

Improvement in plagiocephaly, cervical range of movement, primitive reflexes, and subjective parental feedback in an infant co-managed with chiropractic care and helmet therapy:

A case report and review of the literature.

Matthew Doyle

Abstract: Objective: To chronicle the improvement in plagiocephaly measurements, cervical range of movement, primitive reflexes, and subjective parental feedback in an infant co-managed with age appropriate chiropractic care for assessment and correction of vertebral and cranial subluxation and helmet therapy. This case report was prepared following the CARE guidelines as presented in 2017. (1) **Clinical features:** A five-month-old female infant was presented to clinic by her mother “seeking shared care” for her daughters plagiocephaly. Previous care included four chiropractic visits over the previous month, and recent attendance at a specialist paediatric physiotherapist. Clinical assessments using the caliper system demonstrated a 20 mm difference in diagonal cranial vault measurement. Decreased left lateral flexion and left rotation of the cervical spine, cranial restrictions, vertebral subluxations, and altered primitive reflexes were found. **Intervention and Outcomes:** Age appropriate chiropractic care was delivered on 35 visits between 5 months and 17 months of age. Home care including tummy time and infant exercise ball posterior chain activation was recommended. Helmet therapy began at 6 months and finished at 10.5 months. Growth charts were within considered developmentally appropriate percentiles. Prior to helmet therapy beginning, cervical range of motion and aberrant primitive reflexes improved. Cranial Vault Asymmetry (CVA) and Cranial Vault Asymmetry Index (CVAI) improved over the 12 months from a CVA of 20mm and CVAI of 14.3% to a CVA of 9mm and CVAI of 5.8%. **Conclusion:** This case report chronicles reduction of plagiocephaly rating from severe to mild, improvements in primitive reflexes and in cervical range of motion, and subjective parent reported infant quality of life in an infant co-managed with age appropriate chiropractic care and helmet therapy. Further prospective studies are required to ascertain the clinical significance of helmet therapy with chiropractic care, helmet therapy versus chiropractic care, and different technical approaches (cranial/cervical/pelvic or combinations of each) for the delivery of the adjustment.

Indexing Terms: plagiocephaly; chiropractic; helmet therapy, case report.

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Quick Tap or Scan:



Introduction

Plagiocephaly as a condition is reportedly first described by Virchow in 1851. (2) Ellwood, Draper-Rodi, and Carnes in their 2020 synthesis of systematic reviews and guidelines of manual therapy for plagiocephaly succinctly discuss the condition, its background, and non-surgical interventions as follows:

'Cranial asymmetry, also known as plagiocephaly, is the most common form of "flat head syndrome" and presents itself as an asymmetrical head shape. Positional plagiocephaly (PP) (sometimes referred to as deformational plagiocephaly or non-synostotic plagiocephaly) typically occurs in infants and results from mechanical factors which, when applied over a period of time in utero, at birth, or postnatally, alter the shape of the skull. In this condition there is flattening of one side of the occiput, with anterior displacement of the ipsilateral ear. The region of occipital flattening relates to the side that the head is toward when in the supine sleeping position.

A rise in the prevalence of PP occurred after widespread implementation in western countries of the 'Back to Sleep' campaigns which recommended that healthy term infants be positioned on their backs during sleep to prevent Sudden Infant Death Syndrome (SIDS). Prior to 1992, the incidence of the deformity was estimated at 1 in 300 infants. Estimates for PP prevalence now range from 16 to 48% of typical healthy infants younger than 1 year depending on the diagnostic criteria used and 37.8% for infants aged between 8 and 12 weeks old. Considering this large increase in the incidence of PP, there has been much interest in investigating, managing, and preventing this condition.

Although the optimal timing and modality of interventions have yet to be clearly established, primary treatments for plagiocephaly are nonsurgical and include observation, head repositioning, manual therapy (including practitioner-led stretching exercises), and helmet therapy/orthotic devices.' (3)

Cognitive and academic outcomes are reported as scoring lower in school aged children with moderate to severe PP. (4) Positional plagiocephaly was reported as having a defined link in neurodevelopmental delay, including motor skills development, though only at a correlational not causal level. (5) Chiropractic case studies, retrospective case series, and prospective case series report positive outcomes associated with age appropriate chiropractic care of infants. (6, 7, 8, 9)

