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Positional plagiocephaly among tribal societies and contemporary western societies: a comparison of treatments, results, and effects

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**POSITIONAL PLAGIOCEPHALY AMONG TRIBAL SOCIETIES AND
CONTEMPORARY WESTERN SOCIETIES: A COMPARISON OF
TREATMENTS, RESULTS, AND EFFECTS**

**A Thesis Submitted
in Partial Fulfillment
of the Requirements for the
University Honors Program**

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ABSTRACT

This study explores the two causes of positional plagiocephaly, or abnormal head shape in infants as well as effects and treatments. To do so, two groups were chosen for comparison: contemporary western societies and tribal Native American societies. In the first group, the medical condition known as positional plagiocephaly is considered before, during and after the Safe to Sleep campaign of the 1990's. In the second group infant head flattening is discussed as a result of cradling practices and carrying techniques. The importance of this study is to contribute new insight into positional plagiocephaly and its treatments. The study combines materials from those attempting prevention and correction of this condition, as well as providing information for those wanting to further study positional plagiocephaly and its effects.

INTRODUCTION

This study describes the etiology of positional plagiocephaly (PP) for both tribal Native American societies and contemporary western societies. A comparison between past and present positional or accidental plagiocephaly has not been made. A need for further anthropological research is necessary to examine PP in a multidisciplinary approach.

Positional Plagiocephaly (PP) is a condition that few parents are aware of. With this research I want to introduce a comprehensive study and comparison of the causes and effects of PP. The problem I address in my thesis is the high rates of children showing significant signs of PP since the development of the “Safe to Sleep” or “Back to Sleep” campaign. The campaign was developed in the 1990’s by the National Institute of Health. A comparison of positional plagiocephaly in contemporary and prehistoric North America and benefits or detriments of various PP treatments available were examined. Throughout my research I examined cases such as those found in the Southwest Pueblo tribes and Ozark bluff dwellers, as well as modern societies in the United States.

Many of the effects of positional plagiocephaly are aesthetic; however, delayed gross motor skills have been noticed in infants being placed in the supine position (Robertson 2011). An increase in supine positioning occurred after the “Safe to Sleep” campaign was implemented in the early 1990’s. The campaign that began in 1992 recommended children be placed in supine position to sleep in order to prevent Sudden Infant Death Syndrome or SIDS. This led to increased occurrence and awareness of PP. Before the safe to sleep campaign began, PP was prevalent in .003% of births. After the campaign this increased to 8.2% of all live births (Lee et. al 2008), a 3.2% increase (McKinney et. al. 2008). In tribal societies that used cradling and carrying techniques with hard materials, multiple infants showed morphological characteristics of PP. According to Kelley et. al. (1999), environmental factors other than cradleboards may include a premature birth, restrictive intrauterine environment, muscular torticollis or other subtle neck muscle injuries, lack of full bone mineralization, and/or birth trauma.

Study of PP is important for physical, cultural, and archaeological anthropology. Knowledge of PP risks and effects are important in the study of the health and medical anthropology of infants. Research of PP is also important in the study of its cultural effects within concepts of psychology and sociology, as well the study of the culturally defined norms and beauty. Cultural practices that are imposed upon the malleable infant skull are an intriguing marker of a society's practices with regards to child care.

RESEARCH QUESTIONS

In order to address my topic I will answer the following questions:

1. What are the differences in cranial morphology found in the cradling techniques of tribal societies from North America within the United States versus contemporary western societies?
2. Are there significant cognitive, behavioral, and motor function effects from positional plagiocephaly?
3. Are the modern treatments for positional plagiocephaly effective and are there similar treatments recorded that were used in tribal societies of North America within the United States?

