard is joint aspiration for synovial fluid analysis. Synovial fluid in septic arthritis typically shows elevated white cell count with neutrophil predominance, along with positive Gram staining and culture results in up to 50% of cases.[6, 22] Blood cultures should also be obtained as they may identify the causative pathogen even if synovial fluid cultures are negative.[26] Imaging such as ultrasound can confirm joint effusion and guide aspiration, while MRI may be warranted to assess for concurrent osteomyelitis in complex cases.[24]

2. Juvenile Idiopathic Arthritis (JIA)

The diagnosis of JIA is largely clinical, based on the International League of Associations for Rheumatology (ILAR) criteria, which require joint inflammation persisting for at least six weeks in patients under 16 years of age.[2] Laboratory investigations, such as ANA and RF, help subtype JIA, as ANA positivity is often associated with an increased risk of uveitis in oligoarticular JIA.[9, 20] Elevated ESR and CRP support the presence of inflammation, although these markers may be normal in some JIA subtypes. Imaging findings in JIA can include joint space narrowing and erosions on X-ray, particularly in advanced disease.[27]

3. Lyme Arthritis

Lyme disease is another important infectious cause of joint pain, especially in endemic areas. Lyme arthritis typically presents as monoarticular or oligoarticular arthritis, most commonly affecting the knee[7]. Diagnosis relies on serologic testing, with enzyme-linked immunosorbent assay (ELISA) followed by confirmatory Western blot testing for Borrelia burgdorferi.[28] Synovial fluid analysis may reveal high white blood cell counts, but cultures are generally negative as Borrelia does not readily grow in culture.[29] Early antibiotic treatment can prevent chronic complications, such as joint damage or neurologic sequelae.[30]

4. Haematological and Malignant Causes

In cases where leukaemia or bone malignancy is suspected, laboratory tests such as a complete blood count (CBC) and peripheral smear can reveal anaemia, leukopenia, or blasts, which suggest malignancy.[14] Bone pain from malignancies may often be deep, persistent, and worse at night, raising suspicion of osteosarcoma or Ewing sarcoma. MRI is essential for visualising bone marrow involvement and assessing tumour extent, and it is more sensitive than X-rays in early disease.[15, 24] Biopsy is often necessary for definitive diagnosis.[31]

Management Approaches

Management of paediatric joint pain depends significantly on the underlying diagnosis and can range from supportive care for benign conditions to aggressive treatment for infections and autoimmune disorders. Prompt antibiotic therapy is critical in managing septic arthritis and osteomyelitis. Empiric treatment should cover Staphylococcus aureus, the most common pathogen, with consideration of methicillin-resistant Staphylococcus aureus (MRSA) in areas with high prevalence.[6, 26] Surgical drainage of the infected joint is often necessary to clear infection and prevent damage.[32] Intravenous antibiotics are typically administered for two to four weeks, followed by oral antibiotics depending on clinical response and laboratory markers.[33] The treatment of JIA involves nonsteroidal anti-inflammatory drugs (NSAIDs) as first-line therapy for pain and inflammation. Disease-modifying antirheumatic drugs (DMARDs), such as methotrexate, are indicated for patients with persistent or polyarticular disease.[34] Biologic agents, including TNF inhibitors, may be considered in refractory cases to prevent joint damage and improve quality of life.[35] Physical therapy is crucial in maintaining joint function and preventing contractures.[36] Table 3 outlines general management approaches for common causes of paediatric joint pain.

Table 3: General Management Approaches for Common Causes of Paediatric Joint Pain

Condition	Primary Treatment	Additional Considerations
Septic Arthritis	IV antibiotics, joint drainage	MRSA coverage if indicated, follow - up imaging
Juvenile Idiopathic Arthritis	NSAIDs, DMARDs (e.g., methotrexate), biologics	Physical therapy for joint mobility
Lyme Arthritis	Antibiotic therapy (e.g., doxycycline, amoxicillin)	Monitor for long - term joint complications
Haematologic Malignancies	Chemotherapy, supportive care	Oncology consultation, palliative care

Emerging Diagnostic and Management Strategies

Advances in diagnostic tools and treatment protocols are transforming the approach to paediatric joint pain, allowing for more accurate diagnoses and targeted therapies. Recent research has focused on improving biomarkers, imaging modalities, and biologic treatments.

Biomarkers and Molecular Testing

Emerging biomarkers may help differentiate between inflammatory, infectious, and neoplastic causes of joint pain. Studies indicate that certain cytokine profiles, such as elevated interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-alpha), are commonly seen in inflammatory arthritis and can help identify patients with juvenile idiopathic arthritis (JIA) earlier in their disease course.[37] Genetic testing, such as HLA typing, may also aid in identifying autoimmune predispositions, allowing for earlier intervention in children at higher risk of conditions like JIA.[38, 40]

Imaging Innovations

While MRI is a highly sensitive imaging technique for evaluating bone and joint pathology, advancements in imaging techniques, such as diffusion-weighted MRI and dynamic contrast-enhanced MRI, are proving useful for differentiating infectious from inflammatory causes without the need for invasive procedures.[24,29] Additionally, point-of-care ultrasound is gaining traction as a rapid, non-invasive method for assessing joint effusions and guiding synovial fluid aspiration, particularly useful in emergency and outpatient settings.[25, 28]

Advances in Biologic Therapy

Biologic agents have revolutionised the management of autoimmune joint disorders, especially JIA. Targeted therapies, such as TNF inhibitors and interleukin-1 blockers, offer tailored options for children unresponsive to traditional DMARDs.[34, 36] These biologics have demonstrated success in reducing disease activity, preserving joint function, and improving quality of life.[35, 39] However, careful monitoring for adverse effects, particularly infection risk, remains essential due to immune modulation associated with biologic therapies.[40]

Conclusion:

In conclusion, the evaluation of paediatric joint pain requires an integrated approach, combining thorough history-taking, physical examination, targeted diagnostics, and multidisciplinary care. Recognising red-flag symptoms and selecting appropriate investigations can help differentiate between common and high-risk conditions, enabling timely and effective management. Recent advances in biomarkers, imaging, and biologic therapies provide promising avenues for early diagnosis and personalised care, ensuring better outcomes for children with joint pain.

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