Conventional chiropractors and students recognize that the central focus of chiropractic care is to assess for and reduce nerve interference, caused by vertebral subluxation, to enhance nervous system function and support the optimization of health and well-being. (10, 11, 12, 13, 14, 15, 16, 17, 18) The Australian Spinal Research Foundation (SR) conceptually define subluxation as 'a diminished state of being, comprising of a state of reduced coherence, altered biomechanical function, altered neurological function and altered adaptability.' (19) A vertebral subluxation has been recognized as a complex of functional and/or structural changes in articulations of the spine and pelvis that compromise neural integrity and may influence organ system function and general health. (20) A vertebral subluxation represents an altered state of afferent input which can lead to maladaptive changes in central neural plasticity resulting in dysfunction. (21) Vertebral subluxation correction is achieved through chiropractic adjustments that are typically manually performed. Cranial patterns of subluxation have been reported in the literature for decades (22, 23) and textbooks are published on their assessment and correction (24, 25, 26) Chiropractic adjustments in infants and children are appropriately modified for age and stage of development. (27)

Helmet therapy is a commonly used orthopaedic intervention in moderate to severe cases of PP which has retrospective analysis support (28) and positive low level evidence support in the

most recent synthesis of systematic reviews and guidelines. (3) No literature was found regarding co-management of infants with PP through chiropractic care and helmet therapy.

The purpose of this case report is to chronicle the improvement in plagiocephaly measurements, cervical range of motion, primitive reflexes, and subjective parental feedback in an infant co-managed with age appropriate chiropractic care for assessment and correction of vertebral and cranial subluxation and helmet therapy.

Case Report

History

A five-month-old was presented for assessment and opinion following referral from her mother's chiropractor. Her mother had attended four chiropractic visits with her daughter between 11 and 17 weeks of age for 'colic' and 'general wellbeing'. The chiropractor noted the mother had also attended a paediatric physiotherapist for a developing plagiocephaly for which a cranial helmet was under consideration. She wanted further paediatric chiropractic opinion and was referred to this practice.

Her mothers' reason for attending was '*seeking shared care – plagiocephaly helmet plus physiotherapy plus chiropractic.*' She noted issues with head shape asymmetry, poor neck movement, and issues with digestion. She wanted further paediatric chiropractic opinion and care after referral from her regular chiropractor for her child. The family was taking a three-week holiday in five weeks overseas and they wanted their child to have further chiropractic assessment and indicated care prior to getting a helmet fitted in the days before leaving on their trip.

Maternal history revealed this as the first full term pregnancy, with two previous miscarriages. A fall was noted mid pregnancy onto concrete resulting in sacroiliac joint pain and sciatica. Severe morning sickness was reported in first term, with hyperemesis requiring several hospital stays. The seasonal flu shot was taken. She has a family history of scoliosis, and a long-term history of Fluoxetine usage for anxiety/depression. Paternal history included poor eyesight and thalassemia minor.

The infant was reported as being engaged for weeks prior to birth and being head down during labour, which occurred at 38+1 weeks gestation. Labour was at her location of choice (hospital) with no doula present. During labour gas and an epidural were given, with vacuum extraction assistance required for a vaginal delivery. Mother reported pushing actively for 4 hours. Birth weight was reported as 3.385kg, length 50.5cm, head circumference 35cm. Her child was reported as alert after birth and had jaundice.

Initial consent included consent for de-identified data to be used for research purposes. Further parental consent to this data publication was received following the third review 12 months later.

Clinical Findings

Relevant measurements are noted in Table 1.

Table 1: Relevant clinical measurements

Date/age DOB 17-07-18	Length (cm)*	Weight (kg)*	Head Circ (cm)*	Diagonal left front (mm)	Diagonal right front (mm)	Difference CVAm CVAI%	Palmer Grasp	Landau Reflex	Chiro care visits
17-12-18 21 weeks 6 days (5 mnths)	63.5	6.82	41	120	140	20mm 14.3%	Weak on right	Weak on right	0
25-01-19 27 weeks 3 days (6.5 mnths)	66.5	7.5	42.5	127	145	18mm 12.4%	NAD	NAD	13
13-03-19 34 weeks 1 day (8 mnths)	68.5	9.15	43.5	128	143	15mm 10.5%	-	-	18
21-12-19 (17mnths)	79	10.36	45.5	146	155	9mm 5.8%	-	-	35

Decreases in left lateral flexion and left cervical rotation were noted. Vertebral subluxations were listed at her occiput bilaterally, T3, and S2. Facial symmetry changes were noted with anterior displacement of her right ear, right frontal bossing (apparent bulging relative to the opposite frontal area), and contralateral bossing of her occiput resulting in a parallelogram-shaped head. Cranial restrictions were recorded at the occiput, right temporal, and right sphenoid. No evidence of lambdoidal craniosynostosis was found which commonly presents with a more trapezoidal head shape. Her asymmetric tonic neck reflex was weak on the right.