METHODOLOGY

I used meta-analysis, or secondary research, of various academic resources to create a compendium of knowledge to better understand the phenomenon of positional plagiocephaly. While examining the sources used I looked into cause and effect, cradleboards versus cradle mattresses, locations where this phenomenon occurs, types of cushioning available, and when this phenomenon occurs, the effects on the infant's life as well as the parents' lives. By using coding, or quickly looking for key words, I was able to look through many articles faster. I coded for words such as cradleboards, mattresses, infant deformation, infant skull abnormalities, deformational plagiocephaly, accidental plagiocephaly, and positional plagiocephaly. Resources that examined contemporary societies and prehistoric native societies within the United States were researched. Through my research I conducted a literary analysis. With this research the hope was to accomplish a new analysis on and a compendium of information for positional plagiocephaly by comparing separate instances throughout the United States.

LITERATURE REVIEW

Positional Plagiocephaly: cause, demographics, and effects

Plagiocephaly is a general term used to describe a medical condition for patients with cranial asymmetry (Lee et. al. 2008) (see Image 1). Kelley et. al. (1999) define positional plagiocephaly (PP) as the asymmetrical condition of the head arising from extrinsic molding rather than intrinsic synostotic events. In the early to mid-1990's positional plagiocephaly had been defined as having an abnormally flat head shape (Miller et. al. 2011). *Plagiocephaly* itself is derived from Greek meaning "oblique head" (Laughlin et. al. 2012). According to Junior League of Erie (2008), a more current definition of positional plagiocephaly is the "asymmetrical shape of the head caused by repeated pressure to one side of the back of the head." With the development of PP, a child's head can show abnormalities. A child's head can become flattened during sleep on the preferred side of the head.

Plagiocephaly occurs while an infant's skull is the most malleable: within the first three months after birth (Steinbok and Mortenson 2008). In addition to the infant having an oblique head from the effects of positional plagiocephaly, infants can also experience ipsilateral frontal bulging, meaning a bulge in the front of the skull on the same side as the occipital deformation, and ear displacement (Lee et. al. 2010). A study by Meyer-Marcotty et. al. (2012) states that unilateral positional plagiocephaly is the most common infant head deformity. Within the last ten years an increase of up to 600% in plagiocephaly referrals were reported in both craniofacial centers and primary care providers in the United States (McKinney et. al. 2008).

The main cause of PP studied today is extensive supine positioning, or the infant laying on its back. PP may occur more in infants subject to intrauterine constrain and subtle neck muscle injuries (Lee et. al. 2008), postnatal positioning or even a predisposed condition of a flat spot on the head (McKinney et. al. 2008). It is suggested that these other factors may play a role in the development of accidental or positional plagiocephaly, rather than solely supine positioning (McKinney et. al. 2008). The hard

materials and resources used to make cradleboards were a cause of PP in tribal societies of North America.

A study by Elwood et. al. (2005) stated that a majority of children entered into PP treatments are boys. This study stated that “consistent with prior literature, there were a majority of boys entered into the study,” (2005:342). Despite the thought that twins represent a potential cause of deformation, only two sets of twins were in this study. Males represented over 70% of children enrolled, while females only represented 29.3%. In a separate study by Korpilahti et. al. (2011), out of 61 subjects, 66% were male. In a study by Shamji et. al. (2012), 65% of patients were male. The sex of the child appears to be substantial factor in the development of PP.

Few cognitive, behavioral, or motor function risks lie in having PP. A study by Dennis and Dennis (1940a) generated results that showed there were no effects on the onset of walking after the infant had been held in a cradleboard for at least three months. In a separate study done by Korpilahti et. al. (2011), 25% of non-operated PP patients were found to have severe problems in receptive language skills. This is opposed to all operated-on deformational posterior plagiocephaly patients in the study having normal language comprehension. A study by Lee et. al. (2008) found that after a median of 5.6 years post-treatment, children who had used helmet therapy, or orthotic therapy in an effort to reduce the plagiocephaly, in their infancy still showed some deviations from the normal development. Out of 28 patients in their study, 19 showed chin point deviation toward the unaffected side with respect to occipital deformation. This means that if the child showed right posterior deformation in infancy, the chin deviated towards the left. For all of these 28 patients, there was a statistically significant negative correlation with cranial vault asymmetry and chin deviations. In addition to chin deviations, the Lee study also examined dental midline deviations. Lower dental midline deviations were found in 89.5% of the patients. In a study by Shamji et. al. (2012) those with left-sided deformities were predicted to have poorer language development and academic performance. Speech abnormalities occurred in twice as many patients with left-sided deformities compared to those with right-sided

deformities.

