

Review

NARRATIVE REVIEW ON POSITIONAL PLAGIOCEPHALY

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ABSTRACT

Plagiocephaly, characterized by asymmetrical skull distortion, affects infants and can manifest in various severities, impacting both aesthetics and cranial function. Historically linked to cultural practices like cradleboarding, modern medicine now focuses on its pathological aspects. Plagiocephaly is primarily categorized into synostotic plagiocephaly, caused by premature cranial suture fusion requiring surgical intervention, and positional plagiocephaly (PP), resulting from external pressures and managed through non-surgical methods. The prevalence of PP has increased since the 1990s due to the "Back to Sleep" campaign aimed at reducing sudden infant death syndrome, leading to prolonged supine positioning. PP affects approximately 20% of infants, with higher incidence in males, preterm infants, and those with limited neck mobility. Clinical significance extends beyond cosmetic concerns, potentially impacting cranial development, auditory and visual alignment, and cognitive development. Prevention involves maternal nutrition, safe sleeping practices, tummy time, repositioning, and parental education. Argenta's classification system categorizes PP severity, guiding intervention strategies from repositioning and physical therapy to helmet therapy and, rarely, surgical intervention. Challenges include parental awareness, cost, and adherence to preventive measures. Current research focuses on advanced diagnostic imaging, innovative treatments, and understanding long-term outcomes, emphasizing the importance of early detection and intervention for optimal cranial development.

KEYWORDS: *positional plagiocephaly, rigid mattress, flat head, semi-rigid mattress, infant well-being, infant cranial development, cranial deformation*

INTRODUCTION

Plagiocephaly, a condition characterized by an asymmetrical distortion of the skull, derives its name from the Greek words "plagios" (oblique) and "kefale" (head). This condition predominantly affects infants and can manifest in various forms and severities, impacting both the aesthetic and functional aspects of the cranial structure (1, 2). It is a condition that has been recognized and documented throughout medical history, with its clinical significance becoming increasingly prominent in recent decades due to changes in infant care practices. Historically, plagiocephaly was often attributed to cultural practices such as cradleboarding, where the infant's head was intentionally shaped by applying pressure through

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binding or positioning. These cultural practices were widespread among various indigenous populations and were considered a norm for achieving desired cranial shapes. In modern medical practice, the focus has shifted to understanding the pathological aspects of plagiocephaly and its implications for infant health and development. Plagiocephaly can be broadly categorized into two primary forms: synostotic plagiocephaly and deformational or positional plagiocephaly (PP) (3-5).

- Synostotic plagiocephaly: This form of plagiocephaly is caused by the premature fusion of one or more cranial sutures, a condition known as craniosynostosis. The early fusion restricts the normal growth of the skull, leading to compensatory growth in other areas and resulting in an asymmetrical head shape. Synostotic plagiocephaly requires surgical intervention to correct the suture fusion and allow for normal cranial development (6-9).
- PP: this type occurs due to external pressures on the skull, typically from consistent positioning during sleep, limited movement, or other external forces. Unlike synostotic plagiocephaly, PP does not involve the premature fusion of cranial sutures and is generally managed through non-surgical interventions such as repositioning techniques, physical therapy, and, in some cases, orthotic devices (10-13). PP also can involve one or both sides of the occiput (Fig. 1).

