Chiropractic management of non-synostotic deformational plagiocephaly in the Netherlands: a cross-sectional study

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ABSTRACT

Background: Non-synostotic deformational plagiocephaly (NDP) is a common condition affecting 48% of infants. It is frequently cited as a reason for presentation to a chiropractor, however little is currently known about chiropractic management of NDP. This cross-sectional study aims to begin to address this literature gap. **Objectives:** 1) To determine the characteristics of chiropractic management of non-synostotic deformational plagiocephaly (NDP) in the Netherlands and; 2) To investigate the type and number of treatments chiropractors expected for full resolution of the head turning preference. **Methods:** Cross-sectional survey of registered chiropractors in the Netherlands. **Results:** Seventy-eight chiropractors completed the survey, of which 86% (N=67) treated pediatric patients, and of which 73% (N=38) treated infants with NDP. The most common presentation was head turning preference (with or without NDP) (75%, N=39) for 0-11-month-olds and the most common treatment technique was 'touch and hold' (65%, N=33). Participating chiropractors reported 'no side effects' (39%, n=20) more commonly than any specific side effects. On average, participating chiropractors expected 4 treatments for full resolution of the head turning preference. There is currently limited clinical evidence on the effectiveness of management for full resolution of the head turning preference. There is currently limited clinical evidence on the effectiveness of management techniques for head turning preference and NDP, this should be the focus of future research.

Key Words: Non-synostotic deformational plagiocephaly, plagiocephaly, head turning preference, chiropractic, the Netherlands.

Introduction

Chiropractic is:

"a health profession concerned with diagnosis, treatment and prevention of mechanical disorders of the musculoskeletal system, and the effects of these disorders on the function of the nervous system and general health"¹ and is categorised as complementary and alternative medicine (CAM).^{2,3}

Approximately 5-17% of global chiropractic practice are represented by pediatric patients.⁴ A recent international demographic chiropractic study, based on 1,498 respondents from 17 countries over 6 continents, showed that 90% of chiropractors accepted pediatric patients.⁵ Despite its widespread use, there is debate over the appropriateness of pediatric chiropractic care, with concerns relating to safety, effectiveness, presentations/complaints⁶ and a paucity of high-quality research.^{4,6} In terms of safety, studies have shown that mild side effects, which are selflimiting, following pediatric chiropractic care comprise the majority of side effects with an incidence of 1% in patients under three.⁷ Systematic reviews demonstrate no deaths reported, and that in the rare cases of serious adverse events (requiring hospitalization), underlying pre-existing pathology preceded.^{8,9}

Controversy around chiropractic care for infants is also driven by the variety of musculoskeletal and non-musculoskeletal complaints which are treated in chiropractic practices.¹⁰ Research claims about beneficial effects of chiropractic on commonly treated non-musculoskeletal conditions include sleep issues, asthma, otitis media, and even jet lag.¹¹ However, evidence supporting treatment of nonmusculoskeletal conditions are typically of low scientific value, consisting of clinical experience and case studies.¹¹ Most pediatric patients are presented for chiropractic care with musculoskeletal problems, the frequency of which increases with age, from 23-33% in preschool children and 75-84% in teenagers.^{12,13}

One of the most common orthopedic conditions in infants is non-synostotic deformational plagiocephaly (NDP), with prevalence estimates of 48% of infants.¹⁴ NDP is defined as cranial asymmetry manifesting in flattening of the skull secondary to external forces without fusion of the skull sutures (synostosis).^{15,16} The incidence of NDP has increased five-fold since the 'Back to Sleep' campaign and the American Academy of Pedatrics' recommendation for healthy new-borns to sleep supine to reduce the risk of sudden infant death syndrome.¹⁷⁻¹⁹ NDP is associated with cosmetic consequences and has been associated with neurodevelopmental delay, although no causal relationship has been demonstrated.²⁰⁻²² There is some evidence that infants with NDP but no neurodevelopmental delay may later develop delay in childhood, resulting in language disorders, attention deficits and learning disabilities.²³ While evidence around NDP and developmental delay is still emerging, it could be argued that the cosmetic element alone is worth preventing.