The main effects from positional plagiocephaly are cosmetic such as malformation of the head. A top view of the effects of PP on an infant's head can be seen in Image 2. However, these cosmetic effects can lead to psychosocial problems. Among these are insecurity, low self-esteem, and bullying or teasing during the school years (Mawji et. al. 2013). Unfortunately, these psychosocial problems are the result of a societal view of what is beautiful and what should be normal. Studies have been done to determine the satisfaction of parents after treatment of positional plagiocephaly (Elwood et. al. 2005). This shows that there is a major concern from parents about their child's head shape before and after the treatment of PP. Because the word *beautiful* is culturally defined, positional plagiocephaly is often looked upon as abnormal in child development and is a concern for parents.

Safe to Sleep Campaign

In the 1980's many children began dying in infancy due to Sudden Infant Death Syndrome, or SIDS (National Center for Chronic Disease Prevention and Health Promotion 2014). In 1986, 2.6 children per 1000 were dying from SIDS (Graham 2007:160-161). Common causes of SIDS can be suffocation, overlay, wedging or entrapment, and strangulation. Known risk factors include sleeping on soft surfaces, sleeping on the stomach, and sleeping under loose bedding (National Institute of Health 2013). The "Safe to Sleep" campaign arose from a need to reduce the risk of (SIDS). The "Safe to Sleep" campaign, formerly known as the "Back to Sleep" campaign (National Institute of Health 2013), began in 1992 by the American Academy of Pediatrics (Graham 2007:160-161). After the "Safe to Sleep" campaign, SIDS mortality rates decreased from 144 deaths in 1999 to 76 deaths in 2004. This was an eight percent decrease over five years (Mawji et. al. 2013).

After health care providers realized what was causing SIDS, the government started the "Safe to Sleep" campaign to educate parents around the U.S. The "Safe to Sleep" campaign originally stated concepts such as laying the infant on its side or back

at night (Graham 2007:160-161), switching to firm crib mattresses, and uses tight fitting sheets (National Institute of Health 2013). However, after SIDS was still seen in the infants, the campaign changed the suggestions in 1996 to solely placing the child on its back during sleep, excluding side sleeping (Graham 2007:160-161).

The supine position recommendation came from the American Academy of Pediatrics. Because infants were now being laid on their back in the supine position, a rise in positional plagiocephaly was seen (McKinney et. al. 2008). The relationship between PP and sleep positioning can be seen in Image 3. A 1984 Swedish study showed a higher percentage of children sleeping in the supine position had a positional preference compared to those sleeping in prone position, or on their stomach (Graham 2007:160-161). Since the 1990's doctors and practitioners have seen an increase in incidents of PP throughout the United States. However, it was not until 1997 that the American Academy of Pediatrics acknowledged plagiocephaly as a complication of the supine sleeping recommended, 3 years after the "Safe to Sleep" campaign started (Miller et.al. 2011) and one year after the American Academy of Pediatrics changed the suggestions of the campaign to exclude side sleeping (Graham 2007:160-161).

Treatment and Diagnosis

There is currently no standard tool for assessment of progress or efficacy described in the literature (Lee et. al. 2010). Steinbock and Mortenson (2008) states the proper way to diagnose PP is to stand behind the infant and look down from above to determine if there is flattening of the head on a particular side. The physician is also to place their fingers in both of the ear canals of the infant to further determine if the plagiocephaly corresponds with the anteriorly positioned ear. Fish (2004), used visual and manual exams, as well as clinical measurements of the cranial vault, skull base, and upper face in her clinical study. To maintain a watchful eye on the progress of PP in an infant's care, measurements are recommended at the beginning, end, and every 4-6 weeks of PP treatment. To assess language acquisition, Korpilahti et. al. (2011) used a

certified speech-language pathologist to perform the assessments of development on the subjects. Other studies, such as that by Lee et. al. (2010) used an internet-based questionnaire to gather information on treatment recommendations.

