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CRANIOSACRAL THERAPY FOR PRETERM NEONATES AND INFANTS

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Abstract

This pilot study evaluates changes in sensorimotor responses in premature infants after receiving craniosacral therapy. The study included a total of 63 infants born between 28 and 31 weeks of gestation. These infants underwent three craniosacral therapy treatments during their hospitalization. The assessment used a sensorimotor reactivity scale to evaluate eye contact, response to two-point static and kinetic tactile stimulation, turning onto the side, and willingness to grasp and suck an offered finger. Differences in gross scores between pairs of measurements for each item were tested at a 5% significance level using the Wilcoxon paired test. All differences within the evaluated items were statistically significant ($p<0.05$). The strongest effect of the statistically significant dependence was found in the eye contact item. This difference was more pronounced in bottle-fed infants than in breast-fed infants. Therefore, craniosacral therapy may have the potential to enhance self-regulation and promote healthy development in premature infants, but this finding needs to be supported by further research.

Key words

craniosacral therapy, premature infants, sensorimotor reactivity, eye contact, self-regulation

Introduction

Craniosacral therapy (CST) is a holistic therapeutic approach using a gentle, non-invasive form of manual therapy that focuses on releasing constraints and tension in all tissues of the craniosacral system including the skull (cranium), spine (columna vertebralis), and sacrum (Ernst, 2012). This therapeutic method was developed by John Upledger based on the research of William Garner Sutherland, who assumed that cranial structures exhibit internal mobility and this can be detected by manual palpation (Upledger, 2000). The basic assumption on which this therapy is based is that movements in the cranial and sacral bones and dural membranes are associated with rhythmic, pulsating movements of cerebrospinal fluid from the skull to the sacrum (Green et al., 1999). The assumption that the bones of the skull are not fixed but can move to a very minimal extent was confirmed, among other things, by a study by a research team (Oleski et al., 2016), which monitored the mobility of cranial bones through imaging methods. Upledger (2000) hypothesized that dural tension and decrease in cerebrospinal fluid flow may correlate with a decrease in the palpability of the cranial rhythmic impulse and can be corrected by gentle manipulation of the skull and sacrum.

This is currently a very popular method, used to treat musculoskeletal pain in adults as well as in infants with neurodevelopmental disorders (Ceballos-Laita et al., 2024). The WHO classifies this method as an osteopathic method and considers it an alternative and complementary method (WHO, 2010). It differs from other forms of manual therapy, but also from osteodynamic methods, by the type of palpation methods used. These are often strong and directive in osteodynamic methods, while in CST only a light touch with a pressure of about 5–10 grams is used (Upledger, 2009).

CST in young infants began to be researched and used by Beryl Arbuckle, a pediatrician and collaborator of W. G. Sutherland (Upledger, 2009). Subsequently, researchers began to consider using this method in preterm children. A study

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(Raith et al., 2016) used this method in 30 infants with gestational age ranging from 25 to 33 weeks in the intensive care unit of the University Hospital Graz. Within this study, the General Movement Assessment (GMA) was used as according to Professor Prechtl, being a method of assessing spontaneous movements of infants to assess the risk of neurological disorders. In infants who underwent craniosacral therapy, the restrictions of the craniosacral system became more relaxed, there was no change in the character of spontaneous movement, or deterioration of the condition. The authors of this pilot study therefore concluded that from a neurological point of view, this method can be considered safe.