According to a cross-sectional study by Roby et al. (2012)²⁴ 38% of infants with NDP and/or brachycephaly had abnormal facial characteristics and have a 2% chance of having those facial deformities persist into adolescence when left untreated. Two other studies in preschool-aged children demonstrated a prevalence of remaining deformity of 3.3% at two years of $age^{26,27}$ and 2.4%-4% at three years of age.^{26,28} Robinson and Proctor (2009) estimate that 0.5-1% of children will show obvious cranial deformities when entering school.²⁵ Hence, in a small proportion of infants with NDP, facial and cranial deformities persist into childhood. The craniofacial deformity and possibly consequential teasing, bullying or embarrassment is one of the most reported parental concerns relating to their child's NDP²⁹ which might be valid because it has been shown that facial "attractiveness" significantly influences the behaviors of caregivers,³⁰ social interactions with peers³¹⁻³³ and teachers' expectations about intelligence and popularity of the child.34 Two very recent studies also showed that persons with craniofacial deformities are susceptible to (cyber)bullying³⁵ and are at higher risk of psychosocial problems.36

Sleeping supine with head preference predisposes to NDP.³⁶⁻³⁸ This is why head positional preference is discussed in this study. There is currently limited research exploring pediatric chiropractic in the Netherlands. Whilst four studies have been conducted³⁹⁴¹ none have investigated the clinical characteristics of pediatric chiropractic care and the treatment of NDP in infants.

There are many different chiropractic treatment techniques used with pediatric patients, and chiropractors adapt force and speed used in manual therapy to match the child's age and development.⁴² Due to the wide range of treatment techniques, this study investigates association between treatment techniques and the total number of treatments expected for full resolution of the head turning preference, as well as determining the characteristics of how chiropractors manage NDP, all providing new insight into chiropractic management of NDP in the Netherlands.

Given that NDP and head turning preference are reported by parents as reasons for presenting their infant to the chiropractor, and the limited evidence for chiropractic management of NDP, this paper sets out to describe chiropractors' experiences and perceptions of this common problem and may serve as a starting point for future research into this condition. This paper does not provide evidence of effectiveness but does highlight the frequency of the condition, treatment types and side effects.

Methods

The research design was a cross-sectional study of practicing chiropractors in the Netherlands. Ethical approval (E142/03/2021) was obtained from AECC University College and Nederlandse Chiropractoren Associatie's Science Committee.

Sample

The inclusion criteria were practicing chiropractors in the Netherlands who were registered with one of the Dutch chiropractic associations: Dutch Chiropractic Federation (DCF), Christelijke Chiropractoren Associatie (CCA) or Nederlandse Chiropractoren Associatie (NCA). Participating chiropractors also had to comprehend written English.

According to Fincham (2008), the response rate should approach 60% to enable appropriate generalization.⁴³ In previous cross-sectional surveys about pediatric chiropractic care, Lee et al. (2000) achieved a response rate of 60% (90 respondents),⁴⁴ and Durant et al. (2001) achieved a response rate of 57% (77 respondents).⁴⁵ A previous demographic survey study in the Netherlands about chiropractic achieved a response rate of 78% (94 respondents).⁴¹ Based on these previous similar studies and the scientific quality provided by response rates of >60%, this was the recruitment goal for this study (60%, n=296).

Data collection

Data were collected via a one-time online anonymous questionnaire. The questionnaire was hosted on Jisc Online Surveys.

Face and content validity of the questionnaire was established using a panel of three experts: a Lecturer in Research Methods at AECC UC, a Dutch chiropractor with knowledge of advanced research methods, and the Course Lead for the MSc APP Pediatric Musculoskeletal Health at AECC UC. These experts were asked for feedback and minor modifications were made based on this, including wording, content, and English language.

This study is part of a larger study. The overall questionnaire

concerned more general information about pediatric chiropractic management, but data specifically related to infants and NDP was pulled from that questionnaire and used for this study.

The information sheet, instructions, and survey were emailed to the Dutch chiropractic associations for distribution to their members. All associations agreed to participate. A reminder email was sent to association members after ten days, the survey was closed one week after this. Timelines were limited as this was a MSc project.

Data analysis

Data were transferred into Excel and IBM SPSS Statistics 24 for analysis. Descriptive statistics were used to quantify the demographic profile of participating chiropractors. A one-way ANOVA test was performed to determine any association between treatment techniques used and number of treatments needed for full resolution of the head turning preference (Table 1).