Cranial vault asymmetry was assessed using calipers as it is reported to be a clinically reliable method (29). The *Mimos* system (30) was used with an elasticised garter and plastic caliper as can be seen in the excellent images in Gordon's 2017 article. (8) The frontozygomatic to contralateral occiput (euryon) distance was measured using spreading calipers on both sides of each patient. The distances were defined as diagonal A (fzA to euA) and B (fzB to euB), with A>B. The cranial vault asymmetry (CVA) was determined by subtracting B from A. The cranial vault asymmetry index (CVAI) given as a percentage was determined by subtracting B from A, dividing the resultant by A, and multiplying it by 100. (28)

Intervention and Outcomes

The initial care schedule was three visits in the week before Christmas, no visits over Christmas and New Year as the practice was closed, and three visits a week in the three weeks prior to leaving on their overseas trip.

Common chiropractic interventions included; dural releases with occipito-sacral decompression; cranial techniques as indicated on assessment visit to visit, including plagiocephaly specific contacts per Stephen Williams text (25) on an anterior-posterior strain pattern; adjustments of the upper cervical vertebral subluxation using a touch and hold technique from 5.5 months of age (prior to this age the primary subluxation patterns were addressed with

cranial work); seated anterior thumb lifts for thoracic subluxations from 9 months of age; ankle and hip mobilisations.

On the 7th visit her parent noted the plagiocephaly physiotherapist reported the infant was have *'atypical positive improvements'*.

The helmet was fitted on the one day between 12th and 13th visit. The initial chiropractic visits occurred over a five-week time frame. Diagonal caliper measurement on the 13th visit demonstrated a 2 mm decrease in diagonal length difference from 20 mm to 18 mm.

Parents left for overseas for three weeks following the review visit (13th).

On return post travels, on her 14th visit parents reported her handling the helmet well. Clinical assessment demonstrated an inspiration restriction of the fronto-nasal-maxillary region which was much more evident than on the previous visit.

Five visits were attended for chiropractic care over 18 days upon which another full review was completed on the 13th March 2019. This review was also noted as after 6 weeks of daily helmet use. This demonstrated a 15 mm diagonal measurement difference. Helmet therapy continued daily for a further 4 months, with adjustments to helmet size and shape twice in that time frame. Helmet therapy stopped at 10.5 months of age.

From the 13th March 2019 she had 6 visits at a fortnightly interval (one within a week as she had had a cold and her mother chose to bring her in earlier for a checkup). She was diagnosed with a peanut allergy age 11 months (June 2019) and parents began carrying an epi-pen. She received the normal Australian vaccination schedule. A further 11 visits were attended over the following 6 months between 2 and 4 weeks based on parent discretion (ie following a fall off a bed, chest infection) and clinical presentation (ie increased dural tone on assessment of lateral spinal flexion, increased restriction in upper cervical joint play and increased cranial restrictions).

On review 21st December 2019 her mother reported the child had *'sleep quality improved, fewer days rundown, decreased allergies/rashes, and decreased cold/flu duration'* through her time in care. This documented 12 months of chiropractic care with a total of 35 visits, within which helmet therapy was used for 4.5 months (6 months to 10.5 months of age). Over the course of her care the child demonstrated improvements in her primitive reflexes (palmer grasp, landau reflex, and ATNR) and within-limits development of her length, weight, and head circumference. Her cervical range of motion improved with decreased restriction in lateral flexion and left rotation. Her asymmetry decreased a total of 11mm (from 20mm to 9mm, for a cranial vault asymmetry index change (CVAI) of 8.5% (from 14.3% to 5.8%).

