A RETROSPECTIVE STUDY OF THE MANAGEMENT OF DEFORMATIONAL PLAGIOCEPHALY WITH CHIROPRACTIC CARE

Brent D. Gordon[1]

[1] *Private Practice, Shirley Rd Chiropractic, Crow's Nest and Norwest Business Park, Sydney, Australia*

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ABSTRACT

Objective: Deformational plagiocephaly (DP) is a common post-natal acquired condition that occurs as a result of persistent direct pressure on unilateral occipital structures. Various cognitive and motor developmental delays have been associated with DP and this study investigates the impact of chiropractic management on infants with DP.

Methods: Diagonal skull measurements were analysed from 23 infants determined to have mild (3-7%), moderate (7-12%) or severe (>12%) DP using the cranial vault asymmetry index (CVAI). Parents were offered chiropractic management alone or chiropractic management and a pressure reducing pillow.

Results: The average age at initial presentation was 12.5 weeks. The mean CVAI decreased during the first six weeks of treatment from 8.77% (SD 2.65%) to 5.60% (SD 2.95%) (Δ CVAI 3.17%) and to a further 4.60% (SD 2.84%) at final assessment at an average age of 29.8 weeks (Δ CVAI 4.18%). On average there was a 36.1% improvement in CVAI for the first six weeks of treatment and an overall 47.7% improvement in CVAI from initial presentation to final measurement following 6.9 visits on average. The 17 children who utilized pillows in conjunction with chiropractic treatment had their mean CVAI decrease from 8.81% (SD 2.41%) to 5.17% (SD 2.90%) (Δ CVAI 3.64%), whereas the six children who had chiropractic treatment alone had their mean CVAI decrease from 8.67% (SD 3.50%) to 2.99% (SD 2.12%) (Δ CVAI 5.68%), an overall improvement of 65.5%. This was statistically different (p=0.031).

Conclusion: Chiropractic management of DP shows objective improvements in infant skull shape. Chiropractic management with no ancillary pillow device offers greater improvement, likely because of increased ease of cervical rotation and better re-moulding from a firm mattress rather than a soft pillow. The broader implications on potential cognitive and motor development outcomes needs further investigation and collaboration. (Chiropr J Australia 2017;45:155-174)

Key Indexing Terms: Deformational Plagiocephal; Chiropractic; Pediatrics

INTRODUCTION

Deformational plagiocephaly (DP) is a post-natal acquired condition that occurs in early infancy as a result of persistent direct pressure on unilateral occipital structures.[1] Post partum, the predominance of DP increases to four months however the cranial bones remain malleable during the first two years of life.[2] The risk factors for DP include being firstborn, male, having limited passive neck rotation at birth, limited active head rotation, supine sleeping at birth and six weeks, lower activity level and trying unsuccessfully to vary the head position when putting the infant to sleep.[2] The likelihood of developing DP also increases in relation to various in-utero constraint issues such as multiple births, reduced maternal pelvic volume, breech positioning[3] and also in assisted vaginal deliveries, prolonged labours[1,4-7] and newborns with congenital torticollis.[8]

The prevalence of prone sleeping reduced from 70 percent to 10.5 percent between 1992 and 1997[9] following the introduction of the "Back to Sleep" campaign and guidelines in 1992 by the American Academy of Paediatrics to reduce the likelihood of sudden infant death syndrome (SIDS).[10] This campaign was effective in that it reduced the incidence of SIDS from 2.6 per 1000 in 1986 to 1.0 per 1000 in 1998 but there has been an accompanying increase in deformational plagiocephaly with reports of plagiocephaly ranging between 1 in 60 (1.7 percent) in 1996,[11] 8.2 percent in 2001,[12] and as much as 22.1 percent in 2008.[1] This contrasts with rates of plagiocephaly occurring only once in every 300 live births (0.3 percent) among prone-sleeping infants in 1974.[13]

In DP, not only does sustained pressure lead to ipsilateral flattening of occipitoparietal structures, but, due to indirect pressure on the petrous temporal and frontal bones, there may be anterior displacement of the ipsilateral ear and frontal bossing. There is also consequential facial symmetry changes[3], ipsilateral frontal bossing in most cases and contralateral occipital bossing resulting in a parallelogram-shaped head (Figure 1B).[14] This contrasts to the rare case of lambdoidal craniosynostosis where there is no displacement of the ear or a posterior displacement of the ear on the ipsilateral side, no ipsilateral frontal bossing and a typical resultant trapezoid-shaped head as a result of lambdoidal sutural fusion (Figure 1C) [14] that requires paediatric neurosurgical evaluation.