Results

Seventy-eight responses were received from a total of 493 members of the chiropractic associations, a 16% response rate, significantly less than the 60% target. Of the 78 responses, 86% (N=67) treated pediatric patients. The results presented are all based on the chiropractors' report, rather than medical records.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	88.702	43	2.063	2.06	0.30
Within Groups	3	3	1	3	5
Total	91.702	46			

Table 1. One-way ANOVA - association between treatment techniques used and number of treatments needed for NDP.

Presentations

Participating chiropractors could choose more than one answer. For the age group 0-11 months, the most common presentation reported was head turning preference (with or without NDP) (75%, N=39) and most participants (73%, N=38) treated NDP.

Treatment techniques

Participating chiropractors could choose more than one answer. The definitions of the treatment techniques can be found in Table 2. The most common treatment technique for NDP was 'touch and hold' (68%, N=26), followed by cranial techniques (58%, N=22) and exercises and advice to parents both at 55% (N=21) (Table 3). The data do not specify where

the touch and hold technique was applied.

Referral and co-management patterns

Participating chiropractors could choose more than one answer. Infants with NDP were most commonly referred to participating chiropractors by midwives (55%, N=22) and physiotherapists (48%, N=19) (Table 4, page 1988). In terms of outward referrals, participating chiropractors most frequently referred infants with NDP to GPs (60%, N= 24) and physiotherapists (50%, N=20), either for comanagement or sole management by that practitioner. The inward and outward referrals were two different questions and do not necessarily relate to the same patients.

Age and number of treatments

The mean age at which NDP was mostly encountered was 1.53 months (M=1.53, SD=0.554) (Tables 5 and 6, page 1988). If NDP was associated with a head turning preference, participating chiropractors expected four treatments on average (M=4.15, SD 1.562) for full resolution of the head

Activator technique	A handheld, spring-loaded instrument that provides a specific low-force-type thrust to restricted joints of the spine or extremities
Applied Kinesiology (AK)	Correction of muscle weakness/imbalance via the nervous system, lymphatic system, vascular system, and nutrition
Diversified technique	SMT (spinal manipulative therapy) including a high-velocity, low-amplitude (HVLA) thrust to areas of restricted joints of the spine or extremities
Neural Organization Technique (NOT)	Technique to reorganize and enhance the au- tonomic nervous system's function by using combinations of specific SMT, SOT, AK, and acupressure (neuro-lymphatic and neuro- vascular points) with coordinated breathing to improve the function of the systems con- trolled by the autonomic nervous system
NeuroImpulse Protocol (NIP)	A very gentle technique with focus on neuro- logical precision. Not intended to restore joint function but to restore normal neurological function and repositioning the body through the central nervous system
Sacro-occipital technique (SOT)	A technique that focuses on the relationship between the sacrum and occiput
Steve Williams' technique	Technique that focuses on functional pediat- rics, SOT and craniopathy
Toggle recoil	Fast but light thrust, quickly removing chiro- practor's hands away from the contact point
Touch and hold	A gentle pressure is applied to the fixated structure until the practitioner feels the ten- sion releasing

Table 2. Definition of techniques used by participating chiropractors.

Treatment techniques	Responses N	% of cases
Activator technique	14	7%
Applied kinesiology	2	5%
Cranial techniques	22	58%
Diversified technique	3	8%
Exercises	21	55%
Advice to parents	21	55%
NeuroImpulse Protocol	6	16%
Sacro Occipital Technique	12	32%
Soft tissue work	16	42%
Steve Williams' technique	17	45%
Toggle recoil	3	8%
Touch and hold	26	69%
Neural Org. Technique	1	3%
Total	164	432%

Table 3. Treatment techniques for NDP.

turning preference (Table 6, page 1989). There was no statistically significant relationship between treatment techniques used for NDP and number of treatments estimated for full resolution of the head turning preference, determined by the one-way ANOVA (p = .305) (Table 1).

