|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Study (Year) | Study design | Participants/  Target Audience | Treatment/Objective | Main Outcomes | Additional Remarks |
| Lennartsson  et al. (2016)1 | Cross-sectional survey within an intervention study | 26 health care centers in Skaraborg County; 272 parent respondents; 180 in intervention group (all participating nurses, infants, & parents in the clinic exposed to the project) & 92 in control group (where no nurse had any previous exposure to project) | An educational program taught guidelines of nonsynostotic plagiocephaly (NSP) prevention to child health nurses working with parents of infants. Program included instructing the nurses to relay detailed recommendations to parents at infant age 2-weeks old, complete monthly infant cranial asymmetry assessments for at least 4 months. New recommendations included: how to prevent, reverse, assess, when to refer to MD, & what to teach parents. New details included how to decrease pressure on head when infant is awake, how to make tummy time more tolerable, & suggestions to relieve already flattened spots. Control group had child health nurses work typically, using Swedish National Board of Health and Welfare recommendations. Both groups had nurses inform parents about cranial asymmetry prevention when they thought appropriate (first home visit, first clinic visit, & any child health clinic visit). | Significantly higher percentage of parents in intervention group were aware of regular recommendations than control group in alternating direction of infant’s head when putting to bed, when pillow is appropriate to use, & when to remove pillow. A significantly higher percentage of parents in intervention group were aware of new recommendations (limiting time in car seats, limiting infant bouncer time, avoiding putting head on hard surfaces, & changing arms during feeding). Parents in intervention group found information was easy to understand, helpful, had better understanding of why to complete these recommendations | NSP peaks at 4 months; risk for permanent asymmetry at 6-months; intervention can occur during a window of time when the cranium is less calcified & growth is rapid; American Academy of Pediatrics (AAP) recommends primary care providers to counsel parents starting 2-4 weeks old  Educating providers, who teach parents, helps increase parent’s awareness of what to do & how to safely assist in NSP prevention |
| Wittmeier and Mulder (2017)2 | Research Commentary | As this was a commentary of current research, clinical experience, and existing literature, there were no participants, but rather a target audience of pediatricians | Providing a synopsis of research on three main points health care providers should know: communicate “back to sleep, tummy to play”, early detection importance, & plagiocephaly is a marker for developmental risk. | With the Back to Sleep Campaign, almost half of caregivers never put babies on their tummies, with emphasis of tummy time put to the side of Sudden Infant Death Syndrome (SIDS) prevention. When primary care providers equal emphasized “back to sleep, tummy to play”, referral patterns for plagiocephaly/torticollis significantly decreased.  Examination of skull shape and neck range of motion should be routine newborn assessment so parents can use positioning and handling suggestions more quickly and efficiently. When incorporating infant handling/positioning intervention, presence of plagiocephaly dropped significantly at 3 months and was half of the presence in parent groups who were being taught SIDS prevention alone.  Cognitive and motor developmental delays have been linked to plagiocephaly up to 36 months of age due to environmental positioning and underlying central nervous system dysfunction. | The Back to Sleep Campaign was introduced to the U.S. in 1992.  Supervised tummy time is most efficient in developing neck strength in a safe environment.  The Canadian Pediatric Society (CPS) suggests well-baby checks at 1st week, 2 & 4 months to include positional plagiocephaly evaluation |
| Linz et al. (2017)3 | Literature Review | Primary care providers, health care providers working with infants | Highlight the pathogenesis, potential risk factors, symptoms, diagnosis, and treatment for positional skull deformities | Volume of the cerebrum doubles within first 6-7 months of life, with the skull being easily moldable to allow for growth and subject to deformation.  Risk factors: male sex, 1st child, young parents, low education, abnormal intrauterine positioning, traumatic birth, large birth weight, prematurity, large head circumference, supine positioning, torticollis, side preference, lack of changing while feeding, no/little tummy time, developmental delay.  The infant’s cranium is evaluated on clinical description, diagonal diameters, position, width, & circumference. Cranial vault asymmetry (CVA) is noted, with >/=3 mm to be considered mild-moderate asymmetry deviation and >/12 mm is moderate to severe. Imaging using radiation-free scanning can be used for exact and reliable measurements.  Prevention through early parent education before the infant is 4 months old is inexpensive, simple, and effective.  Positioning aids should be used with caution as SIDS guidelines state beds should be free from all pillows or cushions.  Cranial remolding orthosis use is effective, but should be considered in severe cases or late diagnosis. | Rate of skull deformities decrease with age, indicating the importance for early intervention.  Deformities: unilateral flattening of occiput, forward ear shift, forehead prominence, facial asymmetry, & compensatory temporal prominence or vertical occiput growth  CVA = the difference between the largest and smallest diagonal diameter of the skill  3-30 minutes of supervised tummy time helps reduce the risk of plagiocephaly development.  Most existing studies have big limitations: small number of patients, lack of control groups, selection biases, & few prospective studies. This may be due, however, to the ethical nature in working with this population. |
