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Osteopathic intervention for infants with breastfeeding difficulty: A retrospective case series

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ABSTRACT

Background: The importance of breastfeeding and its effect on reducing the burden of disease is recognised globally. The physical aspect of successful breastfeeding is multifactorial and requires maternal comfort and confidence and an infant's ability to latch and maintain intra-oral sucking functions. Infants need to have sufficient function of their musculoskeletal system to maintain positioning and attachment.
Objectives: The primary aim was to investigate the effect of osteopathic intervention on mothers and infants with breastfeeding difficulty. The secondary aim was to record the musculoskeletal dysfunctions found in those infants.
Design: A retrospective case series of de-identified patient files.
Setting: Osteopathic private practice.
Methods: A Breastfeeding Self-Efficacy Scale and Visual Analogue Scale for maternal pain while feeding, ability to latch, ability to maintain latch and noise while feeding were completed before and after osteopathic intervention.
Participants: Eighteen mother-infant-dyad files were retrospectively reviewed.
Results: Following an average of five osteopathic treatments over 7.4 weeks, all 18 mother-infant-dyads noted improvement in breastfeeding confidence and/or improvements in the ability to latch and maintain latch, maternal pain at the breast and infant noise while feeding. The greatest improvements were seen in the seven mother-infant dyads identified at risk of ceasing breastfeeding at baseline ($p=<0.001$).
Conclusion: This study provides evidence that osteopathic intervention may be capable of delivering benefits in breastfeeding confidence and function. Our results also indicate that osteopathic intervention may benefit mothers at risk of ceasing breastfeeding. Further research, including prospective clinical trials with a comparator group, is warranted.

Implications for practice

Osteopathic intervention appears to be safe. It has the potential to improve breastfeeding confidence and dysfunction in mother-infant dyads at risk of ceasing breastfeeding in infants under 10 weeks of age.Validated outcome measures are beneficial for determining the effect of osteopathic intervention in breastfeeding mothers at risk of ceasing breastfeeding.Expanding osteopathic clinical education to include breastfeeding observation as part of any management protocol for breastfeeding difficulties may improve patient care.

1. Introduction

Breastfeeding is a complex endeavour that does not always progress easily for mothers or infants. The importance of breastfeeding and its effect on reducing the burden of disease for mothers and their infants has been recognised by the World Health Organization [1] and the Australian Government [2]. Evidence for the benefits of breastfeeding has been challenged by some scholars, who questioned the benefits of breastmilk to infants and suggest that the difference between breastfeeding and bottle feeding has little impact on the overwhelming majority of infants in the developed world [3]. However, the dominant medical thinking and research supports the notion that human breastmilk is the optimal source of nutrition for pre-term and full-term infants [4,5] and is

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uniquely suited to the human infant, both in its nutritional composition and bioactive factors that promote survival and healthy development [6]. Breastmilk is alive with fats, proteins, probiotics and distinct bioactive molecules that protect against infection and inflammation and contribute to immune maturation, organ development and healthy microbial colonisation [7,8].

Although many studies on the effect of breastfeeding on child development are observational, it has been demonstrated that there are many benefits for breastfed children, including cognitively [9–11]. Epidemiology studies have reported that children who are breastfed for extended periods have lower infectious morbidity and mortality [12], fewer dental malocclusions [13] and reduced incidence of acute otitis media [14]. As well as the long-term consequences, acute consequences of inadequate breast milk intake include hyperbilirubinemia, infant hunger, slow weight gain and failure to thrive [15]. Furthermore, there have been reports that breastfeeding might protect against becoming overweight and developing diabetes later in life [16]. Victora et al.'s (2016) review estimated that by improving breastfeeding rates, 823,000 child deaths could be prevented annually [17].

Breastfeeding also benefits mothers. It can prevent breast cancer [18] (approximately 20,000 breast cancer deaths per year globally) [17], and may reduce a woman's risk of diabetes [19] and ovarian cancer [20]. Postnatal depression has also been linked to early breastfeeding cessation [21] while breastfeeding has been shown to foster mother-infant bonding, maternal sensitivity and secure attachment [22].

In the field of manual therapy, several studies have looked at the effectiveness of osteopathic treatment for common infant ailments, including musculoskeletal postural asymmetry [23] and sucking dysfunction [24–28]. Mother-infant dyads (MID) comprise an important group of healthcare consumers utilising health services such as osteopathy to help with these conditions [29]. In the limited body of evidence supporting the use of osteopathy for infants with breastfeeding difficulties [26,27], osteopaths have reported a clinical correlation between breastfeeding difficulties and musculoskeletal dysfunction in infants [28,30]. Notwithstanding this evidence, more studies investigating musculoskeletal dysfunction in infants and its influence on a baby's ability to effectively breastfeed are needed.

Osteopathic intervention includes a thorough medical history including maternal health, prenatal, perinatal and postnatal factors, observation of the MID breastfeeding, and observation and physical examination of the infant including orthopaedic and neurological assessments that evaluate tone, texture and function of the musculoskeletal system. Once a diagnosis of musculoskeletal dysfunction has been established, osteopaths apply gentle manual techniques designed to remove obstructions and impediments to normal function [31] While there appears to be a growing demand for osteopathic intervention among breastfeeding mothers, objective evidence outlining its effectiveness for treating breastfeeding difficulties is limited.

