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JCCP JOURNAL OF CLINICAL CHIROPRACTIC PEDIATRICS

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Editorial

Is modern technology affecting our children's musculoskeletal and neurological development?

By Sharon A. Vallone, DC, FICCP

Dear Journal Reader:

Welcome to the premier issue of the *Journal of Clinical Chiropractic Pediatrics* in its new open access format. We are hopeful that this venue will provide field clinicians interested in maternal health and pediatric chiropractic with current research, case reports and clinical commentary that they will find both useful and informative. We invite you to submit your own research or scientific writing to be considered for publication in this journal.

This issue of JCCP includes interesting case reports, current research and informational commentaries emphasizing the ever growing importance of keeping abreast of current trends, maintaining clear lines of communication in collaborative work, and accepting responsibility as providers of public health information as it applies to our patient populations. Sometimes these reports are dramatic responses to chiropractic care in otherwise non responsive or poorly responsive situations. Sometimes what we do (or are able to influence) seems very ordinary. But what needs to be emphasized is that nothing is "ordinary" or without merit. Whether the chiropractic adjustment "fixes a boo boo" as the young patient may express it, or whether it is to prevent neurologic aberrancy that could result in organic dysfunction or disease, the chiropractic adjustment is the tool we are most skilled at applying.

Our role as healthcare providers includes a responsibility to educate our patients not only about spinal health but to promote a healthy lifestyle, as well. Educating children, as well as adjusting the pediatric spine can have a vital impact on their growth and development including cognition, motor function and imagination. Take for example, our nation's obsession with technology. As I write this editorial, I am awed at the work and technological expertise that went into creating an online journal. But this technology has crept into every aspect of our lives. It has become indispensable in avenues that extend from our simple daily communication (phone, text, twitter, Facebook) to how we conduct our professional lives (education, clinical data collection, scheduling and billing, etc.). It is even apparent in the lives of our children at home and at school. Watching this trend to own and play with more and more technological tools (or toys as the case may be), we must ask ourselves what are the long term ramifications on our children's musculoskeletal health?

Everything a child does is a learning experience. Everything they touch, see, smell, taste… all expands the child's experience of the world. One of the greatest gifts of parenthood and grandparenthood, as well as our daily interaction with the children we treat in our practices, is witnessing the miracles around us through the eyes of children… the wonders of nature, the amazing human mind and all of the things we have invented to improve our quality of life and to function cooperatively as a society.

The technology of the interactive tablet, like the very popular iPad, or even more readily accessible "smart phones" like the iPhone, are some of those miracles. Four years ago the iPad didn't exist, and now people wonder how they ever survived without one. How many office visits are "calmer" because of a child being allowed to pacify themselves with a tablet or cell phone while their parents receive their chiropractic adjustment? But we should all be aware of the potential hazards of these constant pacifying activities especially with those younger than two years of age (American Academy of Pediatrics' most current policy statement issued in 2011). It is often a source of wonder for parents that their one-year-old has mastered their smart phone, considering it a feat of exceptional motor development without considering the bigger picture.

I recently observed a young girl in my office engaged in three popular activities with her iPad: watching cartoons (sitting absolutely still, eyes glazed over), coloring pictures, and playing puzzle games.

When coloring pictures, she selected a color from the palette, tapped an area and it filled it in completely…always within the lines. Other than greatly improving the aim of her index finger, how does this add to her development? If she was coloring with crayons on paper, her grip strength would improve, she would explore different intensities of color with varied pressure on the crayon with her fingers, experience the frustration of coloring outside the lines, or even breaking a crayon. She would be using her imagination and maybe draw pictures of her own world.

When she was working on a puzzle app, the screen showed a complete outline of the puzzle, including the shapes of the individual puzzle pieces. She dragged the puzzle pieces close to where they belonged on the puzzle, and the iPad slid it perfectly into its place. Yes, one might say this is a

way to learn shape recognition or problem solve by putting the flat edge pieces along the flat border of the iPad. But if she had been working with a real puzzle, the learning would have been more rich in sensory input and emotional output, even frustration! She may have sat there trying to jam pieces together that didn't fit. There would have been the opportunity to learn skills to improve her proficiency, like finding the corner pieces first. There are also different tactile sensations experienced when handling a wooden puzzle with handles to grasp, carefully tearing apart a cardboard puzzle for the first time, or the sticky resistance of foam puzzles. Eye hand coordination is developed while matching up similar colored and shaped pieces. There are also consequences if puzzles are not taken care of and pieces are lost.

Let's consider the apps that read books. Most of them are interactive, so it is still preferable to watching cartoons, but once again it all happens with the touch of the index finger. For very young children reading a book with a parent or grandparent is an experience they will remember for years to come. The child feels the warmth and safety of being snuggled against the adult. They ask questions, find things in the pictures, repeat parts they like, turn the pages, feel the texture of the paper and the cover, recognize letters and word, memorize and pretend to read. Acting out stories and making their voices match the characters they are enthralled with are experiences that are memorable. This is the fun of a Saturday night read in front of the crackling fire, with real logs, fire and smoke…not the noisy replica on the iPad app!

Sensory stimulation is critical for the development of brain structure and function in very young children. Children's sensory experiences (sight, hearing, touch, taste, smell and movement) stimulate neural activity that differentiates and creates the complex nerve networks that are key for optimum development in early life (Cynader & Mustard, 1998), Mustard, 2008). When coloring a picture on an iPad the child is missing the feel of the crayon between the fingers (touch), the smell of the wax (smell), the visual assessment of the size of the crayon and the difference in shading (sight), the texture of the crayon on paper (touch), the crinkle of the paper as they color (sound). Other than chewing on the crayon (and depending on age, this too may be part of the experience), all of these senses are utilized and plastic connections made in different parts of the brain. I am not saying there are no senses stimulated by the iPad experience, but they are limited in comparison to the richness of the sensory input experienced "in real life" situations of coloring a picture with crayons, baking a cupcake from scratch (yes, there's an iPad app to bake cupcakes!) or putting a 100 piece jigsaw puzzle of their favorite story book character together with the family gathered around the dinner table.

Neuroscientists have also found that repeated observation of actions (either passive or active with the intention to reproduce the action) increases brain activity and can result in experience dependent changes (Chong et al., 2008). It is hypothesized that through the mirror neuron system, children develop the ability to understand the actions of others, to imitate and to teach others (Blakemore et al., 2005). Because mirror neurons are used to learn and feel from what is observed, they allow learning through imitation, rather than having to use trial and error (Geake, 2009), meaning that demonstrations can be very effective in helping children learn (Chong et al., 2008). Do we want our children learning how to interact with other children and adults through exposure to the human community or from an iPad?

These products of modern technology can be valuable tools for education. They will enhance and broaden many aspects of education. They provide a means to communicate for many of our nonverbal children with special needs (Flores 2012/Shane 2012). The academic environment is rapidly promoting proficiency in our children around technology. But let's not rush. The window of learning the world during the early years of life is irreplaceable. The brain constantly rewires itself with every thought and experience the young child has. Multi-sensory experiences of normal, everyday life are actually far richer than getting to experience everything in the world through the screen of a tablet. Developing the auditory, visual, and kinesthetic nervous system is vital at this tender age. Multisensory learning helps ensure that the developing child is adaptable to different styles of learning once they are immersed in formal education. Developing their imagination and problem solving skills improves their resiliency in challenging situations. It also improves their overall health and well-being which is our goal as their chiropractor.

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Adverse reactions of medications in children: The need for vigilance, a case study

By Edward Holmes, DC[1] and Joyce Miller, BSc, DC, DABCO, FCC[2]

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Summary: This study demonstrates that adverse drug reactions do potentially pose a public health risk within the pediatric population and all healthcare providers need to be mindful of this risk. Adverse events to medication within this population are prevalent particularly in children under the age of two. Chiropractors must therefore be aware of adverse drug reactions and recognize symptoms within their patient population.

Key terms: off label use; non-prescription drugs, child, pediatrics, drug toxicity guidelines, adverse medication reactions in children

Introduction

A 19-week-old premature infant presented to a chiropractic teaching clinic with a 'poor feeding pattern, recent slowing in weight gain and increase in crying' over a three week period. The mother stated that this had started following a respiratory infection which occurred two months ago, with an associated rash that spread from her abdomen to the back of her neck, face and head. At least six weeks previously her GP had prescribed a cold remedy for the day (Calcold®) and Calpol® Night for the evening for the respiratory infection, and cortisone cream when a rash developed two weeks later. The medications seemed to help the child sleep, in fact she seemed to sleep much more during the day and night, which was put down to illness. However this did not change in the ensuing weeks after the respiratory infection abated. The mother continued with the Calpol® Night at the recommendation of the GP along with a change to Calpol® (instead of Calcold®) in the day, since it seemed to have helped with sleep. We examined a lethargic infant with an erythematous rash covering the trunk, head and neck who had decreased almost two centiles on her growth chart in the previous several weeks, and although not losing weight, she was nevertheless not gaining weight. Without another obvious etiology, was there an association between the medication and the child's signs and symptoms?

Upon further investigation, we discovered that advice from the Medicines and Healthcare products Regulatory Agency (MHRA) stated that cold and cough medications should not be given to children under six years of age. MHRA states, "There is no evidence that cough and cold medications work and can cause side effects such as allergic reactions, effects on sleep and hallucinations."[1] It was noted on the Calpol® website that three of their products (Calcold®, Calcough® and Calpol® Night[2]) were in this category. They recommend discussing the use of these with the child's doctor or pharmacist when children are under six years of age.[2] Calcold® contains paracetamol and diphenhydramine and Calpol® Night contains the exact same ingredients at the same concentrations.[2]

Paracetamol (aka acetaminophen) is an analgesic and an anti-pyretic drug, which has been associated with childhood asthma when taken in infancy.[3] Diphenhydramine is a sedative as well as an antihistamine used to treat allergic reactions involving the nasal passages. The website states that no paracetamol product is recommended for a child under three months of age.[2] It was realized that in this case, where the child was four weeks premature that these products had been supplied either at the actual age of 12 weeks or just at the cusp of that age. Side effects of paracetamol are listed as skin rash, blood disorders, swollen pancreas, liver damage and sudden death secondary to a severe overdose.[4] There are no side effects listed for children. It was noted that paracetamol has a narrow therapeutic index, with the therapeutic dose and the toxic dose being very close. In infants under three months the toxic dose is thought to be 10mg/kg of body weight.[5]

The World Health Organisation (WHO) defines an adverse drug reaction (ADR) as "a response to a drug that is noxious and unintended and occurs in doses normally used in adults for prophylaxis, diagnosis or therapy of disease or for modification of physiological function."[6] ADRs are a major health issue and can range from short term mild effects to more chronic symptoms, and can even be life threatening.[7] Identification and evaluation of ADRs in the pediatric population is of particular importance since they may be more susceptible to toxicity at lower doses (Table 1).[8]
The identification, reporting and monitoring of adverse drug reactions (ADRs) are vital in predicting drug safety. The yellow card reporting system used in United Kingdom (UK) hospitals is an essential means of identifying drug reactions.[9]

Reporting of ADRs is complicated by a number of factors. Many children are below speaking age, which provides diagnostic difficulties.[8] Information therefore relies heavily on observation from nurses, physicians and pharmacists. Clinicians have been found to under-estimate adverse reactions in patients.[10] Clinician communication has also been a factor; parent interviews in a recent study demonstrated that clinician's communication about ADRs was poor indicating improvements are needed.[11] Then there is mis-interpretation of correct dosage due to off-label pre-

scribing. The definition of off-labeling differs between Europe and the United States (Table 2).[12] Essentially though, off-label prescribing refers to administration of a drug for a particular indication that has not yet received approval.[12] Many medicinal products currently used to treat the pediatric population have not been studied or authorized for such use.[13] A recent study in Italy showed that a number of respiratory drugs prescribed to children under two years of age were done in an off-label way.[14]

Table 1. Physiological factors which can increase risk for ADRs in Children[8]

- Among neonates and children, decreased intestinal motility and delayed gastric emptying can result in a greater lag time between drug administration and plasma concentration compared to adults. There is therefore a potential for increased drug absorption.
- The presence of increased gastric irritability in neonatal life such as reflux can result in loss of medication dose.
- Children have higher levels of water and extracellular fluid; this will result in increased distribution and dilution of water-soluble drugs.
- Reduced protein binding of drugs in neonates can result in higher concentrations of free drugs in the body.
- The blood brain barrier is not fully formed in neonates; therefore some medications may have an enhanced effect.
- Neonatal livers are not yet fully developed to be able to metabolise a large proportion of drug substrates.
- Glomerular filtration and tubular function within the kidney are not as efficient in neonates; therefore drug excretion is decreased.

(Modified from Barnes: paediatrics a guide for nurse practitioners 2003)

Additionally there is a high usage of over-the-counter medication (OTC) use in children.[15] A study conducted in Germany in August 2009 found that over the course of one week in a population of 17,450, 0 to 17 year olds, 17% used OTC medication.[15] A similar study carried out in the United States (US) in August 2009, stated that in a population of 2,857 infants, 56% had used more than one OTC drug in the seven days prior to interview.[16] OTC use is therefore very common (Table 3).

One major issue is that there are considerable ethical restrictions to conducting drug trials in children. Current European guidelines as quoted by Sammons et al (2007)[17] state that "medical trials cannot be carried out unless the child may benefit directly from the intervention." Consequently there are a limited number of clinical drug trials involving children.[17]

These restrictions are historically related to major incidents such as the use of sulphonamides in pregnancy causing Kernicterus in the infant, and notably Thalidomide which resulted in congenital defects after use of this medication during the first trimester.[18] Following these tragedies, medicine manufacturers have been required by drug agencies to carry out much more extensive research into the efficacy and safety of their products prior to marketing and distribution.[18] The drug licensing regulatory process was introduced by the Medicines Act 1968, and this was "established to ensure that drugs were safe, effective and of high quality."[10]

This has been reflected in subsequent legislation. With respect to medicinal products for pediatric use, legislation came into force in January 2007.[18] This was aimed at enhancing the safety of medicine for children through the use of research and development, by authorizing safe medicines based on pediatric experience, without subjecting this population to clinical trials.[17]

It was indicated to investigate further the use of drugs in children as information from a 2009 survey in a university-affiliated chiropractic teaching clinic (N=770) revealed 45% of crying babies had been treated with medication prior to their presentation to this clinic (Figure 1).[19] Health care providers must therefore be aware of the signs of ADRs and the misinterpretation of dosage via off-label prescribing. In order to determine the prevalence of ADRs in infants and children, a literature search was performed. Medline and PubMed were searched using the following search terms: off-label use, non-prescription drugs, child, pediatrics, prevalence, drug toxicity guidelines. Papers were limited to those published in the English language.

For the purposes of this investigation, research focused on adverse effects from OTC (over-the-counter) medication and off-label prescribing.

Over-the-counter medication effects

Paracetamol and non-steroidal anti-inflammatory drugs (NSAIDS) represent widely used forms of OTC medications

Table 2. Off-label definitions in the USA and Europe[12]

Country	Definition
United States	• As defined by the Food and Drugs Administration (FDA) • Unapproved use of a licensed drug • The use of an indication, dosage form, dose regime, population or other parameter not mentioned in the approved labelling.
Europe	• Defined according to directive 2001/83/EC • Terms are included but ill defined • Definitions only present for pediatric medication • Off label medication in children is the use of medicines not authorized for children • The use of medication in children that have been authorized for adults.