Discussion

Strengths and weaknesses

This case chronicles the improvements seen in a female infant undergoing co-managed care for plagiocephaly. It provides clinical evidence about the chiropractic care of this infant with plagiocephaly and her progress over time regarding CVA, cervical ranges of motion, and primitive reflex integration. Case reports carry inherent weaknesses. These weaknesses are reported in the literature *'based on an ontology of materialism and epistemology towards objectivity'* as they lead to a number of confounding factors such as *'natural history and spontaneous regression to the mean, the effects of placebo, the demand characteristics of the therapeutic encounter and subjective validation on the part of the parent/patient'*. (31) Readers are encouraged to weigh the balance of dual ontologies – that noted above of objectivism and the lack of weight of evidence it gives to case studies (versus randomised controlled trials), with that of constructivism. In this constructivist perspective, reality is built upon perception with its epistemology weighing meaning from scaffolded experiences. In a clinical profession like chiropractic balancing the

literature base, the parents and patient's perspective and preferences, and the clinicians experience allows for an optimisation of the clinical interaction.

Literature Review

The highest quality study to date regarding plagiocephaly and manual therapy was a systematic review completed by Ellwood, Draper-Rodi, and Carnes in 2020. The authors make note of concerns regarding positional plagiocephaly (PP) due to literature citing associations with developmental dysplasia of the hip, brachial plexus injury, foot or lower limb anomalies and cognitive and motor development. (3)

Etiologic factors reported in multiple publications include a suggested link with the birth process. (6, 32) Considered rationales include: small maternal pelvis, multiple births, breech position, oligohydramnios, male sex of fetus, gestational diabetes, nulliparity of mother, high birth weight, large neonatal head size, vaginal delivery, prolonged post-delivery hospital stay (>4 days), and prolonged stage 2 of labor. Further stressors reported as influencing PP from 6 weeks are: limited passive neck range of motion at birth; preferential head orientation; supine sleep positioning; and head position not varying when put to sleep. (32) It is reported in a 2014 study that PP was found equally in males and female neonates, that perhaps it is more likely to persist in males, but this concept has yet to be further investigated. (9)

When presented with a child with PP the clinician needs to have reliable, reproducible, valid, clinically applicable and time effective tools to measure PP. Siegenthaler reviewed methods to diagnose, classify, and monitor this in her narrative review of 2015. (29) Six measurement tools were found:

- ▶ visual assessment
- ▶ anthropometric measurements with a caliper
- ▶ measurements with a flexicurve
- ▶ plagiocephalometry
- ▶ 3-dimensional photography and
- ▶ radiological imaging.

She concluded from the review of evidence that anthropometric measurements with a caliper and plagiocephalometry are more reliable clinical measurement methods. The clinical experiences of this author supports the use of the calipers for measurement of PP.

One of the mechanical factors leading towards PP that Ellwood, Draper-Rodi, and Carnes described was birth. Hosaka and Alcantara describe a recent case of neonatal plagiocephaly following birth trauma associated with an asynclitic vaginal presentation. This position is '*defined as a lateral flexion of the head with respect to the pelvic inlet of the birth canal.*' (31) The paper reports on a 6-hour old infant with a positional preference for the left breast to feed, occipital oedema, cranial restrictions, hypertonicity of flexor muscles, decreased suck reflex, and tongue retraction on sucking. These were reported to improve following one cranial adjustment using sustained contact on the greater wings of the sphenoid and on the external occipital protuberance.

One of the concerning questions regarding PP is that of neurodevelopmental delay in infants and toddlers. Marinus explored this question in his November 2019 publication in the *Journal of Clinical Chiropractic Pediatrics*. The results reported an effect seen more so in motor skills during infancy which was noted to extend to preschool aged children, and PP patients demonstrated a greater likelihood of altered muscle tone. There was no correlation between severity of asymmetry of the cranium and the level of neurodevelopmental delay. Marinus noted correlation not causation and offered the possibility that pre-existing neurodevelopmental delay may be the

cause of PP. Usefully he offers that *'it is likely to be a combination of risk factors of supine sleep, lack of prone awake time, variable muscle tone, low activity levels, male gender and neck muscle dysfunction that attributes to the delays that have been recognized in these infants.'* (5)