Identifying MIDs at risk of ceasing breastfeeding and understanding the reasons for early cessation is essential for effective breastfeeding management. Many factors can influence the success or failure of a mother's attempt to breastfeed and contribute to early breastfeeding cessation [32,33]. Maternal pain, poor infant latch, intrapartum interventions,17 poor breastfeeding support from partners or other family members, previous failed attempts at breastfeeding, early return to work and delayed initiation of breastfeeding in the hospital setting are just some of these factors [2,34].

Dysfunctional breastfeeding symptoms that lead to early breastfeeding cessation can be complex and present differently with each MID. Nipple pain is a common experience when establishing breastfeeding. There is a high incidence of nipple pain, especially in the first 30 days postpartum, with dysfunctional and disorganised sucking more prevalent in the early neonatal period [35]. Nipple trauma is a painful condition that can interrupt exclusive breastfeeding with prolonged and persistent nipple pain, one of the most common reasons given by mothers for ceasing exclusive breastfeeding [36–38]. The most common cause of nipple pain is incorrect positioning and attachment of the infant at the breast [37]. The literature suggests that early management, diagnosis and treatment of nipple pain are crucial to avoid early weaning [37,39].

The role of osteopaths in breastfeeding management may include helping both members of the MID team - the mother and the infant. Maternal factors such as assisting a mother with breastfeeding technique, position and latching her infant to the breast should form part of osteopathic breastfeeding management protocols, especially in the absence of lactation care from an International Board-Certified Lactation Consultant (IBCLC). Assistance with positioning may be the only assistance that mothers require for successful breastfeeding [40]. In cases where assisting positioning does not help alleviate symptoms, it may be necessary to examine the infant's musculoskeletal system for possible contributing musculoskeletal dysfunction.

This study looks at the osteopath's role in breastfeeding management when the infant is also having difficulty. The infant may have a musculoskeletal condition such as mandibular asymmetry [41] or torticollis [42] that may affect infant positioning and attachment [43,44]. Infants must also have sufficient movement and control of the neck and temporomandibular joint (TMJ), functional movement of the tongue [45], palate, hyoid and suprahyoid musculature [46,47] and adequate facial muscle tone to stabilise the nipple within the mouth [48,49]. The combined function of these anatomical structures creates the latch and intra-oral vacuum effect that draws the mother's nipple to the junction of the hard and soft palate in the infant's mouth [50]. The MID may need help with positioning and body posture of the infant and attachment and latch at the breast. Therefore, clinical examination and observation of the infant breastfeeding are required for the adequate diagnosis of breastfeeding difficulty.

In this study, we define musculoskeletal dysfunction as the impaired or altered function of skeletal, visceral, arthrodial and myofascial structures [31]. Successful breastfeeding requires infants have adequate musculoskeletal tone [51]. The central nervous system and cranial nerves [46,52] must coordinate oral sensorimotor and swallowing reflexes, and the infant must also have a healthy gastrointestinal and pulmonary function [51].

Breastfeeding self-efficacy is a social cognitive theory developed by Dennis (2003) [53,54], and designed to capture how a mother perceives her breastfeeding ability. It has been demonstrated that mothers with high self-efficacy often persevere with breastfeeding difficulties more easily than those with low self-efficacy [55]. Consequently, maternal breastfeeding self-efficacy is a significant predictor of breastfeeding duration and level [55], and can be a useful tool for practitioners to increase their understanding of the particular aspects of breastfeeding that the MID finds challenging.

The primary aim of this study was to investigate the effect of osteopathic intervention on mothers and infants with breastfeeding difficulties. The secondary aim was to record the musculoskeletal dysfunctions found in those infants.

2. Methods

2.1. Selection methods and inclusion criteria

We selected the period August 2019 to April 2020 *a priori* for data collection. We searched the patient records of one osteopathic practice for MIDs presenting with breastfeeding difficulty as their primary reason for seeking osteopathic intervention during that period, as recorded by the mother on the infant's pre-consultation medical history form. Only MIDs with completed consent forms, baseline, and discharge breastfeeding self-efficacy scale short form (BSES-SF) and visual analogue scale (VAS) scores, medical history forms, clinical observation of a breastfeed and clinical examination of the infant musculoskeletal system were included.

2.2. Exclusion criteria

A MID was excluded from the study if the primary reason for seeking osteopathic treatment was not breastfeeding difficulty, the MID was not breastfeeding and did not intend to initiate or reinstate breastfeeding, the infant had a congenital condition that impacted feeding, such as cleft palate, or the infant was born prematurely (under 35 weeks).

2.3. Data collection

Data were collected from eighteen breastfeeding dyads who attended a single osteopathic clinic in Canberra, Australia, between August 2019 and April 2020. Data were de-identified immediately after the data collection was completed. Data provided by the mothers included infant and maternal medical histories (e.g. feeding modality) plus pre and post-intervention BSES-SF and VAS scores. Birth and neonatal health statistics were collected from the infant's community maternal health records shared by the mothers at the initial consultation (see Table 1). Mothers' written comments were recorded and collected from the medical history forms, and clinical notes of the mother's spoken testimony within the history-taking portion of the initial and follow-up osteopathic consultations. Infant examination, observation of the infant breastfeeding, musculoskeletal findings and adverse events were recorded in the infant's medical file during the treatment phase.