(modified from Neubert et al 2009)

Table 3. Over-the-counter medication use in children, Germany and USA[15, 16]

Country	Date	Population Size	Percentage of use	Age Range (years)
USA	March 2009	17,450	17	0-17
Germany	August 2009	2,857	56	0-1

(modified from Yong et al 2009 and Vernacchio et al 2009)

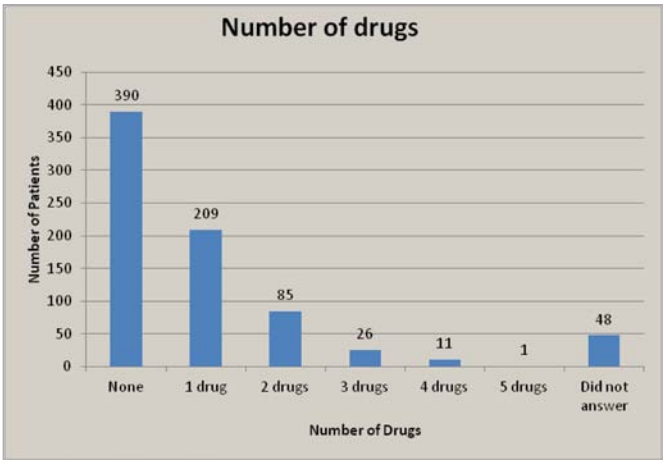
within the pediatric population.[20] However a review was recommended in Australia following reports of an increasing number of ADRs related to NSAIDS over the previous five years.[20] Nineteen reports of ADRs to NSAIDS and six to Paracetamol were discovered with age groups ranging from four months of age to 22 years of age.[21] Patients presented with side effects including skin, gastrointestinal and respiratory symptoms. One patient died after acute exacerbation of asthma after taking Rofecoxib, (NSAID which was voluntarily withdrawn by Merck® in 2004, following trials that suggested use of this drug may lead to cardiovascular events, such as heart attack or stroke).[21] Titchen, Cranswick and Beggs (2005) showed that use of NSAIDS could be a significant cause of morbidity in children, and there was therefore an increased need for efficient drug surveillance.[20]

Much of the research regarding pediatric OTCs concerns cough and cold medications. A retrospective review of electronic records submitted to the New Jersey Poison Information and Education system was carried out between 2000 and 2007 by Vassilev.[22] Ninety-one cases demonstrated adverse drug reactions to OTCs in children with the majority of moderate to severe reactions occurring in children two to eleven years of age. This study highlighted the fact that there is no evidence to suggest this type of medication is effective in children under the age of two years.[22] Dart et al (2009) assessed all reported pediatric fatalities from 1983 to 2007 within the US, using a variety of databases.[23] They found that in children below the age of 12 years, a total of 118 deaths could be directly related to ingredients from cough and cold medications. Of these only 82 were due to OTCs in isolation.[23] They also discovered that these fatalities were more prevalent in children under the age of two years. The reason for this is, as highlighted by Fattahi et al (2009) that young children carry certain risk factors for ADRs.[7] These include differences in drug metabolism, which may increase their susceptibility to certain medications, and may mean some organs are more sensitive to side effects than others.[7]

In 2009, cough and cold medications were withdrawn for age groups under six years.[1] In a recent community-wide survey, 60% of a population of 179 parents had used OTC cough and cold medications for their pre-school child.[24] Many of the participants, when asked, indicated using an inappropriate dose.[24] In another 2009 study, all general pediatricians surveyed were aware of the withdrawal of these medications for children under the age of two years and the consideration of withdrawal for children under six years of age; however six per cent of physicians asked stated they would continue to prescribe these products.[24]

A significant problem identified with OTCs is mis-interpretation of use by the general public.[25] Lokker et al (2009) ex-

Figure 1. Number of drugs used in AECC patients under one year of age.[19]



N=770 (reproduced from Miller et al 2009)

amined the perceptions of caregivers of children aged one year of age and below within three general pediatric outpatient clinics across the US.[25] All medication labels instructed consumers to seek medical advice before administering it to children under the age of two years. When shown these medications, however, 50% of the time child caregivers stated that they would give them to a 13-month-old child with flu-like symptoms.[25]

Mis-use of medications by caregivers was a common occurrence found in a study by Lokker et al (2009) who showed that the most common factors influencing parental decisions were packaging (if the bottle was brightly colored or had pictures of teddy bears, for example) and labelling (if the product had infant or pediatric written on the label).[25] Their survey revealed that dosing directions on medication packets only influenced the dosing decisions of child caregivers 47% of the time.[25] This study showed that misunderstandings are common, and labelling and packaging can confuse parents.

Off-label medication events:

This case study related to prescribed medication, and there is a substantial amount of research related to off-label prescription of medication in children. Mcintyre et al (2000) conducted a retrospective study of all prescriptions over a one-year period within a single general practice.[26] They found that out of 3,347 prescriptions, 1,175 were for children. Of these, ten were used in an unlicensed manner and 351 in an off-label way.[26] This study highlighted that the use of off-label medications is widespread.

ADRs associated with off-label prescribing were found to be common in a one year cross sectional observational study carried out in Sweden.[27] From 112 patient reports, 158 ADRs were identified. Of these 158 ADRs, 30% (47.4) were considered serious. All reports concerned outpatients under the age of 16 years. The proportion of off-label drug prescribing amongst these 112 patients was 42%.[27] The majority of these were related to inappropriate dosage. This suggests that off-label drugs frequently contribute towards ADRs in children.

In case control studies at a children's hospital in the Netherlands it was found that out of a total of 138,449 prescriptions, clinicians had intervened on 1577 of them. Most of those interventions (81%) corrected prescriptions that may have resulted in ADRs.[28] This highlights that prescribing errors are a frequent occurrence. [28]

Further, this is a world-wide issue. In another children's hospital setting, this time in Italy, 486 children were hospitalized for upper gastrointestinal complications; medication use within these cases were higher when compared with a control group.[29] A prospective survey into ADRs was conducted in 2005 by Jonville-Bera and Leca, which suggested a causal link between incorrect dosage and increased number of ADRs.[30] The study took information from the 'Regional Pharmacovigilance Centre (RPC) in Tours, France.[30] Drug use was assessed over a five-month period, and focused on off label medications and medications where inappropriate dosage was used.[30] Within the study, 642 medications were identified, and of those, 26% (167) were used incorrectly. Correctly used drugs appeared to be less likely to cause ADRs compared to incorrectly used drugs with a ratio of 59.45% to 75%, respectively.[30]

Clavenna and Bonati (2009) systematically reviewed 8 prospective studies published between 2001 and December 2007 in order to evaluate ADRs in the pediatric population.[31] They suggested greater regulation of medicinal warning labels was necessary to ensure paediatric safety.[31] The researchers showed that ADRs in children were more common in hospitalised patients compared to those admitted to hospital and this was statistically significant.

Discussion

A significant limitation of much of the research was the comparability of studies. Specifically when searching the literature, some information related to off-labelling and some to the use of OTC medication. It is therefore difficult to establish a causal link. Another limitation was the under-reporting of ADRs. Additionally, there was a significant lack of information relating to OTCs. Few studies were found relating to paracetamol and NSAIDS but much more information was related to cough and cold medications.[22-24] Studies did tend to suggest that there is significant

potential for ADRs with OTC use and that increased drug surveillance is needed.[22-25] Research suggests that there is an increased prevalence of minor ADRs in patients under the age of two years, with ADRs of increasing severity in older children up to the age of 11 years.[22-25]

Despite the best efforts of clinicians and researchers, there is a deficit in reporting of ADRs in pediatric patients. Evidence does indicate, however, that off-label prescribing is widespread and the labelling of over-the-counter medications can sometimes be difficult to interpret. It is the lack of clinical trials conducted in the pediatric population, which is a significant obstacle.

Anderson and Holford (2013) highlighted that currently there are fewer pharmacodynamic (PD) studies when compared to pharmacokinetic (PK) studies in respect to ADRs in children.[32] This proves a huge problem for dosing, and whilst regulatory agencies are encouraging more studies to be done, these studies tend to be more PK based and most predict dose based on size difference between adults and children.[32] Anderson and Holford therefore state that these studies are insufficient without the corresponding infant specific PD data.[32]

The main issue, however, is that of ethical considerations. Consent to participate in a clinical trial must be obtained based on reliable and clear information and the individual or legal guardian must have capacity to give that consent.[33] Children over the age of 16 are considered to be legally competent to make such a decision, whereas those under 16 are not.[33] This was echoed by a recent article highlighting the difficulties of striking the balance between ethical demand to protect individual children and the importance of facilitating research.[33] Welzing et al (2007) found that pediatric trials were not included in the current legislation, and meeting requirements of the directive would prove difficult, expensive and unethical.[34] This has meant that the risk/benefit requirement hasn't been applied to children. Current guidelines within the European Union were revised in 2007 and are based on the growing insight that it is unacceptable that drugs prescribed to children have not been proven to be safe and/or effective.[34] The guidelines state that medications must cause minimal risk, and the risk benefit ratio must be favorable when compared with alternative treatments.[34]

Conclusion

Adverse drug reactions do potentially pose a public health risk within the pediatric population and all healthcare providers need be mindful of this risk, whether they prescribe medications in their practice or not. Chiropractors must therefore be aware of ADRs and spot these symptoms within their patient population. Chiropractors should be aware that ADRs tend to be more prevalent in those under two years of age. Knowledge of ADRs is therefore extremely important in a clinical review of every patient regardless of age. In terms of the infant in the clinic, it was important to recognize the symptoms of ADRs and this aided the management of the case. Based on the information found in the literature and the symptoms of the infant, an ADR seemed very likely in this case. The parents were referred back to the GP regarding the suspicion of an ADR in this case. All medications were stopped and the patient recovered her energy levels and growth and the child was monitored for one month, without further adverse events.

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Deformational plagiocephaly and chiropractic care: A narrative review and case report

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ABSTRACT

An increase in deformational plagiocephaly has been noted since 1992, when the American Academy of Pediatrics began recommending infants be placed to sleep in the prone position, in an effort to decrease the number of Sudden Infant Death Syndrome (SIDS)-associated fatalities.[1-5] Intrauterine constraint, late gestational age, birthing forces/ trauma, and postnatal positioning also play a role in the development of this condition.[4-6] Once believed to be a purely cosmetic problem, studies and reports are now linking deformational plagiocephaly to possible mental, psychomotor, or developmental delays, auditory processing disorders, strabismus, and mandibular asymmetry.[1, 4, 6-12] Non-intervention, positional changes, physical therapy, cranial remodeling orthotics, and surgical procedures are traditionally utilized to treat this condition.[11, 12] A literature search was conducted using the Cochrane Library, UpToDate, PubMed, Science Direct, and the Index to Chiropractic Literature. Publications were included if they were systematic reviews, RCTs with a control group, or specifically related to plagiocephaly interventions. The intent of this case report is to describe the result of chiropractic care on a single patient with deformational plagiocephaly. No adverse effects were reported as a result of the therapy and the patient's chief complaint of right-sided occipital flattening resolved completely during the course of treatment.

Introduction

After multiple international studies determined a direct relationship between placing infants in the prone position to sleep and the incidence of Sudden Infant Death Syndrome (SIDS),[1, 4, 5] the American Academy of Pediatrics released a report recommending infants be placed supine when put to bed. Since the "Back to Sleep Campaign" began in 1992, the national SIDS rate has declined 40%,[2] however, the incidence of deformational plagiocephaly has risen from 1 in 300 infants per year to estimates as high as 48% of infants under one year old.[2-4] Other factors that are considered to contribute to the formation of deformational plagiocephaly include intrauterine constraint, birthing forces/ trauma during delivery, and postnatal positioning of the infant.[4-6]

Deformational plagiocephaly, also known as positional, or nonsynostotic plagiocephaly, is a condition that describes changes in skull shape or symmetry.[7] Postnatal positioning can play a role in the development of this condition. Tremendous growth of the brain and cranium occurs during the first weeks of life, yet weak cervical musculature will not allow the infant to actively reposition his/her own head at this time. If the child is placed in the same position for sleep, favors a certain side, or looks at stimuli while only in a certain position, this can culminate in deformational plagiocephaly of the malleable cranium, usually presenting by the fourth month of life.[11] The deformity can be classified as brachycephaly, characterized by bilateral flattening of the posterior cranium, or plagiocephaly, characterized by unilateral occipital flattening. Unilateral asymmetry often presents with an accompanying hairless patch over the flattened area, anterior progression of the ipsilateral ear, and protrusion of the frontal bone on the affected side, resulting in a parallelogram-shaped cranium.[7]

It is important to differentiate deformational plagiocephaly from craniosynostosis or microcephaly since these conditions have very different neurological implications, which may require more aggressive intervention.[8] Craniosynostosis involves deformation due to the premature closure of cranial sutures. Synostotic plagiocephaly results in the posterior progression of the ipsilateral ear, with contralateral frontal bone protrusion, typically resulting in a trapezoid-shaped cranium.[13] Surgical correction is often necessary[7] for craniosynostotic patients, as increased intracranial pressure and impairment in neurological development are likely to occur if the condition is left untreated.[2] Microcephaly can follow any insult that disturbs early brain growth. It is typically diagnosed when head circumference is less than -2 SD14 from the normal range for the child's age group. Referral to a chiropractic or pediatric neurologist, radiographs,[14] or further imaging may be useful in identifying any structural causes of microcephaly. Targeted and specific genetic tests can be ordered when there is no clear evidence of an acquired or environmental etiology. Screening for coexistent conditions such as cerebral palsy, epilepsy, mental retardation, ophthalmologic disorders and sensory deficits may also be considered, depending on the individual presentation.[14] Table 1 compares characteristics of each condition, which may be useful in determining the correct diagnosis. Figure 1 depicts an algorithm of appropriate diagnostic and treatment protocols for the plagiocephalic patient.