| Ballardini et al. (2018)4 | Prospective cohort | Healthy infants presenting to Ferrara University Hospital at 8 to 12 weeks of age | 283 infants presenting to the clinic were examined for prevalence of positional plagiocephaly (PP) using the Argenta’s assessment tool (Type I: posterior flattening of skull, Type II: adds malposition of ipsilateral ear, Type III: adds forehead deformity, Type IV: adds malar deformity, Type V: adds vertical or temporal compensatory growing). Parents also provided demographic and perinatal data to identify risk factors. | 37.8% of infants had PP, with higher rates on right side (64.5%). Head circumference and maternal age correlated with PP presence. Infants born at earlier gestation age were at greater risk for PP development. Amongst infants with PP, 69% had a side preference in first weeks of life. 63.3% of parents performed tummy time, 49% of parents reported being informed of its importance, and only 8.5% of parents alternated head position in cribs | The study was performed using healthy infants, excluding for pre-term infants. Prevalence of PP tends to be higher in pre-term infant population. |
| Martiniuk et al. (2017)5 | Systematic Review | 19 articles were reviewed for the use of both parents and clinicians to guide screening, early intervention, and determine prognostic outcomes | Articles were reviewed for the association between plagiocephaly and developmental delay. Inclusion criteria: all study design types, participants 0-18 years old, PP or brachycephaly, articles reporting developmental outcomes (motor, language, cognition, adaptive behavior). Exclusion criteria: studies summarizing info about PP, synostotic plagiocephaly, letters, editorials, not published in English | All 6 of the studies with the highest level of evidence (marked by a score of 6-7/7 on a critical appraisal tool) found association between plagiocephaly and developmental delay from 6 months to 3 years. These delays include motor, language, cognition, and parent report. Without regard to quality of the study, 68% saw an association between PP and developmental delays. The most commonly reported delay was motor, followed by language. Stronger associations were found in infants less than 2 years old. Early intervention focusing on motor-based strategies are effective in reducing CVA. | Prevalence varies from 22.1% at 7 weeks age to 3.3% at 2 years old. It can range from 8.2% to 48% of infants, depending on age and criteria.  PP is associated with delayed development in gross and fine motor skills, problem solving, and personal social skills.  Head control is considered to be a key component of early development. |
| Lam et al. (2017)6 | Retrospective cohort | All healthy infants <1 year old who entered a treatment program for positional cranial deformation at Texas Children’s Hospital between 2007-2014. 552 patients completed treatment & obtained scans. | History of infants were gathered, including prenatal constraint, preferred sleeping positions, swaddling use, and positioning strategies. They were screened for torticollis & underwent cranial measurement using a 3D laser surface scan at the start and each visit. Oblique diagonal difference (ODD) and cephalic ratio(cranial width divided by cranial anterior-posterior length) were recorded. First and last visit values were compared.  Infants 1-4 months with ODD >10 mm were recommended repositioning therapy (RP) & physical therapy (PT) if torticollis was present. If head shape did not improve at 4-6 week follow-up, cranial orthosis (CO) was recommended. If infant was 4-6 months old initially with previous intervention, cranial orthosis was recommended, with RP/PT otherwise. Most infants received conservative management initially and referred for CO if there was no change or worsening at the 4-6 week follow-up. If infants were 7-9 months old, time between RP/PT and CO prescription were shortened due to slowing in velocity of head growth based on previous research. CO therapy would end at 12 months of age and RP/PT at therapist’s discretion. | 543 infants (54.8%) were initially given RP/PT, at average 6.1 months old. Average age suggested for CO was 6.4 months. More severe cases tended to transfer to CO from RP/PT, with the majority (86.2%) being able to be treated conservatively. CO was well tolerated by infants, with compliance at 95.2%. Significant factors influencing outcomes were corrected age at presentation and type of treatment received. The CO group had the largest ODD change, reflecting severity of initial presentation. Authors found that age at initiation and severity of deformation play the largest roles in choosing treatment and determining outcomes. | For PP, an ODD <10 mm is mild, 10-15 mm moderate, & >15 mm severe.  As a child reaches 7-9 months, velocity of head growth starts to slow down, closing on window of opportunity for conservative intervention. |
| Aarnivala et al. (2015)7 | Randomized Control Trial | Subjects were recruited at Oulu University Hospital from 02/2012 to 12/2013. Infants born after 35-weeks gestation, healthy enough for intensive intervention, lived within 30-min of Oulu University Hospital, & no cleilopalatoschisis, craniosynostosis, or dysmorphic features were included. | All infants had an initial physical exam 26-72 hours after birth, and randomized into either intervention or control group. Infants had a follow-up visit at 3-months age, where they had another physical exam. Parents of intervention group underwent a 15-min session with a neonatologist detailing recommendations for infant environment, positioning, and handling, as well as a printout. If infant started to show preference, parents were instructed to place objects on opposite side, change handling, feeding, and sleeping side to encourage movement as well as stretches for cervical muscles. Parents of the control group received traditional guidance on infant handling before hospital discharge, i.e, putting infant to sleep on their back.  45 infants in intervention group and 52 in control group were analyzed. | Infants in the intervention group spent significantly more time on the floor than in carriers, car seats, and bouncers, when compared to the control group. Infants in control group had more hanging toys and toys placed asymmetrically. 11% of infants in the intervention group, compared to 31% of infants in the control group had deformational plagiocephaly (DP) in 2D analysis, on 3D analysis 15% of intervention group, compared to 33% of control group, had DP. Diagonal difference was higher in control group (*p*<0.05). Boys had higher occurrence of DP and flattening was more common on the right side. Late pre-term infants had higher imbalance than longer gestation infants. Infants with DP had lower scores in motor development than infants without DP, with no significant difference between groups. | Recommendations include: sleep on infant’s back, alternating head positions nightly, setting up environment to not limit infant movement, spreading out toys on floor to encourage interaction in all directions, place infant’s head or feet towards a source of light, alternating handling sides, supervised tummy time, and minimal time in bouncers. |

