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Annalise Worsdall

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Annalise Worsdall

Research Advisor: Alexia E. Metz, Ph.D., OTR/L

Occupational Therapy Doctorate Program

Department of Rehabilitation Sciences

The University of Toledo

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This scholarly project reflects individualized, original research conducted in partial fulfillment of the requirements for the Occupational Therapy Doctoral Program, The University of Toledo.

Abstract

The purpose of this study was to determine if there is a relationship between prone positioning equipment and infant anthropometry in time spent in prone. There were 19 infants that participated in this scholarly project. A randomized, counterbalanced design was used to place the infants in three positioning conditions (Play Mat, Blanket Roll, and Mini Boppy ©). Measurements of the infants' size were taken. Interactions were tested between the three conditions and the anthropometric measurements. The results indicated that there were no significant effects, suggesting that infants' size does not affect time spent in wakeful prone within the three conditions. These results suggest that when making recommendations for wakeful prone positioning strategies to increase infant's tolerance in prone, occupational therapists can apply the results of studies with infants of the appropriate age without concern for anthropometrics.

In 1992, the American Academy of Pediatrics (AAP) made recommendations about positioning healthy infants for sleep in supine (on back) rather than in the prone position (on stomach). This recommendation was given to help reduce the prevalence of Sudden Infant Death Syndrome (SIDS). In 2005, the American Academy of Pediatrics reported that their recommendation led to a 50% decrease in SIDS. Though the AAP recommendation was effective with reducing the occurrence of SIDS, it also resulted in a decrease of the frequency infants were being placed in a prone position throughout the day. This has brought about a new set of concerns.

Regular placement with pressure on the same spot of the skull can cause a skull deformity. An example of a skull deformity is *plagiocephaly*, which means oblique head. This can be caused if an infants' head position is not changed because pressure to the same spot results in the flattening of one side of the infant's skull (Laughlin, Luerssen, Dias, et al., 2011). One thing parents can do to decrease the chance of a skull deformity is to change the position of their infants' heads when laying them down to sleep, alternating to the left and right (Laughlin, et al., 2011). Skull deformity is not the only risk infants face as a result of supine sleeping.

Darrah and colleagues (1998) studied the development of motor milestones in 45 healthy, infants, utilizing the Alberta Infant Motor Scales (AIMS, Piper & Darrah, 1998). The AIMS assesses infant motor development in prone, supine, sitting, and standing positions. The data collection was ended when the infants reached 18 months or when all the items on the developmental test were mastered. The results demonstrated that there is variety in the timeline of motor development in normally developing infants, due to many different factors, including the interactions between the child, environment, and support system. Nonetheless, the infants tended to develop skills in a predictable order although at different rates.

Infants placed in supine when sleeping and when awake has led to the concern of delay in early milestones. Infants with limited exposure to prone positioning may have a delay in motor skills that require antigravity extension because they do not have as much opportunity to learn these skills if they are not placed in prone when awake (Russell, Kriel, Joubert, & Goosen, 2009). Examples of motor skills that can be delayed from reduced exposure to awake prone positioning during infancy are crawling and pulling up into a standing position (Russell, et al., 2009). Infants can also have problems with sitting up or rolling over. A strategy parents can use to reduce the risk of delay while adhering to the supine sleeping recommendations is called *tummy time.* Tummy time occurs when infants are awake and supervised in a prone position (Russell, et al., 2009). Tummy time is very important to the development of infants. It allows infants to accomplish their milestones. Infants who have the opportunity to sleep in supine but play in a prone position are more likely to achieve developmental milestones than the infants who do not have the opportunity to play in a prone position (Russell, et al., 2009).

A study conducted by Monson, Deitz, and Kartin (2003) examined the effects that positioning has on infant motor development in 30 infants who slept in supine. The infants were approximately six months in age and were divided into two groups, prone and non- prone, based on the amount of time the infants spent in prone daily. There were 16 infants in the prone group and 14 in the non- prone group. The AIMS assessment was used to assess the results of this study. The study's results indicated that the infants who were placed in prone when awake scored higher on the standardized gross motor assessment than the infants who were not placed in prone throughout the day.