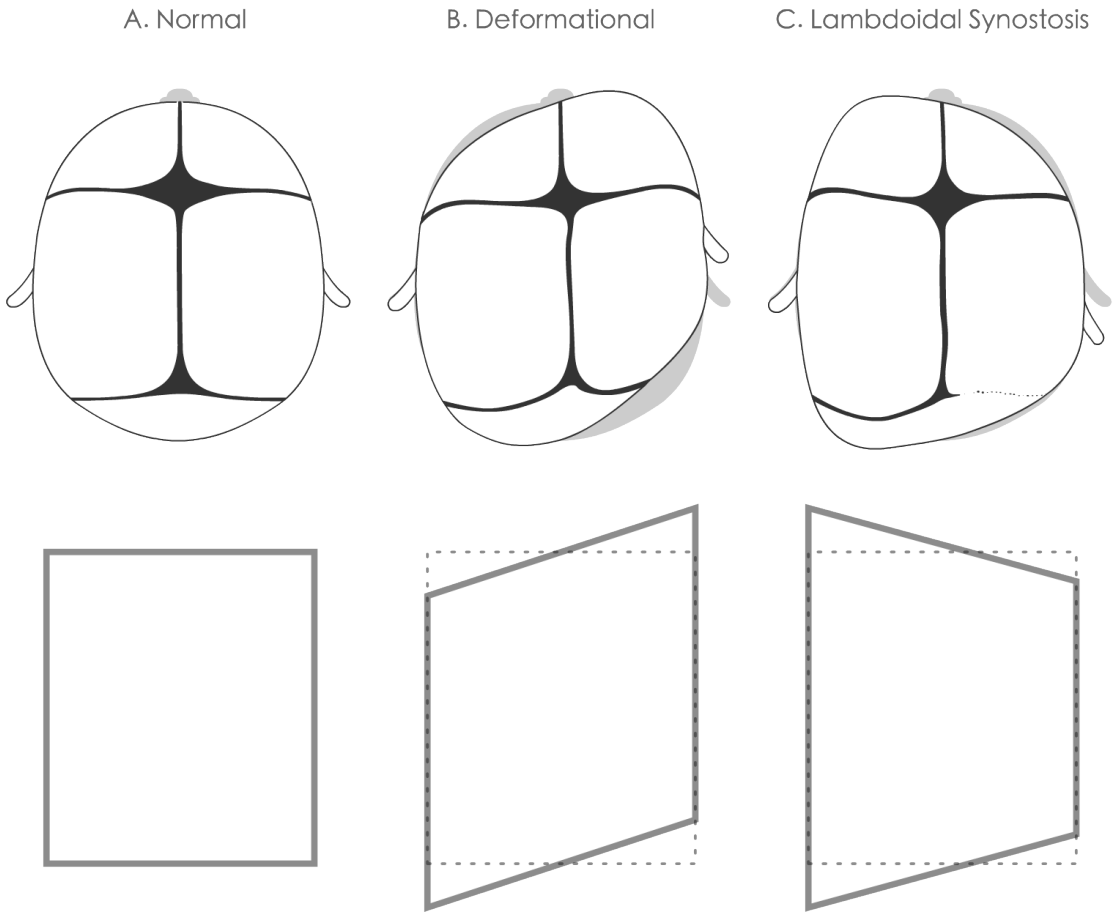

Figure 1. A. Schematic illustration of the skull from above showing the relative symmetrical shape in the normal setting. B. Deformational plagiocephaly typically demonstrates ipsilateral occipitoparietal flattening, displacement of the ipsilateral ear anteriorly and ipsilateral frontal bossing with contralateral occipital bossing. This creates a parallelogram-type shape. C. In contrast, plagiocephaly related to lambdoidal craniosynostosis will typically demonstrate ipsilateral occipitoparietal flattening, displacement of the ipsilateral ear posteriorly and contralateral frontal and parietal bossing. This will create a trapezoid-type shape.

When assessing cranial deformity, anthropometric caliper measurements are highly reproducible and a reliable measure of cranial deformity in early childhood.[15] The cranial vault asymmetry index (CVAI) is a measure that compares equivalent diagonal skull measurements. A measured difference of up to three percent is considered within the normal range, a difference of three to seven percent is a mild deformity, moderate when CVAI is seven to twelve percent and severe if the CVAI is greater than twelve percent (Table 1).[16]

Table 1. Summary of categories for Cranial Vault Asymmetry Index (CVAI).

	Cranial Vault Asymmetry Index (CVAI)
Normal	0-3%
Mild	3-7%
Moderate	7-12%
Severe	>12%

It has been previously widely published that DP does not cause any life-threatening or debilitating neurologic deficits, and that most specialists do not fear serious long-term consequences.[17,18] DP has been described as a cosmetic problem[19] however, in more recent studies, deficits in cognition and motor development have highlighted the potential need to be less flippant with issues of DP. Miller and Clarren in 2000 revealed that 39.7 percent of 254 infants with DP required special education and assistance.[20] In 2002, evidence of brain dysfunction in infants with plagiocephaly was suggestive of an elevated risk of an auditory processing disorder[21] while others have found that DP may affect visual field development.[22] It was shown in a population of 110 infants with DP there are significant delays in both mental and psychomotor development and no child with DP showed signs of accelerated development.[23] Fowler and colleagues (2008) determined there to be a statistical difference in muscle tone in infants with DP versus those without[24] and Speltz et al. (2010), in a case-controlled study found clear evidence of neurodevelopmental disadvantage among infants with DP.[25] In a further follow up Speltz's group have found that these same children when preschool-aged continue to receive lower developmental scores than unaffected controls.[26] It was concluded that DP may serve as a marker of developmental risk and that early identification and intervention is to be encouraged.

Current treatment methods for DP include general advice, counterpositioning, pillow use, neck stretching, physiotherapy, osteopathy[27] and orthotic helmet therapy.[8,28] Orthotic helmet therapy has been reported to improve head shape in varied studies[29-33] with many authors reporting improvements in cranial vault asymmetry between forty to sixty percent of cases.[3] However, in a recent randomised controlled study it was determined that no effect was present with helmet therapy in infants with moderate to severe positional skull deformation when compared with no treatment at follow up when 24 months of age.[34] To date, there is no case series study looking at the effectiveness of chiropractic on DP.

