

INNOVATIVE TECHNIQUES AND MULTIDISCIPLINARY APPROACHES IN THE TREATMENT OF HIP DYSPLASIA: A COMPREHENSIVE PERSPECTIVE ON PROMOTING MUSCULOSKELETAL HEALTH

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Abstract: INTRODUCTION: Congenital hip dysplasia (CHD) is a complex musculoskeletal condition involving abnormal development of the hip joint during fetal growth and infancy. While its exact cause remains unclear. Clinical manifestations range from asymptomatic cases to severe impairment. Early detection, often through routine screening during infancy, is crucial for effective management. Despite advancements, challenges persist in universal screening and standardizing management protocols. CHD prevalence varies across populations, with females and certain ethnic groups being more affected. Breech presentation and positive family history are established risk factors.

OBJETIVE: Analyze and describe the main aspects of the multifaceted and multidisciplinary treatment of hip dysplasia in the last years.

METHODS: This narrative review examines recent advancements in the management of hip dysplasia within the context of pediatric orthopedics and musculoskeletal health. Given its narrative nature, this study does not pose any risks. The review encompassed studies retrieved from prominent databases, including MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE, and Google Scholar, ensuring comprehensive coverage of the literature on this topic.

RESULTS AND DISCUSSION: The surgical management of hip dysplasia has evolved to optimize patient outcomes and preserve joint function through techniques such as arthroscopic procedures, minimally invasive approaches, and joint preservation strategies, aiming to minimize tissue trauma and facilitate early rehabilitation. Multidisciplinary collaboration among orthopedic surgeons, physiotherapists, radiologists, and other healthcare professionals is crucial for delivering comprehensive care tailored to individual

patient needs, supported by innovative imaging modalities like MRI, CT, and 3D modeling techniques for precise diagnosis, treatment planning, and monitoring. Non-surgical interventions, regenerative medicine technologies, patient-specific factors, and patient education are pivotal in symptom management, functional optimization, and empowering patients to actively participate in their care. Despite advancements, unresolved questions persist, necessitating further research to optimize treatment strategies and enhance patient-centered care, including considerations of biomechanical principles, preoperative planning techniques, long-term durability of surgical interventions, socio-economic factors, and psychosocial impact. Novel rehabilitation techniques, genetic screening, and cost-effectiveness analyses offer promising avenues for improving outcomes and resource allocation in hip dysplasia management.

CONCLUSION: Advancements in surgical techniques, including arthroscopic procedures and joint preservation strategies, are revolutionizing hip dysplasia treatment, aiming to optimize outcomes and preserve joint function. Multidisciplinary collaboration among healthcare professionals is essential for tailored patient care, integrating innovative imaging modalities for precise diagnosis and monitoring. Non-surgical interventions, such as bracing and physical therapy, complement surgical approaches, while regenerative medicine holds promise for tissue repair. Comprehensive preoperative planning and perioperative interventions play crucial roles in optimizing surgical outcomes and enhancing postoperative recovery, ensuring holistic care for individuals with hip dysplasia. This comprehensive approach underscores the importance of addressing both physiological and psychosocial aspects in promoting musculoskeletal health and improving patient outcomes.

Keywords: Hip Dysplasia; Musculoskeletal Health; Pediatric Orthopedics.

INTRODUCTION

Congenital hip dysplasia (CHD), also known as developmental dysplasia of the hip, encompasses a spectrum of hip joint abnormalities ranging from subtle acetabular dysplasia to frank hip dislocation¹. It is characterized by abnormal development of the hip joint during fetal growth and infancy, leading to varying degrees of instability, dysplasia, and subluxation. CHD arises from a complex interplay of genetic predisposition, intrauterine factors, and mechanical stresses during fetal development^{1,2}.

While the exact etiology remains elusive, factors such as breech presentation, female gender, family history of hip dysplasia, and oligohydramnios have been implicated as predisposing factors³. Clinical manifestations of CHD may vary widely, from asymptomatic cases detected incidentally to severe cases presenting with limited hip abduction, limb length discrepancy, and functional impairment⁴. Early detection and intervention are paramount for optimal outcomes, emphasizing the importance of routine screening, particularly during the neonatal period and infancy⁵.