2.4. Data analysis

Patient demographics were analysed using descriptive statistics, including mean, mode, standard deviation and interquartile range for the chosen variables and outcome measures. Also recorded were the MID's reasons for seeking osteopathic intervention, referral source for osteopathic intervention, breastfeeding difficulties and current feeding modality employed by the MIDs. Exploratory analyses for the purpose of generating hypotheses were conducted using the statistical software package R (version 4.1.0 and R Studio version 2022.07.1). Wilcoxon signed rank tests with continuity correction were used to calculate p values for changes in BSES-SF and VAS scores pre and post intervention and Wilcoxon rank-sum tests were used to determine whether BSES-SF scores differed between baseline BSES-SF $\leq$50 or BSES-SF $>$50 groups (see Table 2).

2.5. Outcome measures

The BSES-SF and VAS were administered on two occasions: at the initial osteopathic consultation (BSES-SF-0; VAS-0) and at discharge from osteopathic care (BSES-SF-1; VAS-1).

2.6. Breastfeeding self-efficacy scale (short form)

The BSES-SF is a validated, 14 question, 5-point Likert scale (range 0–70) that measures maternal breastfeeding confidence [53]. It is set within a positive framework, with each question preceded by the phrase "I can always" (Supplementary material). The higher the score, the greater the level of breastfeeding self-efficacy. A BSES-SF score of 50 is considered the threshold for identifying women at risk of ceasing exclusive breastfeeding, with scores $\leq$50 indicating an increased risk [56]. This threshold has a sensitivity of 79% and specificity of 52% and reflects those women who are likely to require interventions to support breastfeeding [56].

2.7. Visual analogue scale

The VAS (continuous scale from 0 to 10) was used to assess four aspects of breastfeeding: nipple and breast pain experienced by the mother while feeding; the level of noise made by the infant while breastfeeding; the infant's ability to latch to the breast; and the infant's ability to maintain latch. A high score means worse symptoms for questions regarding nipple and breast pain and noise while feeding. A low score means more severe symptoms for questions regarding the infant's ability to latch and maintain latch.

Table 1
Demographics of mother-infant dyads (MIDs). Standard Deviation (SD), Interquartile Range (IQR).

		Females	Male
		(%, SD, IQR)	(%, SD, IQR)
Number of infants (n, (%))	18	10 (55.6%)	8 (44.4%)
Maternal age at birth (yrs) (Median, (IQR))	33, (30–36)		
Infant at birth			
Gestational age (weeks) (mean, (SD))	39 (±10.4)	266 (±10.5)	280 (±4.5)
Birth Weight (kgs) (mean, (SD))	3.3 (±0.49)	3.3 (±0.49)	3.3 (±0.49)
Birth Length (cm) (mean, (SD))	49.0 (±2.3)	48.8 (±1.9)	49.7 (±3.8)
Birth Head circumference (cm) (mean, (SD))	34.8 (±1.3)	35.0 (±1.4)	34.5 (±1.5)
Infant at initial consultation			
Age (days) (Median, (IQR))	23 (14–46)	23 (14–46)	25 (16–52)
Weight (kgs) (Mean, (SD))	4.0 (±0.9)	3.9 (±0.8)	4.1 (±0.9)
APGAR			
1-min (Median, IQR)	9, (9-9)	9, (9–10)	9, (9–10)
5-min (Median, IQR)	9, (9-9)	9, (9-9)	9, (9–10)
Parity			
Parity 1 (n, (%))	7 (38.8%)		
Parity 2 (n, (%))	10 (55.5%)		
Parity 3 (n, (%))	1 (5.5%)		
Birth Location			
Hospital (n, (%))	15 (83.3%)	8 (44.4%)	7 (38.8%)
Birth Centre (n, (%))	3 (16.6%)	2 (11.1%)	1 (5.5%)
Caesarean			
Elective (n, (%))	2 (11.1%)	1 (5.5%)	1 (5.5%)
Emergency (n, (%))	3 (16.6%)	0	3 (16.6%)
Vaginal Birth			
Labour Duration (Mean, (SD))	6.4 (±5.0)	5.1(±3.6)	6.6(±6.5)
Spontaneous (n,(%))	10 (55.5%)	5 (27.7%)	5 (27.7%)
Medically induced (n,(%))	6 (33.3%)	2 (11.1%)	4 (22.2%)
Forceps (vaginal delivery) (n,(%))	1 (5.5%)	1 (5.5%)	0
Forceps (caesarean delivery) (n,(%))	1 (5.5%)	0	1 (5.5%)
Vacuum (n,(%))	1 (5.5%)	1 (5.5%)	0
Episiotomy (n,(%))	2 (11.1%)	2 (11.1%)	0
Epidural (n, (%))	2 (11.1%)	1 (5.5%)	1 (5.5%)
Infants requiring special care (n,%)	1 (5.5%)	1 (5.5%)	
Post-partum haemorrhage	7 (38.9%)		
Meconium passed during delivery	2 (11.1%)		
Infants experienced cord entanglement/ compression during delivery	2 (11.1%)		
Irregular head shape after birth	5 (27.7%)		
Facial bruising	1 (5.5%)		
Esotropia	1 (5.5%)		
Vaccination at Birth			
Vitamin K	15 (83.3%)		
Hepatitis B	15 (83.3%)		
Unvaccinated infants	3(16.6%)		
Ankyloglossia	10		