Repositioning

Incidences of plagiocephaly decrease at older ages and improvement can be seen with normal growth and development of the children. However, there can be some clinical, physical, and cosmetic consequences of positional plagiocephaly. According to Cartlidge and Rutter (1988), two clinical consequences of PP include a misleadingly high measurement of occipitofrontal circumference and cosmetic consequences. Not all skulls correct themselves with further growth and development. There are many skulls that need further treatment by implementing cranial molding headbands and helmets, as well as repositioning the head of the child while in supine position (Steinbok and Mortenson 2008). It is recommended that repositioning be used in children under six months of age as their skulls are still malleable. This malleability allows for alternate pressure to reverse the effects PP. The repositioning of the child's head will in turn correct the occurrence of plagiocephaly (Steinbok and Mortenson 2008). Repositioning can have a significant positive effect if it is performed early and done with diligence (Fish 2004).

When the infant is five to six months of age, repositioning starts to lose its effectiveness and activities such as "tummy time" and "awake and up" strategies can be implemented. In addition to repositioning and other activities, Fish (2004) suggests rearranging furniture to encourage opposite head rolling, limiting time in carriers and swings, and creating feeding positions that limit forces to the posterior region of the infant's skull.

Cranial Orthotics

Kelley et. al. (1999) defines orthosis as a proprietary thermoplastic construct. Orthotic helmets and bands are used to treat PP after repositioning has been attempted

(Steinbock and Mortenson 2008). An example of a cranial orthotic helmet can be seen in Image 4. An age of five to six months is where cranial molding headbands or helmets are useful in corrective procedures. Improvements past repositioning are occasionally possible with various cranial remolding orthosis, or cranial molding helmets and headbands. However, further improvements are not likely after the age of 12 months, when the skull becomes increasingly less malleable (Steinbok and Mortenson 2008).

After repositioning treatment of PP has started, a follow-up exam should show improvement at 3-4 months of age. If no improvement is shown, a cranial remolding orthosis is recommended. The earlier the orthosis is introduced the more effective its treatment will be (Fish 2004). According to a study done by Kelley et. al. (1999), the initial severity is significant with the amount of correction seen during treatment of PP using head orthotics, whereas the length of treatment does not hold as much significance.

Recently, 3-D imaging has been used to generate a standard database of infants without head deformities. An example of 3-D imaging can be seen in Image 5. This was used to better evaluate the effectiveness of growth control using head orthotics. A recent study of 20 plagiocephalic infants determined that head orthosis therapy led to significant improvement of the asymmetry (Meyer-Marcotty et. al. 2012).

There are many orthotic companies that exist and make cranial orthotic options. Cranial orthotic options can be costly depending on which company is producing the orthotic as well as whether or not an insurance plan will cover the costs. A study by Lee et. al. (2010) showed that neurosurgeons were less likely to recommend helmet therapy when cost was taken into consideration. The cost of helmet therapy can be anywhere from \$1500 to \$3000. This study also determined that helmets manufactured by local orthotics were more likely to be recommended by neurosurgeons and plastic surgeons alike.

One not-for-profit facility in Minnesota was the first not-for-profit orthotic facility to receive FDA clearance. The use of these orthotics is directed by the physicians of the craniofacial team in St. Paul, Minnesota at Gillette Children's Hospital. The

program at Gillette Children's Hospital was established as the CranioCap program in 1999 and received FDA clearance in 2000. A study done on the parental satisfaction of this program stated that out of a random sample of parents, almost 100% would repeat the program with a subsequent child. Only three parents of 81 experienced minor complications. Fifty-one of these parents also said that their child continued to show improvement past the treatment time (Elwood et. al. 2005). Lee et. al. (2008) conducted a study that showed very little change occurring during post treatment, but significant change during helmet therapy. One hundred percent of parents in the Lee et. al. study were satisfied with the results of the helmet therapy on their child.