METHODS

Parents presented with their baby to one of two private chiropractic clinics between October 2011 and May 2013 with concerns that a flatness was developing or had developed on one side of the skull. Of the 32 infants that presented, they were either referred by their paediatrician, lactation consultant, allied health practitioner or through word of mouth. On initial

assessment a detailed history was obtained including obstetric, perinatal and postnatal information. Examination included standard paediatric orthopaedic and neurological assessment and also included infantile primitive reflexes and postural reflex assessments. Further chiropractic assessments were done to ascertain any restrictions of movement within the cranial bones, cervical spine or musculoskeletal system which may predispose the infant to have a comfort position outside of neutral that may contribute to having a preferred positional lay when sleeping supine. Imaging studies were usually unnecessary but were reviewed in cases when available and any sutural craniosynostosis ruled out. It was determined that the child was suffering from deformational plagiocephaly rather than brachycephaly or scaphocephaly by observation and taking measurements in antero-posterior and medio-lateral planes and also in diagonal planes using a set of spreading calipers. The oblique measurement was taken from the ipsilateral fronto-temporal area to the contralateral lambdoid suture at the level of the head circumference measurement on each side of the head. An elasticised garter with symmetrically located reference points from *infocefalia.com* was used for consistency of measurements (Figure 2). These measurements were used to determine the cranial vault asymmetry index (CVAI) (CVAI = *difference in cranial diagonal diameters / shorter cranial diagonal* x 100). Follow up examinations included oblique measurements on most visits.

The inclusion criteria for the study were that the CVAI had to be greater than or equal to three percent, placing the child in at least the mild range of deformational plagiocephaly, and the follow-up needed to include a minimum of three measurements for the data set for each child. Measurements were made by the author for all children and for all visits. No infant was suffering from craniosynostosis.

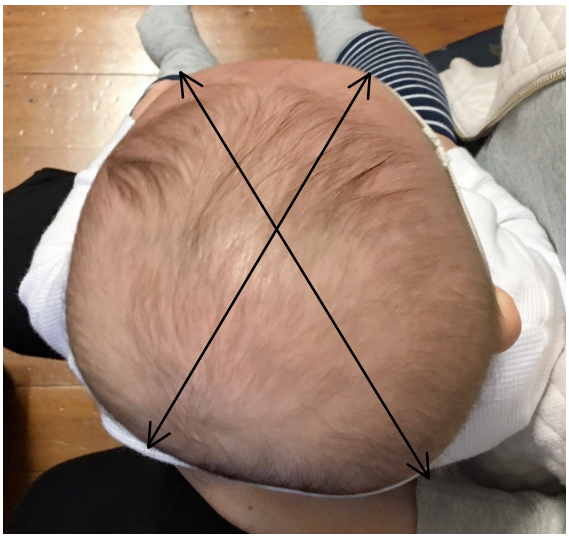

Figure 2. Photographs depicting the elasticised garter utilized for assistance in the consistency of measurements of the cranial vault. Diagonal measurements were taken using spreading calipers to determine the distance between set points on the infant's skull.

The choice of chiropractic treatment techniques partly depended upon the restrictions and faults found within the infant's examination. The specific goal of chiropractic care was to provide the infant with an unrestricted biomechanical chain of movement allowing them to move freely and comfortably and to reduce muscle tone differences. This was achieved in this study using gentle sustained light force chiropractic techniques of the cranial bones, cranial sutures, spinal, shoulder, pelvic and/or sacral structures. This also included specific muscle release techniques of the sub-occipital muscle groups, sternocleidomastoid and upper trapezius as necessary. There were no forceful manipulative techniques used in this study and there was no manipulation of the cervical spine.

As an adjunct to therapy, a Mimos^{TM} Air-Spacer Pillow (mimosbabypillow.com) was offered to parents if they felt it may assist with positioning of the infant while sleeping or laying inactive for long periods. The pillow is a lightweight, breathable donut shape made from open cell polyester foam that claims to provide 400% less pressure than a normal mattress surface and to be 100% breathable and safe. It has been designed to reduce the pressure from the baby's skull while sleeping and minimize further deformation.

RESULTS

Over the time period of data collection 32 children presented to the clinic with a primary concern of deformational plagiocephaly (Figure 3). The average age at initial presentation of all babies was 13.1 weeks. There were eighteen males and fourteen females, twenty (62.5%) presented with right plagiocephaly and twelve (37.5%) presented with left plagiocephaly. Two

children were born preterm (before the 37th week of pregnancy) and nineteen births were natural vaginal delivery and there were thirteen caesarian sections. There was one identical twin in the group, but the mother chose to only assess and treat the child with more significant deformational plagiocephaly.

Figure 3. Top view photograph showing the typical features of a moderate, verging on severe, right deformational plagiocephaly. There is flattening of the right occipitoparietal structures and a forward displacement of the right ear. There is ipsilateral frontal bossing and contralateral occipital bossing typical of the parallelogram-type shape deformational plagiocephaly.

Of the 32 children that presented four of these had CVAI measurements that fell within the normal range (0 - 3%), two were predominantly treated by an associate practitioner, two were not measured on more than two occasions and one had both a helmet and was also receiving osteopathic treatment. These nine children were excluded from further data analysis. In two children, they additionally sought helmet treatment and in these cases, the data obtained is only included up to the point where other treatment was applied.

Of the 23 children that remained, the average age of initial presentation with concern of head shape was 12.5 weeks (5 weeks to 30 weeks). Seventeen of the participants (74%) also chose to use the Mimos pillow and six (26%) did not (Figure 4). None of the children sought any other form of treatment within the period of data collection other than what was offered at Shirley Rd Chiropractic. The average age at final CVAI measurement was 29.8 weeks and average number of visits over this period was 6.9.