2.8. Musculoskeletal findings

Findings from the musculoskeletal physical examination of an infant were initially recorded by the treating osteopath in the infant's file and

Table 2
Median (interquartile range) change pre and post-intervention

Variable	Pre-intervention	Post-intervention	Change (post - pre)	p-value
BSES	52	64	11 (8, 15)	<0.001[a]
$BSES_{BL\ BSES\leq 50}$	45	62	17 (14,25)[b]	0.022[a]
$BSES_{BL\ BSES>50}$	57	65	8 (5,11)	0.005[a]
Pain	2.3	0.0	-3 (-5.0, -1.0)	0.006[a]
$Pain_{BL\ BSES\leq 50}$	1.8	0.0	-2.0 (-5.9, 1.9)	0.150
$Pain_{BL\ BSES>50}$	2.5	0.0	-3.7 (-6.2, -0.8)	0.022[a]
Noise	7.7	3.0	-3.5 (-5.1, -1.3)	0.009[a]
$Noise_{BL\ BSES\leq 50}$	8.0	3.0	-5.0 (-7.2, 2.6)	0.202
$Noise_{BL\ BSES>50}$	7.3	3.0	-3.0 (-5.6, -0.8)	0.025[a]
Latch	5.6	9.0	3.4 (2.1, 4.8)	<0.001[a]
$Latch_{BL\ BSES\leq 50}$	5.4	8.2	2.8 (0.9, 7.0)	0.022[a]
$Latch_{BL\ BSES>50}$	6.5	9.0	3.4 (1.8, 5.1)	0.006[a]
Maintain latch	4.0	8.5	4.0 (2.5, 5.2)	<0.001[a]
$Maintain_{BL\ BSES\leq 50}$	3.9	7.6	4.2 (1.4, 6.5)	0.022[a]
$Maintain_{BL\ BSES>50}$	4.8	9.0	3.7 (2.0, 5.5)	0.005[a]

BSES: Breastfeeding self-efficacy score; $BSES_{BL\ BSES\leq 50}$: BSES pre-intervention score ≤50 at baseline; $BSES_{BL\ BSES>50}$: BSES pre-intervention score >50 at baseline; Pain: Visual Analogue Scale score for Pain; $Pain_{BL\ BSES\leq 50}$: Baseline Pain score for participants with BSES pre-intervention score ≤50; $Pain_{BL\ BSES>50}$: Baseline Pain score for participants with a BSES pre-intervention score >50; Noise: Visual Analogue Scale score for Noise; $Noise_{BL\ BSES\leq 50}$: Baseline HOISE score for participants with BSES pre-intervention score ≤50; $Noise_{BL\ BSES>50}$: Baseline NOISE score for participants with BSES pre-intervention score >50; Latch: Visual Analogue Scale score for Latch; $Latch_{BL\ BSES\leq 50}$: Baseline score for participants with BSES pre-intervention score ≤50; $Latch_{BL\ BSES>50}$: Baseline score for participants with BSES pre-intervention score >50; Maintain Latch: Visual Analogue Scale score for Maintaining Latch; $Maintain_{BL\ BSES\leq 50}$: Baseline score for participants with BSES pre-intervention score ≤50; $Maintain_{BL\ BSES>50}$: Baseline score for participants with BSES pre-intervention score >50.

[a] Significant at the 5% level.

[b] 90% confidence interval provided; 95% not possible due to ties in the data.

later transposed to an excel spreadsheet (KG). Information on infants presenting with a pre-existing ankyloglossia diagnosis, with or without frenotomy surgery, were recorded.

2.9. Blinding and quality assurance

The practice receptionist collected all BSES-SF and VAS data. The treating osteopath (KG) was blinded to the results of these measures at both baseline and discharge during the treatment period. The treating osteopath (KG) was not blinded to the medical history form, consent form or treatment effects. After the treatment period had ended (August 2019 to April 2020), the treating osteopath (KG) was unblinded to the BSES-SF and VAS results. The data were then entered into an Excel spreadsheet (KG). The master copy of the data was sent to another member of the research team (RE) for quality assurance and cleansing before data interpretation, and analyses were conducted. The CARE [57] guidelines checklist for case reports guided the reporting process.

2.10. Consent

All mothers who attended the clinic between August 2019 and April 2020 completed a consent form for osteopathic examination and treatment of their infants and for the use of that data in a de-identified format in future analyses.

2.11. Ethics

The study was a retrospective case series of de-identified patient files from a single osteopath in private practice in Australia. As the case series did not involve direct contact with participants, ethics approval was waived by the relevant ethics committee.

3. Results

Eighteen MIDs were included in this retrospective case series. A summary of the medical histories, demographic data, reason for seeking osteopathic care, breastfeeding status and conditions experienced by the mother during pregnancy are reported in Table 1. All infants were under ten weeks of age, healthy and growing normally, according to the World Health Organization's growth charts for breastfed infants [58]. Seven dyads had an initial BSES-SF score of ≤50. Data from these were analysed separately and reported along with the results of the entire cohort.