Identifying the dysfunction in the neuromusculoskeletal system in the infant in a neonatology ward has been explored by Italian Osteopaths Cerritelli et al. (33) The osteopaths term this *'somatic dysfunction'* (SD) which is listed in the International Classification of Disease (ICD10) codes as M99.0-9. Chiropractors using the ICD10 codes report vertebral subluxation as M99.1. Both of these codes fall under the ICD10 section M99 – biomechanical lesions, not elsewhere classified. (34) When reflecting on the technical approaches used by osteopaths and chiropractors for infants this author's clinical experience and reading of the literature suggest significant technical overlap. Underlying philosophical foundations of the profession have variants on a central theme of the body's homeodynamic optimisation however further discussion is beyond the remit of this case report. The authors describe a clinically useful protocol of assessment (in a NICU crib) that *'starts from the skull, continuing with the spine and pelvis passing through upper and lower limbs and ends with the rib cage and viscera. The evaluation is performed according to TART (Tissue alteration, Asymmetry, Range of Motion and Tenderness) criteria aimed to locate SD.'* (33) Chiropractic publications over the past decade have described similar assessments as central to paediatric chiropractic, and further describe an overview of paediatric chiropractic (35) and consensus publications (27, 36) on best practices.

In a South Korean retrospective study of 108 children who used helmet therapy, the authors reported best results from around 5 months of age, with not less than 7 months of wearing the helmet and ideally at least 20 hours a day. Treatment success (defined by the authors as a reduction in CVA below 5.5 mm, was significantly decreased if the helmet was started after 9 months of age. (28) The authors considered a CVA greater than 10 mm was an appropriate candidate for helmet therapy. This case started helmet therapy at 6 months and discontinued its use at 10.5 months when recommended by the prescribing helmet therapist. Her CVA was 18 mm at the time of initialising helmet therapy.

A conservative option that has been explored in the literature for plagiocephaly is chiropractic care. Humphris, Askin, and Glucina-Russell describe improvements in a 6 month old female Australian presenting with plagiocephaly receiving chiropractic care for vertebral subluxation. (37) The chiropractor delivered one adjustment to one different segment on three different visits. They make careful differentiation between synostotic (*'craniosynostosis, which results from intrinsic factors and is more likely to require surgical intervention'*) and non-synostotic (*'being a morphological abnormality, is not known to spontaneously resolve and the common assumption is that the deformation will gradually continue if the external causative factor is not addressed'*). They theorise that if the chiropractic adjustments reduced interference in the somatosensory processing and integration (17) of the infant, allowing for improved cervical motion and decreased hypertonicity of the sternocleidomastoid, the cranial bones may have regained more normal contours due to this increased mechanical and neurologic control of the cervical spine. This perspective is reflected in Walker and Russell's discussion of a 4 month old males improvements in plagiocephaly and cervical range of motion following chiropractic care for vertebral subluxations. (6)

In technical contrast to single visit adjustments delivered in this Australian case, Hirshowitz and Swenson (7) from the USA report on using cranial, cervical, and sacral adjusting styles on the case series of three 10 week old infants. Each of these was found to have visual improvements in symmetry of the cranial bones with associated reduction of other systemic symptoms in 12 weeks or less.

The importance of the cranial structures are reviewed by Parker in her paper on breastfeeding difficulty and plagiocephaly improving in a 4 day old Texan with chiropractic care. (32) Citing midwifery journals she notes '*breastfeeding difficulty is a synchronised event requiring the infant to suck, swallow, and breathe. Performing this coordinated event requires 6 of the 12 cranial nerves; 22 cranial bones articulated at 34 sutures/places; and 60 muscles that are both voluntary and involuntary*'. Rapid improvements are noted with breastfeeding, with excellent descriptions of cranial and spinal adjusting techniques along with a thorough review of issues with suck dysfunction and the somatosensory integration required for an efficient feeding technique.

While not specifying the individual rationales for presentation such as breastfeeding, Gordon has published an excellent Australian retrospective study of 23 infants under chiropractic care with plagiocephaly. (8) The chiropractic care entailed gentle sustained light force techniques for cranial bones and sutures, spinal, shoulder, pelvic and or sacral structures, along with indicated soft tissue releases of sub-occipital, sternocleidomastoid, or upper trapezius muscles. No manipulation of the cervical spine was performed. The author provides excellent drawings of PP (written as deformational plagiocephaly) versus lambdoidal synostosis, and images of the elasticised garter provided with the Mimos infocephalia calipers. He lists the grading of the cranial vault index (CVAI) in the following percentages:

- ▶ Normal 0-3%
- ▶ Mild 3-7%
- ▶ Moderate 8-12%
- ▶ Severe >12%.