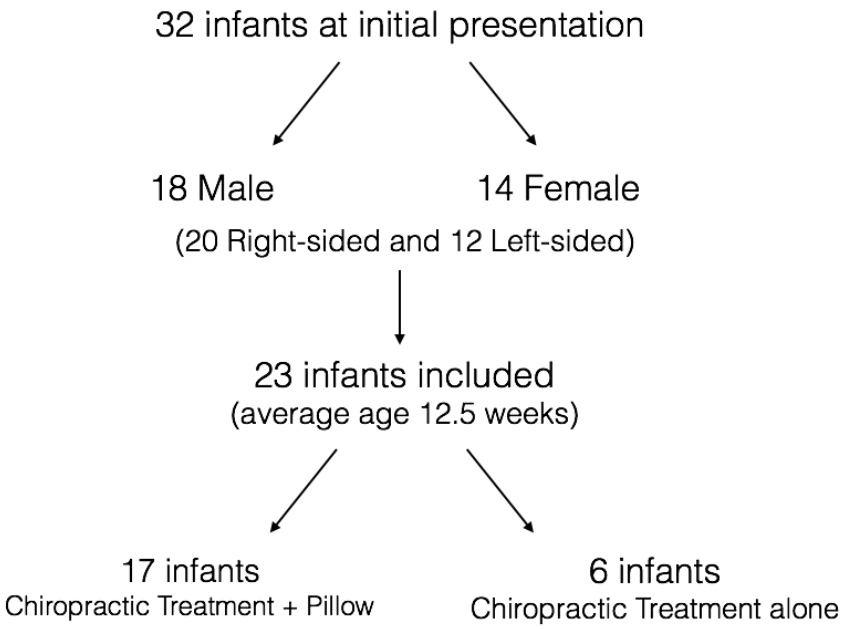

Figure 4. Selection process for infants included in the study. Thirty-two infants were reduced to twenty-three as nine did not meet the inclusion criteria. Seventeen of these received chiropractic treatment plus pillow and six received chiropractic treatment alone.

In most cases there was impeded passive movement in gross rotational and lateral flexion manoeuvres of the spine when laying the child supine and supporting their weight on the occiput and sacrum. There was frequently decreased active and passive cervical rotation in the opposite direction to the involved side of deformational plagiocephaly. This obvious lack of independent cervical rotation upon the thoracic spine was easily identified by whole body rotation on the side of restriction (Figure 5).

Figure 5. A. Photograph of an infant with mild right plagiocephaly before treatment showing typical ease of rotation of the cervical spine to the right. B.

Inability to freely rotate the head to the left without corresponding body rotation including the thoracic spine, lumbar spine and pelvic structures.

Within the cranium there were cranial restriction abnormalities found, these often involved the sphenobasilar junction. Generally speaking, cervical rotation improvements were achieved on the first or second visit in most cases. This was identified by increased independent passive range of movement of the cervical spine on the thoracic spine (Figure 6).

Figure 6. Following chiropractic treatment, ease of head rotation to the left was re-instated with no signs of body rotation at full range of movement.

There was an improvement in 91% (21 of 23) of cases over the initial 6 weeks and 96% (22 of 23) by the final measurement. The mean CVAI decreased during the first six weeks of treatment from 8.77% (SD 2.65%) to 5.60% (SD 2.95%) (Δ CVAI 3.17%) and to a further 4.60% (SD 2.84%) at final assessment (Δ CVAI 4.18%) (Figure 7, Table 2). On average there was a 36.1% improvement in CVAI for the first 6 weeks of treatment and an overall 47.7% improvement in CVAI from initial presentation to final measurement.

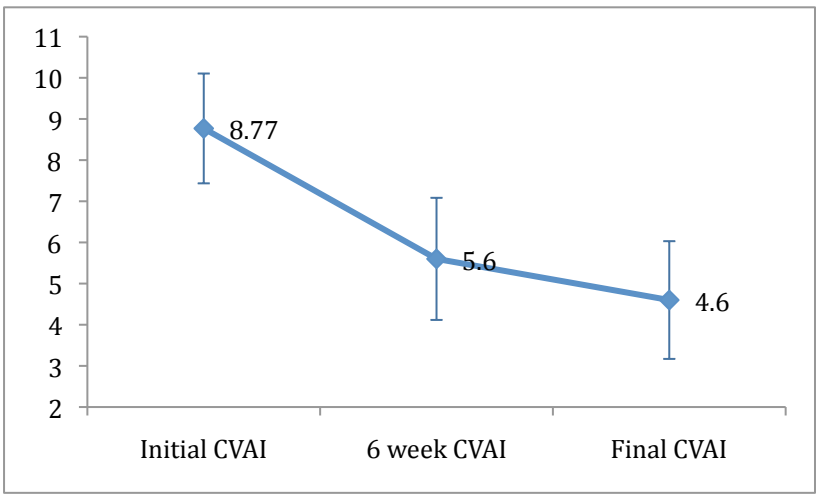

Figure 7. Course of Cranial Vault Asymmetry Index (CVAI) values at initial measurement, 6 weeks into treatment and at final measurement. 95% confidence interval (CI) indicated by error bars.