The primary reason for seeking osteopathic intervention as recorded by mothers on the infant's medical history form was breastfeeding difficulty (15/18). Secondary reasons included referral from practitioners for latching difficulty after frenotomy (9/18), and jaw and/or muscular tightness (6/18), in the infant (Supplementary Material). The MIDs were referred for infant osteopathic intervention by general practitioners, IBCLC and midwives who had recognised that the infant's difficulty breastfeeding may be due to musculoskeletal dysfunction. When breastfeeding symptoms due to ankyloglossia did not resolve with frenotomy and prescribed post-frenotomy exercises alone, MIDs were referred for osteopathic intervention. All tongue-tie-related diagnoses were made by the referring practitioners and not the treating osteopath.

Of the 18 infants in the study, ten (10/18) had been diagnosed with ankyloglossia with nine of these (9/10) undergoing frenotomy prior to osteopathic intervention, one infant did not undergo frenotomy prior to osteopathic intervention. Eight of the infants who underwent frenotomy (8/9) were in the not at risk of ceasing breastfeeding group (baseline BSES-SF >50), only one was in the at-risk group of ceasing breastfeeding.

At the time of the initial consultation, 16/18 MIDs were breastfeeding as part of their feeding routine. Two (2/18) were exclusively bottle feeding with expressed breast milk (EBM) and attempting to breastfeed but were so far unsuccessful (the infant was unable to latch to the breast), and nine (9/18) were exclusively breastfeeding. Three (3/18) infants were fed with a combination of breastfeeding and EBM via bottle feeding and four (4/18) used a combination of breastfed with a mixture of EBM and formula. At discharge all MIDs were breastfeeding, either exclusively or breastfeeding with EBM supplementation to their satisfaction. During the observation of infants breastfeeding, it was noted by the osteopath that some infants displayed behaviours such as chomping on the breast, pulling off and crying at the breast, difficulty latching on, inability to maintain latch, tiring at the breast prematurely, maintaining a shallow latch and an inability to create a suck or swallow and respiration rhythm.

Ten dyads had previously received support from an IBCLC, while the remaining eight had not received additional breastfeeding support. Information about low milk supply, milk oversupply, lactose overload, pharmaceutical help for milk supply, use of nipple shield, supply line, aerophagia, slow weight gain and mastitis were also recorded (Supplementary Material).

While the majority of mothers (14/18, 78%) experienced a healthy pregnancy without complication, several reported medical challenges during the pregnancy that included gestational diabetes (4/18), prolonged breach position post 38 weeks (2/18), preeclampsia (1/18), hyperemesis gravarum (1/18), hypothyroid (1/18) and bipolar disorder (1/18) (Supplementary Material).

The number of osteopathic interventions provided for the eighteen MIDs during the treatment period ranged from 3 to 7 (median 5, IQR 3–5). Interventions occurred over an average period of 7.4 weeks with

the majority of interventions occurring weekly for the first three weeks, moving to fortnightly intervals after that.

3.1. Breastfeeding self-efficacy short form

Eighteen women completed the BSES-SF at their initial (BSES-SF-0) and discharge (BSES-SF-1) consultations. Across the whole cohort, there was a significant increase from BSES-SF-0 scores to BSES-SF-1 scores ($p < 0.001$). Fig. 1 describes the mean change in BSES-SF scores pre- and post-osteopathic intervention for the whole cohort ($n = 18$), for women with a BSES-SF score >50 at baseline ($n = 11$), and for women with a BSES-SF score ≤50 at baseline ($n = 7$). There was a significant increase post-intervention in BSES-SF scores ($p = 0.005$) in the subgroup with baseline BSES-SF scores >50. There was a significant increase post-intervention in BSES-SF scores ($p = 0.022$) in the subgroup with baseline BSES-SF scores ≤50. Those with BSES-SF ≤ 50 had significantly more change than those with BSES-SF > 50 at baseline ($p < 0.001$).

Based on BSES-SF scores for all 18 dyads, the proportion of dyads reporting confidence in breastfeeding increased from (1/18) 5.5% at baseline to (13/18) 72.2% at discharge.

3.2. Visual analogue scale

Eighteen women completed a VAS at their initial (VAS-0) and discharge (VAS-1) consultations for the four domains. Fig. 2 describes the mean change in VAS scores pre- and post-osteopathic intervention for each of the four domains. At baseline, two mothers rated pain while breastfeeding a major concern, five rated it a minor concern and 11 rated it as not a problem or insignificant. At discharge, all 18 mothers rated their pain while breastfeeding as either not a problem or insignificant.

For noise while breastfeeding, ten women rated it a major concern, four a minor concern and four not a problem or insignificant at baseline. At discharge, two women rated noise while breastfeeding a major concern, three rated it a minor concern, and thirteen rated it not a problem or insignificant.

For ability to latch, four women rated it a major concern, thirteen rated it a minor concern, and one rated it not a problem or insignificant at baseline. At discharge, no women rated ability to latch a major concern, one woman rated it a minor concern while the remaining 17 women rated it not a problem or insignificant.

For ability to maintain latch, ten women rated it a major concern, five rated it a minor concern, and three reported it not a problem or insignificant. At discharge, no women rated the ability to maintain latch a major concern, four rated it a minor concern, and fourteen rated it not a problem or insignificant.

Across the entire cohort, there were significant decreases in pain and noise ($p = 0.006$ and $p = 0.009$ respectively) and significant increases in the ability to latch and maintain latch ($p < 0.001$ and $p < 0.001$ respectively).

