TRIDHA
Journal of Clinical Cases & Reports
Volume 2023, Issue S15, 7 pages
https://doi.org/10.46619/joccr.2023.6-S15-1085

REVIEW ARTICLE

Helmet Therapy in Childhood: Clear Guidelines are Missing

Stefan Bittmann*, Elisabeth Luchter, Lara Bittmann and Gloria Villalon

Ped Mind Institute, Hindenburgring 4 48599 Gronau, Germany

Correspondence should be addressed to Stefan Bittmann, Ped Mind Institute, Hindenburgring 4 48599 Gronau, Germany

Received: 1 July 2023; Accepted: 5 August 2023; Published: 16 August 2023

ABSTRACT

Head positioning deformity is much more common than synostosis deformity and occurs more frequently due to supine positioning favored to avoid cot death. A postnatal head deformity occurs in the sixth to eighth week of life. Initiated repositioning measures rarely lead to success due to the one-sided preference. Supportive physiotherapy and, if necessary, osteopathy to improve the asymmetry regularly lead to an improvement in mobility, which, however, only has a limited positive effect on the shape of the head. Malformations caused by birth trauma are subject to self-correction due to intracranial pressure and the growing brain trying to shape the still-soft skull bone into an ideal round shape. This is not the case with postnatal malformations caused by positioning. With increasing age, the skull bone mineralizes and becomes correspondingly harder, so that from the fourth to fifth month of life the shape of the skull no longer changes. There is only an increase in size along percentile growth. Thus, a relative improvement in the overall impression can be expected and, last but not least, the hair growth leads to a further concealment of the deformity. Minor asymmetries and deformities therefore do not require further treatment. Asymmetries of less than one centimetre when measuring the diagonal can be classified aesthetically and are usually hardly visible in adulthood and therefore do not require treatment in infancy. From two centimetres of asymmetry we assume an absolute indication for the treatment of the deformity due to its visibility in adulthood. Based on the connection between age, self-correction and degree of severity, the development of the head shape in the infant can be estimated, which provides important decision-making aids with regard to further action and a possible need for treatment of the head deformity. In this review, we focus on the current treatment options in terms of severity and the recommendation of a new classification.

INTRODUCTION

Twenty percent of new-born has plagiocephaly at age 4 months, 7 percent with one year, untreated. It is more often found in boys, right-sided plagiocephaly are prominent. Positional plagiocephalus can lead to cognitive impairment. A classification due to Argenta describes different types of plagiocephalus (Argenta 1-5). Moreover a more general classification decides into occipital plagiocephalus, frontooccipital plagiocephalus and posterior brachycephalus. Since 1992, there has been a recommendation to place infants on their backs, which has led to a

significant reduction in sudden infant death syndrome (SIDS). Therefore, there should be no deviation from this reasonable recommendation. Concurrent with this recommendation was an increase in reports of largely mild cranial deformities, clinically impressive as a unilateral or bilateral flattening of the occiput, in children as young as a few weeks of age. Although causality has not been proven strictly speaking, an association with the positioning recommendation seems plausible. The incidence of cranial deformities decreases with increasing age of children. In a cohort study, 16% of infants had cranial deformities at 6 weeks of age, whereas at 2 years of age, the incidence in the cohort decreased to 3.3%. In a prospective, epidemiologic study from the Netherlands, moderate to severe findings were present in 1% of patients studied at 5.5 years of age. In daily practice, cranial asymmetries, especially in the first 6 months of life, frequently raise questions about differential diagnoses and intervention options. At birth, the cranial sutures are not yet ossified, so the cranial plates can shift as they pass through the birth canal and the skull can rapidly increase in size postpartum. The decisive force here is the increase in size of the brain, which doubles in volume during the first 6-7 months of life. The skull is easily deformable in the first months of life and an externally applied force can lead to deformation of both the cerebral and facial skull. Therefore, supine positioning may result in unilateral flattening of the back of the head (positional plagiocephalus, LP) or symmetrical flattening of the entire back of the head (positional brachycephalus. Intrauterine constriction or constrained positions are discussed as predisposing factors. This may explain why the incidence is twice as high in boys, who tend to be larger. Multiple births are also associated with an increased risk. Limitations in cervical spine motion, for example, due to torticollis or obstetric hemorrhage into the sternocleidomastoid muscle, are additional risk factors for developing LP. Torticollis is present in 20% of children with LP but in only 0.1-2% of children with symmetrical head shape. Cranial deformity is also more common in first-time mothers and after obstetric procedures (forceps, vacuum cup). In addition, prematurity and developmental delays, possibly accompanied by a prolonged stay in an intensive care unit, are further risk factors. Side preference can also result from one-sided offering of stimuli, for example, if the feeding position is always the same. According to our own studies, 8% of infants under 16 weeks of age show a side preference, resulting in a one-sided flattening of the back of the head in almost half of the cases. In contrast, breastfeeding has a protective effect because of the changing positions during feeding. As previously described, consistent supine positioning is also considered a risk factor. Ultimately, the development and underlying mechanisms of positioning-related cranial deformities are not yet conclusively understood. Usually, the diagnosis of positional cranial asymmetry can be made by a physician's clinical examination alone. The clinical presentation of LP is different from that of LB. Argenta et al. have made a classification based on the clinical features. Disadvantages of this classification are that the individual features do not always build on each other in the individual case and that the severity of the individual abnormalities is not mapped. Among other things, this makes the assessment of progression more difficult. If uncertainty persists after careful clinical examination, ultrasonography can be performed to confirm the diagnosis. Within the first 13 months of life, open and fused cranial sutures can thus be distinguished with a high degree of reliability. The next step, which is thus required only in rare cases of doubt, involves radiographic examination of the skull in two planes. In the diagnosis of positional skull asymmetries, there is no justifiable indication for computed tomography, which is associated with significant radiation exposure. Differentially, a positional cranial deformity must be distinguished from premature cranial suture closure. In particular, premature unilateral closure of the lambdoid suture, accompanied by unilateral flattening of the occiput, may be mistaken for LP. When unilateral