He also reports on the literature suggesting neurodevelopmental disadvantage in infants with PP. From a statistical point of view, the 23 infants received an average of 6.9 visits. In the first 6 weeks the mean CVAI decreased from 8.77% at 12.5 weeks to 5.6%, and at final assessment at average age of 29.8 weeks to 4.6%. He presents subgroup data on those who used a mimos donut pillow as well as chiropractic care which demonstrated a statistically significant improvement in those who only had chiropractic care. When considered in relation to these CVAI levels, the child in this case report started at a severe rating of 14.3% and obtained mild rating result of 5.8% at her 12-month review.

Providing a technical contrast to the use of no cervical adjusting with cranial and sacral adjustments is the 2016 UK study at the Anglo European College of Chiropractic (AECC). This is the highest quality study to date on the topic given its prospective cohort nature and its 64 participants. (9) Whereas the Gordon study did not manipulate the cervical spine (appeared primarily cranial and pelvic work) the AECC study specifically addressed the cervical spine. They used a prototype measurement: from the external occipital protuberance to the anterior ear on both ears, finding the difference between the two, with greater than 0.4cm recorded as a plagiocephaly. This is confusing given Siegenthaler's 2015 paper (while studying at the AECC) describing the 6 reported measurement styles already in the literature and recommendation that calipers or plagiocephalometry offer reliable clinical measurements. Nonetheless, with an average of 5 visits over 6 weeks, a statistically significant reduction in difference of measurement was recorded along with 20 of the 64 obtaining resolution of plagiocephaly (within their measurement structure of 0.4cm or less). The authors chose a six week maximum time frame as they considered that a reduction in that time to be '*well ahead of the natural history of the disorder.*' (9)

A recent Australian retrospective analysis of 150 consecutive infant cases was published investigating an association between plagiocephaly restrictions in passive range of motion. The

results demonstrated that for those cases with plagiocephaly, 92.2% were found to have restrictions in cervical range of motion. (38)

As with any disorder, an appreciation for home care with specific guidelines can be useful. Vallone and Miller, with over 100 published paediatric chiropractic papers between them, offered expert commentary in 2016 on Tummy Time. They note the prevalence of head shape deformity at different infant ages as: 16% at 6 weeks; 19.7% at 4 months; 9.2% at 8 months; 6.8% at 12 months, and 3.3% at 24 months. Key home care for infants in general, and particularly for plagiocephaly cases, is recommended as: 5 minutes/day at 1 week; 10 minutes at 4 weeks; 20 at 8 weeks; 45 at 12 weeks and 80 minutes a day at 16 weeks. (39)

The evidence to support the chiropractic care of children continues to evolve and has been considered previously. (40, 41) The care of children is documented globally (42), appropriate force application has been described (43), and the very low risk of adverse events has been reported. (44) Recent Australian governmental body investigations by *Safer Care Victoria* into spinal manipulation under the age of 12 returned numerous interesting findings. (45) An extensive search for harm sustained by children who had received spinal manipulation (Cochrane Australia literature review, capture of data from the national professional regulatory body, capture of claims data from primary Australian insurance providers, and stakeholder feedback) identified very little evidence of harm occurring in Australia. Importantly *'there were no patient complaints or practitioner notifications that arose from significant harm to a child following spinal manipulation'*. (45). A public consultation for parents and guardians who had accessed chiropractic care was conducted for their experiences – both positive and negative. To date this is likely the largest global public survey of its type with 21,824 submissions. Negative reports were 0.3% (n=74) which related to concerns of treatment with no improvement, excessive use of x-rays, or perceived pressure to avoid medications or advice previously offered by other practitioners. The overwhelming majority of parent/guardians reported that spinal care helped their child, with 98% (21,474) indicating that their child improved after treatment. The report states:

'it was clear that parents/guardians appreciated the time that their child's chiropractor took to listen to their child's symptoms and to engage with them and their child. A sentiment that was strongly expressed was the right of a parent/guardian to choose their child's care. Parents/guardians reported that they accessed chiropractic care for their child for a wide range of conditions and complaints, including maintaining general health and wellbeing. The most common conditions included posture concerns, colic, neck pain, difficulty with breastfeeding, back pain and headache.' (45)

This case report documents positive improvement in a co-managed infant for plagiocephaly with chiropractic care and helmet therapy. The time frame for changes in the varying measurements recorded afford some interesting considerations. In the first month of chiropractic care, improvement in cervical ROM and primitive reflexes were documented prior to initialisation of the helmet therapy, along with a 2mm improvement in CVA. This difference may be within the reporting error for the calipers but showed a trend in a healthier direction. Following the first 6 weeks of helmet usage, along with a further 3 weeks of chiropractic care when the family was in-country, a further 3mm CVA improvement was noted. Recording performed 6 weeks after the helmet therapy was removed, and 17 chiropractic visits after last measurement, showed a further 6mm CVA decrease. This entailed a CVAI decrease from 14.3% (severe rating, >12%) to 5.8% (mild).