Craniosacral therapy for infants born prematurely with self-regulation problems

Children born prematurely undergo a number of painful procedures during hospitalization. The total number of these procedures is high and varies according to the child's health condition. On average, according to Johnston et al. (2011), there are about 33 painful procedures per week. Thirty years ago, it was generally believed that babies born prematurely did not feel pain. We now know that this is not the case. Conversely, due to the immaturity of their neurological system, these infants are particularly sensitive to pain (Stevens et al., 1996). It is reported that only half of the painful procedures that infants born prematurely undergo during hospitalization are accompanied by a pharmacological or non-pharmacological intervention for pain relief (Cruz et al., 2016). The effects of repeated pain in infants born prematurely have been examined by studies (Valeri et al., 2016; Hermann et al., 2006). These authors hypothesize that untreated pain is probably the main etiological factor in the development of sensory disorders in the sense of hypersensitivity, which occur at a higher rate in infants born prematurely than in infants born at term. Grunau et al. (2009) hypothesize that untreated pain causing stress also causes lower mental capacity and delays in psychomotor development in premature newborns.

It is believed that every painful event is stressful, but not all stress is painful. Stress is an important factor that affects how infants perceive pain and how they respond to it (Jones et al., 2018). In the neonatal period, it is quite difficult to distinguish between stress and pain (Abdallah & Geha, 2017), and even painless sensations can be perceived as painful. Some authors have concluded that early and frequent pain perception in the youngest infants is associated with the development of a persistent state of stress (Grunau, 2009).

Stress is closely linked to anxiety. Stress is the body's general response to a demanding or challenging situation, while anxiety is a specific psychological state characterized by feelings of fear, worry, and nervousness. Chronic stress can lead to the development of anxiety disorders. Anxiety is a natural response to stress that has an adaptive function and helps mobilize the body to solve problems. If stress persists and the body cannot cope with it, an anxiety disorder can develop.

Therefore, finding ways to reduce pain, discomfort and stress in infants born prematurely is still a topical topic, the effective solution of which can have a far-reaching impact on further education and success in the lives of these infants (Kothari et al., 2016). With the CST method, the most frequently cited benefit of this treatment approach is the release of tension as well as mental and physical relief.

Recently, there has been an increased interest in investigating the effect of massage therapy or tactile-kinetic stimulation, including osteopathic manipulative treatment, on infants born prematurely (Niemi, 2017). Meta-analyses (Wang et al., 2013; Vickers et al., 2004) point to a possible positive effect of massage on weight gain, motor and neurodevelopmental outcomes, shortening the length of hospitalization and improving attachment in premature babies. The effectiveness of CST has also been investigated in infants with colic (Castejón-Castejón et al., 2022).

Babies born prematurely often have regulatory problems, which include high levels of irritability, difficulty processing sensations coming from the senses, difficulty sleeping and eating (Galling et al., 2023). The ability to self-regulate affects a wide range of physiological, sensory, motor, attentional and emotional processes. The cause of these difficulties is multifactorial. Possible causes are arranged (as per Galling et al., 2003) by factors on the parent's side (postpartum emotional difficulties, lack of parental intuitive skills, socioeconomic distress), difficulties in pregnancy and childbirth (hypoxia, asphyxia, microtremors of the newborn's head), but also a factor on the part of the child (difficulty processing sensory inputs). We have decided to investigate changes related to the senses in infants born prematurely, specifically the responses to visual and tactile stimulation.

The course of the research study, research set and methods

This observational, descriptive study took place at the Department of Neonatology of the University Hospital Brno from January 2023 to June 2025. The selection of infants for the research group was deliberate. Inclusion criteria: very immature infants according to classification (Fendrychová & Borek, 2007), born between 28–31 weeks of gestation with a birth weight of 1000–1499 g, tolerating full enteral intake, breast-fed or bottle-fed, whose parents agreed to their being treated with craniosacral therapy and completed an informed consent. Excluded from the research group were infants with congenital malformations, bronchopulmonary dysplasia, severe gastrointestinal complications (necrotizing enterocolitis), cardiovascular disease (patent ductus arteriosus), neurological disease (intraventricular haemorrhage, hypoxic ischemic encephalopathy, periventricular leukomalacia), and infants with an Apgar score of ≤3 points in the first minute of life.