To support neuro-motor development, parents should place their infant in the prone position when they are awake throughout the first year of life (Davis, Moon, Sachs, & Ottolini,

1998). One guideline for tummy time is that infants should be placed in prone every day for a minimum of 30 to 60 minutes while they are awake and supervised (Laughlin, et al., 2011). The prone position allows the infants to engage their extensor muscles of their neck and back, which leads to them having control over their head movements (Russell, et al., 2009). It is also important for infants to develop their strength for weight bearing positions, such as quadruped and sitting (Horowitz & Sharby, 1988). Tummy time also ensures that infants are not subjected to constant pressure to the same areas, decreasing the chance of their heads molding and encouraging muscle development in the infants' upper body (Laughlin, et al., 2011).

A cross-sectional developmental study was conducted in South Africa by Russell and colleagues (2009). This study attempted to determine "whether the back to sleep campaign had an effect on the development of babies in South Africa" (p.11). They recruited 120 healthy infants who were born at full term and who were six weeks old, with a deviation of six days. There were 61 female infants and 59 male infants. Through surveying the mothers of the infants, they found that 72% did not sleep in a prone position. A large majority, 103 infants, were classified as not being placed in the prone position or being in the prone position for too short of a period of time when awake. When compared to the infants who were classified to have spent a sufficient amount time in prone, the non- prone group demonstrated a lower skill level in head control. Only 32% of those infants could turn their heads in the prone position, compared to 94% in the prone group. Also fewer infants in the non- prone group were able to raise their head to 45 degrees when in the prone position. Other areas of difference included active arm movements and pushing in prone. Overall, the infants who were placed in prone were able to perform better than those who were not.

Together, these results support the importance of tummy time by providing evidence that infant development is affected by the awake positioning. Spending 30 minutes or more in a prone position daily supports development of strength and skills for normal development, such as head control and arm movement. Those infants who spend less than 30 minutes in awake prone positioning may have difficulty and delay in developing their strength and skills (Russell, et al., 2009). A further step to increasing the infants' ability to remain in the prone position would be to utilize equipment; however, little research has been conducted pertaining to its use.

Beyond age and positioning experience, other factors influence motor development in infants. In a large, longitudinal, multinational study, the Department of Nutrition, World Health Organization, Geneva, Switzerland and Members of the WHO Multicentre Growth Reference Study Group (2006) demonstrated that, for the most part, absolute physical size and rate of growth are not strongly associated with the obtainment of motor milestones. Rather, balance between infants' body segments, muscle strength, and gravitational forces results in them being able to lift their heads and chests. Jensen and colleagues (1997) conducted a longitudinal study that focused on the change in infants' body segments and how gravity affects infants' developmental milestones. The researchers demonstrated that caudal segments are proportionally larger in younger babies and decrease in proportion with age, contributing to the cephalocaudal progression of skills.

These two studies support the conclusion that infants' body size proportions may influence motor development. Infants' development is individualized, with each infant having periods of growth or a plateau period, throughout which the infant's skills should be supported. Babies with larger heads/chests (cephalic segments) may face more discomfort in prone and/or

more difficulty in obtaining prone-based milestones. Conversely, they may have greater strength, making them better prepared to work against gravity to obtain prone-based motor skills.

Anthropometry is the measurement of the physical characteristics of body segments, such as size and weight. To date, little to no research has addressed infant anthropometry in studies of practices that promote time spent in prone. However there have been studies that have assessed the role of the scale of hand size to the size of the object in determining grip configuration (Newell, McDonald, & Baillargeon, 1993; Cesari, & Newell, 2000). These two studies have helped identify a relationship between the scale of infants', children's and adults' hands to the grip configuration used to grasp objects. It is important to use objects and equipment that are *just right* for the infants so they will be successful, whether it is in their grasping or staying for longer periods of time in the prone position. Having positioning equipment that is not appropriate for the infants' body size may not be as effective.

The purpose of this study was to determine if there is a relationship between prone positioning equipment and infant anthropometry in time spent in prone. This study was conducted in parallel with a study that sought to determine the effectiveness of the prone positioning equipment for improving the amount of time infants spend in the prone position. This study is a continuation of Guidetti's scholarly project (2011). The study examined the effect of positioning three different apparatus (Play Mat, Blanket Roll, and Mini Boppy ©) has on time spent in prone.

Methods

This study was approved by the University of Toledo Biomedical Institutional Review Board of the Health Science Campus.

Study Design

A randomized counter-balanced design was used to determine the order in which infants were positioned in prone in each of three conditions (see below for descriptions of positional support conditions) in three separate sessions. Data were collected in the location of parent/caregiver's preference with options including laboratory space at the University of Toledo, child care centers, and private homes.