Musculoskeletal dysfunction in the infants was recorded at each consultation. All eighteen infants showed signs of tissue tension and potential discomfort in the cervical and occipital, facial, and cranial regions. Fourteen infants had tension in the sphenoid and zygoma regions of the skull, while eleven had musculoskeletal dysfunction in the hyoid, palatine, temporal, mandibular and/or pelvic regions (Supplementary material).

3.3. Adverse events

There were no adverse events reported by the mothers throughout the treatment period of the study.

4. Discussion

This retrospective analysis of 18 MIDs undergoing osteopathic intervention for breastfeeding difficulty found improvements in breastfeeding confidence and dysfunctional breastfeeding symptoms, including ability to latch, ability to maintain latch, maternal pain at the breast and noise produced while feeding. These were reported following an average of five osteopathic treatments. Our results are in line with those of Cornall (2015), who reported that osteopathic intervention was capable of addressing the multiple factors that influence a mother's confidence and ability to breastfeed [28]. In this study, mothers self-evaluated their breastfeeding experience at the initial osteopathic consultation (BSES-SF-0) and again at discharge (BSES-SF-1). The greatest improvements were seen in the seven MIDs identified at the greatest risk of ceasing breastfeeding at baseline (BSES-SF ≤ 50 group). Results from our study support the theory that dysfunction in the infant's musculoskeletal system may contribute to breastfeeding difficulty and that helping infants resolve musculoskeletal dysfunction may improve dysfunctional breastfeeding symptoms in infants under 10 weeks of age.

Results from the outcome measures provided context and clarity to the scope of MIDs breastfeeding confidence and breastfeeding difficulties. Self-efficacy is a cognitive process in which individuals evaluate their perceived ability to perform a specific task or behaviour [59]. Self-efficacy for breastfeeding confidence was chosen because deterioration in a mother's breastfeeding confidence during the early postpartum period is a major factor in their decision to stop breastfeeding [28,56,60,61]. Increasing a mother's confidence in her ability to breastfeed, may also help her to persevere in the presence of ongoing

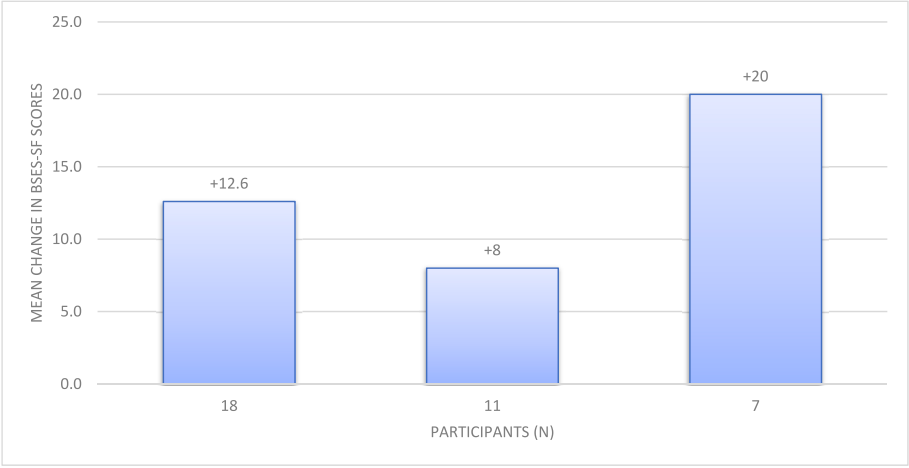

Fig. 1. Mean change in BSES-SF scores pre- and post-osteopathic intervention.

