Original Article

The role of orthopedic interventions in treating pediatric musculoskeletal disorders: exploring surgical and non-surgical approaches for managing conditions like scoliosis, developmental dysplasia of the hip, and Blount's disease

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Abstract

Background: Pediatric musculoskeletal disorders can significantly affect physical development, mobility, and quality of life. Conditions such as scoliosis, developmental dysplasia of the hip (DDH), and Blount's disease require timely diagnosis and appropriate orthopedic management to prevent long-term complications. Treatment strategies vary according to the patient's age, disease severity, skeletal maturity, and functional status. **Objective**: To explore the role of surgical and non-surgical orthopedic interventions in the management of pediatric scoliosis, developmental dysplasia of the hip, and Blount's disease, emphasizing their effectiveness in improving musculoskeletal function and preventing deformity progression. **Methods**: This review examines established orthopedic management approaches for these three conditions, including observation, physiotherapy, bracing, orthotic devices, casting, and surgical correction. Treatment indications are considered in relation to age, severity of deformity, skeletal development, and expected clinical outcomes. **Results**: Non-surgical interventions are important in managing selected pediatric musculoskeletal disorders, particularly when abnormalities are identified early and remain amenable to conservative treatment. Bracing may help limit the progression of scoliosis in appropriately selected growing children, while harness treatment and casting are established approaches for selected cases of DDH. Observation, guided growth, and orthotic management may be appropriate for certain children with Blount's disease, depending on age and disease severity. **Conclusion**: Orthopedic interventions play a vital role in managing pediatric musculoskeletal disorders and promoting healthy physical development. An individualized approach integrating early diagnosis, appropriate conservative treatment, and timely surgical intervention can improve alignment, mobility, and functional outcomes.

Keywords: Pediatric orthopedics, scoliosis, developmental dysplasia of the hip, Blount's disease, surgical intervention, conservative management, musculoskeletal disorders, childhood deformities.
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Introduction

Pediatric musculoskeletal disorders represent a significant clinical concern because they can interfere with normal skeletal growth, physical development, mobility, and quality of life. Conditions such as scoliosis, developmental dysplasia of the hip (DDH), and Blount's disease may result in progressive deformity, functional limitations, chronic pain, and long-term disability if not identified and managed appropriately. The developing musculoskeletal system presents unique treatment challenges because therapeutic decisions must consider the child's age, remaining growth potential, severity of deformity, and risk of recurrence. Early diagnosis and timely orthopedic intervention are therefore essential for optimizing functional outcomes and reducing the need for more extensive corrective procedures [1][2].

Scoliosis is characterized by a three-dimensional spinal deformity involving lateral curvature and vertebral rotation. Adolescent idiopathic scoliosis is among the most frequently encountered forms, although scoliosis may also develop in younger children or occur secondary to neuromuscular and congenital conditions. Management depends on curve magnitude, skeletal maturity, and the likelihood of progression. Observation is appropriate for selected mild curves, while bracing is commonly recommended for growing patients with progressive curves of sufficient magnitude. Surgical correction, generally involving spinal instrumentation and fusion, may be indicated in severe or progressive cases when conservative management is unlikely to prevent further deformity [1][3].

Developmental dysplasia of the hip refers to a spectrum of abnormalities involving the formation and stability of the hip joint, ranging from acetabular shallowness to partial or complete displacement of the femoral head. Early recognition is particularly important because treatment becomes more complex as the child grows and the hip joint develops secondary structural changes. In young infants, a Pavlik harness or another suitable abduction orthosis may facilitate stable hip positioning and promote normal joint development. Closed reduction with spica casting or open reduction, sometimes combined with pelvic or femoral osteotomy, may be necessary when the hip remains unstable, treatment fails, or diagnosis occurs later in childhood [2][4].

Blount's disease is a growth-related disorder affecting the medial proximal tibial growth plate, leading to progressive bowing of the legs and, in some cases, limb-length discrepancy and gait abnormalities. Its development is associated with factors such as increased body weight, early walking, and abnormal mechanical loading of the tibia. Management depends on the child's age, disease stage, and degree of angular deformity. Observation and bracing may be considered in

selected early cases, whereas guided growth procedures or corrective tibial osteotomy may be required for progressive or advanced deformities [5][6]. These interventions aim to restore lower-limb alignment, improve gait, and minimize the risk of secondary joint degeneration.