Participants

The population was a convenience sample of healthy infants from two and a half to four months old. Infants were recruited by flyers and word of mouth. Infants were eligible if they had no known impairments. Infants also had to be full-term and score within their developmental age-range on a standardized measure of motor development to participate in this study. A total of 19 healthy infants participated in the study.

The infants' age ranged between 2.7 months and 3.7 months (3.2±0.5). Out of the 19 infants, seven were female and 12 were male. The Posture and Fine Motor Assessment of Infant Posture Scale (PFMAI-1, Case-Smith & Bigsby, 2000) was used to determine baseline information of the infants' gross motor abilities. This test uses observation to gather information about the infant's abilities in their fine and gross motor skills. Through this assessment the infant's strengths and weaknesses are determined. The PFMAI-1 inter-observer reliability, and test, retest reliability has been determined through multiple studies. Inter-observer reliability was high in two studies, in 1989 and 1992. For both studies the evaluators were trained and the correlations were above a .97. The same correlations were found in the 1997 standardized version of the PFMAI-1 (Case-Smith & Bigsby, 1997, 2000).

The infants' PFMAI score ranged between 44.3 and 53.1 (48.7±4.4). Infants scoring in this range are typically able to maintain their heads in midline, against gravity for periods

varying in length. In prone, they can weight bear through their forearms with different elbow positions. In supine, they are able to attempt or bring their hands to midline, supported against their body.

The infants were weighed and measured, including infant's head circumference, total body length, shoulder width, humeral length, and forearm length (see Table 1). The parents of the infants were given a questionnaire regarding demographic characteristics of the infants and their families (see Appendix A). The demographic information gathered included the infants' age, any past or current medical issues, positioning history and preferences, information about other children who reside within the home, and if the infants attend day care (see Table 2).

Parents were asked about their racial/ethnic identity, level of education, and employment status. The Hollingshead Four Factor Index of Social Status scale was used to determine the parent's socioeconomic status (SES). The SES scale ranges from 66 to 8. Individuals who are near the higher end of the spectrum would be government officials and business executives. Individuals who are near the lower end would be laborers, ushers, and maids. The average of the parents' SES was 45.7 (±14.7). Of the 19 infants 16 were Caucasian, one was Hispanic, one was Asian, and one was Middle Eastern descent.

Conditions

There were three devices tested in this study, a play mat (Play Mat, Figure 1), a standard 30''x 40'' rolled baby blanket (Blanket Roll, Figure 2), and a Mini Boppy © (Boppy, Figure 3). For the Play Mat condition, an infant play blanket was spread over the floor. In the Blanket Roll condition, a standard 30''x 40'' baby blanket was rolled up to provide support for the infant under the infants' axilla and placed on top of the play mat. For the Boppy condition, The Boppy © (Boppy, Golden, Colorado) was also positioned on top of the play mat.

In each condition, there was a variety of toys placed in front of the infant to help sustain the infant's attention. The toys that were used in this study included a soft, stuffed caterpillar that played music, a stuffed lady bug, a mirror with a fabric covered back, a stuffed turtle that rattled when shaken, and an infant rattle. The blanket was made of very soft fabric.

Procedure

Infants who were close to two to three months in age were enrolled so that data collection could occur while they were two and a half to four months. During the initial visit the parent's consent was obtained by the researcher, the parent questionnaire was administered, the infant's level of motor development was determined by administering the PFMAI-1 Postural Scale, and the infant's measurements were taken. The parents were given a brochure from Pathways (2012), educating them on the importance of supervising their infant while they are in wakeful prone. The parents were also given an informative brochure on SIDs (American Academy of Pediatrics, 2008), reviewing recommendations that infants sleep in supine.

Once all the initial steps were taken, three data collection sessions were scheduled to occur within a ten-day span. In each session, the infants were placed in prone in one of the three conditions: Play Mat, Blanket Roll, or Boppy. Each condition consisted of three trials, and each trial could last a maximum of 20 minutes.

A distress scale, established by Guidetti (2011), was used to determine infant tolerance for prone. It ranges from 1-5 with 5 indicating the infant is highly distressed. At any point the infant reached a 5, as observed by the parent, the trial was ended immediately. If the infant reached a 3 on the scale, the researcher made up to three attempts to calm the infant within a minute. The calming efforts made consisted of gentle touch, verbal encouragement, and by using a toy as a distractions. An example of a toy distraction consisted of shaking a rattle lightly.