Table 1. Differential Diagnoses for Cranial Asymmetry

	Deformational Plagiocephaly	Craniosynostosis	Microcephaly
Characteristic Effect(s) on Ears	Anterior migration of the ipsilateral ear with outward flaring	Posterior migration of the ipsilateral ear	Normal position typically, may be low set or larger in size
Characteristic Effect(s) on Frontal Bone Morphology	Anterior protrusion on ipsilateral side	Minute to absent anterior protrusion on ipsilateral side; possible anterior protrusion on contralateral side	Sloped posteriorly, to varying degrees
Shape of Cranium from Superior View	Parallelogram-shaped	Trapezoid-shaped	Smaller than normal, with varying cranial asymmetries
Defining Features	May have accompanying hairless patch over area of flattening	Palpable ridge may be present over lambdoid or occipitomastoid sutures	Small, posteriorly-sloping forehead with hypoplastic cranium

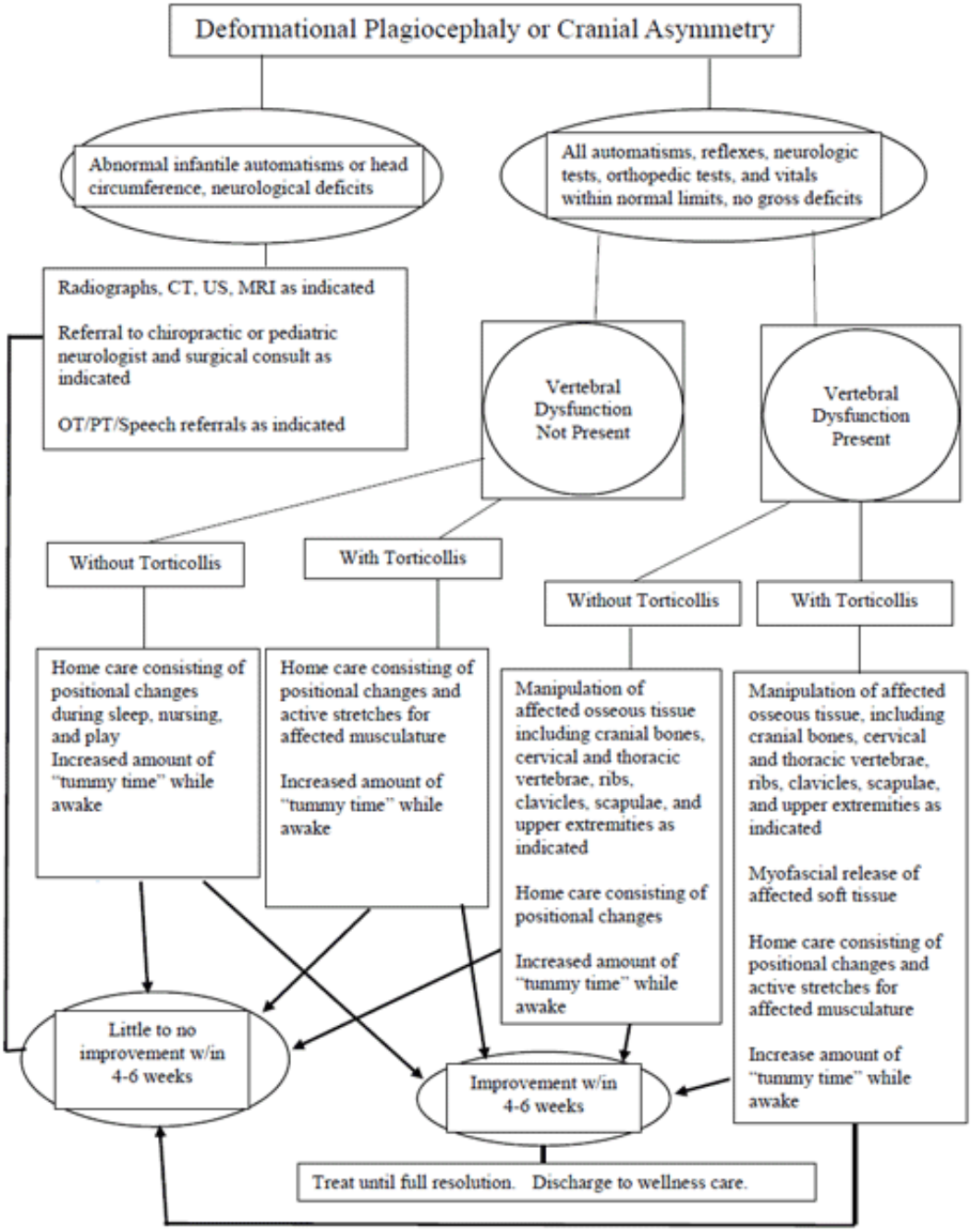
Widely considered the least serious of the three conditions and sometimes thought of primarily as a cosmetic issue[7,8] without neurological implications,[1] the literature is now linking plagiocephaly to possible detrimental sequelae.[1,7-10,12,14-16] The most evident effect, facial asymmetry, can incur emotional costs that must be considered.[8] In addition, several studies have suggested that infants with positional plagiocephaly "may be at risk for a delay in the acquisition of certain motor skills."[9] The American Academy of Pediatrics reported increased rates of nonsynostotic plagiocephaly among children with developmental delay and/or neurological injury, although a causal relationship has not been defined.[10] A study, using standardized mental and psychomotor developmental tests, showed that no infants affected by positional plagiocephaly scored in the accelerated range.[10] It also suggested that affected infants were actually more likely to score in the mildly-to-severely delayed range on both outcome assessments.[10] These delays during infancy may contribute to subtle developmental difficulties, which one study reported may present more commonly at elementary school age[8] in affected children. Stallings et al also demonstrated an association between plagiocephaly and auditory processing disorders, mandibular asymmetry, and strabismus.[15] Still others have said that the condition requires intervention, as it can worsen over time, resulting in cosmetic and neurological problems.[12, 16]

Many physicians adopt a "wait and see" approach for treating these patients, believing that the condition does not cause any long-term physical or cognitive problems.[7] While it has been suggested that more than 70% of cases will spontaneously correct themselves,[1] 10% of affected infants will demonstrate persistent cosmetic deformities.[5, 8] Flannery et al conducted a review of the literature and reported that the condition will worsen without intervention, with the possibilities of serious complications occurring as a result.[12] Other studies have suggested a possible relationship between deformational plagiocephaly and decreased mental and psychomotor development,[10] thus making proactive care an option, worthy of consideration across multiple health care disciplines.

There are several treatments currently being utilized for infants with deformational plagiocephaly. The use of physical therapy is quite common. This is especially important in cases where torticollis is present. Torticollis results when the sternocleidomastoid, trapezius, splenius capitis, scalenii, levator scapulae, semispinalis, or paraspinal erector trunci muscles become contracted.[17] Congenital torticollis, which presents at birth, may be caused by factors such as intrauterine constraint, physical injury to the muscles during delivery, and subluxations of the upper cervical spine.[18,19] Acquired torticollis typically presents within the first four to six months of life. It is associated with physical trauma to the cervical spine and musculature, sometimes resulting in atlantoaxial subluxation, infections, metabolic disorders, and syndromes with associated skeletal anomalies.[18] A pseudotumor (palpable area of non-tender, fibrotic tissue and edema)[20] may also be present within the musculature, particularly within the mid to lower portion of the sternal head of the SCM. These cases may present with more severe torticollis (deficits greater than 30° in cervical range of motion) that can be difficult to treat, sometimes requiring multiple approaches and even surgical release in some cases. [20]

Despite the cause, the contracted musculature restricts range of motion, perpetuating the position of the head on

Figure 1: Algorithm for Treatment of Deformational Plagiocephaly/Cranial Asymmetry



the flattened side and may contribute to greater facial deformity.[2] Neck exercises are often recommended. The parent is instructed to gently rotate the infant's head toward the shoulder, hold for ten seconds, then repeat with the head rotated to the other side. The neck is then laterally bent and held for ten seconds on each side. The exercises should be performed at every diaper change and can be very effective, as one study found that one-half of the plagiocephalic infants improved with physical therapy alone.[8]

Thorough case history and visual examination provide vital clues in diagnosing deformational plagiocephaly. Radiography and computed tomography (CT) scans are not typically utilized, due to the radiation exposure to the patient and occasional need to sedate the patient in order to obtain the views.[4] These tools are reserved for further investigation in cases where the infant exhibits an atypical skull pattern, has a moderate to severe deformity, or fails to respond to care.[6,11,12] If obscured sutures are found on x-

ray or CT, or if patent sutures are found on an infant whose condition is unresponsive or progressing, referral to a pediatric neurosurgeon or a craniofacial surgeon should be made.[2,11,12] Treatment at this stage could include a cranial remodeling orthosis (helmet/DOC) or surgery. The helmet works by applying "pressure to the abnormal prominences and provides relief where cranial growth is required."[7] Helmets are most successful when therapy is implemented on babies four to twelve months old,[2] due to the malleability of the infant skull. Treatment duration is typically about three months.[1] Although skull remodeling helmets can be expensive[2,6,12] and yield mixed results,[4,12] they should be recommended as an effort to avoid surgical correction,[1] as this is an invasive procedure, in close proximity to the posterior dural venous sinuses and sometimes requires blood transfusions.[1] It should, however, be noted that the vast majority of deformational plagiocephaly cases do not require surgical intervention.[13]

Chiropractic care is another treatment option for this condition. An Australian study of twenty-five infants diagnosed with positional plagiocephaly suggested full resolution of the condition after receiving three to four months of chiropractic care.[17] Persing has observed less facial and skull deformity when cervical range of motion was restored.[15] Vertebral, cranial, and extremity manipulations may address deficits in range of motion through the correction of the somatic dysfunction of the underlying osseous anatomy, including the cranial bones, the cervical and thoracic spine, ribs, clavicles, and scapulae.[6,17,21,22] Evidence-based recommendations researched by Leighton concluded that it was "appropriate to propose a course of pediatric chiropractic manual therapy along with advice and recommendations regarding active counter-positioning, "tummy time," and appropriate infant placement."[17] Parents should also be well-educated about the use of car-seat carriers, bouncers, and swings, as well as the risk factors for SIDS, with a thorough explanation concerning manual therapy and care alternatives.[17]

Methods

A search of the literature was conducted using the key terms "deformational plagiocephaly," "positional plagiocephaly," "chiropractic and plagiocephaly," and "torticollis," using the Cochrane Library, PubMed, Science Direct, UpToDate, and the Index to Chiropractic Literature. Publications appraised included systematic reviews, randomized controlled trials, case studies, or those specifi¬cally related to plagiocephaly interventions. Literature published before 2002 was excluded in order to determine current trends in intervention for plagiocephaly. Twenty-three articles met this criteria. Other articles and resources were used to provide background information.

Case Report

Clinical Presentation

The intent of the case report is to describe the result of chiropractic care on a single patient with deformational plagiocephaly. A two-month old girl was brought into the Palmer Clinic by her parents, with the chief complaint of right-sided occipital flattening. They reported that the flattening began when the baby was approximately one month old and was gradually worsening. The infant was placed supine while sleeping, for approximately eight hours each night, and would nap lying supine in a swing for approximately three hours per day. The parents had tried placing the baby prone for "tummy time" and, while this would improve the occipital flattening, the baby would become angry and fussy so that she would only remain prone for several minutes at a time.

A comprehensive exam was performed by the student intern at the first visit. The mother reported that the baby was in the transverse position until the thirty-sixth week of gestation, when she turned head down. Delivery was induced at forty weeks and three days of gestation and an epidural was administered. The child was born twenty-three hours later, with APGAR scores of 8 and 9, and all vitals within normal limits. She was exclusively breast fed and had no difficulties with latching or suckling.

Visual examination of the patient showed noticeable flattening of the occipital bone on the right. The infant also had a small, hairless patch on the right, in the same region as the flattening. The right ear appeared more anterior and flared than the left ear. Readings of the Atlas fossae, located slightly inferior and anterior to the mastoid processes bilaterally, were taken with a DT-25 thermal instrument, as outlined in the Palmer College of Chiropractic Adjusting Technique Manual.[23] This reading is of clinical significance to the chiropractic physician, as the corresponding body readings should be symmetrical. While less than one degree of asymmetry is considered normal, in certain cases, less than one degree can be clinically significant. Variations between bilateral areas of the body are indicative of differences in the underlying physiology and often correlate to levels of sympathetic nervous system dysfunction.[23,24] There was a one degree differential in temperature between the right and left fossae of the patient.

A thorough chiropractic examination and orthopedic/neurologic assessment followed. The child's length, weight, and head circumference were appropriate for gestational age. Perceived increased acetabular sponginess was found on the right when the child's legs were raised, knees flexed, and a downward pressure was applied through the knees toward the acetabuli, in a procedure known as the acetabu-

lar pump. Barlow's and Ortolani's tests were performed to assess the stability of the hip joint. While supine, the child's hips were flexed and her thighs were adducted, while a posterior and slightly lateral pressure was applied down the longitudinal axis of the femur. The motion of the femoral head during abduction of the thighs was then assessed. Both tests were negative for hip dislocation or instability so a modified version of the inverted heel swing was performed next.[25] While being supported by her father, the child was inverted by her legs over a padded chiropractic adjusting table. While still being fully supported, the tension in each leg was released unilaterally for approximately 5-10 seconds, and the decreased ability of the child to rotate her head to the right was noted. This finding indicates possible somatic dysfunction along the ipsilateral side of decreased range of motion, commonly in the form of joint fixation in the upper cervical region, myospasm, and dural/fascial restriction.[25]

Motion palpation examination revealed decreased right posterior to anterior occipital glide as well as right lateral bending and rotation of C1. Accompanying muscle guarding was noted on the right at C1, along with increased tonicity of the right sternocleidomastoid and suboccipital muscles. Frontal and parietal bone overlapping was also noted bilaterally, with a palpable ridge along the coronal suture. All other vitals, reflexes, organ system examinations, infantile automatisms, and developmental assessments were within normal limits and appropriate for gestational age.

Intervention

The treatment schedule is summarized in Table 2. Cranial work was performed on various visits, as indicated. This consisted of decompression of the occiput, which was performed on the supine infant by applying a slight, posterolateral tractioning force to the occipital bone and mastoid processes bilaterally, using the pads of the second through fourth digits. A frontal bone lift was also performed, using the pads of the second through fourth digits to apply a slight, anterosuperior tractioning force. The temporals were tractioned bilaterally, with a gentle anterior, inferior pull on the ear lobes. Chiropractic spinal manipulation was performed at C1 for a right lateral displacement with anterior rotation after decreased right lateral flexion and right rotation were found at that level through motion palpation of the atlantooccipital and atlantoaxial joints. Segmental dysfunction was assessed in a similar manner at each visit, with increased range of motion noted after specific spinal manipulations were performed when indicated, as summarized in Table 2.

To administer the manipulation, the infant was placed supine and a high-velocity, low amplitude (HVLA), modified toggle-like thrust was administered to the tip of the right transverse process of C1, using the tip of the third digit. The left hand was used to stabilize occiput and C2. Similar spinal areas were manipulated in recent studies by McWilliams and Gloar[22] and Alcantara and Anderson; in the latter, a 3 month old girl was treated successfully for gastroesophogeal reflux (GERD), nursing issues, torticollis, and plagiocephaly.[21]

The parents in this study were also instructed to perform the following home care daily: increase the baby's amount of "tummy time" to at least thirty minutes per day, place a rolled washcloth behind her head on the right side while she was lying supine, and stretch the right sternocleidomastoid at every diaper change by gently rotating and laterally bending the child's head to the left and holding for ten to twenty seconds. The parents were advised to bring the child in for adjustments every week for four weeks, but were unable to schedule the next appointment until two weeks later, due to the limited availability of appointments in the student clinic. They were able to schedule all other appointments as recommended and fully complied with the home care instructions as directed.

Outcomes

No adverse effects were reported by the parents or noted by the clinicians during the course of treatment. The patient was re-evaluated at the ninth visit, during the fourteenth week of treatment. Visual inspection of the child's cranium and external ears revealed no abnormalities. All vitals, reflexes, organ system examinations, infantile automatisms, and developmental assessments were within normal limits and appropriate for gestational age. The infant was discharged to wellness care. A comprehensive physical examination six months later again revealed no cranial abnormalities or deficits in motor or neural development. The child is now five and has had no reoccurrence of plagiocephaly.

