COLLÈGE D'ÉTUDES OSTÉOPATHIQUES DE MONTRÉAL

CLINICAL PROJECT EXPLORING THE EFFECT OF OSTEOPATHIC TREATMENT ON CRANIAL ASYMMETRIES IN INFANTS

PROJET DE STANDARDISATION CLINIQUE EXPLORANT L'EFFET DU TRAITEMENT OSTÉOPATHIQUE SUR LES ASYMÉTRIES CRÂNIENNES CHEZ LES NOURRISSONS.

English version : Abstract

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Problem Identification

Occipital plagiocephaly is a condition described as a cranial deformity. Literature indicates 2 families of plagiocephaly: Synostosis (malformation plagiocephaly due to premature fusion of the cranial sutures) (Brunetau et Mulliken, 1992) and Occipital Non-Synostotic Plagiocephaly (NSOP) (Peitsch et al., 2002; Terpenning, 2001; Huang et al., 1996). Plagiocephaly can be caused by mechanical strains such as traction or compression applied before, during or after birth, therefore causing a unilateral flattening of the occiput (Ehret et al., 2004; Captier et al., 2002; Rekate, 1998). Since the "Back to sleep" campaign initiated by the American Academy of Pediatrics in 1992, this type of skull deformity has become more prevalent (Peitsch et al.., 2002; Kane, 1996). Despite popular belief, significant research studies reveal that without intervention, NSOP, in the majority of cases, does not resolve in time (Sergueef et al., 2006 ; Kane et al., 1996 ; Ripley et al., 1994).

An increasing number of studies confirm the impacts of plagiocephaly (Miller et Clarren, 2000). Available results on the subject show that children with this condition are more prone to developing eventual problems related to: visual perception (Siatkowski, 2005 ; Pankaj et al., 2003), auditory issues (Balan et al., 2002) and temporo-mandibular articulation (St-John and al., 2002), psycho-motor skill delays (Habal et al., 2003 ; Balan et al., 2002 ; Panchal et al., 2001) and postural compensations (Barry, 2001 ; Moss, 1997 ; Hylton, 1997), learning difficulties (Scheuerle, 2001) and language problems (Habal et al., 2003). A growing number of parents bring their infants with NSOP to be treated in osteopathy, and to our knowledge, no study has yet quantified the impact of osteopathic treatments (including positioning advice) on the evolution of cranial asymmetries.

Objectives and hypothesis

The objectives of this clinical project were to observe and quantify the evolution of cranial asymmetries in infants exhibiting non-synostotic plagiocephalic symptoms who were to undergo a course of four osteopathic treatments (in addition to the standard positioning recommendations). This project also explored the effect of osteopathic treatments by comparing changes in the asymmetry with other studies using

repositioning alone. Finally it allowed for the development of a methodology that may be used to conduct a randomized clinical trial with a larger sample size in a future study. The hypothesis of this report is that osteopathic treatments can contribute to modifying cranial asymmetries of infants younger than six and a half months old presenting with NSOP signs.

Methods

Infants evaluated and treated in the project were either recommended by doctors or via word of mouth. Twelve infants completed the project, 4.1 months of average age. Each infant was seen for 4 osteopathic sessions scheduled 15 days apart (±4 days). Each osteopathic treatment was of 60 minutes duration. At the start of the first session a detailed history was taken including obstetrical, perinatal and postnatal information. The structure of this project was very similar to that of a quasi-experimental design with no control group. It included a pre-test (T1) and two post-tests: during the third treatment (T2) and two weeks after the fourth one (T3). Two measurement methods were used: anthropometric and plagiocephalometric, in order to evaluate the cranial asymmetries. An evaluator who was not aware of the nature of the project or the treatments, made the following measurements: 1) anthropometric, using a spreading caliper (Kolar et Salter, 1997) to monitor the asymmetry of the Cranial Vault (CVA), the Skull Base (SBA) and the Trans-cranial Diagonal (Kelly et al., 1998, Terpenning, 2001); 2) plagiocephalometric, via cranial circumference molds using a low-temperature thermoplastic (sansplint), to monitor the evolution of the oblique diameter left (ODL) and oblique diameter right (ODR) as described by Van Vlimmeren et al., (2005; 2007). We also used descriptive elements (osteopathic evaluations, subjective questions to the parents, and a daily log) in order to put the obtained results into perspective. Digital photographs were taken during the first week and two weeks after the fourth treatment.