The selection between surgical and non-surgical orthopedic approaches remains a central consideration in pediatric musculoskeletal care. Conservative treatments can reduce treatment-related risks and preserve normal growth in suitable patients; however, their effectiveness may be limited in severe, rigid, or progressive deformities. Surgical procedures can provide more definitive correction but may involve complications, including infection, neurovascular injury, growth disturbances, recurrence, and the need for additional operations. Therefore, treatment planning should incorporate clinical examination, appropriate imaging, skeletal maturity, family preferences, and regular postoperative or conservative-treatment follow-up [3][7].

Despite advances in pediatric orthopedic techniques, achieving optimal long-term outcomes requires individualized treatment strategies and coordinated care involving orthopedic surgeons, pediatricians, physiotherapists, rehabilitation specialists, and families. This review explores the role of surgical and non-surgical interventions in managing scoliosis, developmental dysplasia of the hip, and Blount's disease. It focuses on treatment indications, clinical effectiveness, limitations, and the importance of early diagnosis in preventing progressive deformity and improving children's functional independence and quality of life [4][8].

Methodology

This review adopted a narrative literature review approach to examine surgical and non-surgical orthopedic interventions for pediatric musculoskeletal disorders, focusing on scoliosis, developmental dysplasia of the hip (DDH), and Blount's disease. Relevant literature was identified through searches of PubMed, Scopus, Web of Science, and Google Scholar using combinations of keywords including pediatric orthopedic disorders, scoliosis management, developmental dysplasia of the hip, Blount's disease, conservative treatment, bracing, corrective osteotomy, and surgical intervention. Publications addressing clinical assessment, treatment indications, therapeutic effectiveness, complications, and long-term functional outcomes were considered.

Studies were selected based on their relevance to pediatric populations and their discussion of established surgical or non-surgical treatment strategies. Randomized controlled trials, prospective and retrospective cohort studies, systematic reviews, clinical practice guidelines, and relevant observational studies were

considered. Publications involving adult-only populations or unrelated musculoskeletal conditions were excluded. Greater emphasis was placed on contemporary evidence, while older landmark studies were included when they provided important foundational information.

The findings were organized according to the three target conditions and categorized into conservative and surgical management approaches. Conservative interventions included observation, physiotherapy where appropriate, spinal bracing, hip abduction orthoses, casting, and lower-limb bracing. Surgical interventions included spinal correction and fusion, closed or open hip reduction, pelvic or femoral osteotomy, guided growth, and corrective tibial osteotomy. The review compared these approaches in terms of treatment indications, deformity correction, mobility, complications, recurrence, and the influence of age and skeletal maturity on outcomes.

Because this was a narrative review, no pooled statistical analysis or formal meta-analysis was performed. The findings were synthesized descriptively to highlight the clinical benefits, limitations, and considerations associated with each treatment strategy. Particular attention was given to early diagnosis, individualized treatment planning, multidisciplinary care, and long-term follow-up in improving functional outcomes and supporting normal musculoskeletal development in children.

Results

The results of this narrative review are presented in four tables summarizing the clinical characteristics of pediatric musculoskeletal disorders, conservative treatment approaches, surgical interventions, and factors influencing clinical outcomes. The findings focus on scoliosis, developmental dysplasia of the hip (DDH), and Blount's disease. As this review does not report original patient-level data or a quantitative meta-analysis, the results are presented descriptively rather than as new statistical findings.

Table 1. Clinical characteristics and management priorities

Clinical parameter	**Scoliosis**	**Developmental dysplasia of the hip**	**Blount's disease**
Main abnormality	Three-dimensional spinal curvature	Abnormal hip development or displacement	Abnormal proximal tibial growth and bowing
Important risk factors	Growth-related progression, underlying	Developmental and mechanical factors,	Increased mechanical loading,

	neuromuscular or congenital disorders	including breech presentation and family history	elevated body weight, and early walking
Primary assessment	Curve magnitude, skeletal maturity, progression	Hip stability, age, imaging, reducibility	Age, tibial alignment, disease stage, growth potential
Initial management	Observation for selected mild curves	Age-appropriate orthosis in selected infants	Observation or bracing in selected early cases
Escalation of treatment	Bracing or spinal surgery	Reduction, casting, or osteotomy	Guided growth or corrective osteotomy

Interpretation: The three disorders differ in anatomical location and disease mechanism, requiring condition-specific assessment and management. In scoliosis, the risk of curve progression and remaining skeletal growth influence treatment decisions. For DDH, early recognition and stable positioning of the femoral head are central to successful management. Blount's disease requires careful evaluation of tibial deformity and growth-plate involvement. Across all three conditions, early diagnosis can facilitate timely intervention and reduce the likelihood of advanced deformity.

