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Preterm Birth's Impact on Musculoskeletal Health and Related Disorders

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Abstract

Preterm birth is linked to a number of illnesses and problems that need for interdisciplinary medical treatment. Premature birth affects 10% of all newborns worldwide, with an improving survival rate in practically all Western nations. The maintenance of adequate medical treatment regimens, which must be continued throughout the patients lifetimes, is being made more difficult by this continuous but desired tendency. Orthopedic surgeons concentrate on treating musculoskeletal conditions and enhancing their patients' capacity to deal with the stresses of daily living. Cerebral palsy and an abnormal calcium/phosphorus metabolism that can result in fractures are the two diseases most frequently linked to preterm delivery. The clinical presentation and biological expression of these disorders might differ substantially. This necessitates collaboration across disciplines and parental support. Clinical treatment aims to improve a patient's physical and neurological state as soon as possible and to stop the emergence of subsequent musculoskeletal problems. In this article, we provide a review of recent research on the most prevalent musculoskeletal conditions linked to preterm delivery and critically examine cutting-edge diagnostic guidelines and treatment plans.

Keywords: Preterm birth; Metabolic bone disease; Fracture; Developmental dysplasia of the hip; Cerebral palsy

Introduction

When the baby is born before the 37th week of pregnancy, the condition is known as preterm birth (PTB). Between the 34th and 36th gestational week, 75% of PTBs take place [1]. There are several risk factors known. The most frequent factors that increase the likelihood of spontaneous PTB are intrauterine infections, a history of preterm deliveries, short cervical lengths, and anomalies of the developing foetus or placenta [2]. PTB is typically linked to conditions that impact the bronchopulmonary, cardiovascular, and central neurological systems as well as a greater risk of overall mortality. Additionally, early onset musculoskeletal problems, which will be covered in this review article, may affect preterm-born infants. PTB-related problems may have a substantial influence on the future development and well-being of young people since paediatric orthopaedic surgeons specialise in the treatment of diseases that affect the function of the musculoskeletal system. The latest research on orthopaedic diseases associated with preterm birth will be covered in the sections that follow.

Orthopedic Conditions Related to Preterm Birth

Cerebral palsy

The most prevalent musculoskeletal impairment linked to PTB is cerebral palsy (CP). According to Rosenbaum et al. [3], it is "a collection of chronic abnormalities of movement and posture development, limiting activity, that are linked to non progressive problems that occurred in the developing foetal or newborn brain." The frequency is about 1-2/1000 of all live births [4], with individuals born preterm having a much greater incidence.

Although the exact aetiology is frequently unclear, white matter brain injury may be primarily responsible. The coherences of PTB and asphyxia, which were believed to be the basic causes of CP, were initially described by little. Later research revealed that perinatal infection is the main risk factor for preterm delivery, surpassing short gestational age and low birth weight. Proinflammatory cytokines are present in intrauterine infections, which not only encourage PTB but also lead to neuronal injury that increases the likelihood of developing CP. Every type of postnatal inflammation, excluding intrauterine infection, may be a contributing factor. This results in necrosis or death of neurons and glia cells, which is caused by mitochondrial energy depletion increased by oxidative stress [5].

These days, it may be challenging to accurately diagnose cases of birth asphyxia, and it may also be erroneously asserted that this condition is the primary cause of CP. Less than 10% of all CP cases may be directly related to birth asphyxia, according to a research by Ellenberg and Nelson [6]. A broadly applicable preventative approach has not yet been created, despite a constant growth in information regarding the causes of CP. In women at risk for PTB before the 34th gestational week, magnesium sulphate treatment has been shown to have neuroprotective benefits. Magnesium sulphate was the only intervention with good quality evidence of effectiveness that decreased the incidence of CP in children, according to an overview review by the Cochrane Library that identified and summarised 15 systematic studies. Animal studies revealed a reduced incidence of neuronal death following ischemic brain damage and a lowered generation of proinflammatory cytokines despite the fact that the mechanism of action is still not completely understood. Additionally, within the first six hours after delivery, hypothermia demonstrated potential outcomes in late preterm newborns by altering the processes of programmed apoptosis in neural cells and reducing the metabolic rate of neurons to prevent energy depletion. For CP patients, the adductor and flexor muscles of the lower extremities, in particular, exhibit symmetrical muscular spasticity. Most of them struggle with having adequate motor skills. There might be a number of causes for this. Patients with CP have a diminished capacity for producing fast muscular force and total muscle strength as well as a propensity to engage agonistic and antagonistic muscle groups concurrently [7]. In varied degrees, this