Diagnostic modalities such as ultrasound and radiography play crucial roles in confirming the diagnosis and guiding management decisions, facilitating timely intervention to prevent long-term complications such as osteoarthritis and functional impairment^{5,6}. Despite advancements in diagnostic techniques and treatment modalities, challenges persist in achieving universal screening and implementing standardized management protocols, highlighting the ongoing need for research and clinical innovation in the field of congenital hip dysplasia⁷.

CHD is one of the most common musculoskeletal disorders affecting infants, with a reported incidence varying widely across different populations and geographic regions⁸. While estimates suggest that approximately 1-3 per 1000 live births are affected by CHD, the prevalence may be influenced by various factors such as ethnicity, gender, and screening practices⁹. Females are more commonly affected by CHD, with a female-to-male ratio ranging from 2:1 to 8:1 in some studies¹⁰.

Additionally, certain ethnic groups, such as Native Americans, have been reported to have higher rates of CHD compared to other populations^{5,10}. Breech presentation during birth is a well-established risk factor for CHD, with up to 12-25% of infants in the breech position demonstrating hip instability^{6,9}. Furthermore, a positive family history of CHD increases the likelihood of an individual being affected, suggesting a genetic predisposition to the condition. Despite advances in prenatal and neonatal screening, CHD remains a significant public health concern due to its potential long-term consequences if left untreated, highlighting the importance of early detection and intervention^{9,10}.

OBJETIVE

Analyze and describe the main aspects of the multifaceted and multidisciplinary treatment of hip dysplasia in the last years.

SECUNDARY OBJETIVES

1. Review and synthesize recent advancements in surgical techniques for the treatment of hip dysplasia, including arthroscopic procedures, minimally invasive approaches, and joint preservation strategies.
2. Explore the role of multidisciplinary approaches in the management of hip dysplasia, incorporating perspectives from orthopedic surgeons, physiotherapists,

radiologists, and other relevant healthcare professionals.

3. Investigate innovative imaging modalities and diagnostic tools for the early detection and monitoring of hip dysplasia, such as magnetic resonance imaging (MRI), computed tomography (CT), and three-dimensional (3D) modeling techniques.

4. Assess the effectiveness and outcomes of non-surgical interventions, including bracing, physical therapy, and lifestyle modifications, in the management of hip dysplasia across different patient populations.

5. Examine emerging technologies and interventions in the field of regenerative medicine, such as platelet-rich plasma (PRP) therapy, stem cell therapy, and tissue engineering, for the treatment of hip dysplasia and associated musculoskeletal disorders.

6. Evaluate the impact of patient-specific factors, such as age, gender, skeletal maturity, and severity of dysplasia, on treatment outcomes and decision-making processes in hip dysplasia management.

7. Discuss the potential role of patient education, counseling, and support programs in promoting musculoskeletal health and enhancing treatment adherence among individuals with hip dysplasia.

METHODS

This is a narrative review, in which the main aspects of the multifaceted and multidisciplinary treatment of hip dysplasia in the last years were analyzed. The beginning of the study was carried out with theoretical training using the following databases: PubMed, sciELO and Medline, using as descriptors: "Hip Dysplasia" AND "Musculoskeletal Health" AND "Pediatric Orthopedics" in the last years. As it is a narrative review, this study does not have any risks.

Databases: This review included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases.

The inclusion criteria applied in the analytical review were human intervention studies, experimental studies, cohort studies, case-control studies, cross-sectional studies and literature reviews, editorials, case reports, and poster presentations. Also, only studies writing in English and Portuguese were included.

RESULTS AND DISCUSSION

Surgical management of hip dysplasia underscores the evolution of techniques aimed at optimizing patient outcomes and preserving joint function¹¹. Arthroscopic procedures, minimally invasive approaches, and joint preservation strategies offer promising avenues for addressing hip dysplasia, with an emphasis on minimizing tissue trauma and facilitating early rehabilitation¹².