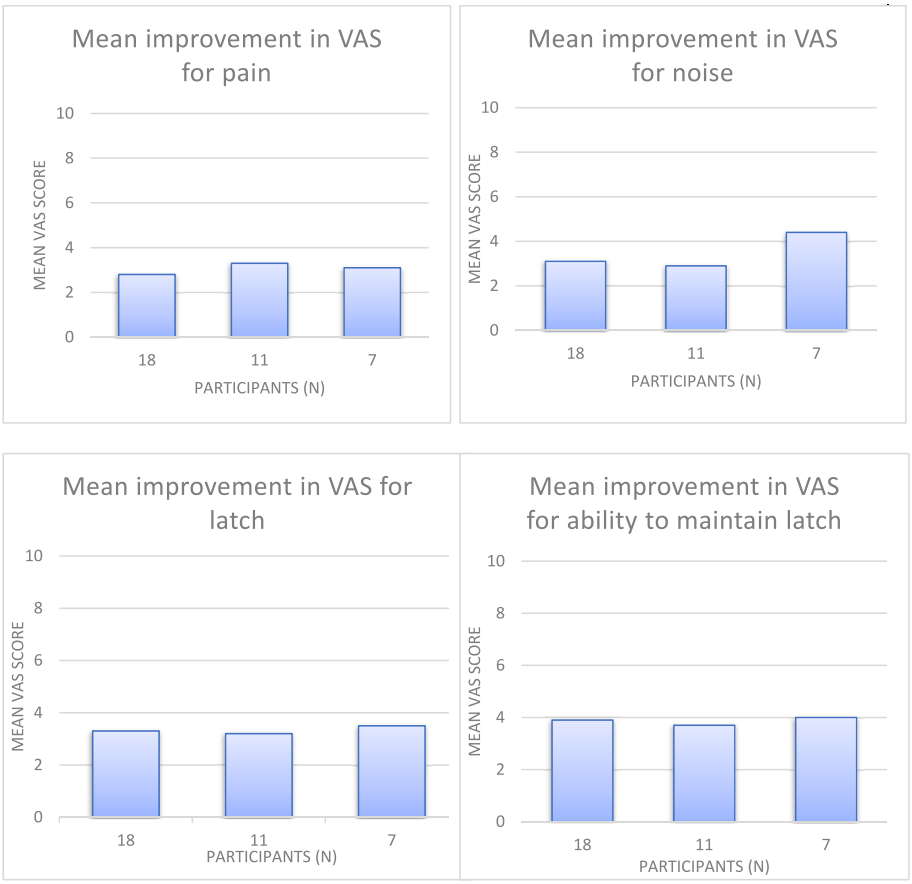

Fig. 2. Change in VAS scores for pain, noise, ability to latch, and ability to maintain latch while breastfeeding.

breastfeeding difficulties [55].

Integrating self-efficacy-enhancing strategies into osteopathic practice may improve the quality of care that osteopaths can deliver. Breastfeeding self-efficacy results highlight how a mother is feeling about her breastfeeding as well as the MID's ability to breastfeed [28]. Identifying when a mother needs support and/or encouragement during breastfeeding is an integral part of osteopathic intervention. A low confidence level may also indicate a multidisciplinary approach is required with the inclusion of lactation support from an IBCLC.

The results from this study highlight the potential benefits of osteopathic intervention for mothers at risk of ceasing breastfeeding who also have dysfunctional feeding symptoms. In the group of MIDs considered 'at risk' of ceasing breastfeeding (BSES-SF $\leq$ 50), six of the seven moved from a position of 'at risk' to 'not at risk' following intervention. The remaining MID was discharged with a BSES-SF score of 48. While this may still be considered 'at risk', this MID had an improvement of 16 points, was exclusively breastfeeding with EBM top-ups, had their infant feeding well with the mother comfortable and confident she could continue.

In this study, we measured an infant's ability to latch and maintain latch through the VAS. The ability to latch relates to an infant's ability to open their jaw, lead with their mandible, and take enough of their mother's breast tissue into the mouth. The ability to maintain the latch relates to an infant's ability to create and maintain the intra-oral vacuum for adequate milk transfer. At baseline (10/18) 56% of MIDs rated this as a significant concern for them. At discharge ability to maintain latch was no longer a concern for any of the MIDs. The 'at risk of ceasing breastfeeding' group also rated greater severity in breastfeeding symptoms, as identified by the VAS. As a group, these seven 'at risk of ceasing breastfeeding' dyads showed the greatest improvement in latch, ability to maintain latch and feeding noise following osteopathic intervention. Our results are in line with other reports in the literature showing improvements in latching following osteopathic intervention [27].

In this study we measured pain while feeding by VAS and showed a potential decrease in breastfeeding-related pain following osteopathic intervention. Persistent nipple pain is one of the most common reasons women give for ceasing exclusive breastfeeding [37]. While women anticipate some discomfort in the initial phases of establishing breastfeeding, ongoing nipple pain and nipple injury associated with poor infant latch and dysfunctional sucking action can impede a woman's attempt to breastfeed by inhibiting lactation, altering milk composition and secretion yield [62]. Our results indicate a decrease in breast and nipple pain following osteopathic intervention.

In this study we measured feeding noise and showed a decrease following osteopathic intervention. Some infant noise during breastfeeding, such as swallowing noise, is normal, especially with a mother's fast let-down [63]. However, anecdotal evidence reported in the literature has attributed loud or noisy feeding (clicking or smacking noise) being due to an ineffective latch and loss of vacuum during the sucking phase [63,64]. When repositioning the infant at the breast does not help, noisy feeding may indicate a more serious dysfunctional feeding problem. The cause of feeding noise, and its relationship to poor infant latch and loss of suction, needs further clarification.

In line with our second aim, musculoskeletal dysfunction data was collected from the infant examination. The results from this demonstrated that musculoskeletal dysfunction was prominent in the cervical, cranial, facial and TMJ regions of the infant with difficulty breastfeeding. If an infant is uncomfortable in this region of their body, they may find breastfeeding difficult. Our results show that osteopathic intervention has the potential to resolve musculoskeletal dysfunction and improve breastfeeding symptoms.

The possible causes of musculoskeletal dysfunction in an infant have

been discussed in the literature. A history of difficult or prolonged birth may be associated with trouble breastfeeding due to the effect of birth trauma, birth interventions [32] and possible effects on the infant's musculoskeletal system [52,65]. This link between birth trauma and musculoskeletal dysfunction in the infant has the potential to interfere with breastfeeding [28,66]. Musculoskeletal dysfunctions may affect an infant's ability to latch onto the breast, lie comfortably in their mother's embrace, have adequate ability to extend and flex the neck (bobbing motion) and open the jaw wide enough to acquire enough breast tissue. The tongue, which moves forward as the jaw opens, consists of intrinsic muscles concerned with changing the shape of the tongue, and extrinsic muscles that attach to the jaw, skull and hyoid bone [46,49]. As the tongue changes shape, it moves rapidly away from the palate, accompanied by a lowering of the jaw, creating a negative pressure or suck-induced intra-oral vacuum which draws the nipple and milk towards the hard-soft palate junction [50] in preparation for swallowing.