Fifteen seconds after an attempt was made, the researcher re-evaluated the infant's distress state to determine if another calming effort was needed. Trials ended if the infant needed three calming efforts within a minute, if the infant fell asleep, or if any single trial reached 20 minutes in duration, whichever came first. Only one of the 19 participants reached the 20 minute trial period. The infants' needs were met in between trials, this included diaper changing, soothing, feeding, and, rarely, napping.

There was variability in the signs of distress that were associated with each level of the scale, allowing the parents' guidance in evaluating each infant appropriately. Inter-rater reliability of the distress scale was established.

Data Analysis

The primary hypothesis of this study was that infant anthropometrics would have an effect on time spent in prone within the three conditions. The primary outcome measure was time spent in prone for each condition. Time spent in prone in the three trials in each condition was summed for the measure of time spent in prone for each condition. The data had a normal distribution curve; however, the variances were not equal across the different conditions. An ANOVA with repeated measures with Greenhouse-Geisser correction provided comparisons of time in prone. To determine the interaction of the infant size and positioning equipment, each anthropometric measure was entered in the ANOVA for conditions as between- subject factors. Significance was determined at α=.05.

Results

A cohort of 19 infants participated for this scholarly project. Averaged anthropometric measurements for participants are presented in Table 1. A summary of the participants' positioning histories, per parent report, is presented in Table 2. The infants' anthropometric

measurements (head circumference, should breadth, humeral length, forearm length, body length, and weight) were each entered into the comparison of time spent in prone in the three conditions (Play Mat, Blanket Roll, and Boppy ©), testing the interaction between conditions and anthropometric measures. There were no significant effects (see Table 3 for results of tests of significance). This suggests that infant body size was not a factor that influenced time spent in wakeful prone in the three conditions tested in this study.

Discussion

The results indicate that the infants' anthropometrics do not affect time in wakeful prone across the conditions in this study. These findings are similar to those of Guidetti (2011) who did not report an interaction effect of anthropometrics and the same positioning conditions but did find a correlation with time spent in prone regardless of condition. Currently, there is very little research that addresses infants' anthropometrics. Further research should be performed to investigate the relationship between the infants' anthropometry, utilizing a larger sample to test the infants' anthropometrics within the different conditions.

According to Laughlin and colleagues (2011) the recommended time an infant should spend in wakeful prone daily is 30-60 minutes minimum. Being in the prone position at least 30 minutes while awake promotes the development of the extensor muscles, responsible for head control and coordinated arm movement. Anything shy of 30 minutes could have a negative effect on the infants' development (Russell et al, 2009). From the parental questionnaire 3% of infants who participated in this study were meeting the minimum standard and 3% exceeded the minimum being placed in prone 60-120 minutes. With 12% of the infants who prefer being held, parents may not have generalized the prone position to their holding techniques, possibly resulting in documented less time in prone. Yet, the small percentage of the infants being placed

in prone for the recommended amount of time could be related to poor tolerance for the position. The results of the questionnaire indicated that 21% of the infants preferred to be placed on their back and 29% of the infants that participated within this study disliked the prone position. The parents reported that 35% of the infants were placed in prone 2-3 times per day. If infants do not tolerate being in prone for more than a few seconds each time they are placed on their tummies, meeting the recommended amount of time will be difficult. However, any time in prone is more beneficial then no time in prone to assist with their motor development.

Even though there is no evidence that infant's size is a factor in time spent in prone the infants' appeared to remain within the prone position longer when on the Mini Boppy ©, then the rolled blanket, and then the play mat. Analysis of these results is presented by Wells (2015). The infants appeared to be able to engage and/or look at the toys when in the Boppy and the roll conditions. The Boppy and the roll conditions may have provided more support and placed the infants in an appropriate position. The height difference of the Mini Boppy © and the rolled blanket could have delayed the fatigue of the infants' extensors because they did not have to extend as much as they did within the blanket condition.

Limitations and Future Recommendations

One of the study's limitations was the small sample size, potentially causing a type II error. A larger sample size is recommended for future research. This would increase the ability to see if there is a correlation between the infants' anthropometrics and the three conditions used within this study. Another limitation of this study was the utilization of a convenience sample.