The total number of very immature infants included in the research group is (n=63). The basic set was divided into two main cohorts. The first included breast-fed infants (n=35), the second included infants fed from a bottle with a teat (n=28).

As of the 32nd week of gestation, the infants were treated with CST a total of three times, always one week apart. At the same time as each treatment, the infants were assessed during their calm alertness phase by the Sensorimotor Reactivity Scale, which is presented in Table 1. We have revised this scale, because although the publication Assessment Methodologies in Neonatology (Fendrychová, 2013) has been published for Czech practice, containing a number of tools for the assessment of postpartum adaptation (assessment of the state of consciousness, assessment of behaviour, assessment of breathing disorders, assessment of pain manifestations, assessment of withdrawal symptoms, assessment of bedsores and sepsis, etc.), none of the tools listed in this publication are suitable for the assessment of child stress manifested in responses to sensory perceptions. This scale can also be used as a supplementary assessment of food intake and nursing operations preceding and following food intake. This scale is scored. A higher degree of distress is evaluated by a higher point value.

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Sensorimotor reactivity scale		
Eye contact, attention and interaction	No fixation of the gaze, wandering eyes, does not react to the face of an adult at a distance of 25 cm, impossibility of establishing contact	1
	Avoids eye contact (glassy gaze, looks "through")	0,5
	Staring at an adult's face, alert expression, lively expression	0
Willingness to grasp an offered finger For one minute, we offer a finger to grasp	The infant grasps the offered finger	0
	Without reaction, fingers open, does not grasp the offered finger	0,5
Willingness to suck an offered finger For one minute, we offer a finger to suck	When finger is put in the mouth, proceeds to suck	0
	After inserting the finger into the mouth, does not suck, tries to push it out, dodges	1
Reactions to two-point static touch Gentle touch of the ball of the thumb and forefinger at the same time on the forehead; we evaluate expressions for one minute of alert time	Grimaces in the face (pursing of the lips, tension in the area of the nasolabial fold, wrinkle of the forehead); movements of limbs or fingers in flection	0,5
	Movements to extension: › stretching of fingers › leg extension › stretching of arms/saluting	1
	Disorganized movement of the whole body, jerky movements of the body, other disproportionate reactions lasting ≥30 seconds	2
Reaction to kinetic touch Stroking the head with the surface of the whole palm; we evaluate expressions for one minute of alert time	Grimaces in the face (pursing of the lips, tension in the area of the nasolabial fold, wrinkle of the forehead); movements of limbs or fingers in flection	0,5
	Movements to extension: › stretching of fingers › leg extension › stretching of arms/saluting	1
	Disorganized movement of the whole body, jerky movements of the body, other disproportionate reactions lasting ≥30 seconds	2
Reactions to being turned on the side Very gently and slowly turning the infant to the side, supported by whole palms placed on the tummy and on the back, observing reactions for one minute	Grimaces in the face (pursing of the lips, tension in the area of the nasolabial fold, wrinkle of the forehead); movements of limbs or fingers in flection	0,5
	Movements to extension: › stretching of fingers › leg extension › stretching of arms/saluting	1
	Disorganized movement of the whole body, jerky movements of the body, other disproportionate reactions lasting ≥30 seconds	2

Table 1: ***Sensorimotor reactivity scale***

Descriptive statistics

The demographic and clinical characteristics of infants at the time of birth are presented in Table 2. The normality of data distribution for continuous variables was tested using the Shapiro-Wilk test. The data for weight, length and head circumference conformed to the expected normal distribution; however, the data for age did not conform to a normal distribution. Consequently, non-parametric statistical tests were employed for its analysis.

Depending on gender, among the breast-fed infants there is a higher proportion of boys, and a smaller proportion of boys than girls in bottle-fed infants. Among breast-fed infants, only about a quarter were born vaginally (28.6%), the vast majority of infants (71.4%) were born by C-section. In bottle-fed infants, the majority were also delivered by C-section (65.5%) and about a third were born vaginally (34.5%). Among breast-fed infants, three-quarters (77.1%) were born spontaneously, while only about two-thirds (69%) in the case of the bottle-fed.