Discussion

According to Hestbaek & Stochkhendahl (2010),⁴⁶ musculoskeletal conditions are the most common presentations/diagnoses in children which was also shown in this study. This is consistent with Durant et al. (2001),⁴⁵ Verhoef and Papadopoulos (1999),⁴⁷ Hestbaek et al. (2009)⁴⁸ and Miller (2010).⁴⁹ This might be explained because musculoskeletal complaints frequently present in general pediatric practice as well,⁵⁰ and chiropractors are known to be musculoskeletal specialists.⁴⁸

Pediatric chiropractic practice in the Netherlands is common with 86% (N=67) of participating chiropractors treating patients under 18. It is not known why the other chiropractors did not respond, however given the high proportion of respondents who treated pediatric patients, it may be that these chiropractors were more inclined to respond to the survey.

Although NDP was the least commonly chosen presentation for the 0-11-month-olds, the most common presentation was head turning preference (with or without NDP) (Table 7, page 1990) and the majority of participating chiropractors indicated in the survey that they treated NDP.

The mean age at which NDP was encountered was 1.53 months (M=1.53, SD=0.554) (Table 6, page 1989)

Professionals	Responses N (percent of cases)			
	Professionals to which chiropractors refer infants	Professionals that refer infants to chiropractors		
Another chiropractor	9 (23%)	11 (28%)		
Craniosacral therapist	1 (3%)	1 (3%)		
General practitioner	24 (60%)	9 (23%)		
Homeopath	2 (5%)	2 (5%)		
Lactation consultant	-	13 (33%)		
Maternity care physician	-	13 (33%)		
Midwife	-	22 (55%)		
Physiotherapist	20 (50%)	19 (48%)		
Specialist at the hospital	12 (30%)	2 (5%)		
(Specialist at) tongue tie clinic	-	1 (3%)		
Doula	-	1 (3%)		
Osteopath	7 (18%)	-		
None	4 (10%)	6 (15%)		
Total	79 (198%)	100 (250%)		

Table 4. Referral patterns for NDP.

which aligns with existing prevalence data demonstrating increases in NDP in healthy infants up to 16 weeks of age.⁴⁰

If NDP was associated with a head turning preference, participating chiropractors expected four treatments on average (M=4.15, SD 1.562) for full resolution of the head turning preference (Table 6). This represents a relatively rapid resolution compared to eight chiropractic treatments reported by Hash (2014),¹⁴ and three to four months of chiropractic care recommended by Davies (2002).⁵¹ However, it is important to note that Hash (2014) and Davies (2002) described these timelines for full resolution of NDP, rather than head turning preference alone.^{14,46} This estimate of four treatments was consistent with Saedt et al. (2018), where the head turning preference resolved in averagely 3.5 treatments of manual therapy with the greatest effects obtained after 1.8 treatments.⁴⁰

Participating chiropractors reported a relatively young infant population and relatively low numbers of treatments

for resolution of the head turning preference and it may be plausible that older infants may require additional/longer term treatment, although there is no definitive evidence to confirm at this stage and differences in resolution times across different ages should be addressed in future research.

In our study, there was no statistically significant relationship between treatment techniques used for NDP and number of treatments needed for full resolution of the head turning preference, indicating that effects are specific to the individual. Participating chiropractors of this study indicated 'touch and hold' and cranial techniques as the two most common treatment techniques for NDP, followed by exercises and advice to parents as the third most common treatment types. Likewise, cranial techniques, including decompression of the occiput, frontal bone lift and traction of the temporals, were also a large component of the treatment plan in the study of Hash (2014).¹⁴

Hash (2014), Davies (2002) and Cabrera-Martos et al. (2016)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-3 months	20	38.5	50	50
	3-6 months	19	36.5	47.5	97.5
	6-9 months	1	1.9	2.5	100
	Total	40	76.9	100	
	System	12	23.1		
Missing Total		52	100		

Table 5. Ages at which the chiropractors encounter NDP.

		At what age does the chiropractor encounter NDP the most?	If plagiocephaly is caused by a head turning preference, how many treatments does the chi- ropractor usually expect, on average, for full resolution of the head turning preference?
Ν	Valid	40	40
	Missing	12	12
Mean		1.53	4.15
Median		1.5	4
Mode		1	4
Std. Deviation		0.554	1.562
Variance		0.307	2.438
Percentiles	25	1	3
	50	1.5	4
	75	2	5

Table 6. Statistics on age and number of treatments for NDP.