This project has been accepted by the *Comité de Recherche et du Conseil Académique du Collège d'études ostéopathiques de Montréal* and in accordance with their ethical norms. The data for all infants was collected from medical files using a coding system thus guaranteeing the confidentiality for both infants and their parents. An Informed

Consent to participate in the project and to allow photos of the infants to be taken and used in future scientific publications/presentations was signed by the parents prior to inclusion in the project. Variance analysis with repeated measurements (in time) was applied through the SAS software.

Results

Population characteristics

The mean age of our group was of 124.0 (±34,0) days at the time of the initial evaluation, and all were diagnosed with or presented signs of non-synostotic plagiocephaly. Generaly speaking, parents start consultations when the child is 4.1 months old, and this, according to the parents, is caused by a lack of information on the subject, the misunderstanding of the help available, and on the false belief that asymmetries will disappear by themselves in time (Ripley et al., 1994**).**

Results of the Inferential Statistics

The results revealed significant improvements for the four measurements of cranial asymmetry (asymmetry of the vault, the base, the trans-cranial diagonal and the ODL-ODR oblique diameters) between the initial evaluation (T1) and the final evaluation (T3). Other significant results were also confirmed between T1-T2 and T2-T3.

Anthropometric measurements results

Table 1: Anthropometric measurement average asymmetry

Parameters	*Pre-treatment (%)*	*Post-treatment (%)*	*Residual (%)*	*p*
Base	*5.6 (± 2.2)*	*2.4 (± 2.3)*	*52 (± 29)*	*0.004*
Trans-cranial	*8.8 (± 3.3)*	*3.8 (± 2.3)*	*40 (± 20)*	*<0.001*
Vault	*5.4 (± 3.0)*	*1.5 (± 1.1)*	*38 (± 33)*	*0.003*

Trans-cranial asymmetry

The mean trans-cranial asymmetries showed a significant improvement ($p < 0.001$) from 12.7 (±5,3) mm (T1) to 5.6 (±3.6) mm at the final evaluation (T3), resulting in a mean improvement of 7.0 (±3,1) mm.

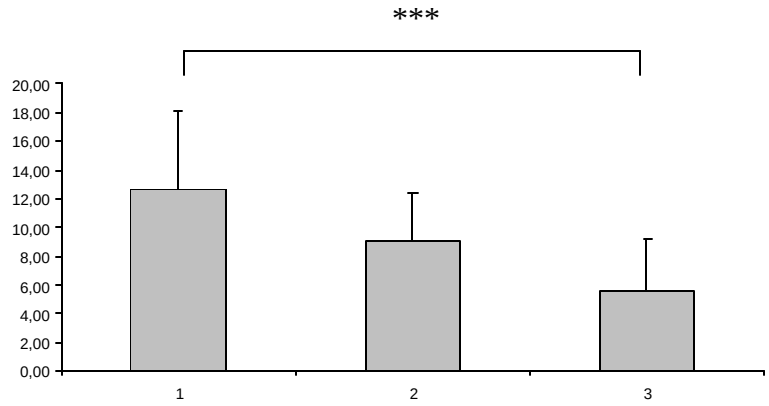

Figure 1: Trans-cranial asymmetry evolution (mm) as a function of the evaluations, * = p < 0.05, ** = p < 0.01 and *** = p < 0.001

Cranial vault asymmetry

The final mean cranial vault assymetries (T3), were significantly reduced (p = 0.002), moving from 7.4 (± 4.2) mm (T1) to 2.1 (± 1.6) mm (T3), resulting in a mean improvement of 5.3 (± 5.2) mm.

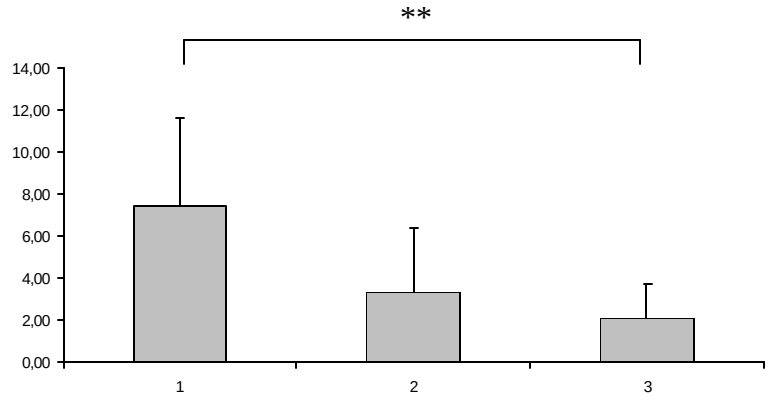

Figure 2: Vault asymmetry evolution (mm) as a function of the evaluations, * = p < 0.05, ** = p < 0.01 and *** = p < 0.001

Skull base asymmetry

From initial measurements (T1) to final measurements (T3), the mean skull base asymmetries showed a significant decrease (p = 0.003), from 5.1 (±2.5) mm to 2.2 (±2.0) mm, resulting in a mean improvement of 2.9 (±2.7) mm.