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may result in dyskinesia, ataxia, and athetosis. Patients are also more likely to experience muscular rigidity and contractures. Contrary to what was previously thought, this is not brought on by an overuse of the afflicted muscle groups but rather by a combination of shorter sarcomere length and higher collagen type I presence in the connective tissue surrounding the muscle fibres. Decreased proprioceptive skills are frequently present and worsen the underlying issue. According to the disease's severity, hearing and/or vision impairment, mental impairment, a delay in the development of psycho-cognitive abilities, and even dysregulation of the circulatory and respiratory systems may exist. Even in relatively moderate instances, a considerable deterioration of fine motor abilities may exist that is not immediately obvious. Clinical and radiological examination methods are used to make the diagnosis, with a focus on examiner observations and parent reports.

The Gross Motor Function Classification System (GMFCS) can be used to gauge CP severity [8,9] and forecast a patient's future progress. However, recent research indicates that this is a relatively challenging task. Many individuals who were initially given the diagnosis of having CP later turned out to be false positives. As the infantile brain is still developing, many symptoms might manifest later in life or perhaps get worse. Even medical professionals' exams have a certain percentage of false positive results. The fact that CP is a nonprogressive syndrome must be highlighted, nevertheless.

To ascertain if a patient has CP, efforts are currently being made to employ standardised parent-reported functional scores and gait patterns. The step width at a corrected age of 20 months is one independent parameter for CP. One of the most crucial pillars for getting the right diagnosis and spotting white matter brain injury early on is modern MRI equipment, as it can be very challenging to spot in early cerebral ultrasound tests. Periventricular leukomalacia, which is primarily responsible for white matter brain damage, is brought on by the juvenile brain's failure to improve blood flow to border zones that are hypoperfused. The degree of white matter brain damage and, consequently, the severity of the illness in CP patients are correlated with the neurological prognosis. Diffusion tensor imaging and gait impairment patterns in preterm children may be used to accurately predict future motor function impairment [10].

A conservative treatment plan and/or surgical intervention may be used to accomplish this. The surgical idea is supported by a number of pillars. First and foremost, the choice to have surgery should only be taken after full consultation with the parents, carers, and physiotherapists who are treating the patient. The objective is to increase the patient's functional capacity and stop additional issues such joint contractures or dislocations. With a positive mid-term result, spasticity may be efficiently treated with botulinum toxin type A. Intrathecal baclofen administration has been demonstrated to be helpful in dystonia patients. Derotational osteotomies, open reduction of hip dislocations with or without concurrent bony operations, tenotomies, or guided growth with temporal (hemi) epiphysiodesis are the typical surgical methods used, depending on the underlying issue. In our clinical experience, it is important to take precautions while performing tenotomies to increase the range of motion (ROM) of the afflicted joints, as doing so typically results in greater muscle weakness. This must be carefully considered since muscular weakness, not spasticity, characterises all forms of CP [11].

Fractures

The last trimester is when bone mineralization is most prevalent. Thus, it is reasonable to suppose that preterm newborns are at an elevated risk for paediatric fractures. Before, it was believed that preterm newborns did not have a higher risk of developing fractures during their first few months of life [12]. Prior to a recent research by Michaud et al., which recognized child maltreatment as a significant cause, assault-related fractures were not included. PTB was recognized in this cohort analysis as a distinct risk factor for hospitalisation for paediatric fractures. The population under study revealed a high rate of fractures caused by assault, most of which occurred before the age of 18. Infants born between the 32nd and 36th gestational weeks had the highest frequency of fractures that necessitated hospitalisation. Low socioeconomic level and family ties may be contributing factors. In addition, despite being born preterm, babies who were judged tiny at gestation may develop into adults with lower bone mass density than those who were an adequate size. This might make some types of fractures more likely to occur later in life.