Table 2. Non-surgical orthopedic interventions

Condition	**Intervention**	**Appropriate clinical context**	**Expected benefit**	**Main limitation**
Scoliosis	Observation and clinical monitoring	Mild curves with low progression risk	Avoids unnecessary intervention while tracking progression	Requires follow-up
Scoliosis	Spinal bracing	Selected growing children with progressive curves	Reduces the risk of curve progression	Depends on appropriate fit and adherence
DDH	Pavlik harness or other suitable orthosis	Selected infants with unstable or	Supports appropriate hip positioning and	Requires monitoring for treatment failure

		reducible hips	development	
DDH	Closed reduction and spica casting	Selected dislocations requiring reduction	Maintains the reduced hip in an appropriate position	May require anesthesia and imaging surveillance
Blount's disease	Observation and bracing	Selected young children with early-stage disease	May improve alignment or limit progression	Limited benefit in advanced disease

Interpretation: Conservative interventions can be effective when selected according to age, disease severity, and the likelihood of progression. Bracing is particularly relevant to scoliosis in growing children at risk of curve progression, while appropriate hip orthoses can support hip development in selected infants. Observation or bracing may be considered in early Blount's disease. Nevertheless, conservative management requires regular reassessment, and persistent or progressive abnormalities may necessitate a change in treatment strategy.

Table 3. Surgical orthopedic interventions and indications

Condition	**Surgical procedure**	**Main indication**	**Expected clinical objective**
Scoliosis	Spinal instrumentation and fusion	Severe or progressive curves meeting surgical criteria	Correct spinal deformity and prevent further progression
DDH	Closed reduction with spica casting	Hip dislocation amenable to closed reduction	Maintain hip-joint alignment
DDH	Open reduction with or without osteotomy	Persistent dislocation or unsuccessful closed reduction	Achieve stable hip reduction and address structural abnormalities
Blount's disease	Guided growth	Selected progressive deformities with sufficient growth remaining	Gradually improve tibial alignment

Blount's disease	Corrective tibial osteotomy	Significant deformity or limited potential for guided growth	Correct angular deformity and improve lower-limb mechanics

Interpretation: Surgical treatment provides an important option when conservative measures are insufficient or when structural deformity requires direct correction. In scoliosis, spinal instrumentation and fusion can stabilize severe progressive curves. For DDH, closed or open reduction is selected according to hip reducibility, age, and anatomical abnormalities. In Blount's disease, guided growth may be suitable for children with substantial remaining growth, whereas corrective osteotomy may be needed for more severe deformities. Surgical planning should balance the degree of correction against complications, recurrence, and the effects of treatment on future skeletal development.

Table 4. Factors influencing treatment selection and outcomes

Factor	**Clinical relevance**	**Implication for management**
Age at diagnosis	Influences treatment options and developmental potential	Encourage timely assessment and diagnosis
Severity of deformity	Determines the likelihood of progression and functional impairment	Match treatment intensity to disease severity
Skeletal maturity	Influences the potential for growth-based correction	Consider growth remaining when selecting bracing or guided growth
Response to conservative treatment	Indicates whether initial management is effective	Reassess and consider escalation when appropriate
Treatment adherence	Particularly important for bracing and orthotic management	Provide education, support, and regular follow-up
Complications and recurrence	May affect function and long-term correction	Monitor clinically and radiographically as appropriate
Family involvement	Influences adherence and continuity of care	Include caregivers in shared decision-making

Interpretation: Clinical outcomes depend on multiple interacting factors rather than the choice of procedure alone. Age, skeletal maturity, and deformity severity influence both treatment

eligibility and the likelihood of successful correction. Adherence is especially relevant to conservative management, while surgical patients require monitoring for complications, residual deformity, and recurrence. Family education and shared decision-making can support treatment adherence and continuity of care. These findings support individualized management rather than a uniform approach for all children.