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Birth variables *Mann-Whitney test **Chi-square test ***t-test	Breast-fed infants n=35	Bottle-fed infants n=28	P-value
Age at birth* Mean, SD	30.7 ± 1.04	31.1 ± 1.11	0.052
Gender – boy**	19 (54.3%)	13 (44.8%)	0.451
Delivery Vaginal/C-section**	10/25	10/18	0.612
Birth – spontaneous**	27 (77.1%)	20/8 (69%)	0.461
Weight (g)***	1506.3 ± 303.94	1490.2 ± 232.23	0.816
Length (cm)***	40.4 ± 2.28	40.4 ± 2.25	0.933
Head circumference (cm)***	28.1 ± 1.78	28.3 ± 1.71	0.514

Table 2: ***Demographic and clinical characteristics of infants***

Research findings

We were interested in whether the differences in the gross score obtained on the sensorimotor reactivity scale within individual items between the first and the second measurements and the second and the third measurements were statistically significant in the whole group. The results of the study are presented in Table 3. For all the items examined, the mean value decreases over time. The differences between the measurement pairs were tested at a 5% significance level using the Wilcoxon pair test. All differences between the first and the second measurements and also between the second and the third measurements are statistically significant (P-value <0.05). Effect size indicates the strength of the statistically significant dependence effect. The values range from −1 to 1, where values close to 0 indicate a small effect, values close to 0.5 indicate a medium effect, and values closer to 1 in absolute terms represent a great effect (Hindl et al., 2006). This assessment indicates that all differences have a significant impact, with the magnitude of this effect consistently stronger between the first and the second measurements compared to the second and the third measurements. The most significant effect was observed between the first and the second measurements in the case of vision and response to kinetic stimulation, and the least significant effect was observed in the willingness to grasp a finger. The magnitude of the effect was found to be most pronounced for vision, and least so for the willingness to grasp a finger and the response to kinetic stimulation, between the second and the third measurements.

Item	Mean gross score; 1st measurement	Mean gross score; 2nd measurement	Mean gross score; 3rd measurement	P-value 1st–2nd measurement*	P-value 2nd–3rd measurement*	Effect size 1st–2nd measurement	Effect size 2nd–3rd measurement
Eye contact	0.844	0.453	0.000	0.000	0.000	−0.833	−0.832
Willingness to grab finger	0.656	0.188	0.000	0.000	0.000	−0.685	−0.433
Reaction to static touch	1.234	0.688	0.500	0.000	0.000	−0.788	−0.612
Reaction to kinetic touch	1.125	0.602	0.500	0.000	0.000	−0.843	−0.451
Reaction to being turned	1.250	0.703	0.500	0.000	0.000	−0.787	−0.637
Willingness to suck finger	0.875	0.344	0.000	0.000	0.000	−0.729	−0.586

Table 3: ***Measured results in the whole group***

We were also interested to find out which group of infants, whether breast-fed or bottle-fed infants would benefit more from craniosacral therapy treatment. Accordingly, we wanted to compare the difference between the results of the first and the third treatments. As illustrated in Table 4, infants were categorised into two distinct groups based on their mode of food intake by mouth. The results show that infants who were fed from a bottle with a teat demonstrated inferior outcomes in terms of visual contact during the first measurement and exhibited heightened aversive reactions when sucking on the finger. The results indicate that these infants exhibited greater improvement in response to the CST treatment.

For the visual contact variable, the difference between the first and the third measurements in breast-fed infants (−0.786) was smaller than in bottle-fed infants (−0.914). This observation is consistent with the findings related to the willingness to suck a finger item (breast-fed infants −0.800 vs. bottle-fed infants −0.966). Conversely, when it comes to grip, static and kinetic tactile stimulation and turning, there is always a greater difference in breast-fed infants. However, only the aversive reaction showed a statistically significant difference at the 5% significance level according to the Mann-Whitney test (U(N=64)=423.5; P=0.048). Yet, given the −0.247 strength of the effect, this relationship is very weak.