Discussion

Based upon visual assessment, the infant's condition of positional plagiocephaly resolved within eight visits, over the course of 12 weeks. The management plan was designed to span four months, with weekly visits for the first month and bi-weekly visits for the remaining three months. A four month interval for treatment was chosen, as most studies indicated resolution of the condition within three to four months.[10,17] The weekly frequency was recommended for the first month in order to closely monitor the progression of the condition. Once it was determined that the child's plagiocephaly was improving, a bi-weekly recommendation was advised. It was determined after eight chiropractic visits that the child had achieved full resolution of the condition. The length of time until resolution was two weeks before the estimated date and the comprehensive re-evalu-

Table 2: Summary of treatments and parent reports by week and visit number

Visit	Parent Report	Motion Palpation Findings	Atlas Fossae Readings	Treatments
1	• "Flat head on right side" • Small "bald spot" over affected area	Pre ↓P-A Occipital glide ↓Right lateral bend at C1 ↓Right rotation at C1 Post ↑Occipital glide ↑Right lateral bend at C1	Pre Right: 94 Left: 92 Post Right: 93 Left: 92	• Occipital decompression • Frontal bone lift • Active right SCM stretch and myofascial release of diaphragm and abdomen • C1 manipulation (ASR) • Home care instructions, to be performed daily by parents
2	• Flattening is "getting better" • Infant slept "almost the whole day" after 1st visit • Tolerates "tummy time" for longer periods • Full compliance with home care instructions	Pre ↓P-A Occipital glide ↓Right lateral bend at C1 ↓Right rotation at C1 Post ↑Occipital glide ↑Right lateral bend at C1 ↑Right rotation at C1	Pre Right: 91 Left: 92 Post Right: 90 Left: 90	• Occipital decompression • C1 manipulation (ASRA) • Continue home care
3	• Flattening was "visibly improving" • Full compliance with home care instructions	Pre ↓Craniosacral rhythm C1 ROM unrestricted ↓Extension at L1 Post ↑Extension at L1	Pre Right: 81 Left: 81 Post N/A	• Occipital decompression • C1 manipulation not indicated • L1 manipulation (P) • Continue home care
4	• Flattening is "steadily improving" • Full compliance with home care instructions	Pre ↓Cranial rhythm at temporals C1 ROM unrestricted Post ↑ and synchronous cranial rhythm	Pre Right: 93 Left: 93 Post N/A	• Temporal traction • C1 manipulation not indicated • Myofasical release • Continue home care
5	• Flattening has "vastly improved" • Full compliance with home care instructions	Pre ↓Cranial rhythm at temporals ↓Right lateral bend at C1 Post ↑ and synchronous cranial rhythm ↑Right lateral bend at C1	Pre Right: 91 Left: 90 Post Right: 90 Left: 90	• Cranial work on the temporal bone • C1 manipulation (ASR) • Continue home care
6	• Flattening is "only slightly visible" • Full compliance with home care instructions	Pre ↓Extension T12 C1 ROM unrestricted Post ↑Extension T12	Pre Right: 80 Left: 80 Post N/A	• C1 manipulation not indicated • T12 manipulation (P) • Continue home care
7	• Flattening appears to be "resolving" • Full compliance with home care instructions	Pre ↓P-A Occipital glide ↓Left lateral bend at C1 ↓Right rotation at C1 Post ↑Occipital glide ↑Left lateral bend at C1 ↑Right rotation at C1	Pre Right: 88 Left: 89 Post Right: 88 Left: 88	• C1 adjustment (ASLP) • Continue home care
8	• Flattening seems to have "resolved" • Full compliance with home care instructions	Pre ↓Left lateral bend at C1 ↓Right rotation at C1 Post ↑Left lateral bend at C1 ↑Right rotation at C1	Pre Right: 90 Left: 89 Post Right: 90 Left: 90	• C1 adjustment (ASLP) • Continue home care • Reevaluation scheduled for next visit rather than 10th visit
9	• Flattening is "still gone" • Full compliance with home care instructions	N/A	N/A	• Child discharged to wellness care per resolution of chief complaint

ation was performed earlier than anticipated.

A limitation of the study was the use of visual observation as a subjective outcome assessment. Methods including calipers,[11] photographs,[6] articulated rulers, manual tracings of molded head shape impressions, elastic/thermoplastic bands,[5] radiographs,[6] CT scans,[22] and MRI have been used to more accurately assess and follow the deformity over time.[11,12] As the student clinic was not equipped with such measurements, and since the diagnosis of deformational plagiocephaly is typically made on the basis of a thorough history and physical exam findings[2,5,6,11] the use of visual inspection was used as the main outcome assessment in this case.

Motion palpation findings were also used to determine areas of somatic dysfunction. Wolff identifies the atlantoaxial subluxation as a cause of torticollis,[19] which often accompanies plagiocephaly, due to the changes it causes in range of motion and movement of the musculature it affects. The upper cervical region was also evaluated and addressed in this case report as a source of decreased range of motion and somatic dysfunction. The intern noted increased range of motion post-manipulation. Improving the range of motion at the joint and decreasing tension within the surrounding musculature may have contributed to the resolution of this patient's symptoms. This finding would be consistent with Persing's observation of improvement of the condition with restoration of cervical range of motion.[15] Although chiropractic spinal manipulation was utilized as the main treatment for this patient, it cannot be ignored that the use of physical therapy, active counter-positioning, and increasing the amount of prone "tummy time" may have contributed significantly to the resolution of the infant's positional deformity as well.[26,27]

Conclusion

Primary health care professionals can focus on preventing the development of positional plagiocephaly through the education of parents[28] and the full compliance of the parents, in this case, may have been a significant factor in the child's recovery. Parents should also be advised to place the infant in alternating positions while lying supine, and to put the infant in the prone position for "tummy time" while he/she is awake and being observed. The infant's orientation to outside activity/stimulation could also be alternated in order to prevent the development of positional preference. The infant can be fed or nursed from alternating sides and parents should also limit the amount of time the infant lies prone in car seats, swings, bouncers, or jumpers.[8] If plagiocephaly has already developed, the same strategies can minimize its progression.[2]

For this specific patient, chiropractic care provided a successful resolution of the condition. While this finding is in accordance with the results of other case reports,[10,17,21,22] the actual research on the effect of chiropractic care on plagiocephaly is scant and conflicting.[29] Further research and investigation into this topic should be pursued to produce evidence for chiropractic care as an alternative, if not adjunct therapy for deformational plagiocephaly.

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Chiropractic treatment of gastro-esophageal reflux disease in a pediatric patient: A case report

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ABSTRACT

Objective: To describe the case of an infant with gastro-esophageal reflux disease which improved while under chiropractic care and to review the literature on chiropractic manipulation and gastro-esophageal reflux disease. **Clinical Features:** A 4-month-old female infant with gastro-esophageal reflux disease was brought into the clinic by her mother for chiropractic care. The mother reported multiple episodes of reflux and vomiting per day. Slight asymmetry of the frontal bone was noticed with a flattening of the left side. **Methods:** A literature search of PubMed using the subject heading "gastro-esophageal reflux disease AND chiropractic" or "GERD AND chiropractic or "acid reflux disease AND chiropractic" was performed. **Intervention and Outcomes:** The patient was treated with chiropractic manipulation in the form of sustained pressure and Activator adjusting instrument. Recommended treatment frequency was 2x/week for 2 weeks and 1x/week for 4 weeks after. Cranial adjustments were performed, particularly on the frontal bone. The patient's mother reported a large bowel movement after the adjustment on the same day and a longer than normal subsequent sleep cycle. At the next visit the patient's mother reported that the number of episodes per day of vomiting and reflux had decreased. Over the next 3 weeks both the number of episodes per day and number of days with any vomiting and reflux decreased. Within 3 weeks the infant had no reflux or vomiting. **Conclusion:** There is limited literature about the effect of chiropractic care as a treatment for gastro-esophageal reflux disease. There are reports of successful chiropractic treatment of gastro-esophageal reflux disease. This patient's reflux and plagiocephaly improved while under chiropractic care.

Key words: chiropractic, pediatrics, breastfeeding, subluxation, fetal, cholelithiasis, gallstones, gall bladder.

Introduction

A number of challenges arise for the chiropractor caring for the pediatric patient presenting with multiple symptoms of both musculoskeletal and non-musculoskeletal etiology. While anecdotal evidence of chiropractors treating gastro-esophageal reflux disease by adjusting the cervical spine[1] or lumbar spine is plentiful, the supporting literature is limited. The purpose of this paper is to describe the case of a 4-month old female whose gastro-esophageal reflux disease and plagiocephaly resolved while under chiropractic care. Gastro-esophageal reflux disease (GERD) is common during the first year of life, peaking at 4 months of age. In a cross sectional survey of 948 parents of healthy children 13 months old and younger the reported frequency of regurgitation was measured. Regurgitation of at least 1 episode per day was reported in half of 0- to 3-month olds. Peak regurgitation was 67% at 4 months. The occurrence of symptoms decreased considerably from 61% to 21% between 6 and 7 months of age. By 10 to 12 months of age this symptom decreased to 5%. Many infants "outgrow" regurgitation by 7 months and most by 1 year.[1-2]

Methods

The chiropractic care of the pediatric patient with non-musculoskeletal complaints is common in the chiropractic profession with an abundance of testimonials and anecdotes. To provide a perspective on the implications of the case, a selective review of the literature concerning the chiropractic care of pediatric patients with GERD was performed. The literature discussing the use of chiropractic spinal manipulation therapy in treating gastro-esophageal reflux (GER) and gastro-esophageal reflux disease (GERD) is sparse at best. A limited number of case reports of treating GER and GERD with chiropractic manipulation exist with positive outcomes presented. However, both the type and volume of research is not definitive.

A literature search of PubMed using the subject heading "gastro-esophageal reflux disease AND chiropractic" or "GERD AND chiropractic or "acid reflux disease AND chiropractic" was performed. Two articles were found. Alcantara and Anderson described the case of chiropractic care of a pediatric patient with symptoms associated with gastro-esophageal reflux disease, fuss-cry-irritability with sleep disorder syndrome and irritable infant syndrome of musculoskeletal origin.[3] Treatment to the patient was described as high velocity low amplitude thrust (HVLA) type spinal manipulative therapy (SMT).[4] This approach to care was successful with a total resolution of symptoms within 3 months of care.

Recently, Jonasson and Knapp presented the care of an 8-yr-old boy with gastro-esophageal reflux disease. The patient initially presented with complaints of headache and neck

pain. Treatment to the patient was described as chiropractic SMT to the upper cervical spine in combination with cranial therapy and dietary advice (i.e., remove all wheat and dairy products from diet). This approach to care was unsuccessful with the patient referred to a colleague where an eventual diagnosis of GERD was made and referred for medical care.[5]

Case presentation

A 4-month-old female was brought in for chiropractic care by her mother for recurrent vomiting after feeds of 2 months duration. The vomit was nonbilious with no suggestion of hematemesis. Prior to starting chiropractic care the mother was recommended to give the patient Ranitidine by her medical practitioner after a diagnosis of gastro-esophageal reflux disease (GERD). The mother was hesitant to commence medication so early in the treatment of GERD. The patient was recommended to a chiropractor by the maternal and child health nurse after the medical practitioner's diagnosis. The patient was being breastfed at the time. Physical examination findings included normal vital signs, reflexes, responses, motor function and milestones. At birth the patient was at the 80th percentile for both height and weight. At 4 weeks the patient's weight had decreased to the 75th percentile while height was still in the 80th percentile. At the 3 month checkup by the maternal and child health nurse the patient's weight had dropped to the 50th percentile, while height was relatively stable at the 70th percentile. The patient's mother reported that she had not gained significant weight in the past 2 months and was concerned that the decreased in percentile of her daughter's weight was an indication of failure to thrive. Mild decreased neck tone was observed. Plagiocephaly was noted with frontal bone asymmetry consisting of a flattening of the left side.

The patient's sleep was not interrupted by the reflux and vomiting. Mild tension of the abdomen was observed. However the patient did not exhibit the typical arching or upper body extension seen in GERD. Based on a chiropractic examination procedure incorporating postural examination and static and dynamic palpation of the spine,[6] it was determined that the patient had spinal segmental dysfunctions at the axis and the 4th cervical vertebrae.[7] The axis was determined to have a right posterior rotation with respect to the C3 vertebral body (VB). C4 was determined to have a left posterior rotation. The left sacroiliac joint was determined to have a posteriority. While the 4th lumbar vertebrae had a left posterior rotation and the 3rd lumbar vertebrae had a right posterior rotation. Following craniosacral technique procedures,[8] cranial distortions of the left frontal and temporal bones were determined.

Intervention and outcomes

With the parent's consent, the infant was treated with chiropractic manipulation in the form of sustained pressure and Activator adjusting instrument. Cranial adjustments were performed where needed, in particular the frontal bone. Myofascial treatment was performed on the abdomen in particular the left lower quadrant and diaphragm.[9] No adverse effects were reported. On the second visit the mother reported on the day of the first adjustment the patient had a large bowel movement soon after, and slept for longer than normal. In the 2 days since the first treatment the mother reported a moderate decrease in the reflux. Considering the positive response to treatment the recommended treatment schedule was 2 visits per week for 2 weeks and 1 visit per week for 4 weeks, which the patient adhered to. Currently the patient is having treatment every 6 weeks. 2 days post-adjustment on the second visit the mother reported a decrease in the number of episodes of vomiting and reflux per day. Over the next 3 weeks both the number of episodes of vomiting and reflux per day decreased and the number of days with vomiting decreased. At the 4-week mark since commencing treatment the patient's mother reported having no episodes of reflux and vomiting. The right-sided anteriority of the frontal bone was observed to be less severe. At 2 months the frontal bone asymmetry was fully resolved. No adverse effects of administered treatments were reported.

Discussion

Gastro-esophageal reflux (GER) is the passage of gastric contents into the esophagus. Its clinical presentation of vomiting or regurgitation is very common in infants and is usually self limiting without requirement for further investigation. In contrast, gastro-esophageal reflux disease (GERD) requires considered management and may be a presenting symptom of food allergy requiring more intensive therapy than simple acid suppression.

The National Library of Medicine describes the following symptoms:

- Cough, especially after eating
- Excessive crying as if in pain
- Excessive vomiting during the first few weeks of life; worse after feeding
- Extremely forceful vomiting
- Not feeding well
- Refusing to eat
- Slow growth
- Weight loss
- Wheezing or other breathing problems[10]

The health care provider can often make the diagnosis based on the infant's symptoms and physical examination. Tests may be ordered if your child is not healthy or growing well, or when symptoms are severe and do not get better with treatment. All investigations for GER (barium, scintig-

raphy, endoscopy and pH probe) have considerable limitations and should only be considered on an individual base after the patient has been assessed. The definitive diagnosis of GERD in the pediatric population is determined by several means although no exact diagnostic protocols exist to accurately diagnose GERD in infants.[11]

Conclusion

In the case described here a 4-month-old patient's GERD resolved while under chiropractic care. This study suggests to the possibility that similar patient groups may benefit from chiropractic treatment. While this was a single case of the successful treatment of GERD through chiropractic, more research must be done. Research into the mechanisms involved in the effect of SMT of the cervical and lumbar spine and the associated changes in the gastro-esophageal system is merited.