Surgery

Surgery in the cases of PP is rare, but can occasionally be necessary. While most clinicians agree that surgery is almost never warranted when it comes to PP treatment, there are severe cases that do necessitate surgical treatment if repositioning and orthotics have not yielded results. Most commonly surgical treatment is only used on single or multiple craniosynostosis, or premature fusion of a cranial suture (Korpilahti et. al. 2011).

Cradleboards

Despite the new treatments developed after awareness of positional plagiocephaly was raised, plagiocephaly can still be seen in adults and children around the world. There are many small tribal communities that have used cradling and carrying technologies contributing to the development of plagiocephaly, with few tribes still carrying on the traditional use today. The Nihewan Foundation for American Indian Education (2002) defines a cradleboard as "a frame, made of natural materials, used by North American Indians to carry a child. The cradleboard style varies from tribe to tribe. It is flexible in use, protective and decorative; a Native American invention much appreciated by other cultures who have adapted the idea to their own uses". An example of a Navajo cradleboard with a head guard is seen in Image 6.

In communities such as the Ozark Bluff Dwellers who lived in Southeastern United States and South Midwestern United States, both flexible and less-flexible cradles were used. In the areas of Pine Hollow, Cob Cave, and Beaver Pond Bluffs, cradles formed by folding stems of wild sunflowers over a wooden frame were used by the bluff dwellers. A cradle made by wrapping splints around a rectangular foundation was commonly found in areas along the upper White River (Dellinger 1936). A typical cradleboard of the Chippewa tribe of Minnesota is seen in Image 7. Pueblo Indians in Southwest United States used wicker cradles made of juniper, a swinging wicker cradle, or single boards with collapsible face guards (Dellinger 1936). Previous to the twentieth century, Cradleboards among the Hopi Indians of Arizona were made of woven sumac branches. During the twentieth century this practice was seldom used except in the First Mesa area. Because the woven cradle took time, labor, and skill, the Hopi Indians opted for a simpler cradleboard using a solid wood board measuring approximately one foot by two feet. A stiff heavy wire served as the face or head guard (Dennis and Dennis 1940a).

In the Southwestern Pueblo communities of the Acoma and Acomita, cradles are preferably made from a tree that has been struck by lightning. The Tewa cradle device consists of a fusion of a cradleboard and a swing (Dennis and Dennis 1940b). Cradleboards were typically made from natural materials found in the area. Often constructed of the same material as baskets, wood and bark from birch, cedar, spruce, and willow trees were common materials (Janulewicz 2006).

Cradleboards were still in everyday use among the Hopi Indians of Arizona in the late 1930's and early 1940's. All except two towns of the Hopi Indians used cradleboards regularly during that time period. Infants among the Hopi were bound to the cradleboard on the first day of life and spent nearly all of their hours bound to the board for at least the first three months of life. Hopi mothers would keep their infants in the cradleboard for an average of 9 months, while some Hopi mothers would contain their infant in a cradleboard for over a year. However, the amount of time spent in the cradleboard would gradually decrease as the infant grew older. (Dennis and Dennis

1940a). Keeping an infant in the cradleboard for an extended period of time could greatly increase the likelihood that any PP happening will be permanent in the infant.

RESULTS

After examining Native North American societies from the United States and contemporary western societies, I have analyzed the effects found in various case studies, the plagiocephalic tendencies for positioning, as well as the various treatment options available for positional plagiocephalic infants. By doing this I compared the way positional plagiocephaly can be found and viewed in Native American societies versus contemporary western societies.