lambdoid suture synostosis is viewed from above, a trapezoidal head shape is noticeable. In contrast, a more parallelogram-like displacement impresses in LP, due to a possible protrusion of the forehead on the side of the occipital flattening. In the view of the occiput, there is a parallelogram-like displacement in lambdoid synostosis caused by a contralateral protrusion of the parietal region and an inferiorly displaced petrous bone with a depressed ear ipsilaterally. In LP, the view of the occiput usually reveals an inconspicuous head shape. A fundamental problem of all studies on this topic is the question whether a developmental delay is a cause or a consequence of a skull deformity. Reliable data on this issue do not yet exist. Numerous studies show methodological problems (inhomogeneous patient groups, missing control groups) and different influencing variables (among others socioeconomic status and intelligence quotient of the parents, individual support). These criticisms are also echoed by Weissler et al. They see developmental delay only as a risk factor and not as a consequence of positional cranial deformity. An association with increased intracranial pressure has not been described. The extent to which positional asymmetries affect the development of the jaws, dentition, and possible malocclusions is insufficiently studied. A relationship between LP and lateral cross-bites might exist, but is not certain. While an increase in incidence is observed up to 4 months of age, a decreasing number of affected children is seen in the further course up to 24 months of age. The incidence has been reported to decrease to 3.3% at 2 years of age. In a recent prospective epidemiologic study from the Netherlands, mild asymmetry was detected in 19% of children 5.5 years of age, with moderate to severe skull deformity accounting for 1%. A study of 14- to 17-year-olds born after the introduction of the positioning recommendation showed a prevalence of 2.1%. Unfortunately, this study did not further investigate a possible burden of the existing asymmetry. Furthermore, it is unfortunately completely unclear which criteria determine a favorable or unfavourable spontaneous course. The large variations in available studies on incidence and spontaneous progression may be explained by different age or different methods (clinically descriptive or cephalometric) in recording as well as differently composed patient groups. While few studies assume that existing asymmetries improve or even completely normalize without treatment, the majority of studies recommend therapy according to stage. A discussion with parents should promote understanding about possible development and thus prevention of positional deformity. Even if psychosocial considerations are in the foreground in the case of position-related cranial deformities, it is not yet possible to make a statement about consequences beyond this. Contact from different sides, for example when holding the child or the alternating orientation of the bed to the window or door, already has a preventive effect. In addition to this alternating contact, the unloved side can be consciously encouraged as a corrective and thus already therapeutic approach. A child's preferential attitude can also arise if the parents prefer one side. Therefore, the observation that the right side is more often affected could be explained by the fact that the majority of parents are right-handed. Daily abdominal positioning ("tummy time") of awake infants under observation for 3 to 30 minutes, depending on the literature, also reduces the risk of developing a positioning-related cranial deformity.

MEASUREMENT OF PLAGIOCEPHALY

A cranial index or cephalic index (CI = maximum cranial width SD x100/maximum cranial length AP) between 79% and 83% or between 76% and 81% is mentioned as the norm. In gynecology, the dolichocephalic skull is considered the norm postnatally. It is observed in about 80% of new-born infants. There is a consensus in gynecology that dolichocephalus and brachiocephalus are normal intrauterine skull shapes with regard to the birth

process. The brachiocephalic skull is considered normal as long as no developmental disorders are present - in the case of developmental delays or premature suture occlusion, it is considered a conspicuous skull shape. There is a consensus in the pediatric literature when speaking of "norm values" which refer to the circumference, length and width growth of the child's skull postpartum. These norm values are presented in the growth percentiles. As far as the cranial measurements concerning the time of birth are concerned, they are given in the same way in the pediatric and gynecological literature. In addition to the clinical description, the oblique diameter, position, width, and circumference of the head are recorded by common cephalometric measurements with a tape measure and pelvic compasses. This measurement, performed directly on the head at anthropometrically defined landmarks, is considered reliable but may be subject to error in restless infants. Moss and Mortenson et al. define cranial vault asymmetry (CVA) as the difference between the largest and smallest skull oblique diameters. A CVA<3 mm is considered physiologic, a difference ≥ 3 and ≤ 12 mm is considered moderate ("mild to moderate"), and a difference > 12 mm is considered severe ("moderate to severe") asymmetry. While CVA is measured without defined angles, Loveday et al. determine the so-called Cranial Vault Asymmetry Index (CVAI). For this purpose, two diagonals angulated at 30° to the median-sagittal plane on both sides are used. The CVAI is calculated by dividing the difference in length of these two diagonals by the larger diagonal. Values below 3.5% are considered physiological. Radiation-free surface scanning techniques are suitable for capturing the three-dimensionality of the skull, and 3-D stereo photogrammetry has become established as a fast, reproducible, and precise method.