Table 2. Raw data for 23 infants showing: Age at presentation (weeks), number of visits, sex (male or female), side of deformational plagiocephaly (left or right), pillow use (yes or no), initial CVAI, maximum CVAI, 6 week CVAI, final CVAI and percentage change from initial measurement to final measurement.

n	Age at presentation (weeks)	Number of visits	Sex	Side of DP	Pillow	Initial CVAI	Maximum CVAI	6 week CVAI	Final CVAI	% change (Initial to 6 weeks)	% change (Initial to final)
1	9	4	M	R	Y	12.8	14.6	9.2	9.2	27.9	27.9
2	14	8	M	L	Y	10.7	10.7	4.1	2.0	61.3	81.8
3	9	4	F	R	Y	11.3	11.3	8.9	6.6	21.4	41.2
4	12	8	M	R	N	12.2	12.2	8.1	5.4	33.7	55.7
5	15	8	F	R	Y	10.2	11.0	8.2	9.5	20.4	7.3
6	16	7	M	L	N	4.6	4.6	0	0	100	100
7	15	10	M	L	Y	10.9	10.9	8.1	5.6	25.4	48.8
8	12	11	M	R	Y	7.7	8.0	4.8	2.1	38.1	73.1
9	16	7	M	R	N	12.8	12.8	7.0	4.7	44.9	63.2
10	13	3	M	L	Y	9.1	9.1	4.8	4.8	47.6	47.6
11	30	7	F	R	Y	9.7	9.7	5.7	7.4	40.6	23.9
12	9	12	F	L	Y	7.2	8.7	7.7	5.3	-6.8	26.4
13	14	13	F	R	Y	8.2	11.8	11.1	8.8	-35.5	-6.8
14	9	5	F	L	Y	5.0	5.0	4.8	3.0	3.2	39.5
15	12	7	M	L	Y	10.7	10.7	8.5	7.3	21.2	31.8
16	5	6	M	R	Y	8.9	8.9	3.5	2.3	60.2	74.2

17	6	9	M	R	Y	5.0	5.0	2.3	2.2	54.2	56.9
18	11	3	M	L	N	6.1	6.1	2.2	2.2	63.7	63.7
19	14	6	F	R	Y	4.0	4.0	0	0	100	100
20	11	8	M	R	N	10.2	10.2	4.4	4.2	57.2	58.6
21	16	4	F	L	N	6.1	6.1	3.6	1.4	41.1	77.4
22	11	4	M	R	Y	8.9	8.9	4.5	4.5	49.6	49.6
23	8	5	M	R	Y	9.5	12.8	7.4	7.4	21.6	21.6

During the period of treatment the number of children with plagiocephaly in the severe range decreased from three to zero and the moderate range from fourteen to six. The mild range increased slightly from six to eight as children dropped into this lower range and there were now nine children who could be classified as normal (Figure 8).

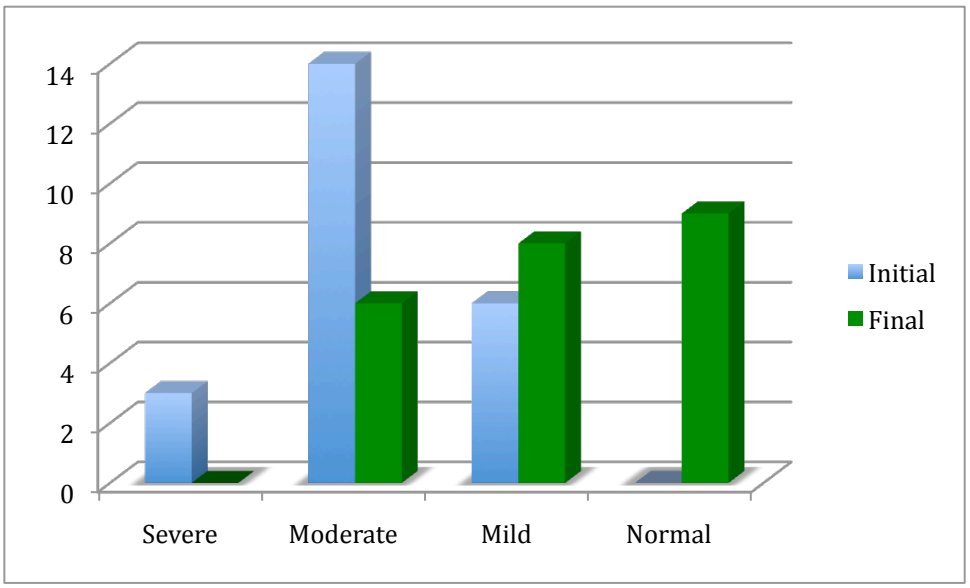

Figure 8. At initial assessment three children fell into the severe range of deformational plagiocepaly, fourteen in the moderate range and six in the mild range. At final assessment there were no children in the severe range, six in the moderate range, fourteen in the mild range and there were nine children classified as normal.

The 17 children who utilized pillows in conjunction with chiropractic treatment had their mean CVAI decrease from 8.81% (SD 2.41%) to 5.17% (SD 2.90%) (Δ CVAI 3.64%), whereas the six children who had chiropractic treatment alone had their mean CVAI decrease from 8.67% (SD 3.50%) to 2.99% (SD

2.12%) (Δ CVAI 5.68%), an overall improvement of 65.5%. This was statistically different (p = 0.031, 95% CI for $\Delta CVAI_{\text{Chiropractic Treatment + Pillow}}$ - $\Delta CVAI_{\text{Chiropractic Treatment alone}}$ = (0.2,3.9)) (Figure 9, Figure 10).