Cradleboards made and used by Native Americans consisted of hard woods as backing. There was little cushion in between the infant's body and the back. The plagiocephaly that would have resulted from using cradleboards in the past would have been extremely similar to that seen in present day infants. Because of limited research on cranial measurements from past and present Native American infants, the morphological differences between Native American societies and contemporary western societies are difficult to determine. Based on knowledge of why and how PP is occurring in contemporary western societies, the PP seen in Native Americans would be very similar. When cradleboards are used, they affect the occipital area of the child's cranium in the flattening appearance typical of positional plagiocephaly in westernized societies. However, cradleboards traditionally used by Native Americans are rare in today's societies. With globalization reaching the far corners of the world, cradleboards have become obsolete amongst Native American societies today. Many are currently in museums around the country.

The result that comes from positional plagiocephaly is a head shape that is different than what is considered normal in contemporary western societies. There were few results stating any effects other than cosmetic found in infants with PP. No cognitive, behavioral, or motor function effects were found amongst tribal societies in the literature I reviewed. The study done by Dennis and Dennis (1940a) found that there were no differences in walking age between infants who had been contained in cradleboards and those who had not. A study by Korpilahti et. al. (2011) described earlier in my thesis considered the effects of PP on language acquisition. Its results

showed that PP patients treated with an operation had normal language development. Only 25% of PP patients not treated with an operation developed severe problems in receptive language skills. This shows that some problems may arise from PP, but these are not common and not always severe. For these risks there is no difference in how the child developed plagiocephaly, and henceforth no change in the risk between tribal societies and westernized societies.

Contemporary western societies have effective treatment options today for correcting PP. There are various orthotic companies able to provide helmet therapy, repositioning therapy, as well as plastic surgery. Opinions of neurosurgeons and plastic surgeons differ on which therapy should be recommended and/or is the most effective (Lee et. al. 2010). Treatment options may also differ due to price. While repositioning may not cost anything at all, cranial orthotics can be costly and often come without insurance coverage. There is no record in the literature I reviewed of treatment options amongst Native American tribes in the past because treatment options such as orthotics were not an option. However, if a Native American tribe today were to use a cradleboard, they would have the same treatment options as those found in contemporary western society.

FUTURE RESEARCH

Future research can be built off this study by basing research on the cosmetic effects of and purposes for treatments for positional plagiocephaly. The use of treatment for positional plagiocephaly is correlated to each society's conception of beauty. What would the consequences be if a child didn't get treated? What would the consequences be if none of the children were treated? Would a divide happen between children with positional plagiocephaly and those without? Parents may form higher distinctions and discriminate against those who have abnormal heads, or they may redefine what is considered normal and beautiful. These are important questions that could be answered by a follow-up cultural anthropological study of this subject.

In addition to the cultural anthropological contribution that can be made, archaeological contribution can be contrived by examining skulls of Native American tribes who used cradleboards and comparing the measurements to those of skulls in modern societies. Researchers can do bioarchaeological excavations to examine any skulls that may be deformed from the use of cradleboards. By doing this comparison, we can gain a better understanding of the daily lives of historic and prehistoric Native Americans. This understanding would come from whether or not Native American tribes attempted any correction, if a correction they attempted was successful, what effects different cradleboards would have on various tribes' skulls, and what materials caused said effects.

Opinions and biases of health care providers can be taken into account, as well as any opinions of parents. In the Lee et. al. (2010) study, treatment decisions were clouded by parental preferences and physician bias. What are the psychological effects on the children as they grow up with teasing or with the knowledge of their earlier deformation? Children may be psychologically affected by the knowledge that their parents may be proud of the result from treatments of the child's PP. Further research can be expanded into any adverse reactions of the children from knowledge that their parents thought they were "deformed" as infants.

Other research areas that can be further examined include any correlation

between the need for orthodontic care as a previously plagiocephalic infant develops further. Any connection that may be found between an infant who experiences right or left posterior PP and whether they become right or left handed is another area that may be of interest for future researchers. There may be a neurological connection between sleeping position and handedness. There are many categories of future research that can diverge off of my compilation of causes and effects found in cases of PP in my thesis.