When looking at other orthopaedic literature such as hip and knee orthosis the concept of prehabilitation is explored for its positive effects. (46) This may be considered in this child's case where the noted primitive reflex integration and improved cervical ROM may help facilitate an

improved outcome with the orthopaedic procedure. This reflection on the positive clinical outcome is worthy of further clinical research exploration.

Several authors theorise that the improvements noted in care targeted at the cervical ROM and subluxation reduction in their case studies may facilitate the bodies capacity to normalise the cranial asymmetry. (6, 9, 37). However this is contrasted with the approach of Gordon in his retrospective case series where the cervical spine was not adjusted, and the chiropractic care appeared to be delivered to the cranial and pelvic regions. (8) It may be possible that the intervention area the chiropractors chose facilitated better 'tone' as described by DD Palmer (47) within the neuro-dural spinal system which allowed for the improved cranial asymmetry and the plethora of symptomatic and subjective improvements recorded in the referred literature (see table 2). In line with Ebrall & Murakami's discussion on aboutness and consilience, Table 2 begins to coalesce some of the data to date on infants presenting with plagiocephaly and the chiropractic care options to be explored. (48)

The current zeitgeist around the chiropractic care of children may be transitioning as the evidence base grows supporting the practice. This may see a shift in the doxa of the Bourdosian field around chiropractic where the growth of evidence facilitates a change in the political noise around the chiropractic care of children. (49) This may open further access to the public usage of care – indeed, one of the recommendations from the independent Victorian governmental panel was to further support research into this area.

Conclusion

What appears to be best practice from the review of literature, beyond that in the best practice guidelines of 2016, is the assessment and correction of the spinal and cranial patterns of subluxation as indicated by age appropriate techniques (low to moderate evidence per Ellwood et al 2020 (3). Home advice regarding tummy time is critical. Usage of calipers is suggested for time efficiency and clinical utility, and review of this measurement regularly. This should likely be done within the first 6 weeks, after 4 to 8 visits. Change may occur over longer time frames so regular reviews are important to continue to document this. Consider co-management with other specialists that can facilitate helmet therapy for severe cases, as this has demonstrated improvements in CVA (low level evidence per Ellwood et al 2020 (3) There may be adaptive value and biological plausibility in using chiropractic care as pre-habilitation for severe cases.

This case report chronicles reduction of plagiocephaly rating from severe to mild, improvements in primitive reflexes and in cervical range of motion, and subjective parent reported infant quality of life in an infant co-managed with age appropriate chiropractic care and helmet therapy. Further prospective studies are required to ascertain the clinical significance of helmet therapy with chiropractic care, helmet therapy versus chiropractic care, and different technical approaches (cranial/cervical/pelvic or combinations of each) for the delivery of the adjustment.

Matthew Doyle

BSc(Neurobiol, BAppSc(Clin)/BChiroSc,MSc(Paed Chiropr), GCTEd, ACP

Private Practice

Brisbane, Queensland, Australia

drmatthewdoyle@gmail.com

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Table 2: Selected plagiocephaly case reports/series