Discussion

Pediatric musculoskeletal disorders require timely recognition and treatment strategies that account for ongoing skeletal growth. The findings of this narrative review indicate that conservative and surgical orthopedic interventions have complementary roles in managing scoliosis, developmental dysplasia of the hip (DDH), and Blount's disease. Treatment selection should reflect the nature of the deformity, its severity, the child's age, and the potential for progression. Early intervention may preserve function and reduce the complexity of later treatment, although the optimal approach varies across conditions.

In scoliosis, observation and bracing remain important options for appropriately selected children who have not reached skeletal maturity. Evidence from the Bracing in Adolescent Idiopathic Scoliosis Trial demonstrated that bracing reduced progression to the threshold for surgery compared with observation, with treatment success in 72% of the combined bracing cohort versus 48% of the observation cohort [1]. The findings also demonstrated a relationship between longer brace-wearing time and treatment success. These results support the use of bracing in suitable patients, while emphasizing that curve severity, skeletal maturity, and adherence must be considered when estimating likely benefit. Surgery remains an important option for severe or progressive deformities that meet operative criteria [2].

For DDH, early identification and appropriate treatment are essential to support normal hip-joint development. The use of a Pavlik harness or another suitable abduction orthosis is established for selected infants with reducible hips [3]. However, treatment should not be applied indiscriminately to all ultrasound-detected abnormalities. Evidence concerning stable dysplastic hips indicates that immediate bracing may not provide a clear advantage over careful surveillance in every case [4]. This distinction highlights the importance of assessing hip stability, age, and imaging findings before initiating treatment. When reduction cannot be achieved or maintained using conservative methods, closed or open reduction and, in selected cases, osteotomy may be required [5].

Blount's disease presents different management challenges because the deformity originates from abnormal growth at the proximal tibial physis. Treatment depends on age, disease severity,

progression, and remaining growth potential. Observation or bracing may be appropriate in selected early cases, whereas guided growth or corrective tibial osteotomy may be required for progressive or advanced deformities [6]. Delayed recognition can allow deformity to become more pronounced, potentially increasing the complexity of correction. Therefore, clinical and radiographic monitoring is important for identifying children who are not responding adequately to conservative management.

Across all three conditions, treatment success should be evaluated in terms of functional improvement, anatomical correction, complications, and long-term development. Surgery can address substantial structural abnormalities, but it also carries risks, including infection, neurovascular injury, growth disturbances, and recurrence. Conservative treatment may avoid operative risks, yet its effectiveness depends on appropriate patient selection, adherence, and continued reassessment. Evidence-based guidelines for DDH similarly emphasize individualized decisions informed by clinical findings and available imaging [7].

Several limitations should be acknowledged. This review is narrative rather than systematic, and no formal risk-of-bias assessment, pooled effect estimate, or meta-analysis was performed. Differences in patient populations, disease severity, treatment protocols, and outcome definitions also limit direct comparisons across studies. Further prospective research with standardized functional and radiographic outcomes would help clarify long-term treatment effectiveness. Overall, the available evidence supports early diagnosis, individualized orthopedic management, family involvement, and continued follow-up to optimize outcomes in children with musculoskeletal disorders.

Conclusion

Orthopedic interventions play a crucial role in the effective management of pediatric musculoskeletal disorders, including scoliosis, developmental dysplasia of the hip, and Blount's disease. Early diagnosis, accurate assessment, and individualized treatment planning are essential for preventing deformity progression and improving mobility, anatomical alignment, and long-term functional outcomes. Non-surgical approaches, including observation, bracing, orthotic devices, and casting, can be effective in appropriately selected children, particularly when treatment begins early. Surgical interventions, including spinal fusion, hip reduction, and corrective tibial osteotomy, remain important for severe, progressive, or treatment-resistant deformities. The selection of treatment should consider the child's age, skeletal maturity, disease severity, and response to initial management. Furthermore, regular follow-up, family education, and multidisciplinary collaboration are essential for monitoring growth, identifying

complications, and minimizing recurrence. Future research should prioritize long-term comparative studies to establish the effectiveness, safety, and cost-effectiveness of different orthopedic interventions. An evidence-based, patient-centered approach can ultimately improve musculoskeletal development and quality of life in affected children.

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