CONCLUSION

Although many societies around the world will experience the effects of positional plagiocephaly, not all will consider PP a defect. However, in westernized societies PP has a tremendous cosmetic effect that is of great concern to parents. The flattening of child's skull is considered abnormal and unpleasant to view. Some treatments have proved most effective, including repositioning and orthotic helmets. Because there is no record that I found of tribal societies correcting any PP, this leads me to believe the cosmetic effects of PP were not a great concern for tribal societies of the United States. Dental midline deviations found in patients with PP lead me to believe that there could be a future correlation between infants with PP, or infants with PP who use helmet therapy, and children needing orthodontic care to straighten the teeth, or perhaps even surgical care to realign the jaw. A better understanding of this subject is needed to raise awareness throughout the United States of how children are being affected and how they could be affected in the future both physically and psychologically.

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Image 1.

Top view of plagiocephalic head (Seattle Children's Hospital Research Foundation 2014).



Image 2.
Top view of infant with PP (Elwood et. al. 2004).

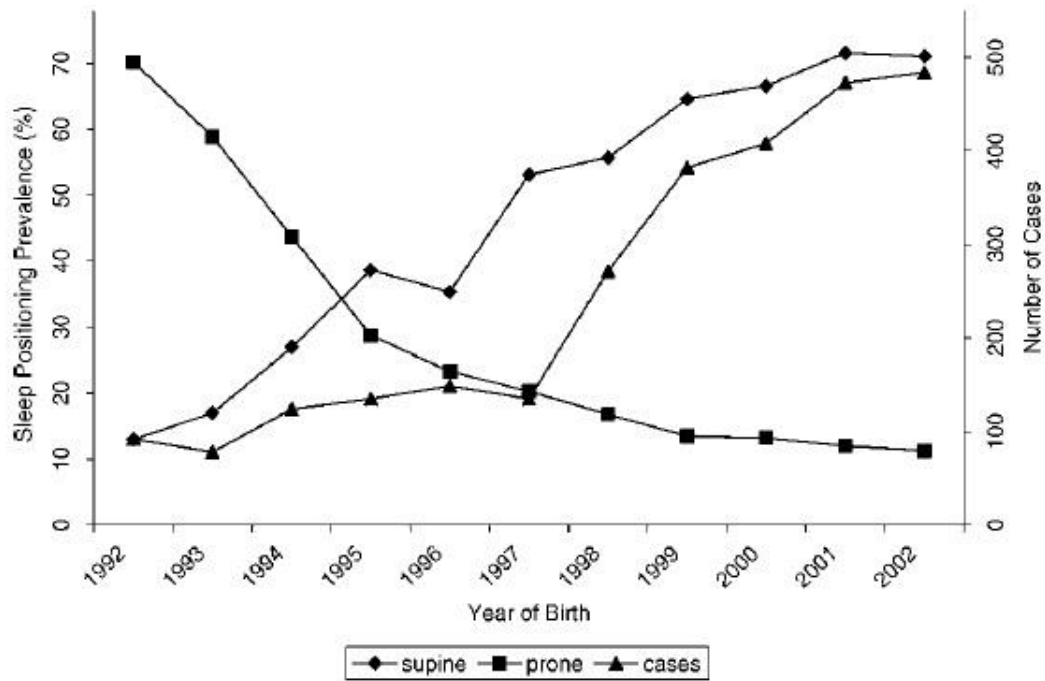


Image 3.

Graphic of changing sleep-positioning prevalence and number of cases of Plagiocephaly. Graphic made by National Infant Sleep Position Study in 2004 (McKinney et. al. 2007).



Image 4.
Finished CranioCap with adjustable Velcro tab (Elwood et. al. 2004).



Image 5.

Example of 3-d imaging of a human skull with premature closure of the right coronal suture (Ebouda 2014).



Image 6.
Navajo cradleboard with head guard (Native Languages of the Americas 2013).



Image 7.

Chippewa mother with child bound by cradleboard (Native Languages of the Americas 2013).

This Study by:

Jacinda Ruggles

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