Author(s) Journal Year	Initial Infant age/sex	Presenting complaint	Clinical Impression	Birth type	Intervention/ Adjustment type	Measurements	Outcomes
Hosaka & Alcantara JPMFH 2019	USA 6 hours female	Crying in pain post birth and when breast feeding Birth Trauma with asynclitic presentation	Hypertonicity of cervical muscles at C1, bilateral pectoral and biceps muscles, decrease suck reflex, restrictions at ethmoid and occipital condyles	Vaginal asynclitic	1 cranial adjustment	No plagiocephaly measurements reported	Improved feeding Decreased hypertonic flexor tone Balanced cervical ROM
Hirshowitz and Swenson JPMFH 2019	USA 3 infants 2.5 months each	#1 asymmetry began developing #2 specifically for plagiocephaly #3 failure to thrive; torticollis, emesis; breast feeding difficulties		#1 vaginal #2 vaginal #3 caesarean section	#1 twice a week for 12 weeks. #2 3 times a week for 3 weeks. #3 3 times a week for 20 visits. Techniques for all = logan basic, cranial work, and upper cervical sustained contact	Visual inspection and cranial photos	Improved symmetry of cranial shape #3 healthy flourishing infant
Parker JPMFH 2019	USA 4 day old male	Inability to latch	Low right occiput with head tilt to the right and rotated to the left; slight flattening of the right frontal and parietal bone with bulging of the left frontal, left parietal, and left temporal bones; middle of the jaw deviated to the left in comparison to the tip of the nose and glabella; short right leg; cervical ROM restrictions in extension, left lateral flexion, and right rotation. VSC = C1R, T1,2,4, left PI ilium	Vaginal 24 hour labour Induced 9 days pre due date due to amniotic fluid leakage; posterior presentation, 5 hour second stage with partial episiotomy	6 visits over a month. Touch and hold/sustained contact techniques were used for cervical and thoracic regions; cranial work with the sphenobasilar symphysis technique	Visual inspection and palpation	Successful breast feeding; further enhanced latch following posterior tongue tie revision by paediatric dentist between 5 th and 6 th visit

Table 2: Selected plagiocephaly case reports/series, continued

Author(s) Journal Year	Initial Infant age/sex	Presenting complaint	Clinical Impression	Birth type	Intervention/ Adjustment type	Measurements	Outcomes
Walker Russell JPMFH 2014	NZ 4 month old male	Plagiocephaly and limited cervical ROM	Primitive reflex assessments – Placing reflex only positive on right, Moro positive, C1 – ASR Left posterior sacrum	Vaginal Induced at 38 weeks Vontuse extraction	6 visits over 5 weeks; then weekly for 6 weeks; ASR adjusted 11 times in initial 12 visits; LP sacrum 8 of 12 times + 2 left PI ilium; all done with modified diversified touch and hold technique.	Visual inspection	Improvements in cervical rotation starting after 1 st adjustment; on 6 th visit noted “infant rolled over for first time” (5 months); 8 th visit he was sleeping to left, 10 th visit noted sleeping evenly both sides; by 12 th visit a “noticeable change in head shape”
Gordon CJA 2017	Australia Initially 32, 9 removed by exclusion criteria; total 18 male, 14 female; 20 right plagio, 12 left plagio; 23 infants Average initial age =12.5 wks		Most cases had impeded passive movement in gross rotational and lateral flexion manoeuvres of the spine when supine. Frequent decreased active and passive cervical rotation in the opposite direction to the plagiocephaly		17 also used a mimos pillow Average number of visits was 6.9	CVAI %	17 with pillow = mean CVAI decreased from 8.81% to 5.17% 6 with chiro only = mean CVAI decreased from 8.67% to 2.99% (this was statistically significant); The oldest children (30 weeks) did not respond as well as the younger.
Douglas Browning Miller JCCP 2016	UK 64 infants included 40 male 24 female Average initial age = 11.5wks		All had limitations in cervical spine motion	56% assisted births 44% natural vaginal deliveries	Paediatric manipulative techniques – low force 2-8 newtons, press and hold methods to the cervical spine; 5 treatments over 6 weeks	Measurement from EOP to either anterior ear, giving the difference as the score	20 out of 64 showed a full resolution All participants had full cervical motion restored Statistically significant reduction in the plagiocephaly measurement.
Fludder Keil Alt Ther Health Med 2020	150 consecutive infants		60.2% had plagiocephaly 92.2% of those had cervical ROM restriction				

Table 2: Selected plagiocephaly case reports/series, concluded

Author(s) Journal Year	Initial Infant age/sex	Presenting complaint	Clinical Impression	Birth type	Intervention/ Adjustment type	Measurements	Outcomes
Humphris, Askin, Glucina- Russell JCCP 2014	Australia 6 month old female	Parental concern of favoured left head rotation and ipsilateral flattening of her posterolateral cranium; Failure to latch and feed on right breast, unsettled sleep patterns and regurgitation after breast feeding.	Occipito-parietal flattening on the left with parallelogram like contour; no bony ridges on sutures; VSC at C1, C3, and sacrum	Vaginal, epidural, 14 hour labour	3 visits with one adjustment on each visit: #1 = C1 #2 = sacrum #3 = C3	Visual inspection	Willing and active motion towards less favoured side of rotation; regular sleep patterns established; no detectable cranial asymmetry at 9 months; no adverse events reported or observed

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