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Item	Breast-fed infants			Infants fed from a bottle with a teat					
	Mean gross score; 1st measurement	Mean gross score; 2nd measurement	Mean gross score; 3rd measurement	Mean gross score; 1st measurement	Mean gross score; 2nd measurement	Mean gross score; 3rd measurement	Difference 1st–3rd measurement in breast-fed infants	Difference 1st–3rd measurement in bottle-fed infants	P value* * Mann-Whitney test
Eye contact	0.786	0.400	0.000	0.914	0.535	0.000	−0.786	−0.914	0.068
Willingness to grab finger	0.714	0.228	0.000	0.607	0.142	0.000	−0.714	−0.607	0.354
Reaction to static touch	1.171	0.700	0.485	1.232	0.696	0.517	−0.771	−0.715	0.831
Reaction to kinetic touch	1.171	0.642	0.500	1.107	0.571	0.571	−0.671	−0.460	0.668
Reaction to being turned	1.257	0.700	0.500	1.267	0.732	0.517	−0.771	−0.757	0.750
Willingness to suck finger	0.542	0.228	0.000	1.000	0.357	0.000	−0. 542	−1.000	0.048

*Table 4: **Measurement results in breast-fed and bottle-fed infants***

Discussion

This pilot observational study showed that craniosacral therapy treatment in preterm infants aged 28–31 weeks of gestation is associated with statistically significant improvements across all monitored items on the sensorimotor reactivity scale, especially with respect to visual contact, tactile sensitivity and behavioural manifestations of self-regulation. After three treatments of CST there was a significant decrease in stress response scores in all domains evaluated. This result suggests that CST has the potential to promote active self-regulation processes in premature infants who are often exposed to high stress and painful procedures during hospitalization.

Eye contact is one of the first ways a child communicates with the world. Improving eye contact has an undeniable effect on a number of areas. It enables parents to better respond to the child's needs (sensitive parenting), strengthens the child's sense of security and supports the emergence of an emotional bond between the child and the parent (attachment). Infants who make eye contact more often tend to be more open in social interactions, learning to recognize emotions and non-verbal signals better, which can reduce the risk of problems with emotion regulation or social communication disorders in premature babies. Eye contact promotes cognitive and language development. It also stimulates mirror neurons, which makes infants learn better. It activates the areas of the brain responsible for social cognition and increases the level of oxytocin (the hormone of bonding), which promotes brain plasticity (Tang et al., 2024). In the context of premature birth, when the brain matures even after birth, this can have a major supportive effect.

Premature babies often experience delayed development of visual perception and a reduced preference for faces, and consequently delayed development of facial recognition skills, including difficulty fixing their gaze on faces, as compared to full-term newborns (Tang et al., 2024). This happens because premature babies miss an important period of visual development, which takes place in the womb, and begin to perceive external visual stimuli with an immature visual system, and moreover, at a time when their stress levels are high. While full-term newborns show preferences for natural faces, premature babies may not show the same preferences. This delay in development can have long-term consequences, with studies showing a correlation between early visual fixation and later visual and visuomotor abilities (Tang et al., 2024). For example, premature babies exhibit atypical neural activity and connectivity in frontotemporal areas when performing theory of mind tasks that require mental representation of the mental states of others (Mossad et al., 2021). This unfavorable condition, when the ability to perceive by sight develops at times of high stress, can be partially compensated by CST through stress release. A more significant improvement in this parameter in bottle-fed infants suggests that this group may have had a worse sensorimotor state at the beginning and thus benefited more from the therapy.