Metabolic Bone Disease

The term "metabolic bone disease" (MBD) refers to a number of conditions and syndromes characterised by abnormal calcium and phosphorus balance. The majority of the bone mineralization occurs after the 27th gestational week, hence patients born before this time are mostly impacted. The range of symptoms includes reduced trabecular bone density, fractures following minor trauma, slowed development, and diminished height. While early clinical diagnosis is challenging, early signs may include increased parathormone and alkaline phosphatase blood levels as well as reduced calcium and phosphorus serum levels. It may be readily missed because it occurs at a rate of about 7% in preterm newborns [13]. A gestational age of less than 30 weeks, a delay in vitamin D supplementation of more than 14 days, and the beginning of pure enteral nourishment beyond 28 days of age were identified as three independent risk factors for the development of MBD in preterm newborns in a recent research [13]. The treating doctors should also look into an early switch to entire enteral feeding.

Developmental Dysplasia of the Hip

Developmental dysplasia of the hip (DDH) is a term used to describe an aberrant acetabular form of the newborn hip that may cause early osteoarthritis, increased wear, and significant functional gait disability if a dislocation goes unnoticed.

There is a significant geographical variation in the overall incidence of developmental dysplasia of the hip (DDH). There have been reports of incidences ranging from 0.66 to 39.4 per 1000 births in Scandinavia and Western Europe. In Austria, the incidence is around 0.24 percent of all live births. Positive family history, breech position, primiparity, oligohydramnios, and genetic susceptibility are all well-known risk factors for developing DDH, but evidence of the latter is scarce.

Positive Barlow and Ortolani sign, abduction deficiency, torticollis, clubfoot deformity, and feminine gender are symptoms that patients may exhibit. Graf originally published the hip sonographic screening technique in the early 1980s, and it is now the accepted diagnostic practise. Graf classified the degree of hip developmental retardation based on the joint's form and associated alpha angle.

Within the first two weeks following delivery, an ultrasonography screening was advised throughout the early phases. Currently, it is advised in clinical practise to do an ultrasonographic examination within the first week of a baby's life and a follow-up examination at 6 weeks. PTB and DDH have long been thought to be related. Even preliminary data, however, suggest that it could be prognostically

advantageous against acquiring DDH. This can be because mechanical risk factors are most prevalent in the final trimester of pregnancy. As the foetus grows at this time, the intrauterine space shrinks, which may cause the femur to abduct toward the side of the mother's spine. A new biomechanical study demonstrates that movement and kicking of the foetus hip joint are necessary for intrauterine joint development. In breech position, the fetus's kicks have less range of motion and overall power, and there are incidences of oligohydramnios, which may delay hip development. Within the 31st gestational week, a normal hip joint is always present, and the alpha angles get smaller from then. Additional research has supported this thesis, with preterm newborns exhibiting greater alpha angles than term infants and less hip immaturity. Nearly all patients in a sizable Scandinavian cohort study had either a completely formed hip joint or a mild maturation delay. Even while PTB does not reduce DDH, preterm children may still be more likely to get hip osteoarthritis, which may necessitate complete hip replacement.

Conclusion

Over the past few decades, preterm infant survival has increased significantly. As a result, it is necessary to prepare for an increase in the number of patients who will require customised treatment plans in the future. Along with neurologists, paediatricians, physiotherapists, occupational therapists, orthopaedic technicians, and many other disciplines, orthopaedic surgeons must also take this into account. The primary objective should be to stop CP from developing. Strong evidence supports both the effectiveness of postnatal cooling in treating infants with hypoxic encephalopathy as well as the neuroprotective benefits of magnesium sulphate administration in women at risk of preterm birth. With the use of contemporary MRI technologies, we have been able to better comprehend the particular pathologic pathways involved in the emergence of cerebral palsy and to predict the likelihood of additional neurological abnormalities. In light of this, a treatment plan should be created as soon as feasible after the diagnosis. In addition, the families of preterm infants should seek psychological assistance as soon as possible following conception. Emergency department doctors must constantly evaluate the potential of child abuse even if parents shouldn't generally be suspected of it since preterm infants are more likely to suffer abuse-related injuries.

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Conflicts of Interest

Author declares no conflict of interest.

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