The last limitation involves the toys. Depending on the infant, some toys worked better for calming or maintaining the infants' interest longer, possibly skewing the data. Further

research on the relationship between different types of toys and tolerance for prone positioning should be conducted.

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Table 1

Infant Measurements

Anthropometric measurements	Mean ± Standard Deviation
Head Circumference (cm)	41.1±1.2
Shoulder breadth (cm)	16±1.7
Humeral length (cm)	10.1±1.6
Forearm length (cm)	9.2±.09
Body length (cm)	61.1±3.9
Weight (lbs)	14.4±1.4

Table 2

Summary of parents' responses to the questionnaire

Characteristic	Percent of participants, unless otherwise noted (n=19)
Age (months)	3.2±0.5
PFMAI Score	48.7±4.4
Infants who slept in prone	50%
Daily time in prone	
<10 minutes	15%
11-20 minutes	24%
21-30 minutes	12%
31-59 minutes	3%
1-2 hours	3%
> 2 hours	0%
Times placed in prone daily	
0-1	6%
2-3	35%
4-5	9%
> 6	6%
Infants preferred positioning	
Back	21%
Equipment	12%
Held	12%
Dislike prone	29%
Other children in the home	32%
Infants who attend day care	18%

Table 3

Results of statistical tests on the interaction of the positioning conditions and each anthropometric measure

	Interaction with Conditions	
	F	p
Head circumference	.717	.689
Shoulder breadth	.951	.525
Humerus length	1.604	.223
Forearm length	.292	.964
Body length	1.007	.513
Weight	1.355	498

ANOVA with repeated measures with Greenhouse-Geisser correction and anthropometric measures as between- subject factors. Significance was determined at α=.05

Figure 1. Play Mat condition. A blanket was placed on top of a play mat, as seen in the above picture. Infants were placed in prone, resting on elbows, on top of the blanket.

Figure 2. Blanket Roll condition. A standard 30'' by 40'' blanket was rolled and rounded, as seen in the above picture. Infants were placed in prone on the play mat, with arms over the rolled up blanket at the axilla.

Figure 3. Boppy condition. A Mini Boppy © was placed on top of a play mat, as seen in the above picture. Infants were placed in prone on the play mat, arms over the Mini Boppy © at the axilla.

Appendix A UT IRB # 106582

Parental Questionnaire

Name of Child:_____
Date:_____

Child's Birth Date: Month _____ Day_____ Year _____

Were there any medical complications at the time birth?

Yes:_____

No

Are there any current medical issues?

Yes: _____

No

1. What position does your child typically sleep in?

On his/her back On his/her side On his/her tummy Other:

2. What position is your child typically in during feedings?

On his/her back On his/her side On his/her tummy

Seated in a seat (such as car seat, high chair, bouncer, Bumbo) Held by caregivers

3. How much time does your child spend on his/her tummy during wakeful hours within a typical 24-hour period?

None <10 minutes 11-20 minutes 21-30 minutes 30-59 minutes 1-2 hours >2 hours

4. How much time does your child spend on their back during wakeful hours within a typical 24-hour period?

None <10 minutes 11-20 minutes 21-30 minutes 30-59 minutes 1-2 hours >2 hours

5. How often is your child placed on his/her tummy in a typical 24-hour period?

0-1 time 2-3 times 4-5 times More than 6 times

6. How often is your child placed on his/her back in a typical 24-hour period?

0-1 time 2-3 times 4-5 times More than 6 times

7. What is your child's **favorite** play position?

Playing while on his/her back

Playing while on his/her side

Playing while on his/her tummy

Playing while in equipment (such as car seat, bouncer, high chair, bumbo)

Playing while held by caregiver

Other:_____

8. What is your child's **least** favorite play position?

Playing while on his/her back

Playing while on his/her side

Playing while on his/her tummy

Playing while in equipment (such as car seat, bouncer, high chair, bumbo)

Playing while held by caregiver

Other:_____

9. What equipment, if any, has your baby used in your home?

10. Are you aware of the American Academy of Pediatrics "Back to Sleep" Campaign?

Yes___ If yes, 2here did you learn about the "Back to Sleep" Campaign?_____

No

11. Has this recommendation influenced your decision in the positioning of your child?

Yes

No

12. Are there any another children that currently live in your home?

    Yes: If yes, how many: _____

    No

13. Does your child currently attend day care?

    Yes: If yes, how frequently does your child attend:_____

    No