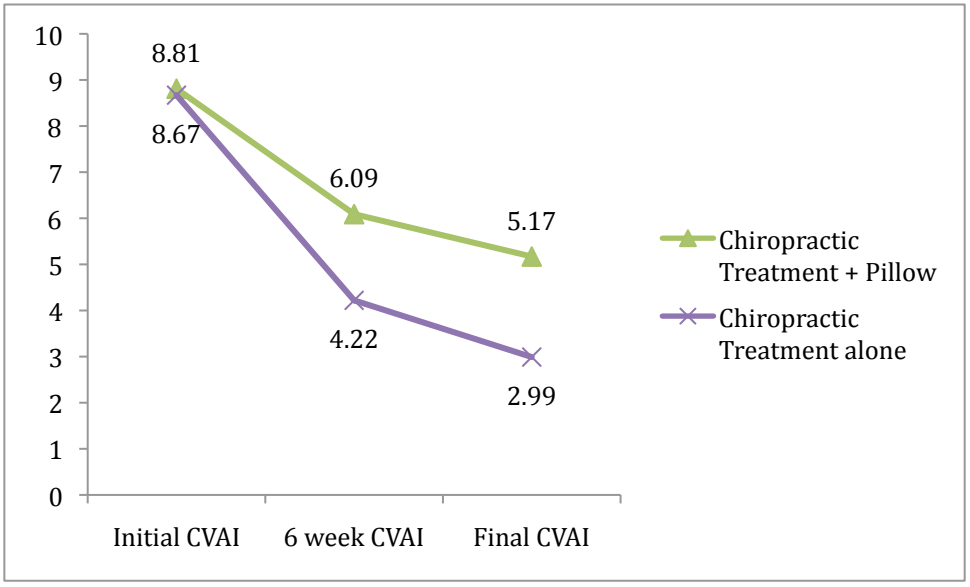

Figure 9. Cranial Vault Asymmetry Index (CVAI) values at initial, 6 week and final measurement comparing chiropractic treatment plus pillow and chiropractic treatment alone.

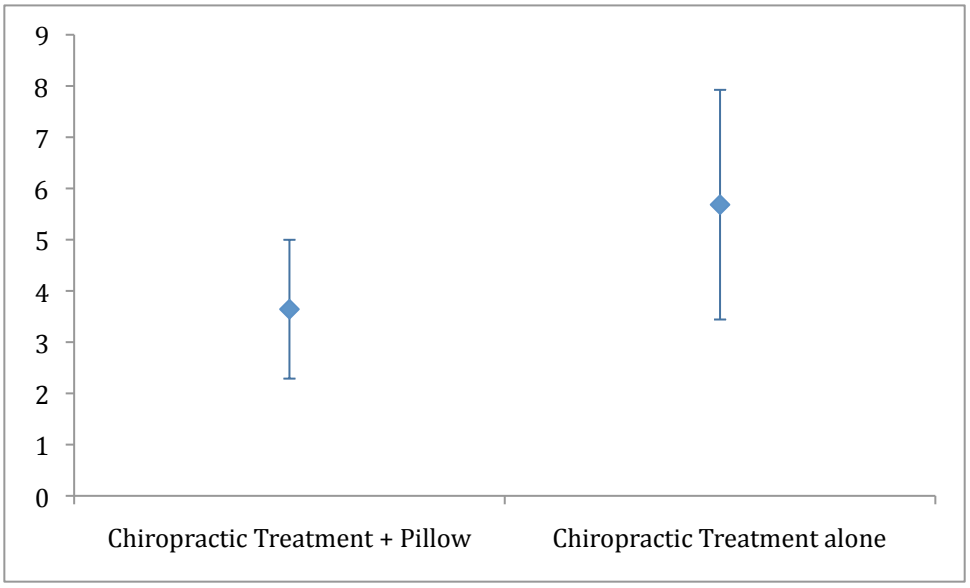

Figure 10. Change in CVAI with chiropractic treatment + pillow and chiropractic treatment alone. These results showed statistical significance (p = 0.031) with those receiving chiropractic treatment alone responding greater than those who also used a pillow. 95% confidence interval (CI) indicated by error bars.

Of the 15 male participants in the study the mean CVAI decreased from 9.34% (SD 2.58%) to 4.26% (SD 2.51%) (Δ CVAI 5.09%), whereas the eight female participants had their mean CVAI decrease from 7.71% (SD 2.61%) to 5.24% (SD 3.47%) (Δ CVAI 2.47%). This was statistically different (p = 0.007, 95% CI for $\Delta CVAI_{Males} - \Delta CVAI_{Females}$ = (4.4,0.8)) (Figure 11).

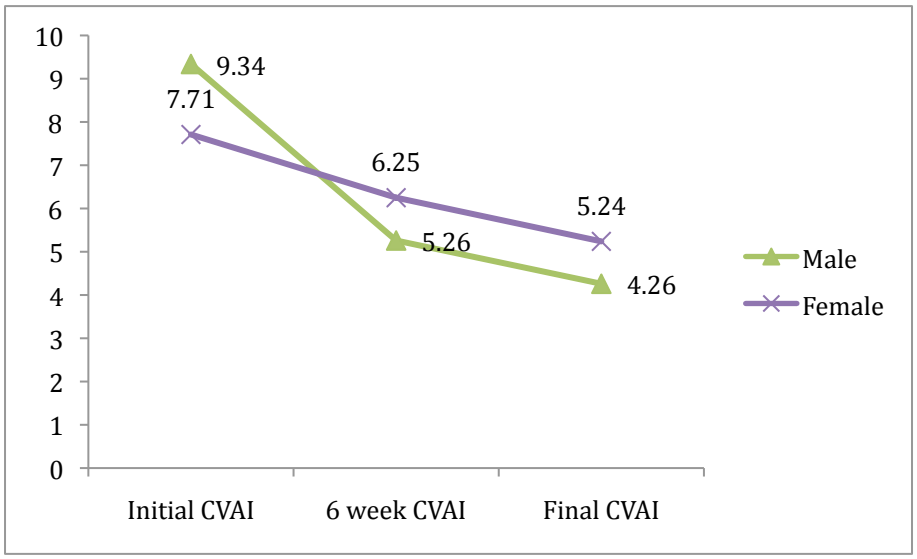

Figure 11. Cranial Vault Asymmetry Index (CVAI) values at initial measurement and final measurement comparing males and females. These results showed statistical significance (p = 0.007).