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Demographic survey of pediatric patients presenting to chiropractic clinics in Norway: A short report

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Introduction
The use of chiropractic services among pediatric patients has become a world-wide growth industry over the past 10 years (Miller, 2010). Yet the demographic features of patients under 18 years of age in Norway are sparsely reported in the research literature. Accordingly, the aim of this study was to investigate the usage of chiropractic care by pediatric patients in Norway over a 12-month period. The main goals of this study were to determine the frequency of presentation in each age group, reasons for seeking care and to report on referral patterns to chiropractors.

Methods
This was a year long, nationwide, paper-based survey. Now nearing its end, the study´s data collection began in December 2012 and is due to end in November 2013. The month of July 2013 was omitted due to school summer holidays. The lengthy data collection period was to account for seasonal variations, as adopted by a Danish study by Hestbæk, Jørgensen and Hartvigsen in 2009.

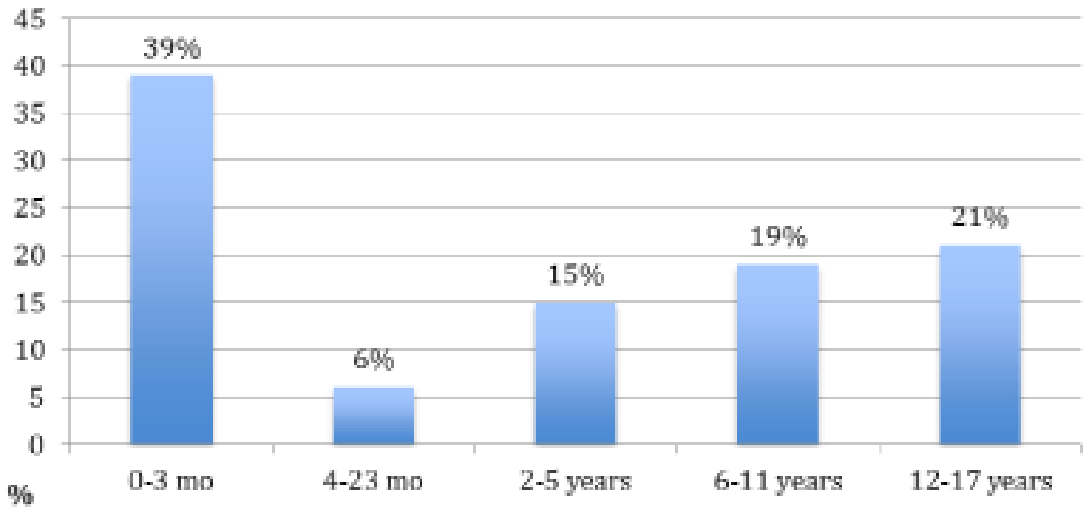
All chiropractors in Norway, registered with the Norwegian chiropractic association (NKF) were invited to participate via email. Each chiropractor who agreed to participate was assigned one month to collect data. Eligible participants were all new patients or patients who had not had treatment in the past year, below the age of 18. Patients were asked to complete questionnaires containing information on presenting complaint and possible consequences of this complaint, age, reasons for seeking care, referral patterns and the use of pain medication.

Descriptive statistical analysis was performed using Microsoft Excel. Ethical approval was sought and granted by the AECC ethics committee, Norwegian data protection services (Norwegian Samfunnvitenskapelig Datatjeneste, NSD) and Norwegian ethics committee (Regional Etisk Komittee og personvernombudet, REK). Individual Informed Consent was obtained from the parent if the child was below 16 years of age and from the patient if they were between 16 and 18 years of age.

Results
So far, a total of 137 completed questionnaires have been received, representing 137 pediatric patient visits (0-18 years of age). The majority of pediatric patients presenting to chiropractors in Norway during the study period to date were in the 0-1 year age category (46%), followed by the 12-17 years of age category (21%). Fifty-seven percent were male while forty-three percent were female.

Pediatric patients between the ages of 0-3 months were the most common age group presenting to chiropractors in Norway (See Figure 1). Of the 62 patients that were below one year of age, 87% were less than four months of age. Excessive crying accounted for more than half of the visits

Figure 1. Ages of pediatric patients presenting to Norwegian chiropractors 2012 - 2013; N137



in the 0-3 month old category. Older children between two and 17 years of age presented with predominantly musculoskeletal complaints (31%). These increased with age from 50% in pre-school children to 76% in teenagers.

Thirty-three percent of children were referred to chiropractors by people other than family and friends. Both general practitioners and health visitors referred babies to Norwegian chiropractors, while teenagers were primarily sent by general practitioners.

Further comments

This is a short progress report on the data received to date. Complete data will be available in approximately one year's time. So far, data from Norway seems to corroborate the findings from other pediatric demographic surveys around the world (Hestbæk, Jørgensen and Hartvigsen, 2009; Miller, 2010, Doyle, 2011).

Competing Interests

This study was funded by the Norwegian Association's research fund. No other competing interests.

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Pediatric cholelithiasis and breastfeeding difficulties: A chiropractic case report

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ABSTRACT

Objective: Through presenting the case of a 7-week-old the object of this report is (1) to create awareness of the increasing rate of cholelithiasis in the pediatric population, and (2) to outline how chiropractic care assisted in the resolution of breastfeeding difficulties. **Design:** A case report. **Clinical Features**: Following a chiropractic health history and physical examination it was identified that the breastfeeding difficulties were a consequence of a combination of issues. The infant was found to have limited left rotation of the neck, a result of upper cervical subluxations and cranial misalignments, and ankyloglossia (tongue-tie). Further investigation via stool analysis, abdominal ultrasound and blood testing led to the diagnosis of fetal cholelithiasis with an underactive gallbladder. **Intervention & outcomes:** Chiropractic adjustments were implemented to correct the cervical and cranial motion. Mother and child were also placed on daily probiotic supplementation. After one month of weekly chiropractic care the child was found to have normal cervical range of movement. A frenotomy was performed at 10 weeks old. The infant displayed complete resolution of the breastfeeding difficulties. At 11 weeks the infant was placed on 1.2ml Ursofalk ursodeoxycholic acid (bile acid) twice a day and 0.2ml colecalciferol (VitD) daily. This continued for one month. No further treatment was implemented for the cholelithiasis. **Conclusion:** As primary care practitioners it is essential that chiropractors recognize and understand the pathophysiology of gallbladder disease in the pediatric population. It is possible that the presenting symptoms may be misdiagnosed and therefore lead to inappropriate treatment. In this case a multidisciplinary approach was required to manage the various presentations. Chiropractic care resolved the biomechanical component of the breastfeeding difficulties which occurred concurrently with the cholelithiasis.

Key words: chiropractic, pediatrics, breastfeeding, subluxation, fetal, cholelithiasis, gallstones, gallbladder.

Introduction

Cholelithiasis, more commonly known as gallstones, is a common disorder of the digestive system affecting approximately 20% of adults over 40 and 30% aged over 70 years[1].

Once known as an adult disease, cholelithiasis has more recently been found to have no age discrimination. The prevalence is on the rise in the pediatric population, an outcome of increased ultrasonography use in this age group and rising childhood obesity levels[2]. Studies indicate a rate of between 0.13%[3] and 1.9%[4].

Often, a chiropractor is the initial health practitioner to examine a child in pain. In a neonate or infant who cannot describe the location or type of pain they are experiencing, the presentation of symptomatic cholelithiasis may possibly be misdiagnosed. Colic, reflux, breastfeeding jaundice and food intolerances are all plausible diagnoses for symptoms of cholelithiasis.

It is therefore the purpose of this report to increase awareness of gallbladder disease in the pediatric patient through outlining the clinical presentation of a 7-week-old infant who initially presented to the chiropractic office to address colic and unsettled behavior and was later diagnosed with cholelithiasis and an underactive gallbladder.

This infant was simultaneously experiencing difficulties with breastfeeding. Breast milk contains the perfect composition required for growth, development and immunity[5]. The world health organization recommends infants be exclusively breastfed for the first 6 months of life, with continued breastfeeding along with suitable complimentary foods for up to 2 years or more[6].

Breastfeeding is a synchronized event requiring the infant to suck, swallow and breathe. Six of the 12 cranial nerves; 22 cranial bones (or segments of bones) connecting at 34 sutures; and 60 voluntary and involuntary muscles are used to perform this coordinated activity[7]. Disruption to the proper function of either the musculoskeletal or nervous systems can therefore impact on an infant's ability to breastfeed successfully[7].

It is therefore imperative that when difficulties with the breastfeeding process arise, they be immediately addressed and corrected to prevent the likely consequence of premature replacement with another food source.

Methods

An online literature search was conducted using the journal databases PubMed, Medline, Science Direct and Index

to Chiropractic Literature. Key search words and phrases included 'cholelithiasis', 'gallstones', 'pediatric cholelithiasis', 'infantile cholelithiasis', 'fetal cholelithiasis', 'pediatric gallstones', 'infantile gallstones', 'fetal gallstones', 'cholelithiasis + chiropractic', 'gallstones + chiropractic', 'breastfeeding difficulties', 'breastfeeding difficulties + chiropractic'. Other internet searches using the above terms were also conducted, as was a manual search of the *Journal of Clinical Chiropractic Pediatrics*. Articles published between 1985 and 2013 were included.

Case Presentation

A 7-week-old female presented to a chiropractic office to address a 4-day history of what her mother described as tummy pain. Symptoms included green stools that contained mucous, dark yellow urine, being very unsettled while awake, and vomiting after feeds. The vomit was defined as being smelly and sometimes lumpy.

Since the onset of symptoms the infant always had to be held, did not want to sleep on her back, which had previously been the norm, or be in the car seat. Also, the infant was said to regularly bring her knees up to her chest, a practice which had been ongoing since birth.

Prenatal history was unremarkable. Gestation was 39.4 weeks ending in a spontaneous labor. Labor lasted 5 hours and 45 minutes and no intervention was used. Following the birth of a 4.06kg, 54cm long girl, the 29-year-old primiparous mother suffered with retained placenta and postpartum hemorrhage. She was placed on iron supplementation and the antibiotics Metrogyl and GenRx Cephalexin. APGAR scores are unknown.

The baby girl has been breastfed since birth. Her mother describes the infant as sometimes having difficulty suckling, having a preference for the left breast and making a clicking sound as she comes off the right breast. She was feeding every 2 hours with each feed taking 10 minutes. The mother did not suffer from mastitis, cracked nipples or pain while feeding.

Prior to the onset of symptoms, the infant had regular bowel movements that were described as a normal consistency and a mustard color.

Family history includes a maternal aunt having undiagnosed digestive issues and maternal great grandfather having his gall bladder removed during his 50's.

Clinical Findings

The 7-week-old infant weighed 5.6kg and was 59.5cm long. Temperature was 36.6ºC and mild jaundice of the skin was present.

During the chiropractic appointment the infant was extremely distressed, crying and inconsolable throughout most of the hour long consult. The positive examination findings included a rigid and tender abdomen on palpation, reduced cervical rotation to the left, ankyloglossia, a high palatal arch, an elongated and thickened labial frenulum, dishing of the greater wings of sphenoid (sphenoid extension) and parietal bone overlap. Subluxations present were a right posterior superior occiput (occ-RPS) and right posterior C2 (C2RP). Spasticity of the right suboccipital muscles was also noted.

The initial diagnosis was breastfeeding difficulties as a result of aberrant upper cervical biomechanics (subluxation), cranial misalignment and tongue-tie. The absence of an elevated temperature indicated infection was unlikely therefore the digestive issues were initially thought to be related to a food allergy. However, it was not until further testing was done that an accurate diagnosis was made.

Subsequent to the chiropractic examination, laboratory investigations identified the infant as having an elevated blood bilirubin level. It was following two abdominal ultrasounds that the infant was found to have a gallstone in the neck of the gallbladder. She was diagnosed with fetal cholelithiasis.

At 11 weeks of age, further ultrasounds diagnosed an underactive gallbladder, contracting at just 32% capacity. The medical doctor informed the infant's mother that the minimum effective level is 35%. At this age, the infant was also identified as having a low Vitamin D level.

Intervention & Outcomes

Chiropractic treatment took place on a weekly basis for 5 weeks then biweekly for 1 session. The objective of the treatment was to restore correct cervical and cranial range of motion which was achieved by the fourth visit. No adverse effects were experienced as a result of the treatment provided.

On the initial assessment the right occiput was found to be subluxated in a posterior and superior direction. Correction was made by applying gentle pressure in anterior and inferior direction for several seconds with the infant supine. This was followed by a gentle rocking motion of the right occiput. C2 was also adjusted this visit with a gentle press and hold on the posterior aspect of the right transverse process. After a few seconds of holding a light thrust in the same direction was applied. A sagittal suture spread was performed by applying light pressure with the fingertips to both sides of the suture in a medial to lateral direction. Lastly, a spheno-basilar flexion mobilization was performed. During this procedure a gloved little finger was placed in

the infants' mouth to apply superior and posterior pressure just posterior to the transverse palatine suture. Pressure was held for 3-5 seconds and repeated 3 times.

As the mother was prescribed antibiotics following labor and the infant was breastfed, both mother and infant were placed on a daily dose of probiotic supplementation. The infant was prescribed 2g once a day of BioCeuticals® Baby-Biotic 0+yrs formula and the mother was prescribed one capsule daily of BioCeuticals® UltraBiotic Pregnancy Care.

The day following the first chiropractic treatment, the infant passed one large bowel movement of normal color and consistency. The subsequent bowel movement returned to green.

The same treatment protocol was repeated one week later whereby the infant was found to be having normal bowel movements, was vomiting less and was said to be more settled. During the 3rd and 4th treatment sessions a SOT gallbladder reflex technique was also performed[8]. By the fourth week the infant was much more settled and cervical range of movement was normal.

At 10 weeks of age a frenotomy was performed to correct the tongue-tie. Following the procedure the infant had a stronger suckle and no longer made a clicking sound coming off the right breast.

The cholelithiasis was monitored from 7 weeks to 4 months of age with the use of abdominal ultrasound (Table 1). It was important to rule out a hemolytic or other specific cause of the cholelithiasis, which is why stool and blood laboratory testing was performed. These tests were negative.

Cholescintigraphy is a test done to identify obstruction of the bile ducts and disease of the gallbladder. A radioactive chemical is injected into the body which is handled by the liver like bile[9]. At 11 weeks old the infant underwent a cholescintigraphy confirming the location of the gallstone and underactivity of the gallbladder. Subsequently the infant was prescribed 1.2ml Ursofalk™ ursodeoxycholic acid twice a day for one month. Ursodeoxycholic acid is a bile acid that is administered in cases of chronic cholestatic liver disease[10]. Its mechanism of action is to increase bile acid output and bile flow from the liver[10], however it is unclear whether this treatment was beneficial. An ultrasound performed at 4 months of age showed the gallstone was still present and the contractility of the gallbladder has not yet been re-tested.