Synchronized photographic cameras with an acquisition time of less than 1.5 ms are used to generate a radiation- and artifact-free 3-D image of the head. These data sets are used for advanced diagnostics, progress monitoring, and simultaneously as a matrix for the fabrication of custom-made head orthoses.

THERAPY

The spectrum of treatment includes different approaches, which should build on each other if therapy is started in time. Against the background of different wishes or expectations of the parents regarding a beautiful head shape, medical and cosmetic aspects have to be weighed up. The simplest therapeutic approach is a positioning therapy carried out by the parents. In the supine position, active alternating positioning or positioning to the unaffected side of the head is suitable, especially before 4 months of age. With moderate LP, this can already normalize the head shape. Positioning aids such as pillows are described in some studies as useful therapy, even comparable or superior to physiotherapy. However, current guidelines for the prevention of sudden infant death syndrome explicitly state that infant beds should be free of pillows or similar items. Thus, positioning therapy is clearly recommended, whereas positioning aids are discouraged.

Physiotherapy

Head movement restrictions are common causes of LP, so they should be treated early. Although no optimal start of treatment can be derived from the literature, according to CNS guidelines, starting additional physiotherapy or manual therapy as early as possible can further reduce the incidence and prevalence of LP. Possible forms of physiotherapy include passive stretching or therapy approaches according to Bobath or Vojta. For detailed discussion of physiotherapeutic approaches, refer to the appropriate guidelines. Physiotherapy performed in addition to positioning or helmet therapy shortens the duration of therapy and improves outcomes in severe forms.

Children younger than 6 months of age and with a CVA<10 mm should initially be treated with positioning therapy as well as physical therapy only. This normalized 77.1% of the existing asymmetries in a study of 4378 children.

Head Orthosis (Molding Helmet Therapy)

A custom-made, pressure less head orthosis models physiological growth by allowing growth in deficient areas and inhibiting growth in areas that are too prominent. This allows passive harmonization of the head. The wearing time is 23 hours per day. Possible risks of head orthosis therapy are skin irritations or pressure points. Problems due to the weight of the orthosis (about 150-180 g) are not to be feared. To our knowledge, possible psychosocial impairments of children due to head orthosis have not been investigated yet. The cost of head orthosis therapy is approximately 2000 Euros. Compared with positioning and physical therapy, head orthosis reduces existing deformities more efficiently in a shorter time. The only randomized trial shows no advantage of helmet therapy over positioning and physical therapy. However, severe cranial deformities were excluded, which unfortunately limits the power of this study. In contrast, the numerically largest but retrospective study showed superiority of head orthosis therapy (95% normalization of asymmetry) over positioning and physical therapy (77.1%). If diagnosed early, positioning and physical therapy may be sufficient. In these cases, helmet therapy should be started only if the asymmetry parameters have not improved after 4 months. Further prospective randomized studies are needed. While LP therapy significantly improves CVA, the ear axis usually corrects only to a lesser extent. For the duration of helmet therapy, continuation of physiotherapeutic measures is reasonable, especially in case of persistent movement restrictions. In principle, head orthosis therapy is recommended for pronounced cranial deformities around 6 months of age. However, in recent studies, earlier onset is associated with better outcomes in severe forms. Therapy can be started as late as the end of 1 year of age, although this late onset may compromise treatment success. Taking into account growth dynamics, previously untreated infants beyond 7 months of age with a CVA > 12 mm or a clearly perceptible deformity should be treated immediately with a helmet. Surgical treatment of positional cranial asymmetries is not justified, except for extremely rare indications based on cosmetic-social considerations.

CONCLUSION

To date, there are no clear recommendations for molding helmet therapy in Germany. Moreover, there are many cases known, which resolve spontaneously with time. In the treatment of positional cranial deformity, the earliest possible and stage-appropriate intervention is important. In addition to initial parental education, targeted positioning measures and physiotherapeutic interventions may already be effective therapies. Although treatment with a modeling head orthosis is very effective, it should be reserved for therapy-resistant and severe forms. Parents' concern about positioning-induced cranial deformities should in no case lead to disregard of the reasonable recommendation for supine positioning.

Insurance coverage of helmet therapy is unclear. It depends on individual policies, coverage companies and the engagement of the treating paediatrician. Overall, change scores do exist, which are equal in both plagiocephaly and brachycephaly.

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