Presentations	Responses N (percent of cases)
Check up without complaints	29 (56%)
Colic	32 (62%)
Feeding difficulty	19 (37%)
Head turning preference (with or without (non-synostotic) plagiocephaly)	39 (75%)
Motor development delay/issues	9 (17%)
Musculoskeletal conditions	12 (23%)
Scoliosis	4 (8%)
Sleeping difficulty	30 (58%)
Frequent colds	1 (2%)
Non-synostotic deformational plagiocephaly	1 (2%)
Ear infection	1 (2%)
Tongue tie	1 (2%)
Birth trauma	1 (2%)
Headache	-
Nocturnal enuresis	-
Neurodevelopmental issues	-
Emotional control	-
Brain injury	-
Gait abnormality	-
Abdominal issues including pain and/or constipation	-
Swimming issues	-
Extremity joint pain	-
Low back pain	-
Neck pain	-
Nocturnal enuresis	-
Performance improvement	-
Sports injury	-
Whiplash Associated Disorder	-
Neurological disorder	-
Learning disorder	-
Not applicable for participant	8 (15%)
Total	187 (360%)

Table 7. Presentations 0-11 months of age.

reported benefit of chiropractic/manual therapy for the management of NDP without side effects.^{14,17,46} The study of Saedt et al. (2018) is an observational study without randomization and control groups so no conclusion can be made about the effectiveness of upper cervical manual therapy. Nevertheless, NDP appeared to improve with upper cervical mobilization techniques. This is believed to be beneficial as NDP is often caused by upper cervical dysfunction resulting in actively and passively restricted cervical ROM.⁴⁰ Fludder and Keil (2020) found restricted

passive cervical ROM in 92% of children with NDP. They also showed 79% of children under the age of one suffered from restricted passive cervical ROM, of which 60% also showed indication of NDP.⁴² These factors might explain why manual therapy can be of benefit in management of NDP.

Limitations

This study comes with limitations. Firstly, there is nonresponse bias. The survey was voluntary and resulted in a relatively low response rate of 16%, significantly below the target of 60%. This means the results only reflect the practice of a small proportion of chiropractors in the Netherlands and limits generalizability. There is no data to explain why participation was low. It can be hypothesized that it may be attributed to the short time frame to complete the survey and the timing. At the time of distribution, chiropractic clinics only had been officially open for a few weeks since the second COVID-19 lockdown as chiropractic is not considered an essential service in the Netherlands.

Chiropractors may well have had other priorities at this time, and this may further account for the low response rate. Future studies could use multiple means of promoting the study such as social media and not email alone. However, the sample size is equivalent to previously published studies in this area. It needs to be considered that this data was pulled from a larger study. The information provided was dependent on the respondent's recollection and accuracy, potentially leading to recall bias. Participating chiropractors with a particular interest in pediatrics might have been more likely to participate which may have introduced selection bias, chiropractors who infrequently treat pediatric patients may be underrepresented in this study and there may be an unreported difference in their practice and management of NDP.

Future studies may want to address specific age groups to get more detailed results, as well as add a longer time frame for response. This is however the first study to investigate pediatric chiropractic practice in the Netherlands. Further research is needed to address this paucity in quality and quantity of data. Initially, a prospective study of infants undergoing chiropractic management, using valid parentreported outcomes about head turning preference and objective measures such as measuring the distance from ear to external occipital protuberance with pre- and posttreatment data collection to assess for change. Future research may also want to address cost/benefit ratio and rates of satisfaction.

Conclusion

This study was based on data collected for a larger study, which will be published separately. Most participating chiropractors treated pediatric patients, mainly using the low-force technique 'touch and hold'. The most common presentation was head turning preference (with or without non-synostotic plagiocephaly). Non-synostotic plagiocephaly is typically encountered at around 1.53 months and treated with 'touch and hold' and cranial techniques. If it was associated with a head turning preference, four treatments were expected on average to achieve full resolution of the head turning preference. Participating chiropractors reported 'no side effects' more commonly than any specific side effects.

This study serves to raise awareness of the high occurrence of non-synostotic deformational plagiocephaly, and the role chiropractors can play in its management, which is in line with current recommendations with regards to treatment types, home advice and number of treatments.

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