General Findings:

Risk factors for plagiocephaly and torticollis are variable in extent of their influence, with the most prevalent risk factors being prolonged supine positioning, pre-term infants, little to no tummy time, and lack of parent education. Early parent education and positioning therapy seem to be the simplest and most cost-effective prevention/intervention method, with referral to physical therapy and potentially cranial remolding orthotic use depending on severity and time of diagnosis. Most effective parent recommendations to prevent and early treat plagiocephaly with or without torticollis include changing infant positions while feeding, changing direction of head while sleeping, limiting time in car seat or other positioning device, and emphasizing tummy time.

References

1. Lennartsson F, Nordin P, Wennergren G. Teaching parents how to prevent acquired cranial asymmetry in infants. *J Pediatr Nurs* 2016;31(4):e252-61. doi:10.1016/j.pedn.2015.12.010.

2. Wittmeier K, Mulder K. Time to revisit tummy time: A commentary on plagiocephaly and development. *Paediatr Child Health* 2017;22(3):159-161. doi:10.1093/pch/pxx046.

3. Linz C, Kunz F, Böhm H, Schweitzer T. Positional Skull Deformities. *Dtsch Arztebl Int* 2017;114(31-32):535-542. doi:10.3238/arztebl.2017.0535.

4. Ballardini E, Sisti M, Basaglia N, et al. Prevalence and characteristics of positional plagiocephaly in healthy full-term infants at 8-12 weeks of life. *Eur J Pediatr* 2018;177(10):1547-1554. doi:10.1007/s00431-018-3212-0.

5. Martiniuk ALC, Vujovich-Dunn C, Park M, Yu W, Lucas BR. Plagiocephaly and developmental delay: A systematic review. *J Dev Behav Pediatr* 2017;38(1):67-78. doi:10.1097/DBP.0000000000000376.

6. Lam S, Pan I-W, Strickland BA, et al. Factors influencing outcomes of the treatment of positional plagiocephaly in infants: a 7-year experience. *J Neurosurg Pediatr* 2017;19(3):273-281. doi:10.3171/2016.9.PEDS16275.

7. Aarnivala H, Vuollo V, Harila V, Heikkinen T, Pirttiniemi P, Valkama AM. Preventing deformational plagiocephaly through parent guidance: a randomized, controlled trial. *Eur J Pediatr* 2015;174(9):1197-1208. doi:10.1007/s00431-015-2520-x.