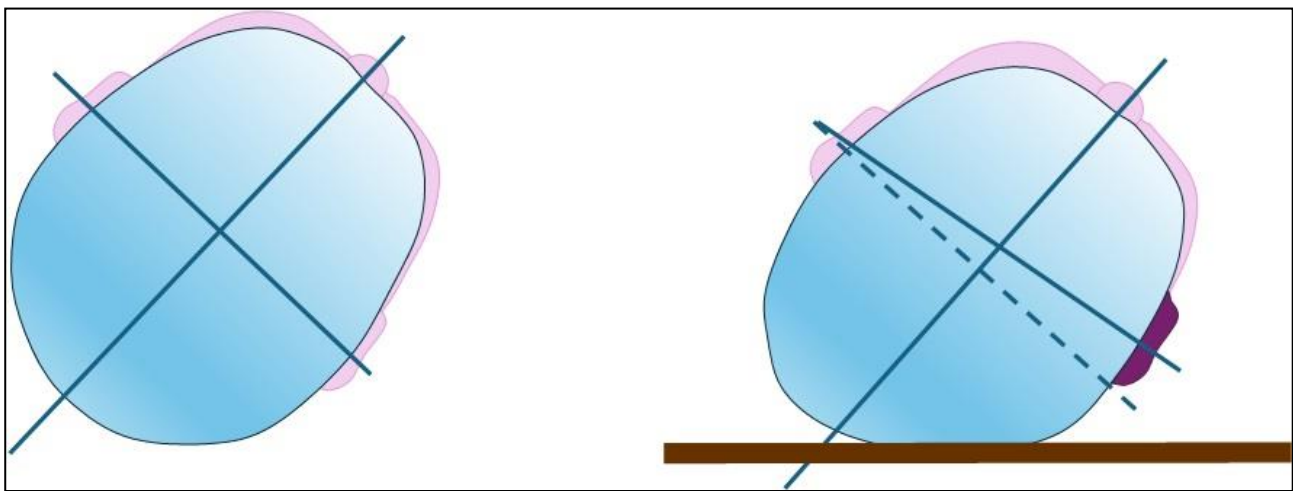


Fig. 1. *The pathogenetic mechanism of skull deformation.*

The prevalence of PP has significantly increased since the early 1990s, coinciding with the American Academy of Pediatrics' "Back to Sleep" campaign. This campaign, aimed at reducing the incidence of sudden infant death syndrome (SIDS), recommended that infants be placed on their backs to sleep. While this initiative successfully decreased SIDS rates, it inadvertently led to a rise in cases of PP due to prolonged supine positioning. Epidemiological studies suggest that PP affects nearly 20% of infants to varying degrees, making it a common concern for parents and healthcare providers. The condition tends to be more prevalent in male infants, preterm babies, and those with limited neck mobility, such as in cases of congenital muscular torticollis (14-18).

MATERIAL AND METHODS

The review was conducted following PRISMA, covering studies from January 2012 to October 2022 across six databases: PubMed, Web of Science, Google Scholar, Scopus, Cochrane Library, and ScienceDirect, focusing on English-language publications. The search used the Boolean keywords "positional plagiocephaly" and "prevention". Inclusion criteria for the review were studies on babies and children aged 0 to 2 years, open access papers, and research on preventative interventions against PP, such as using a hard-surfaced mattress, lateralizing the infant during sleep, and tummy time activities. Two independent reviewers assessed the quality of the included studies based on selection criteria, outcome evaluation methods, and data analysis, with any disagreements resolved by a third researcher. The article reviews existing literature and studies on positional PP, including its categorization, prevalence, clinical significance, pathogenesis, risk factors, diagnosis, prevention strategies, and treatment interventions. It also discusses various preventive measures and their efficacy, challenges in prevention and treatment, and recent advancements in diagnostic

imaging and treatment approaches. The review includes analyzing data from epidemiological studies, clinical evaluations, and recent research trends in the field.

RESULTS

The initial search identified 530 articles, which were narrowed down to 416 after removing duplicates. After screening titles and abstracts, 247 publications were excluded, leaving 169 records. Following further eligibility assessment, 60 publications were found to be off-topic, resulting in 11 papers being included in the review for qualitative analysis.

DISCUSSION

The clinical significance of plagiocephaly extends beyond cosmetic concerns. While the aesthetic impact is often the primary concern for parents, there are potential functional implications that warrant medical attention. Severe cases of plagiocephaly can lead to asymmetries in the face and skull that may affect cranial development, auditory and visual alignment, and, in some instances, cognitive development. Early detection and intervention are crucial in mitigating these potential complications and promoting normal cranial growth and development (19, 20). Positional plagiocephaly develops due to continuous external forces exerted on an infant's malleable skull.

The increased prevalence of PP correlates with the "Back to Sleep" campaign by the American Academy of Pediatrics. While effective in reducing SIDS, this practice has led to an increase in PP cases, highlighting the need for balanced preventive strategies (21-23). The main risk factors for PP are male sex, multiple births, prematurity, assisted delivery, torticollis. Early diagnosis and intervention are crucial in managing PP. Pediatricians play a pivotal role in this process, employing a combination of clinical evaluation and diagnostic tools to identify and assess the severity of PP (24, 25). The clinical examination of an infant suspected of having positional PP begins with a visual assessment to identify any asymmetry in the head shape. Signs of PP may include flattening on one side of the occiput, misalignment of the ears, and, in severe cases, facial asymmetry. Following this, pediatricians perform palpation of the infant's skull to check for ridges along the cranial sutures, which could indicate craniosynostosis, a condition that needs to be differentiated from PP.

Measuring the cranial index (CI) and cranial vault asymmetry index (CVAI) with tools such as calipers or three-dimensional imaging provides a quantitative assessment of cranial asymmetry. Additionally, taking a thorough medical and family history helps to identify any genetic predispositions or family history of craniofacial conditions that might contribute to the development of PP (26). Effective prevention of positional PP involves a multifaceted approach that includes proper maternal nutrition, safe sleeping practices, and regular monitoring of the infant's head shape and positioning. Adequate intake of vitamin D and folic acid during pregnancy is essential for fetal bone and neural development. These nutrients help ensure the proper formation of the infant's skull and reduce the risk of deformities.