Of the 14 children presenting with right plagiocephaly the mean CVAI decreased from 9.39% (SD 2.62%) to 5.31% (SD 2.98%) (Δ CVAI 4.08%), whereas the 9 children who presented with left plagiocephaly had their mean CVAI decrease from 7.82% (SD 2.55%) to 3.50% (SD 2.37%) (Δ CVAI 4.32%). This was not statistically different (p = 0.805) (Figure 12, Figure 13).

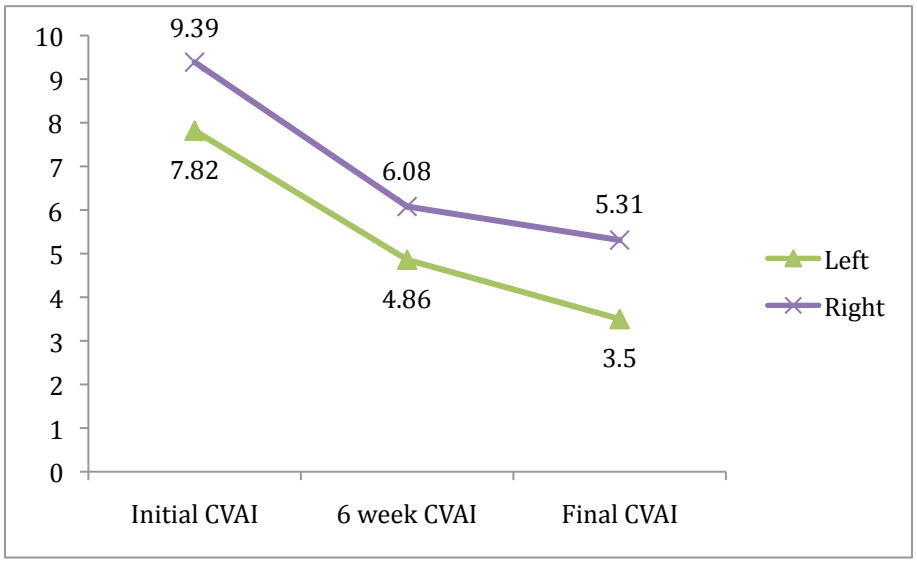

Figure 12. Cranial Vault Asymmetry Index (CVAI) values at initial measurement and final measurement comparing left and right plagiocephaly. These results showed no statistical significance (p = 0.805).

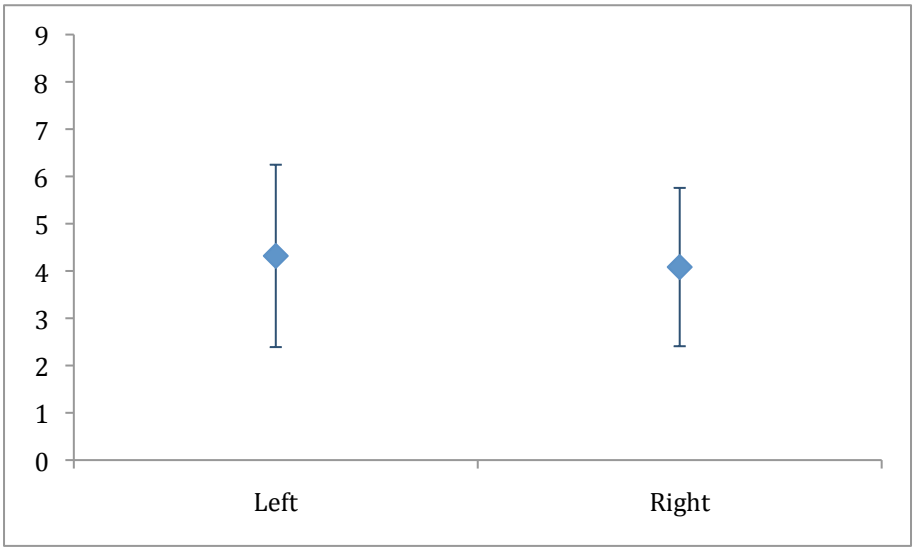

Figure 13. Change in CVAI comparing left plagiocephaly with right plagiocephaly having both received treatment and showing no significant difference in improvements between a left and right presentation. 95% confidence interval (CI) indicated by error bars.

DISCUSSION

On average, the age at initial presentation (13.1 weeks) was generally consistent with that reported in the literature.[35] Most parents had only begun to notice the changes in head shape developing between 6-12 weeks and generally felt that there was no noticeable flattening of the occipital area at birth. The greater number of boys in the study is also consistent with that found in the literature (18 male, 14 female)[32,33] as was the higher incidence of right plagiocephaly (20 right, 12 left)[36] and most likely corresponds to their previous intrauterine lie.[3] The severity of plagiocephaly was also greater on the right side, measuring on average 9.39% CVAI compared to 7.82% CVAI.

The oldest of the children that presented to the study at 30 weeks did not respond as well as the younger children in the group. This is again consistent with that found in the literature and highlights the importance of early intervention.[37] In two cases complete success was achieved and there was no measurable difference in diagonal head diameters post-treatment. In each of these cases the child was within the mild category with initial diagonal measurement differences of 5mm (CVAI 4.00%) and 6mm (CVAI 4.62%).