Other musculoskeletal factors such as soft tissue dysfunctions like ankyloglossia [67] and congenital torticollis [42] have been reported in the literature as conditions that interfere with breastfeeding [68]. Genna (2015) [42] observed that infants with unilateral sternocleidomastoid tension and associated craniofacial, spinal, and hip asymmetries may experience feeding difficulty. Wall (2006) [41] identified breastfeeding problems related to functional asymmetry of the infant's mandible. Anatomic and muscular asymmetry also have the potential to effect the biomechanics of infant breastfeeding and contribute to latch difficulties, nipple pain and poor milk transfer [64]. In our study, musculoskeletal findings such as ankyloglossia were present in 10 infants. Nine of them had undergone frenotomy prior to osteopathic intervention. This represents a potential confounder in our study and reflects the pragmatic nature of clinical practice. Further research is needed to clarify the role of osteopathic intervention for the MID post-frenotomy where dysfunctional breastfeeding symptoms persist.

MIDs were observed breastfeeding or attempting to breastfeed. Observing the infant at the breast assists in identifying possible causes of trouble latching or maintaining latch through disorganised or dysfunctional sucking [64]. Observation can provide valuable additional information to the treating practitioner as well as confirm the self-reported feeding difficulties expressed by the mother. These behaviours may currently be understood as normal breastfeeding behaviours while MIDs are learning to breastfeed. However, they may also be potential signs that an infant is not comfortable feeding as a result of musculoskeletal dysfunction. Such anecdotal observations require further investigation to assess their impact on the relationship between musculoskeletal dysfunction and breastfeeding behaviour.

As part of the infant's medical history, data on the mode of feeding (e.g. exclusively breastfeeding, EBM and formula) were collected from the mothers. At discharge, all MIDs were breastfeeding, either exclusively or breastfeeding with EBM supplementation to their satisfaction and were no longer supplementing with formula. More research is required to examine the relationship between increasing breastfeeding confidence and decreasing breastfeeding dysfunctional symptoms following osteopathic intervention.

The combined results of BSES-SF and VAS may suggest a possible relationship between improved infant breastfeeding function and maternal confidence for MIDs at risk of ceasing breastfeeding. As the infant's musculoskeletal dysfunction following osteopathic intervention appeared to change, so too did the mother's breastfeeding confidence. More research investigating the potential of this relationship is warranted.

4.1. Safety

No adverse events related to osteopathic intervention were reported in this study. While the cohort was small, these results highlight the relative safety of this type of osteopathic intervention on infants under 10 weeks of age.

4.2. Strengths and weaknesses

A strength of this study is that it is a pragmatic reflection of the experience of breastfeeding mothers and the treatment of their infants in osteopathic clinical practice. By using two validated outcome measures to report changes in breastfeeding confidence and breastfeeding symptomatology following osteopathy intervention, the study highlights how practice-based research is achievable.

There are acknowledged weaknesses associated with this type of retrospective case series. For example, this study involved a single practitioner, so there is the possibility that a different practitioner may have produced different results on the same cohort of infants. Furthermore, the absence of a comparator group limits the generalisability of the results. A further weakness in this study is the confounder that nine infants had undergone frenotomy prior to osteopathic intervention.

Finally, while all efforts were made to ensure sample selection was not biased, the nature of this type of study means that an element of selection bias may have been present.

5. Conclusion

As the demand for osteopathic intervention for infants with breastfeeding difficulty continues to increase, any claim that this intervention delivers benefits must be matched with robust evidence of effectiveness. In this study, we provide evidence, albeit limited, that osteopathic intervention appears to be both safe and capable of delivering benefits in breastfeeding confidence and function in infants under 10 weeks of age. While our results also indicate that osteopathic intervention may benefit mothers at risk of ceasing breastfeeding, further research in the form of prospective clinical trials, including a comparator group, are warranted.

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Ethical approval

The study was a retrospective case series of de-identified patient files from a single osteopath in private practice in Australia. As the case series did not involve direct contact with participants, ethics approval was waived by the relevant ethics committee.

CRediT authorship contribution statement

Kirsty Greenwood: Conceptualization, design, All authors contributed to data analysis and interpretation, Writing – original draft, Writing – original draft, Funding acquisition, Writing – review & editing, All authors edited the final version of the manuscript, All authors have approved the final version of the manuscript submitted for consideration for publication. **Roger Engel:** Conceptualization, design, All authors contributed to data analysis and interpretation, Writing – original draft, provided critical revision for important intellectual content, Funding acquisition, Writing – review & editing, All authors have approved the final version of the manuscript submitted for consideration for publication. **Sandra Grace:** Conceptualization, design, All authors contributed to data analysis and interpretation, Writing – original draft, provided critical revision for important intellectual content, Funding acquisition, Writing – review & editing, All authors have approved the final version of the manuscript submitted for consideration for publication.

Conflict of Interest

Roger Engel is an Editor of the International Journal of Osteopathic Medicine, but was not invloved in review or editorial decsions regarding

this manuscript.

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Appendix A. Supplementary data

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