While placing infants on their backs to sleep remains a crucial measure to prevent SIDS, it is equally important to incorporate strategies that mitigate the risk of PP. Encouraging supervised tummy time during waking hours strengthens the neck, shoulder, and upper back muscles, promoting better head control and reducing the risk of positional flat spots. It is recommended to aim for at least 30 minutes of tummy time each day, gradually increasing as the infant grows. Regularly changing the infant's head position during sleep and feeding can prevent constant pressure on one part of the skull. Techniques include alternating the direction the infant faces in the crib and varying feeding positions. Passive sleep curve mattresses are designed to distribute pressure evenly and support natural head shape development. These mattresses can be an effective preventive tool against PP. Educating parents and caregivers about the importance of repositioning, tummy time, and monitoring head shape is critical. Providing clear guidelines and practical tips can empower them to implement these strategies consistently (27).

Argenta's classification system categorizes PP based on the severity and location of cranial asymmetry. Understanding this classification helps clinicians and caregivers tailor intervention strategies appropriately (27).

- type I: mild asymmetry restricted to the back of the skull. This is the most common and least severe form of PP, often resolving with simple repositioning techniques;
- type II: involves posterior cranial asymmetry with ear displacement but no frontal involvement. This type may require more active intervention, such as physical therapy or specialized pillows;
- type III: characterized by a parallelogram-shaped skull with frontal involvement. Infants with Type III PP may need more intensive therapies, including helmet therapy, to correct the asymmetry;

- type IV: includes facial asymmetry and more pronounced cranial deformity. This severity level often necessitates a combination of therapies and close monitoring to ensure effective correction;
- type V: the most severe form, featuring altered vertical skull growth and temporal area protrusion. Infants with type V PP typically require comprehensive treatment plans, including possible surgical intervention, to address the deformity (Fig. 2).

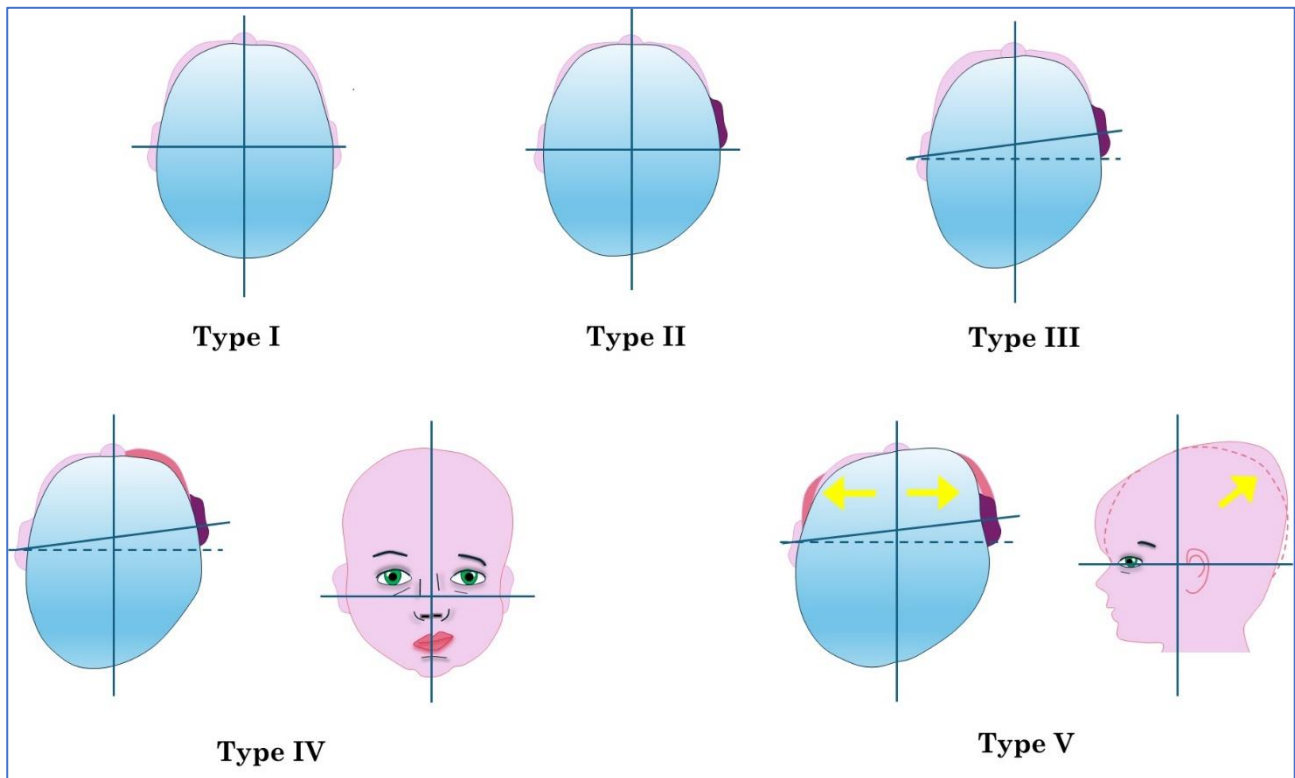


Fig. 2. Classification into 5 types of plagiocephaly according to Argenta.