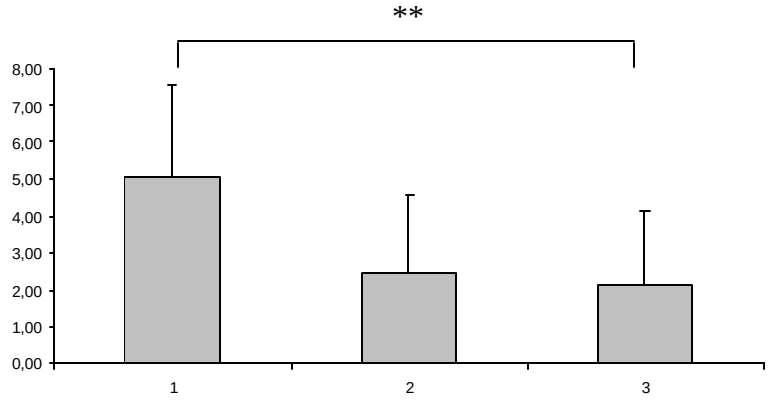

Figure 3: Base asymmetry evolution (mm) as a function of the evaluations, * = p < 0.05, ** = p < 0.01 and *** = p < 0.001

Beside the results already mentionned above, the three anthropometric measurements recorded at T2 also revealed significant improvement of the cranial vault (p = 0.03), the skull base (p = 0.013) and the trans-cranial diagonal (p = 0.048).

Plagiocephalometry results

In the initial evaluation, 10 of the participants presented a clinically significant difference of more than 104 % (Van Vlimmeren et al., 2005; 2007) in the oblique diameter difference index (ODDI). In four treatments, the ODDI of eight participants decreased under the 104% treshold. The average of the ODDI of the 12 participants evolved from 107.9 % (T1) to 103.9% (T3). Furthermore, the moulds of the cranial circumference demonstrate that increased skull growth was primarily at the site of the occipital flattening.

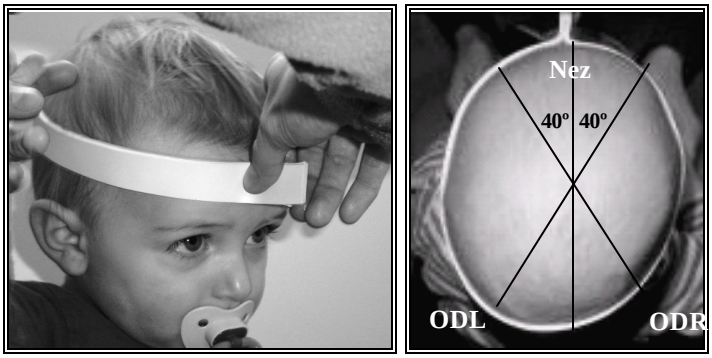

Figure 4: Plagiocephalometry, moulding example

Figure 5a

Figure 5b

Figure 5c

Figure 5d

Figure 5e

Figure 5f

Figure 5: Plagiocephalometry and pictures, evolution within four treatments.
Figures 5 Infant boy, age 4 months and 26 days, presenting with a right flattened occiput **(a-b-c)**: pre-treatment (T1), figures **(d-e-f)**: post-treatment (T3)

Our results support the hypothesis of this project which stated that osteopathic treatment contributes to the modification of the cranial asymmetries of the infant aged less than six and a half months, presenting signs of NSOP.

Discussion

We notice, as Terpenning et al., (2001), that the corrections of the asymmetries of the base occur relatively more slowly than the other asymmetry measures. The fact that the base is more resistant to the corrections may be partially explained by its cartilaginous embryological origin as contrasted to the membraneous origin of the skull vault. The asymmetries of the vault appear to resolve more quickly. The greater treatment impact on the vault asymmetries may also be explained partially by the bregmatique fontanel which closes relatively later than the others and by the adaptive function of the vault which, through mobility provided by the cranial sutures, allows the modelling of the

skull during birth. Among the three anthropometric measurements that were made, that of the trans-cranial diagonal appears, to us, to be the most clinically relevant.