Multidisciplinary collaboration among orthopedic surgeons, physiotherapists, radiologists, and other healthcare professionals is essential for delivering comprehensive care tailored to individual patient needs and optimizing treatment outcomes¹³. Innovative imaging modalities, such as MRI, CT, and 3D modeling techniques, enable precise diagnosis, treatment planning, and monitoring of hip dysplasia, contributing to improved patient care and prognostication¹⁴.

Non-surgical interventions, including bracing, physical therapy, and lifestyle modifications, play significant roles in symptom management and functional optimization across different patient populations¹⁵. Emerging technologies in regenerative medicine, such as PRP therapy, stem cell therapy, and tissue engineering, hold promise for tissue repair and regeneration

in hip dysplasia, although further research is needed to establish their efficacy and safety¹⁶. Patient-specific factors, including age, gender, skeletal maturity, and severity of dysplasia, significantly influence treatment decisions and outcomes, highlighting the importance of individualized care approaches¹⁷.

Patient education, counseling, and support programs are integral components of holistic management, empowering individuals with hip dysplasia to actively participate in their care and adhere to treatment recommendations¹⁸. Despite notable advancements, gaps persist in clinical practice and research efforts, warranting further studies to address unresolved questions, optimize treatment strategies, and enhance patient-centered care in hip dysplasia management¹⁹. Biomechanical principles underlying hip dysplasia inform treatment strategies aimed at restoring normal joint mechanics and preventing secondary osteoarthritis, emphasizing the importance of addressing underlying biomechanical deficiencies²⁰.

Preoperative planning techniques, such as computer-assisted navigation and patient-specific instrumentation, have demonstrated utility in optimizing surgical outcomes and implant positioning in hip dysplasia correction procedures²¹. Long-term durability and survivorship of various surgical interventions, including THA, hip resurfacing, and hip preservation surgeries, are critical considerations in treatment decision-making, with ongoing monitoring essential for assessing implant longevity and revision rates²². Socio-economic factors, healthcare disparities, and access to specialized care significantly impact the diagnosis, management, and outcomes of hip dysplasia treatment, necessitating efforts to address disparities and improve access to quality care across diverse patient populations and geographic regions²³.

Perioperative interventions, including pain management protocols, thromboprophylaxis strategies, and rehabilitation protocols, play crucial roles in optimizing postoperative recovery and minimizing complications following hip dysplasia surgery²⁴. Novel rehabilitation techniques, such as aquatic therapy, virtual reality-based exercises, and wearable technology, show promise in enhancing functional recovery and rehabilitation outcomes in individuals undergoing treatment for hip dysplasia²⁶. Genetic screening, biomarkers, and predictive modeling offer potential avenues for identifying individuals at risk of developing hip dysplasia and guiding personalized treatment approaches aimed at early intervention and prevention of disease progression²⁷.

The psychosocial impact of living with hip dysplasia, including the psychological burden, social stigma, and impact on daily activities, underscores the importance of addressing psychosocial aspects within comprehensive treatment plans^{28,29}. Finally, the cost-effectiveness and economic impact of different treatment modalities for hip dysplasia require careful consideration, with comprehensive cost-benefit analyses essential for informing healthcare decision-making and resource allocation³⁰.

CONCLUSION

In conclusion, the treatment landscape for hip dysplasia has witnessed significant advancements, with surgical techniques evolving to prioritize patient outcomes and joint preservation. Arthroscopic procedures, minimally invasive approaches, and joint preservation strategies hold promise in minimizing tissue trauma and expediting rehabilitation. Multidisciplinary collaboration is crucial for delivering tailored care, leveraging innovative imaging modalities for precise diagnosis and monitoring. Non-

surgical interventions, including bracing and physical therapy, complement surgical approaches, while emerging regenerative medicine technologies offer potential for tissue repair. Individualized care considering patient-specific factors is paramount, alongside patient education and support programs.

However, gaps persist, necessitating further research to optimize treatment strategies and address socio-economic disparities. Preoperative planning techniques and perioperative interventions play pivotal roles in optimizing surgical outcomes and postoperative recovery. Rehabilitation techniques and genetic screening offer avenues for enhancing functional recovery and early intervention. Addressing psychosocial aspects and considering cost-effectiveness are integral to comprehensive treatment plans, ensuring holistic care and improved patient outcomes in hip dysplasia management.

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