A blood test performed at 11 weeks also identified the in-

Table 1. Medical Management of the Infant

Age of infant	Medical Intervention	Outcome
7weeks	Stool sample	Negative for infection
	Blood sample	Elevated bilirubin. Negative for hemolytic disease.
	Two abdominal ultrasounds (one pre and post feeding)	Gallstone in neck of gall bladder Pediatrician recommends monitor
9 weeks	Abdominal ultrasound	1 Gallstone 2.8x6mm
	Blood sample	Results unknown
10 weeks	Frenotomy	Suckle improved
11 weeks	Abdominal ultrasound with dye (cholescintigraphy)	Gallbladder found to be underactive contracting at 32%
	Blood sample	Low vitamin D level. Bilirubin normal. Infant placed on 0.2ml colecalciferol (VitD) daily and 1.2ml Ursofalk ursodeoxycholic acid (bile acid) twice a day.
4 months	Abdominal ultrasound	Stone remains present
	Blood sample	Normal. Stopped taking VitD and Ursofalk
5 months	Hospitalized with fever & vomiting bile	Gastroenteritis diagnosed. Infant administered Hydralyte™. Parents identify gall stone in stool.

fant as having low vitamin D. She was prescribed 0.2ml colecalciferol daily. The next blood reading showed a normal reading so at 4 months the supplementation ceased.

At five months of age the infant was hospitalized with an episode of fever and vomiting bile. A diagnosed of gastroenteritis was made and the infant was placed on a rehydration formula (Hydralyte™). During this period the parents identified what they believed to be a gallstone in the infant's stool. No follow-up ultrasound has yet been performed to confirm the passing of the stone.

Solid foods were introduced to the infant at 6 months of age to supplement the breastfeeding. Initially the infant experienced vomiting episodes after the intake of solid food. Rice cereal, pear, apple and sweet potato were all found to have the same effect. After two weeks of testing different food the infant was found to accept avocado and pumpkin without vomiting. At 7 ½ months old, the infant was still limited by what she could consume, possibly an indication the gallbladder was still not functioning correctly.

A follow-up chiropractic progress examination was performed when the infant was 6 ½ months. During this examination the infant was found to be happy, symptom free and developing well. She had been rolling since 5 months and was sitting up unsupported for a brief period of time. Cervical range of motion was found to be within normal limits and the infant was having no difficulty breastfeeding. Status of the cholelithiasis and gallbladder contractility remains unknown as no further ultrasounds have been performed.

Discussion

The clinical presentation of pediatric cholelithiasis is varied. Age of the child is one factor that may impact how the disease is expressed, etiology is another. The clinical presentation of the infant described in this paper is unusual for two reasons. Her gallstones were not detected until 7 weeks of age and the symptoms she expressed are uncommon for her age. Fetal cholelithiasis is classically detected in the 3rd trimester via routine obstetric ultrasound and stereotypically remains asymptomatic[11,12].

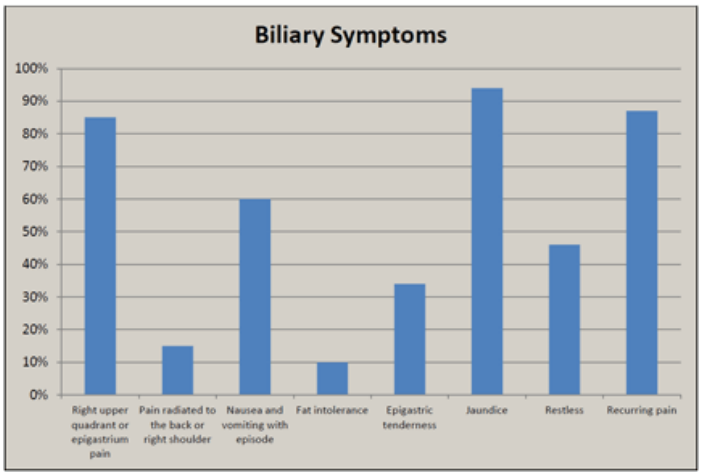
A summary of common clinical presentations at the various ages through childhood is seen in Table 2[11-13]. You will notice that the symptoms become more specific as the age of the child increases. This is possibly because the child is better able to verbalize what they feel.

In a study undertaken by Wesdorp et al.[4], children with cholelithiasis could be categorized into one of 4 groups based upon their symptoms. 17% remain asymptomatic, 24% will show nonspecific abdominal pain that cannot be defined as colicky, 7% will suffer acute abdominal pain, tenderness and fever, and the remaining 52% will experience biliary symptoms (Fig. 1).

Table 2. Clinical presentation and recommended management of gallstones in the pediatric population[11-13].

Age	Symptoms	Management
Fetal (gallstones present in utero)	Generally asymptomatic	Complete spontaneous resolution likely between 1 and 12 months old. Cholecystectomy if persists past 12months
Infant (<2 years)	Usually asymptomatic Jaundice Acholic stool (pale/clay color) Abdominal pain Sepsis	Cholecystectomy if persist for longer than 12 months or if symptomatic
Child (2-14years)	Asymptomatic Right upper quadrant pain or epigastric pain Non-specific abdominal pain (generally in the younger child) +/- Nausea, vomiting and fat intolerance	Observe if asymptomatic Cholecystectomy if symptomatic
Adolescent (14-18years)	Symptoms same as with 2-14 years but right upper quadrant pain and fatty food intolerance more common	Observe if asymptomatic Cholecystectomy if symptomatic

Fig 1: Breakdown of the biliary symptoms identified in children by Wesdorp et al.[4]



As you can see from the graph in figure 1, the biliary symptom Wesdorp et al. found to be most prevalent, is jaundice. From this study it is also interesting to note that gallstone frequency increased as the age of the child increased and the female predominance, as seen in adulthood, did not become evident until 14 years of age.

Similarly, Friesen and Roberts[14] found that jaundice was the most common symptom of cholelithiasis, but only in infants less than one. They found vomiting to be the most common symptom overall. In a study undertaken by Kumar, Nguyen & Shun[15], right upper quadrant pain was found to be the most common symptom, hence illustrating the varied clinical presentation of pediatric cholelithiasis.

The pathophysiological cause of cholelithiasis in a pediatric patient also plays a role in determining the symptoms they may present with. A child may fall into one of three groups depending on the underlying etiology[13,15].

1. *Hemolytic disease*: This is considered the most common associated condition, with prevalence rates of 23%[15] and 46%[14] being reported. Diseases accounted for in this group include sickle-cell disease, thalassemia major, hereditary spherocytosis and rhesus or ABO blood group incompatibility[11].

2. *Specific non-hematological cause*: Included in this category are; prematurity, systemic infection, family history, total parenteral nutrition (TPN), pregnancy, oral contraceptive use, obesity, use of the antibiotic ceftriaxone, congenital anomalies of the biliary tract, disease of the terminal ileum such as Crohn's disease, and surgical resection of the terminal ileum[4,11-13,18].

3. *Idiopathic*: Cholelithiasis with no known cause. According to Kumar et al.[15] 65% of pediatric gallstone cases fall into this category.

If not treated correctly, gallstones may lead to numerous complications. Acute cholecystitis, choledocholithiasis (migration of gallstone(s) into the common bile duct), gallstone pancreatitis[12,16] and cholangitis[4] (inflammation of the bile ducts) are some of the more common complications. The treatment of choice for symptomatic cholelithiasis, regardless of age, is removal of the gallbladder[12,17,18]. Known as cholecystectomy, this procedure has been performed on an infant just 16 days old[19]. This is also the treatment of choice for asymptomatic children when the stones have been present for longer than 12 months[16].

Nerve supply of the gallbladder is via three nerves[20]. Branches of the celiac ganglion supplies sympathetic and visceral afferent fibres, the phrenic nerve supplies somatic afferent fibres, and the vagus nerve is responsible for parasympathetic innervation. Parasympathetic stimulation causes contraction of the gall bladder and an increase in bile secretion. The vagus nerve is also known as the 10th cranial nerve (CNX) and exits the skull via the jugular foramen between the temporal and occipital bones. Along with supplying parasympathetic control to the gall bladder, CNX also has motor branches to the soft palate and larynx, and sensory fibres to the pharynx and larynx[20]. Dysfunction of the vagus nerve may thus affect swallowing, speaking, sense of taste, cause hypo-contractility of the gallbladder and reduce bile acid secretion.

Also exiting through the jugular foramen is the accessory nerve (CNXI). Cranial nerve XI controls the upper trapezius and sternocleidomastoid (SCM) muscles along with cervical 1 & 2 nerves (SCM) and cervical 3 & 4 nerves (upper trapezius)[21]. Both of these muscles control lateral flexion and contralateral rotation of the neck.

During the birth process, a normal procedure that takes place is cranial molding. With each contraction as the infant passes through the birth canal, fluid is forced out of the skull allowing the cranial bones to overlap and reduce the overall cranial size[5]. If excessive force is not applied to a particular region of the skull, normal size and shape will be achieved within a few days[5]. However, in the event that the skull is subject to abnormal mechanical forces, caused either internally by the maternal body or from external intervention, cranial alignment may be disrupted. Consequently, cranial nerve entrapment or irritation as it passes through the foramina of the skull may occur[7].

Birth interventions such as vacuum and forceps extraction are potential sources of trauma to infants during birth. In

a case series of 114 infants presented by Miller et al[22], 41% sustained birth intervention. All 114 infants were experiencing suboptimal breastfeeding due to a biomechanical cause, and with a higher than average rate of birth intervention, this group highlight the possible relationship of birth trauma and breastfeeding difficulties.

Although no external force was used during the labor, it is likely that this 7-week-old infant experienced subtle birth trauma. Subtle birth trauma may manifest as mechanical lesions called spinal and cranial subluxations[23]. Subluxation is when a joint is limited in one or more planes of motion and this fixation has neurologic, vascular, and lymphatic implications on surrounding tissues and organs[24]. Chiropractors identify and correct spinal and cranial subluxations.

In a study on sub-optimal breastfeeding performed by Vallone[24], 18 of the 25 subjects were found to have cervical dysfunction as a result of subluxation of the C1 vertebrae. In 80% of cases improved latch and ability to breastfeed resulted following chiropractic treatment.

Similarly, Holleman et al.[25] presented a case where an 8-day-old infant was demonstrating breastfeeding difficulties. The infant was diagnosed with cranial and C1 subluxations. Hewitt[23] presented two cases of dysfunctional nursing. One infant was found to have subluxation of the occipital condyles and cranium, and the second infant had C1/2 and cranial subluxations. Likewise, Holtrop[26] identified C1/2 and cranial subluxations in an infant with sucking intolerance. In all of these cases, complete resolution of breastfeeding problems resulted from chiropractic treatment. This demonstrates the correlation between upper cervical subluxations, cranial subluxations and breastfeeding dysfunction.

Therefore, taking into consideration the clinical presentation of the 7-week-old infant, it is likely the craniocervical subluxations resulted in a reduced efferent input to the right SCM and/or upper trapezius muscles, limiting their ability to rotate the head to the left. It is acknowledged that a decreased cervical rotation prevents the infant from obtaining a good latch, which is subsequently expressed via the infant having a preference to nurse on a specific breast[5], as was the case with this baby girl.

This case demonstrates the importance of infants having full cervical range of motion for optimal breastfeeding. It is proposed that the chiropractic treatment restored proper neuromuscular control of the SCM and upper trapezius muscles thus enabling a painless and complete left rotation of the head and neck.

In theory, it is also plausible to say that correction of cranial misalignments may result in normal functioning of the vagal nerve. Although no direct improvement was identified in the gallbladder function of the infant in discussion, it is proposed that chiropractic treatment may have optimized the capability of the diseased organ. Further research is needed to investigate this concept.

Conclusion

Cholelithiasis is a condition seen in the pediatric population. The age of the child and the underlying pathophysiology impact the clinical presentation and management. In the younger child an asymptomatic presentation and spontaneous resolution is likely. In the older symptomatic child, or in younger children where resolution is not seen after one year, surgical cholecystectomy is the treatment of choice to prevent complications from developing.

Craniocervical subluxations are often identified in infants as a result of the birth process. In this case, chiropractic care restored optimal cervical range of motion and cranial alignment. Consequently, the infant no longer showed a preference to feed on the left breast. This demonstrates how chiropractic treatment may be beneficial in correcting breastfeeding difficulties that have a biomechanical cause.

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Chiropractic and breastfeeding dysfunction: A literature review

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ABSTRACT

Objective: Breastfeeding an infant has many long and short-term health benefits. Chiropractic care, as part of a multidisciplinary team, has the potential to assist with biomechanical causes of breastfeeding dysfunction. The purpose of this study was to review the literature and explore what evidence there is to support this theory. **Methods**: Database searches were performed (PubMed, MEDLINE, Cumulative Index to Nursing and Allied Health and Index to Chiropractic Literature) and hand searches to identify relevant studies. Inclusion criteria were: written in the English language in a peer-reviewed journal, involving infant human participants and a focus on chiropractic treatment for breastfeeding (dysfunction). **Results**: Eleven articles were reviewed; 6 case studies, 3 case series, 1 clinical trial and 1 narrative. **Conclusions:** Limited evidence exists to support chiropractic treatment for infants with breastfeeding dysfunction. Of the 6 case studies, 3 case series and 1 clinical trial found in this report there was a trend towards resolution of breastfeeding issues with chiropractic treatment of biomechanical imbalances. More meticulous, higher evidence studies are needed to provide further evidence of this.

Key words: breastfeeding, chiropractic, infant, spinal manipulation.

Introduction

Breastfeeding, particularly exclusively for the first 6 months, has been associated with numerous beneficial short and long term health outcomes for an infant.[1,2] Breast milk has been shown to contain secretory IgA antibodies, lactoferrin, oligosaccharides, numerous cytokines and growth factors which all aid in an infant's immune response.[3,4] Purported short term benefits to the infant are a decreased risk of many childhood illnesses.[5] Incidence of gastro-intestinal infections, otitis media, other respiratory tract infections and asthma, even in those with a strong family history, may be decreased in infants who are breastfed.[6,7]

The benefits of breast milk extend into later life with extensive literature to support a decreased incidence of type 2 diabetes and obesity in older children and adults who were breast fed as infants.[6, 8-11] This effect appears to be time dependent; the longer breastfed, the more reduced the likelihood of disproportionate weight later in life.[11,12] The World Health Organization, as well as many other leading authorities, recommend exclusive breastfeeding until the age of 6 months, at which time timely solids can be introduced (with complimentary breastfeeds to at least 12 months).[13]

In Australia, 92% of women are initiating breastfeeding at birth, yet only 56% are exclusively breastfeeding at 3 months and only 14% at 6 months.[14] Reasons for breastfeeding cessation are numerous and include environmental and socioeconomic factors.[15] Others are infant/mother related and include sore nipples, inadequate milk supply, infant having difficulties feeding and a perception that infant wasn't satiated.[16-18]

The mechanics of breastfeeding from an infant perspective are well documented in the literature.[19-21] Amongst other factors successful breastfeeding relies on a series of complex movements facilitated by the craniofacial musculoskeletal anatomy.[20, 21] Imbalances or asymmetries in this delicate system have the potential to alter an infant's suck and could possibly lead to nipple pain, breast engorgement, mastitis and insufficient milk supply.[22]

The purpose of this study was to investigate the available evidence to support the role chiropractic may play in treating breastfeeding dysfunction. At present there has not been a review of the literature to explore this.

Methods

Sources of information

Relevant studies were uncovered via the following electronic databases: PubMed, MEDLINE (ProQuest), Cumulative Index to Nursing and Allied Health (CINAHL) and Index to Chiropractic Literature (ICL). Databases were searched from inception through December 2013 using the search terms delineated below. A hand search of appropriate journals and the reference list of each relevant study was then performed to identify any suitable studies missed by the electronic searches.