In 1 case, a female patient with right-sided plagiocephaly who was born at 41 weeks gestation utilizing a ventouse vacuum extraction and had developed a significant sternocleidomastoid (SCM) hypertonicity and an identifiable SCM

mass, there was an overall increase in CVAI. The initial diagonal measurement difference was 10mm (CVAI 8.2%) at 15 weeks with a maximal measurement some 8 weeks later of 15mm (CVAI 11.81%) reducing to 12mm (CVAI 8.76%) at final measurement (35 weeks). At this stage the child began helmet therapy and at age one year had a CVAI of 10mm (CVAI 6.76%).

In six cases there was an initial increase in CVAI early in the treatment protocol before improvements were made. If these factors are taken into consideration the average ΔCVAI from maximum CVAI measurement during treatment to the final CVAI measurement is now 4.67% (9.27% to 4.60%).

The six week data show that most improvements occur in the early phase of treatment with approximately 75 percent of the improvement occurring in this timeframe and then continued improvements but at a slower rate over the following months. In the absence of a no treatment control, this finding indicates that treatment is having the desired effect rather than just time itself.

Interestingly the babies with the poorest improvement seemed to have had difficult births, were twins or had an older sibling with a similar deformational plagiocephaly issue. This could be explained by the fact that up to ten percent of infants have a condition of congenital deformational plagiocephaly which is thought to be secondary to intrauterine compression between the pelvic brim and lumbosacral spine and persistent right occiput transverse lie.[3]

Early Intervention

In the case of the oldest child at initial presentation of 30 weeks, an identical twin, there was an initial diagonal measurement difference of 13mm (CVAI 9.09%) and a final measurement of 11mm (CVAI 7.38%) at 54 weeks following seven consultations and treatments. The ΔCVAI was 2.32% and below the average improvement for a similar number of treatments potentially highlighting the need for early intervention where possible.

Pillow Vs. No Pillow

Contrary to Wilbrand's study showing that pillow treatment is more effective than physiotherapy, this study supports that chiropractic treatment may be more effective without such devices. This may be because if the impediment to movement is corrected it might be advantageous to have a firm sleeping surface to help re-mould the head into shape at a faster rate rather than a soft pillow. In the group of six infants who had chiropractic treatment and no pillow there was a CVAI decrease from 8.67% to 2.99% (Δ CVAI 5.68%) and an overall improvement of 65.5% compared to the seventeen infants utilizing pillows in conjunction with treatment who had their mean CVAI decrease from 8.81% to 5.17% (Δ CVAI 3.64%) an improvement of 41.3%. This was statistically significant and future studies would benefit from establishing a greater sample size. In the absence of treatment, a pillow that reduces pressure on the skull may be effective in minimising the severity of the developing deformational plagiocephaly, but this current data suggests that chiropractic treatment alone may provide a better clinical outcome for

reducing deformational plagiocephaly. In a clinical setting, a pillow such as the Mimos Baby Pillow may be helpful for parents who have trouble counter-positioning their baby. Previous studies analysing the use of pillows in the treatment of plagiocephaly and brachycephaly have also suggested that some parents indicated the occurrence of bilateral apostasis of the external ear from pillow use.[38]

Physical Therapy

Traditionally physiotherapy has been used if there is neck muscle involvement and treatment revolves around neck stretching exercises. Chiropractic tends to take an approach that aims to address the intrinsic restrictions or tensions that an infant may have developed in-utero or following birth. Individual treatments from various chiropractic practitioners may vary but this study has focussed on underlying cranial, cervical, shoulder girdle and sacral tensions or dysfunctions and did not solely rely upon cervical spine treatments or stretches.

Future Directions

The precise causes of why 1 child will develop deformational plagiocephaly over another are not completely understood. Given there have been objective signs of tonal differences in children who develop deformational plagiocephaly it is unclear as to whether these are causative to the development of deformational plagiocephaly or as a result of deformational plagiocephaly. The same is true for the cognitive and motor developmental delays.

Given the various controversies and the confusion that parents face when dealing with an infant with deformational plagiocephaly it would be ideal if conservative measures such as chiropractic could be offered to parents to see if this early intervention procedure is effective at making measurable differences. If there is a good objective result within 6 weeks this may prevent helmet therapy and if there is minimal change within 6 weeks this could be a selection criteria for the implementation of helmet therapy.

One of the current barriers to conservative management of chiropractic for deformational plagiocephaly is the unwarranted concern that chiropractic may be harmful to the child. A better understanding of the very low force techniques utilised in this study needs to be conveyed to the medical profession so that closer links between interested parties such as general practitioners, paediatricians and community paediatric nurses would potentially benefit all involved.

A randomised controlled trial with a larger sample size and independent measurements would be useful in determining the degree to which chiropractic may assist as a conservative management in deformational plagiocephaly. Follow-up studies in conjunction with educational psychologists and paediatric occupational therapists could also assess children who take part in these studies at future intervals to further determine if those children

who receive treatment have different long-term educational and/or motor skill outcomes.

CONCLUSION

This retrospective study demonstrates chiropractic management of DP consistently resulting in objective improvements in skull shape. Chiropractic intervention may be under-utilised as a conservative management for assessing and treating deformational plagiocephaly. Further investigations with a larger sample size using a randomized controlled design would be recommended in conjunction with future collaboration with other fields to assess the broader implications on potential cognitive and motor development outcomes.

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