Treatment strategies for positional PP vary depending on the severity of the condition and the infant's age, ranging from conservative measures to more intensive therapies. For mild to moderate cases of PP, repositioning techniques are often the primary strategy. This involves encouraging infants to turn their heads to the non-flattened side during sleep and play. Positional devices, such as wedges, rolls, or specially designed pillows, can help maintain the infant's head in the desired position (28). Additionally, environmental adjustments, like placing toys on the non-flattened side, encourage head turning in infants. Physical therapy improves neck muscle strength and head movement symmetry. Helmet therapy corrects moderate to severe PP with custom helmets despite potential discomfort, skin reactions, and social stigma (29-33). In severe cases, cranial vault remodeling surgery corrects asymmetry and ensures proper skull growth, especially in infants with craniosynostosis (32, 34-37).

Recent studies have shed light on the effectiveness of various preventive measures for positional PP, providing valuable insights into the most effective strategies for reducing its incidence and severity. Proper maternal nutrition, especially vitamin D and folic acid intake, lowers the incidence of PP by promoting fetal bone development and a stronger skull. Passive sleep curve mattresses effectively prevent and correct PP by evenly distributing pressure on the skull. Regular tummy time and repositioning techniques also prevent PP by strengthening neck and upper body muscles and reducing positional flat spots. However, challenges include ensuring parents and caregivers are informed about these strategies and overcoming the prohibitive cost of orthotic devices and specialized mattresses for some families. Educating parents and making interventions accessible to all infants are crucial for the effective prevention and treatment of PP (38). Consistent implementation of preventive measures by caregivers, including regular tummy time, repositioning techniques, and follow-up appointments with healthcare providers, is crucial for their effectiveness. Supporting and encouraging parents to follow these recommendations improves outcomes for infants with PP. Recent research focuses on better diagnostic methods, new treatment strategies, and understanding long-term outcomes (39, 40). New imaging technologies, like three - dimensional (3D) surface scanning and advanced ultrasound techniques, offer more accurate and non-invasive methods for diagnosing and monitoring PP, enabling earlier detection and timely intervention. Researchers are exploring

innovative treatment approaches, including custom-made orthotic devices and non-invasive therapies. Advances in 3D printing technology enable the creation of custom-made helmets and cranial orthoses tailored to the specific needs of each infant, offering improved comfort and effectiveness in correcting skull asymmetry. Studies are also investigating non-invasive therapies, such as low-level laser therapy, to promote skull growth and reduce asymmetry (41–44). Understanding the long-term outcomes of infants with PP is a key area of research. Longitudinal studies follow affected infants into childhood and adolescence to assess the impact of PP on cognitive development, academic performance, and psychosocial well-being (45). These studies help identify potential long-term effects and inform strategies for ongoing support and intervention (46, 47).

CONCLUSIONS

The increasing prevalence of positional PP underscores the need for effective prevention and intervention strategies. Pediatricians, parents, and caregivers must work together to ensure early detection and treatment. Simple, cost-effective measures, such as supervised tummy time, repositioning techniques, and the use of passive sleep curve mattresses, can significantly reduce the incidence and severity of PP. Early intervention and consistent monitoring are key to managing this condition and promoting optimal cranial development in infants. The type of mattress used is essential to prevent skull deformity resulting from plagiocephaly. The use of an orthopedic mattress is a modern aspect of PP management. As a result, pressure on the surface where the baby's skull might normally grow, directed by the expanding brain, could be better distributed.

Unlike other methods that rely on repositioning guidance or helmet orthotics, a sleep curve mattress is less expensive and does not require your child's compliance. From the study conducted by the Sant'Orsola hospital in Bologna, the Inglesina Welcome Pad® mattress, compared to other mattresses, facilitates the comfortable maintenance of the supine position and the alignment of the spine, promoting correct breathing of the child. Emerging research is exploring the role of genetic and epigenetic factors in the development of PP. Identifying genetic predispositions and understanding how environmental factors influence gene expression can provide insights into the underlying mechanisms of PP and guide the development of targeted prevention and treatment strategies.

Conflicts of Interest

The authors declare no conflicts of interest.

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