Eleven of the participants presented a right occipital flattening. This was associated with a right lateral strain for seven of the eleven. Also linked with the occipital flattening, we have documented a limitation in assited active cervical rotation to the side opposite of the flattening in all the infants. As reported by Solano (2002) we noticed that in the presence of NSOP, the dura-mater membranes were not in balanced tension (this situation has been noticed for the 12 infants). Clinically, the decrease of the ODDI under the 104 % threshold among 8/10 participants after only four treatments, corresponded to considerable satisfaction on the part of the parents regarding the aesthetic aspect of the problem. We believe that the compression force which deforms the skull is absorbed and transmited in the body as a functionnal unit and that because of this, the global aspect of osteopathic treatment deserves, in our opinion, particular attention.

Results with respect to the age

A visual analysis of the results are consistent with previous studies on NSOP using other interventions, which indicate that early intervention seems to influence the recovery curve, facilitating a better correction of the assymmetries. This pertains to all the anthropometric measurements (cranial vault, skull base and trans-cranial diagonal). However, the results of our project did not demonstrate significant correlation related to the age of the subjects for any of the measures. This is likely due to the small sample size and the relatively narrow age range included. We believe however, that a larger sample with different distribution of the groups, where the youngest would be two months would allow for more objective results, likely facilitating a greater improvement of the youngest.

Observation of the neuro-motor development

From an osteopathic point of view, the particularities characterizing the NSOP are only the tip of the iceberg. The impact of the force which contributed to deforming the skull does not necessarely limit itself to the level of the head or cervical region. The NSOP is

a problem of asymmetry and the flattened occiput transforms the axis and planes of movements of the condyles with regard to the atlas. Furthermore, the flattened occiput which is included in the line of gravity will create some compensations to assure, among others, the horizontality of the glance which the body has to maintain at all cost. We frequently noted some asymmetry and immaturity of certain movement components. The presently available data thus suggests that the infants affected by NSOP should be evaluated and followed to detect and treat, in a proactive way, delays and deficits in development (Collett et al., 2005).

Osteopathic recommendations

Recognizing the importance of treating the whole body based on the osteopathic principle of the unity of function (and dysfunction), we nevertheless, noted some key factors in the osteopathic treatment of NSOP which appeared to facilitate optimal recovery :

- Optimize the mobility of the head/neck in rotation,
- Normalize the skull base and particularly the strains,
- Facilitate equilibrium of the fluids,
- Normalize vertebral alignment and mobility or vertebral lesions,
- Normalize the cranial membranes,
- Normalize the cranial sutures and the intra interosseous lesions.

Clinical recommendations

Despite the contribution of the positional factor in the NSOP development, it is important to apply the *American Academy of Pediatrics* recommendations and to put the infant in supine sleeping position to prevent sudden infant death syndrome (Captier et al., 2003). We wish to remind that as front line health care workers the osteopath has the skills and the responsibility of differentiating pediatric neonatal emergencies from the osteopathic emergencies. When there is the slightest doubt , the infant must be referred to the regular doctor to obtain a precise medical diagnosis because treatments and prognosis differ according to the types of the presenting plagiocephaly. According to our clinical experience some inescapable aspects must be mentioned in order to contribute to the prevention of NSOP and to the optimization of the treatments:

- Inform the parents, the doctors and others health workers of the importance of early referral for treatment. Deny false assumptions that the asymmetry is usually cured by itself with time.
- Demonstrate the importance of tummy time and encourage prone playing when the child is awake and under supervision.

Limitations of the project

Because of the small sample size and the absence of a control group, we cannot definitively conclude that the improvements in asymmetry were due to the osteopathic treatment variable but we can reasonnably assert that any superior results as compared to the current knowledge could be attributable, at least partially, to our intervention. A larger sample, using a randomized control design is recommended.

Conclusion

This project demonstrated statistically and clinically significant improvements in cranial asymmetry of infants with NSOP following four osteopathic treatments (in addition to the standard positioning recommendations), spread out over a two month period. This suggests that the results obtained support the report's hypothesis that osteopathic treatments would contribute to modifying the cranial asymmetries of infants younger than six and a half months old presenting with signs of NSOP. Though it must be considered a preliminary (pilot) project, to our knowledge, this is the first report to document changes in plagiocephaly with osteopathic tretament. This project successfully utilized clinical procedures that could contribute to the methodological basis for creation of standardized clinical procedures which could be expanded into a larger-scale randomized clinical trial.

Recommendations for Further Research

NSOP is a current problem and many research questions are deserving of further investigation in multidisciplinary teams. For example, it would be interesting to measure the impact of osteopathic treatment on the neuro-motor development of the infant with NSOP.