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RESEARCH

Use of the Cranial Cup to Correct Positional Head Shape Deformities in Hospitalized Premature Infants

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ABSTRACT

Objective: To examine the feasibility, effectiveness, and safety of the cranial cup for the correction of visible head shape deformities in premature infants.

Design: A prospective descriptive research design.

Setting: Two study sites, an urban Level 4 NICU and a suburban Level 2 special care nursery.

Participants: The study sample consisted of 23 neonates and infants with deformational plagiocephaly who were born at less than or equal to 35 weeks gestation, weighed greater than 1 kg, and were in the convalescent phase (stable) of their hospitalizations.

Methods: All participants received the experimental treatment with the cranial cup. Infants were positioned on the cranial cup for a minimum of 12 hours per day. They also received routine position changes at least every 3 to 4 hours. Demographic data and baseline and discharge cranial measurements were obtained for each infant.

Results: All participants ($N = 23$) had visible deformational plagiocephaly on study entry, and 86% ($n = 19$) had corresponding abnormal cranial measurements. The median hours per day on the cranial cup was 12.7 (range = 6.3 to 18.0). At hospital discharge, 83% ($n = 19$) of participants had normal cranial measurements. Furthermore, there were no reported safety concerns associated with use of the cranial cup.

Conclusion: Use of the cranial cup during the convalescent phase of hospitalization is feasible and safe, and it provides effective correction of DP for premature neonates and infants.

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Patients in the NICU and special care nursery (SCN) are prone to the development of positional head shape deformities known as deformational plagiocephaly (DP; Hemingway & Oliver, 2000; Ifflaender, Rudiger, Konstantelos, Wahls, & Burkhardt, 2013). Deformational plagiocephaly forms from constant or repeated exposure of the infant's head to a firm or semifirm surface. Several types of DP are described in the literature, although some types are more prevalent in specific patient populations. The asymmetric head shapes referred to as plagiocephaly and occipital flattening (also called brachycephaly) are more common in full-term infants. Both are associated with the supine sleeping position. Dolichocephaly, a narrow, elongated head shape, and scaphocephaly, a triangular-shaped head, are most commonly observed in premature infants (Hummel & Fortado, 2005). These forms of positional head shape deformities develop when the infant is frequently placed in the prone or side-lying position and sometimes have been attributed to the use of ventilation and continuous positive airway pressure (CPAP; Ifflaender et al., 2013).

Deformational plagiocephaly is a concerning condition that has short- and long-term implications; it has been associated with problems of parent–infant attachment, bullying during childhood, and social isolation later in life (Alley, 1981; Badr [Zahr] & Abdallah, 2001; Hemingway & Oliver, 2000; Mawji, Vollman, Hatfield, McNeil, & Sauvé, 2013; Ritter, Casey, & Langlois, 1991). In addition, DP has been associated with a variety of neurobehavioral problems (Constantin, Waters, Morielli, & Brouillette, 1999; Hunter & Malloy, 2002; Hutchison, 2009; Hutchison, Stewart, de Chalain, & Mitchell, 2010; Miller, Johnson, Duggan, & Behm, 2011; Robertson, 2011;

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Speltz et al., 2010). Repositioning procedures, devices such as gel pillows, and other similar positioning aids used by nurses to manage DP with hospitalized infants have had limited success (Hemingway & Oliver, 2000). No specific intervention has been shown to be superior in the management of DP.

Our purpose in this study was to examine the safety, feasibility, and effectiveness of the cranial cup for the correction of visible head shape deformities in a sample of hospitalized premature neonates and infants before discharge. For simplicity, we refer to neonates (≤28 days) and infants (>28 days) as *study participants* or simply *infants*. The cranial cup is an infant positioner that provides support to the cranium and is thought to be beneficial in the prevention and correction of DP. The aims of this study were to determine the feasibility and safety of the use of the cranial cup in a sample of prematurely born NICU or SCN patients with visible DP, as described by the use of the cup in hours and days of treatment and the number of adverse events, and to describe infant head shape using cranial measurements in a sample of prematurely born NICU or SCN patients with DP before and after use of the cranial cup.

Background

Development of DP

The cranial vault is made up of several plates of bone that are separated by sutures (see Figure 1). The bone plates allow protection for the brain, and the sutures allow for expansion and growth of the brain. Brain growth is rapid during the first 3 years of life. During normal growth, it is believed that cells in the dura mater, a lining of the brain, respond to brain expansion and influence cranial bone growth (Scarr, 2008). However, when an infant's head receives constant or repeated exposure to a firm or semifirm surface, the head grows in the direction of least resistance, which results in remodeling and flattening of the head shape, called DP.

Risk factors for DP, common in preterm infants, include restricted uterine environment, birth trauma, prematurity, lack of full bone mineralization (due to relative calcium deficits), neurological deficits, multiple gestation, sedation, paralysis, limited tummy time, torticollis, and preferential head position when lying down (Hemingway & Oliver, 2000; Hummel & Fortado 2005; Hutchison, Thompson, & Mitchell, 2003; van Vlimmeren et al., 2007). Often NICU and SCN patients have a number of these risk factors.

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Infants cared for in SCNs and NICUs (Levels 2 through 4) spend a large part of their days in bed. Their clinical conditions may place limitations on their positions, especially during the critical phase of illness. In these settings, nurses use gel pillows, waterbed therapy, air-filled mattresses, foam mattresses, and repositioning procedures in an attempt to prevent DP (Hemingway & Oliver, 2000; Hummel & Fortado 2005; Hutchison et al., 2010; Schwirian, Eesley, & Cuellar, 1986). However, these devices can flatten with the weight of the infant's head rather than conforming and providing support to the natural round-shaped heads with which infants are born. Thus, DP prevention remains largely dependent on the frequency with which the nurse can reposition the infant (Cavalier et al., 2011).

Problems Associated With DP

The abnormal head shape and facial features of DP can lead to problems with parent–infant attachment, social isolation, and other developmental problems (Alley, 1981; Badr [Zahr] & Abdallah, 2001; Hemingway & Oliver, 2000; Ritter et al., 1991). Studies show that parents of infants with positional head shape deformities can find their infant to be less attractive, because the visual appearance of their infant does not meet their expectations (Alley, 1981). Furthermore, reports indicate that children with DP may be targeted by bullies; adults with atypical head shapes and facial features, such as those that occur from DP, may experience social isolation (Mawji et al., 2013). More recently, investigators have linked DP with developmental problems; this is in response to numerous reports of the relationship between DP and gross and fine motor delays, problem-solving difficulties, communication deficits, vision and hearing problems, and delayed attainment of developmental milestones (Constantin et al., 1999; Hunter & Malloy, 2002; Hutchison, 2009; Hutchison et al., 2010; Miller, Johnson, Duggan, & Behm, 2011; Robertson, 2011; Speltz et al., 2010). Although several studies have linked DP with developmental problems, there could be other causal variables to consider, such as prematurity.

In a recent study of 287 infants with DP, 36% of parents reported that their child had one or more

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