Search terms and delimiting

Search keywords for all databases included: breastfeeding and the similar breast-feeding and breast feeding, chiropractic and spinal manipulation.

Selection criteria employed
All study designs were included and there was no restriction in terms of age of publication. Only articles published in the English language in a peer-reviewed journal, involving infant human participants and focused on chiropractic treatment for breastfeeding (dysfunction) were included.

Results
A literature search of PubMed using the above stated search terms returned 6 results, 4 of which were not relevant. Of the 2 included, 1 was a case series,[23] and the other a case study[24]. The MEDLINE search produced 7 results, only two of which were appropriate, both having been found previously in the PubMed search.[23, 24] The CINAHL search unearthed 7 findings, 4 of which were irrelevant to this study. The 3 found relevant were 2 case series[23, 25] and one case study.[26] Only one of the case series had turned up in the previous searches. The ICL search produced 14 results, 11 of which appeared relevant and 7 that hadn't been produced in previous searches. Of those 7, 4 were case studies,[27-30] one was a case series,[31] another was a clinical trial[32] and finally, a narrative on collaborative care.[33] One of these case studies was later not included as it appeared in a journal that was not peer reviewed.[30] A hand search of each relevant study was performed to identify only one article missed by the electronic investigation.[34] It too was later not included as it involved an infant with feeding problems assisted by chiropractic care who had only been bottle fed and never breastfed. Relevant journals were also hand searched, to reveal one, previously undiscovered narrative review and case report[35].

In summary a thorough literature search revealed only 5 case studies,[24, 26-29] 3 case series,[23, 25, 31] 1 clinical trial[32], 1 narrative[33] and 1 narrative review and case report[35] that fit the selection criteria of this study.

Discussion
There is a lack of literature available on the effects chiropractic care may have on breastfeeding dysfunction. That which is available comes from case studies, case series and one low level clinical trial all of which are based on clinical experiences or possibly anecdotal evidence. The findings of these studies have been summarized in Table 1.

All 5 case studies[24, 26-29] describe findings of biomechanical change to the upper cervical spine, specifically the atlas or atlantoccipital joint. Holleman[24] and Bernard[26] both described cranial restrictions and temperomandibular joint (TMJ) restriction and TMJ asymmetry in mandible with hypertonicity of TMJ musculature respectively. Bernard[26], Cuhel[29] and Willis[27] reported on infants who had difficulty or refused to feed form on particular breast. All cases accounted eventual improvement in infant's breastfeeding ability and resolution of breast side preference and biomechanical changes.

The narrative review and case report produced by Lavigne[35] explores the case of a 3-week-old neonate, presenting to a chiropractor with feeding difficulties due to biomechanical dysfunction of upper cervical spine, TMJ and cranial bones complicated by ankyloglossia (tongue-tie). Lavigne also performed a review to investigate the literature available surrounding alleviation of breastfeeding dysfunction following the frenotomy procedure. In this case a medically performed frenotomy along with conservative chiropractic treatment for the musculoskeletal imbalances saw a marked improvement in breastfeeding difficulties.

Hewitt's study[31] is titled 'a case series', but is however structured as a case report describing two separate cases. Case one denotes an 8-year-old child with cranial restrictions only and case two a 4-week-old male with cranial restrictions as well as biomechanical changes at C1/C2. Hewitt[31] reported complete resolution of symptoms after a period of chiropractic care.

A pilot case series was performed by Stewart[25], who administered a questionnaire to 19 breastfeeding mothers pre and post chiropractic care of their infant. Stewart attempted to correlate specific clinical findings (chiropractic subluxations) with specific infant feeding problems. The questionnaire covered the following components of breastfeeding behavior: attachment, extension/arching of infant, side shaking once attached, side preference and overall stress while feeding. Stewart reported a reduction in each category after chiropractic treatment.

Miller et.al.[23] produced a case series of 114 infants referred to a chiropractor by a medical practitioner for feeding difficulties. The most common clinical findings were posterior cervical joint restriction (88.7%), TMJ imbalance (35.7%) and inadequate suck reflex (34%). Intervention comprised of 2-5 treatments of chiropractic therapy over a 2 week period. The specific outcome desired was exclusive breastfeeding (which none of the infants were achieving prior to treatment). Miller[23] found that all infants showed some improvement with 78% being able to achieve exclusive breastfeeding at the end of the two weeks.

Vallone[32] performed a small clinical trial, comparing the craniofacial and spinal biomechanical characteristics of 25 infants demonstrating breastfeeding difficulty with those of 10 infants with no apparent breastfeeding issues. The 25 infants with breastfeeding difficulty demonstrated imbalanced musculoskeletal action as compared to the infants in the control group. Utilization of soft tissue therapies and chiropractic treatment to the spine and cranium resulted in

improved feeding in 80% of the affected infants.

Conclusion

Limited evidence exists to support chiropractic treatment for infants with breastfeeding dysfunction. Of the 6 case studies, 3 case series and 1 clinical trial found in this report there was a trend towards resolution of breastfeeding issues with chiropractic treatment of biomechanical imbalances. More studies are needed to provide further evidence of this.

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Table 1

Reference	Sample	Presenting Complaint	Findings & Diagnosis	Treatment	Other Complications	Results
Holleman et.al. 2011	8-day-old	Poor latch, quickly pulling away, weak./ poor vacuum + maternal nipple pain	d/c cervical ROM, d/c B abduction arms, d/c sacral extension S1- coccyx, d/c TMJ & CR movement Diagnosis: craniocervical syndrome	4 visits. gentle chiropractic manipulation/ toggle recoil technique to C1, TMJ & coccyx, fingertip pressure to CR,.	None	Post visit 1 — moderate improvement in suckling continuity Post visit 2 — latching on improved (letdown reflex not brisk) Post visit 3 — letdown reflex improved Post visit 4 — breastfeeding non problematic
Bernard et.al. 2012	6-day-old male	Irritable & distress when turning head to mothers L breast	Asymmetry in mandible, d/c L cervical rotation, i/c tension to mm anterior to L TMJ	1 visit Internal mm release L TMJ, Activator adjustment to L C1, cervical stair stepping, CR- occipital pump	Breast-feeding jaundice	Post visit 1 — baby drained L breast without distress. No further breast-feeding complications.
Sheader, 1999	15-day-old male	Inability to BF & colic since birth. Near constant crying, screaming, shaking, rash & vomiting during/after feeding. Excessive abdominal & bowel gas.	Infants legs drawn up, positive L reverse fencer	13 visits/11 treatments Chiropractic adjustment to C1 Chiropractic adjustments	Colic Hepatitis Vaccination	Post visit 1 — immediate reduction in crying, screaming & shaking. Vomiting & crying at feeds also ceased. Post visit 2 — BFing well Visit 3 — no treatment Return of all symptoms post Hepatitis vaccination Visit 4-12 — reduction of symptoms post adjustment Post Visit 13 — no recurrence of symptoms
Cuhel et.al. ,1997	12-day-old male	Difficulty feeding on R breast, short feeding times on R breast, excessive bowel gas	d/c occiput ROM, R atlas fixation in x-translation, positive R reverse fencer	Many Visits Infant toggle recoil adjustment to R C1 TP	Colic Depo-Provera contraceptive injection	Able to feed at R breast without difficulty immediately post initial treatment. Recurrence of symptoms intermittently over following months decreasing in severity over time. Decrease in symptoms after each treatment. Reoccurace thought to be due to Depo-Provera contraceptive injection post birth.
Willis, 2011	4 week old female	Refusing to feed on R breast since birth	d/c R cervical rotation C1 Left posterior subluxation	1 visit activator adjustment to C1 L TP		Able to feed at R breast immediately post treatment. i/c in R cervical rotation immediately post treatment no return of symptoms
Lavigne, 2012	3-week-old male	Maternal Nipple Pain	Restriction in manibular excursion. Cervical dysfunction at C1, CR dysfunction of parietal, frontal and temporal bones.	Unspecified	Tongue-tie	Decrease in Maternal nipple Pain and BF dysfunction following medically performed frenotomy and conservative chiropractic treatment.

CASE SERIES

Reference	Sample	Presenting Complaint	Findings & Diagnosis	Treatment	Results
Stewart, 2012	19 infants	19 breastfeeding mothers referred to chiropractor completed a survey. 14/19 reported attachment issues.	Each child assessed for chiropractic subluxation. A total of 44 were found (average 2.3 per patient). 81% of these were upper cervical and glenohumeral joint subluxations.	Treatment types not given Mothers filled out same survey at end of treatment program.	100% reported improved attachement to breast 94% reported d/c arching 88% reported d/c shaking 84% reported d/c feeding stress overall once attached 77% reported d/c feeding pain 64% reported d/c side preference
Miller et.al. , 2009	114 infants <12 weeks	Referred by medical practitioner for sub-optimal infant breastfeeding. Could not feed exclusively at breast.	Cervical posterior joint dysfunction (89%) TMJ imbalance (36%) Inadequate suck reflex (34%)	Chiropractic therapy in addition to any support given elsewhere.	All infants showed some improvement with 78% able to exclusively breastfeed after 2-5 treatments over a 2 week period.
Hewitt, 1999	2 infants 8-week-old female 4 week old male	8 week old unable to maintain suction since birth. Excessive regurgitation 4 week old unable to latch since birth	8 week old — weak suck reflex, CR imbalance 4 week old — mild mm spasm in R suboccipital region, d/c L rotation & R lateral flexionat C1/C2, CR imbalance	8 week old — cranial therapy 4 week old — modified diversified rotatory break maneuver & cranial therapy	8 week old — Post visit 1 — no excessive regurgitation, maintaining suction 75% of time. Post visit 2 — complete resolution of symptoms 4 week old — Post visit 1 — immediately able to latch effectively to B breasts.

CLINICAL TRIALS

Reference	Sample	Presenting Complaint	Findings & Diagnosis	Treatment	Results
Vallone, 2004	35 infants: 25 treatment, 10 control	Difficulty breastfeeding. Previously seen by LC, midwife, LLLL or physician.	Infants with BFing difficulty revealed imbalanced musculoskeletal action as compared to infants in control group	Manual therapies including; cranial therapy, Logan Basic, massage and gentle manual diversified chiropractic adjustments.	80% of infants showed improvement in feeding

d/c — decreased, B — bilateral, TMJ — temperomandibular joint, CR — cranial(s), L — left, i/c — increased, mm — muscle/musculature, BF — breastfeed, TP — transverse process, LC — lactation consultant, LLLL — La Leche League Leader,

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Weight limit recommendation in backpack use for school-aged children

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ABSTRACT

Background: Every day children use backpacks to get their books back and forth from school. Many children carry very heavy backpacks and there are some concerns that this could be contributing to back pain in children. **Objective**: The purpose of this paper is to assess, using the literature, what is the recommended weight limit that should be carried by school-aged children. **Discussion:** Many organizations, such as Back Pack Safety International, are trying to educate children on how to wear their backpacks properly and on the weight limit those children should carry to minimize back pain. However, many factors such as design, weight, how it is worn, and children's physical fitness have been shown to have an influence on the development of pain caused by backpacks. As well, parents and teachers have a determining role in helping children be better organized to have lighter backpacks. The literature does not seem to agree on a set weight limit but it is shown that to prevent back pain it should definitely not exceed 10-15%. **Conclusion:** Backpacks have an influence on back pain in children and the weight limit should not exceed 10-15% of the child's body weight.

Key words: backpack, back pain, school-aged, chiropractic

Introduction

Children around the world use backpacks to carry their school supplies to and from school. Studies show that at least 90% of school children in the developed world are using backpacks every day[1,2]. The weight of backpacks carried by children is creating growing concerns amongst school administrators, parents and healthcare professionals[3]. Negrini and Carabalona (2002) reported that the average daily load of Italian students over a week ranged from 22% body weight (BW) to 27.5% BW with some students wearing backpacks weighing as much as 46% of their BW, exceeding the 30% bodyweight/load ratio proposed for physically fit adults[4,5]. Some researchers hypothesize that heavy backpacks may be contributing to back pain in school-aged children[2,6].

A child's constantly developing spine experiences the highest rate of growth between the ages of 10-12 for girls and 13-15 for boys, with the secondary centers of ossification not fusing completely until the mid-twenties. At this stage, when the spine may be more susceptible to injury, proper backpack use is crucial to preventing postural deformities[7,8]. As well, it is shown that by adding weight to the back with a backpack, the center of gravity is shifted forward toward the rear of the base of support. Postural compensations are needed to maintain balance and functional motion during gait; however, with improper loading of backpacks these postural compensations can result in injuries to the child's spine. Some of these compensations include an increased forward head carriage, an increase in forward lean of the trunk, as well as changes of pelvic positions and gait patterns. Grimmer et al. (2002) found that more than 20% of students in each age group had a mean change of 5° in craniovertebral angle (CVA) with the greatest changes in the smaller age group[9,10]. The degree of posture change in these children is comparable to the change in CVA in adult women suffering from headaches[4].

To try to prevent back pain caused by backpacks, safety tips and information on choosing the right backpack, on how to fill it properly and how to wear it correctly, are available from various websites including the American Academy of Pediatrics[11], The American Academy of Orthopedics[12], Back Pack Safety International[13], American Chiropractic Association[14], and numerous other sites for parents, teachers and school-age kids[4,15]. Different methods of wearing backpacks have been recorded, for example, some studies showed that 73.2% of students carried with one shoulder. This carrying method seems to be decreasing in the United States with the help of backpack education programs that emphasize even weight distribution to avoid torqueing the spine[4].

Back pain in school-age children is becoming a common complaint, with a prevalence ranging from 30%-65%[2, 6, 16]. Unfortunately, some evidence in the literature shows that children suffering from low back pain may still have pain into adulthood; therefore, prevention is becoming important[17-19]. A factor contributing to this high prevalence of back pain in children stems from their increasingly sedentary lifestyle, with more time spent in front of the computer or television. As well, there are some thoughts that the loading of the spine with backpacks every day is contributing to the issue[2, 5]. It is believed that a certain amount of stress or load on the spine may contribute to its strength, however,

excessive and repetitive stress on a child's body may result in overuse injuries. Some injuries reported with backpack use are low back pain, neck pain, shoulder pain, muscle soreness, and rucksack palsy[2]. Other problems associated with backpack use have been reported including respiratory problems, winged scapula, foot blisters, tripping accidents, and getting hit by the backpack[20, 21]. Siambanes et al (2004) surveyed 3,498 Southern California adolescents and found that 41.3% reported pain when carrying backpacks, with 16.9% consulting a doctor for the pain and 16.1% reporting missing school activity due to pain[22]. Korovessis et al. (2004) studied a sample of 3,141 Greek students between 9 and 15 years old that showed an increase in dorsal pain correlated to increased backpack weight[23]. It has also been reported that girls usually experience more pain with backpack use than boys[4, 15, 24, 25]. It is important to note that these complications have not only been associated with the school bag load, but also with the duration that the school bag is carried. Increased duration will cause fatigue and pain; therefore, limiting only backpack weight may not be the solution[5]. The literature is unclear regarding the recommended weight for children – there is some debate whether the cutoff should be no more than 10% of the BW or up to 15% of the BW.