Improvements in response to tactile stimulation (both static and kinetic) are indicative of the potential of CST to reduce hypersensitivity in somatosensory perceptions, which is particularly important for premature babies due to increased sensitivity to pain and stress (Abdallah & Geha, 2017). Releasing tension in the craniosacral system and reducing dysregulation can lead to better integration of sensory stimuli and thus reduce unpleasant defensive reactions, which can also improve other developmental areas, especially motor skills, emotional regulation, overall self-regulation, and can also have a positive impact on food intake.

An interesting finding is the difference in the effectiveness of CST between breast-fed and bottle-fed babies. While bottle-fed babies had a more significant improvement in eye contact and reduced sucking aversion, breast-fed babies had a more noticeable score decrease in the areas of grasping and response to tactile stimuli. This indication of a different response could be related to different sensory experiences and levels of stress associated with feeding, but requires further verification.

It should be mentioned that all the measured changes had a great effect size, the most pronounced being between the first and the second treatments, indicating a rapid response of the body to CST. Furthermore, differences were noted between the breast-fed and bottle-fed groups of infants, with bottle-fed babies showing more significant changes in the eye contact and a reduction in aversive reactions during sucking. This fact underscores the possible differentiation in the impact of CST depending on the mode of nutrition, which can affect the neurological and behavioral status of the child.

Despite the promising results, several limitations of the study must be mentioned.

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These consist mainly in the absence of a control group, which makes it difficult to clearly attribute positive changes to CST alone, as the influence of natural development, CNS maturation or other factors of care during hospitalization cannot be completely ruled out. The Sensorimotor Reactivity Scale used is not a validated tool and was created for the purposes of this study. There is a lack of data on reliability and validity compared to the international golden standards, such as the Premature Infant Pain Profile (PIPP). Since the size of the research sample was not evaluated, it is not clear whether the size of the research group is sufficient, which also makes it difficult to generalize the results. In addition, only the short-term effect after three treatments was evaluated, so it is not possible to assess the persistence of changes or their impact on long-term neurodevelopment. Also worth a mention is the possibility of a placebo effect or the influence of therapeutic contact. Gentle touch and attention given to the child during a CST session can itself have a non-specific calming effect that is not necessarily specific to the craniosacral mechanism.

Nevertheless, these pilot results provide an important basis for the planning of future randomized controlled trials. From the point of view of clinical significance, CST provides a potential non-pharmacological intervention to reduce stress, pain and hypersensitivity in premature babies, which may have a long-term effect on their self-regulatory abilities, neurodevelopment and quality of life. Increased attention should be paid to early support of visual development and tactile experience, which are crucial for the successful integration of the child into the social environment and communicative development.

As part of the recommendations for future research activities, it is worth stating the need to continue research with larger sets of premature babies and appropriate control conditions, in order to more accurately define the mechanisms of action of CST, to optimize therapy protocols and to better understand the differences in effectiveness between different groups of preterm babies.

In conclusion, CST represents a potentially safe and promising non-pharmacological intervention for promoting self-regulation and reducing sensory hypersensitivity in preterm infants. This is consistent with the study by Raith et al. (2016), who also did not observe adverse CST effects on the spontaneous motility of preterm infants. However, rigorous randomized controlled trials (RCTs) with a larger number of participants, validated measurement tools, a control group (e.g., standard of care or other form of gentle handling), and long-term follow-up are necessary to confirm these results and clarify the mechanisms of action.

Conclusion

Craniosacral therapy offers a natural way to strengthen self-regulation and the healthy development of premature babies. The therapy leads to significant improvements in infant sensorimotor responses, especially in eye contact, which is crucial for social interactions, cognitive and language development, and for the formation of an emotional bond with the parent. More significant positive changes were noted in bottle-fed infants. However, the study was observational, without a control group, and the results need to be confirmed by further research with better methodological quality. Thus, CST represents a promising approach to relieving tension, reducing stress, and improving the ability of self-regulation, concentration, and learning in very immature infants.

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