This paper will review the literature to assess what is the recommended limit for backpack weight worn by school-age children.

Methods

The search was performed using PubMed with the following terms "backpacks and children" with limits of "review" and language "English". This resulted in eight papers, which were all kept for analysis. A second search using the terms with no limits "backpacks and children" revealed 60 articles — 14 were kept for references. The articles not kept did not discuss backpack weight limits specifically and were not retained. The articles were hand-searched and 3 more articles were retained. Evidence-based medicine (EBM) has a hierarchy that puts systematic reviews at the top of a pyramid followed by randomized control trials, cohort studies, case-control studies, case series, case reports and editorials and opinions[26, 27]. The results of this search will be explained in order of highest evidence available according to EBM.

Results

Lindstrom-Hazel (2009) produced a systematic review of the literature looking to answer three questions. First, she asked, "Are school-age children at risk for back pain because of carrying backpacks? How much load is too much?" Secondly, "Does backpack in adolescence predict back pain in adulthood? and thirdly "Are there behaviors that lessen/increase the risk of back pain/injury?"[15]. The review was well performed with explained search methods and tables showing the relevant articles. The conclusions were that girls are more likely to experience back pain than boys, that the time carrying a pack may be a strong contributor to pain, and psychosomatic behavior may contribute to back pain. Lindstrom-Hazel (2009) reported that some authors were strongly calling for a weight limit; however, she believed that, up to this point, scientific studies had not yet produced consistent results that allowed her to wholeheartedly endorse safe limits that would protect all children. She believed that the issue of back pain was multifactorial including weight, time carried, and child's height in relation to the backpack. She concluded that back pain in children was a strong predictor of back pain in adulthood. She also reported that, although many organizations have various recommendations for backpacks, many students still choose their pack according to color and size. It can be assumed that many students do not understand the risk of back pain later in life; however, programs are in place to educate parents and teachers on avoiding unnecessary backpack weight. Therefore, according to this review, weight recommendations are not consistently supported to prevent back pain in children.

Brackley et Stevenson (2004) produced another systematic review trying to determine whether the suggested weight limit of 10-15% BW by certain organizations was the appropriate limit for school-age children and supported by the literature[2]. Their approach to the question was interesting because they separated the literature according to three different effects of backpacks use. They looked at the various literatures discussing the physiological consequences, the biomechanical consequences, and backpack design for children. By looking at the effects of backpack use in different ways, this review was the most complete. The search method was well explained and it included tables summarizing the research articles. The conclusion based on the literature, combining the three effects of backpack use, was that 10-15% BW is a justified weight limit. Further research is required to determine the association between backpacks and injury, and the way in which load, backpack design, as well as personal characteristics such as physical fitness, interact and influence adaptations required when carrying a backpack.

Kistner et al. (2012) looked at a small cohort study of 11 school children aged 8-11 years to examine the various effects of backpack loads on posture and postural compensations by evaluating forward head carriage[4]. The results showed immediate and statistically significant change in CVA, indicating increased forward head positions when using backpacks containing 15% and 20% BW. When students carried backpacks with 15% and 20% BW, more than 50% of the subjects reported discomfort after walking, with the

neck as the primary location of reported pain. The conclusion was that backpack loads should not exceed 10% BW due to the increased forward head position. One limitation to note from this study is the small sample size.

Rodriguez-Oviedo et al. (2012) produced a cross-sectional study in Spain that investigated whether backpack weight is associated with back pain and back pathology in school children[25]. Their results showed that 61.4% of participants carried backpacks exceeding 10% BW and 18.1% exceeded 15% BW. The children carrying the heaviest backpacks had a 50% higher risk of back pain and a 42% higher risk of pathology with girls showing a higher risk of back pain than boys. They encouraged the medical community to advise parents and school children about the risks posed by heavy school bags and the fact that this risk can be easily reduced.

Moore et al. (2007) produced a cohort study looking at 531 students in 5 different California schools from 5th to 12th grade and their backpack weights. This study weighed the backpacks and students were then individually interviewed about how often they experienced pain while carrying a backpack, the site of their pain, and if it interfered with activities. The data supported the use of a 10% BW cutoff for safe backpack use for all grade levels and that girls were more at risk for back problems.

Discussion

When analyzing the literature regarding backpacks, it is challenging to recommend a weight limit that would prevent injury in all the children due to the multiple factors involved in the development of pain, i.e. design, weight, how it is worn, and children's physical fitness. Negrini et al. (2002) suggested time worn was also important to consider when analyzing the effects of backpacks[5]. Macias et al. (2008) concluded that perceived pain in the low back was significantly higher while wearing the backpack on one shoulder versus two shoulders[1]. If one looks at the evidence, the systematic reviews (considered higher evidence in evidenced-based medicine) had conflicting conclusions and therefore were unable to suggest a clear weight limit. These reviews agree that more research is needed. Smaller studies performed more recently point to a 10% BW but they are generally focusing on only one factor, such as biomechanical changes. There has been no research performed to date that considers all factors in their evaluation and analysis. It would be worth doing other studies, with more subjects, and analyzing many factors simultaneously to see if the 10% cut-off point should be recommended.

As chiropractors, it is important to incorporate questions regarding backpack use when taking the history of a child. This information can help point the chiropractor towards some of the possible causes of back pain and should open up the discussion with the child and parent on how to carry books and appropriate weight limit. The chiropractors can then incorporate these recommendations when preparing the treatment plan of the child.

Many people, including chiropractors, have a determining role in trying to reduce the weight children carry in their backpacks. Parents should be sensitized to the weight of the backpack as well as the distance the child has to walk to and from school, as well as the design and wearing technique of the backpack. Teachers can influence the children when it comes to what material needs to be brought home daily. They should be sensitized to the changes of posture created by poor backpack use so they understand the importance of proper use. When they are planning their weekly curriculum, they could do so according to the textbooks children will need on a specific day and assess what goes in the children's backpacks[5]. As part of the weekly routine, teachers could have a scale to weigh backpacks and encourage students to lighten their load. Also, to emphasize physical fitness along with a properly fitted backpack, physical education classes could include relay races while carrying the backpack.

In this era of technology, they can make use of e-books and reduce the number of textbooks needed with the use of smart tablets like the iPad. A word of caution is needed here – the use of computers by some schools has actually increased the load students' carry because a specially designed backpack, which is already heavier, is required. Before switching to digital textbooks, we need to ensure that technology does not, in fact, increase backpack weight. Students need to learn how to make good choices when loading their packs, including choosing to carry only things that are absolutely necessary and not everything they think they might need or want to bring home. Furthermore, they should be taught to load bigger books in the back so to decrease stress on the shoulders. Parents should also make sure that the backpack contains no loose or dangling cords, strings and piece of clothing. These can catch while the child is walking, make them fall and create an injury that could be tragic if it got caught in the door of the bus[28]. With support from parents, the school curriculum should include a component of total backpack use including loading, lifting, holding, wearing, organizing, clearing and storing at school, to help prevent back pain in children.

Conclusion

It is evident that backpacks have an influence on back pain in children, but it is not clear if this pain is caused by weight alone or by multiple factors such as design, time worn, and physical fitness of the child. It seems difficult to design a backpack that would be suitable for all children and usable in every situation. It is fair to say that backpack weight

should not exceed 10-15% BW, however the backpack weight appropriate for each child should be determined individually.

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Improvement in prematurity outcome: A chiropractic case report

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ABSTRACT

Purpose: Prematurity carries with it an increased risk of developmental delays, infections, language development disorders and delays, visual and visuocognitive development disorders and mental health issues later in life. The purpose of this case report is to add to the possible avenues of treatment to gain better outcomes for this population. **Method:** A thorough literature search of MANTIS, BioMed Central, PubMed and National Institute of Health (NIH) revealed that there was not one published case on the use of chiropractic in the treatment of prematurity. **Case:** In this case, the child was born at 26.6 weeks — after 14 weeks of antepartum hemorrhage(APH) and so was at the end of the spectrum for viability. He spent 58 days in neonatal intensive care unit (NICU) and a further 44 days in special care nursery (SCN) until he was released to go home. **Intervention:** The patient was treated chiropractically with low force techniques utilizing sacro-occipital cranial techniques and neurological stimulation to improve proprioceptive input to the cerebellum and to decrease the level of deformational plagiocephaly. **Outcomes:** Treatment was continuous throughout the first two years of life beginning weekly and then every two weeks for regular checkups. His most recent assessment through the Southern Health Growth and Development Clinic showed that he is achieving at least within the normal range for his age and frequently above average across the different scales of the Bayley Scales of Infant Development-3rd edition. **Conclusion:** The patient responded favorably to the regular chiropractic management of sacro-occipital technique and neurological stimulations exercises. He is now outperforming many of his non age corrected peers. It is the hypothesis of the author that the maintenance of normal joint function and movement — including the cranial sutures — globally enhanced the outcomes of this child and could be a source of improved outcomes for this demographic in the future.

Introduction

Prematurity is becoming more common and neonates are surviving at increased rates due to advances in medical care and intervention.[1] This comes with their increased likelihood to exhibit various health conditions from sensory to perceptive to motor disorders,[2, 3, 4, 5] as well as decreased immune function,[6] respiratory weakness[7] and mental health concerns.[8] The current treatment protocol is to monitor the child and deal with each issue as it arises.[9] Literature searches reveal a new body of evidence in neonatal and infant movement patterns, variation and variability as a predictor for normal or abnormal neuromotor development.[10, 11, 12, 13, 14]

Time spent out of the supported environment of the womb and laying on a bed in the neonatal intensive care unit (NICU) and special care nursery (SCN) will also increase the likelihood of the development of a deformational plagiocephaly which in turn can lead to neurodevelopmental disadvantage.[15]

Method

A literature search using the key words, chiropractic and prematurity, was completed using MANTIS, Biomed Central, PubMed and National Institute of Health. There were no case series or case reports available on the use of chiropractic in the treatment of prematurity. It did reveal a number of publications which were used to supply the background for this case report.

Case Report

In this case, the patient was born by elective caesarean at 26.6 weeks under general anesthesia at the Mercy Hospital in Melbourne, Victoria, Australia.

His mother had a bleed at 11 weeks and then off and on until a significant hemorrhage at 20 weeks and then continuously for the duration of the pregnancy.

She was hospitalized from 25 weeks. As there was decreasing amniotic fluid and an evolving retroplacental hematoma, an elective caesarean was performed. The baby cried spontaneously at birth and his Apgars 5 and 9 at 1 and 5 minutes respectively. His birth weight was 1091 grams. Intermittent positive pressure ventilation (IPPV) was given for 30 seconds due to gasping respirations, and oxygen was increased to 40%. He commenced on continuous positive airway pressure (CPAP) for three days then weaned from high flow to low flow. He was diagnosed with respiratory distress syndrome (RDS), moderate patent ductus arteriosus (PDA), jaundice and presumed sepsis.

The baby was 58 days in the NICU at the Mercy Hospital and another 44 days in the SCN at the Frankston Hospital. He was fed breast milk by nasogastric tube until he could suck and begin to feed from the breast. His cranial ultrasound was normal. He was given 4 courses of antibiotics in the first 5 days, 1 dose of Indocid which had no impact on the PDA, and caffeine.

The parents decided to delay the vaccination schedule.

Intervention

The baby was examined in clinic when he was 104 days old. He was chiropractically adjusted at least weekly through the first year and biweekly through the second. The chiropractor was able to assess all primitive reflexes and monitor them for inhibition and encourage the parents to provide tactile stimulation to aid integration. They were asked to move the child and to carry him papoose-style to increase cerebellar stimulation. The treatment consisted of sacro-occipital technique,[16, 17] involving primarily a hold and release strategy to any pelvis or spinal segments that were determined by static and motion palpation to have reduced mobility. Cranial molding techniques were employed that principally involved a fronto-occipital hold to aid the cranial motion to flare the flattened temporo-parietal areas. No adverse events were reported as a result of this treatment.

In the second year as the child became ambulatory, extra stimulation was given to the feet in the form of rubbing and stroking.

During the course of treatment the child had only 1 diagnosable condition, that being a zinc deficiency which manifested as a facial rash and was first misdiagnosed as a staph infection. This is the only time since hospital discharge that the child was prescribed antibiotics before chiropractic care began.

Outcome

The patient was assessed by the staff and pediatrician at Southern Health and Growth Clinic, part of the Monash Medical Centre, when he was:

Chronological age: 27 months 9 days
Corrected age: 24 months 24 days

The Bayley Scales of Infant Develpoment-3rd Edition (BSID-III) was used in assessment. This is a direct observation test that has three major parts: Cognitive, Language and Motor development scales. Scores are made with reference to the ranges found in American children. It has been observed that Australian children may perform better overall than their American counterparts.

The patient scored:

TEST SCALE	TEST COMPOSITE SCORE AND RANGE	DESCRIPTION
Cognitive Scale	110 (101-117)	Above Average
Language Scale	89 (83-97)	
- Receptive		Average
- Expressive		Low Average
Motor Scale	103 (95-112)	
- Fine Motor		Above Average
- Gross Motor		Above Average

The patient had to travel a long distance to be examined and as he was tired when it came to testing this would probably have affected his expressive language rating. The examiner noted that what was noted was very precise and that this score was likely to be an underestimation of his abilities. It was also noted that the gross motor score may also be an underestimation.

The parents had no concerns about the child's development. He presented as a healthy, well-grown boy with two older siblings who he enjoys playing with.

Chiropractic examination revealed that all primitive reflexes had integrated within normal ranges and all developmental milestones were reached at expected age ranges.

The mother reported that the child had generally been well and had not required further antibiotic therapy. This was despite his older siblings being exposed to a pertussis outbreak at their kindergarten and school.

Discussion

Much is known and has been published about the deleterious effects of prematurity. As viability has reached 25 weeks gestation, these outcomes and how to maximize function of the neonate and infant become more challenging.

Prematurity is known to lead to: retinopathy,[18] speech and language disorders,[19, 20, 21] mental health issues,[8] sensory disorders,[22] motor function disorders, cognitive impairment, immune immaturity[6] and increased infection. All of which contributes stress to their families.[23] There is a developing body of evidence that movement patterns, variation and variability can predict some of these outcomes. It is therefore this author's contention that maximizing normal movement and proprioceptive input through increased joint function and proprioceptive firing aids in normal brain development and therefore gentle chiropractic adjustments and movement contributed to a better than average

outcome in this case.

It is also noted in the literature that deformational plagiocephaly can put infants at a neurodevelopmental disadvantage.[24, 25] Deformational plagiocephaly occured in this case as a result of prolonged periods of time lying on alternating sides in the hospital. It is the author's hypothesis that chiropractic and osteopathic cranial techniques could impact both the plagiocephaly and the overall developmental outcome and warrant additional consideration.

Conclusion

This case demonstrates the efficacy of chiropractic to promote normal neurological development, which can be assessed through cognitive ability, receptive and expressive language, fine and motor skills and general wellbeing.

There is no documented evidence of chiropractic adjustments and cranial molding being beneficial for the premature infants. This author contends that further investigation could lead to beneficial outcomes for more children and their families.

No adverse reactions were documented throughout the course of treatment.

Informed consent was obtained from the parents for the writing of this report.

All procedures conformed to the ethical standards of the New Zealand College of Chiropractic.

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