THE PREVALENCE OF EXTREMITY JOINT DYSFUNCTION IN NEONATES AND INFANTS WITHIN A PAEDIATRIC CHIROPRACTIC CLINIC

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ABSTRACT

Introduction: Extremity joint dysfunctions are a commonplace occurrence within the neonate and infant population. While conditions of greater clinical significance are well documented, there is a disturbing lack of data regarding the prevalence of extremity joint dysfunctions within this population. This study aims to provide the first prevalence data on extremity joint dysfunctions in neonates and infants.

Methods: Data was collected from 202 cases of neonates and infants under 12 months of age during the period 1/1/2010 to 31/12/2010 at a paediatric-only chiropractic clinic. Motion palpation findings from four chiropractors with post-registration chiropractic paediatric training were collated.

Results: Of the 202 cases, 153 (75.7%) were found to have extremity joint dysfunction. The shoulder was the most frequent (71.8%), followed by the wrist (5.5%), fibula (5.0%) and elbow (2.5%).

Conclusion: Extremity joint dysfunction is common and likely to be overlooked aspect of neonatal and infant examination. The high prevalence within this cohort suggests that all neonates and infants attending a chiropractor should be assessed to identify the presence of extremity joint dysfunction and receive appropriate treatment. (*Chiropr J Australia 45:359-367*)

Key Indexing Terms: Paediatrics; Chiropractic; Extremity; Shoulder; Prevalence

INTRODUCTION

In the absence of obvious fixed deformity involving an extremity or obvious restriction in extremity joint range of motion, little attention is paid to extremity joint function. This under-appreciation is reflected in the lack of published data regarding prevalence of extremity joint dysfunction within the paediatric population; a thorough search of PubMed did not reveal any articles discussing extremity joint dysfunction prevalence in the neonate or infant. It is my opinion that there is a concerning under-appreciation of extremity joint dysfunction in the neonate and infant population. This study aims to provide the first published data regarding the prevalence of extremity joint dysfunction in the neonate and infant population.

Clinically significant presentations associated with joint dysfunction, such as brachial plexus palsy, developmental dysplasia of the hip or clavicular fracture, are well documented with strong understanding of prevalence, pathogenesis and prognosis [1-3]. These pathological conditions of more obvious clinical significance may involve greater risk for developing adverse long-term outcomes or disability, however there is an under-appreciation of the potential impact from less clinically apparent extremity joint dysfunctions on development and functional ability.

Assessment of extremity joint function in neonates and infants requires increased skills and technical ability, which are not adequately taught in undergraduate programs. Typical extremity joint assessment incorporates findings from active and

passive ranges of joint motion, without assessment of physiological end zone. Clinically obvious joint dysfunctions display limitations within the active and/or passive joint ranges of motion [4,5], however assessment of end play zone of the extremity joint by the examiner would provide a more complete assessment of the extremity joint in question [6] and improve identification of less obvious extremity joint dysfunctions.

METHODS

Data was collected from 202 cases of neonates and infants under 12 months of age seen during the time period 1/1/2010 to 31/12/2010 at a paediatric only chiropractic clinic in Melbourne. Consent for data collection was signed by the parent at the time of consultation. Initial examination motion palpation findings from four chiropractors with post registration chiropractic paediatric training were collated. No identifiable information was collected. Motion palpation techniques were performed as described in *Chiropractic Pediatrics* [7], except for the shoulder joint which was assessed with the humerus held at 90° lateral abduction, the thumb and index finger of the hand holding the humerus contacting the proximal humerus as close as possible to the humeral head with the other hand stabilising the scapula and clavicle to prevent shoulder girdle movement (Image 1). This has been found to be a more age appropriate and accurate method for assessing shoulder joint function in infants based on clinical experience. All extremity joint dysfunction findings were recorded denoting joint affected, side, and restricted biomechanical function. Individual articulations of the wrist were classified as “wrist”, and radius or ulna dysfunctions were classified as “elbow”. Temporomandibular joint dysfunctions were excluded as insufficient data was available. Each instance of joint dysfunction was listed in Table 1. A breakdown of age and percentage of cases was listed in Table 2.

Image 1. – Assessing the shoulder

RESULTS

In 202 cases of neonates and infants, 153 cases had an extremity joint dysfunction present. With 177 instances of extremity joint dysfunction present, this equates to 1.16 instances of extremity joint dysfunction per case, indicating a likelihood of multiple conditions per case. The majority of cases involved the glenohumeral joint (n=145, 71.8%), with the wrist (n=10, 5.0%), tibiofibula joint (n=10, 5.0%) elbow (n=5, 2.5%), and sternoclavicular joint (n=1, 0.5%) representing the remainder of extremity joint dysfunctions. There were no instances of hip or foot joint dysfunctions. Of the 202 cases, 49 presented without extremity joint dysfunction (24.3%). The majority of extremity joint dysfunctions were found to be right-sided (n=138, 77.9%)

compared to left-sided (n=36, 20.3%) with 3 instances being bilateral (1.8%). The most common age of presentation for extremity joint dysfunction was 3-4 months of age (92%), with remaining ages displayed in Table 2.

Table 1. Prevalence of Extremity Joint Dysfunction

	Number of Cases (n=202) (% of total cases)	Number of instances (n=177) (% of instances)
Shoulder (glenohumeral joint) Right Left Bilateral	145 (71.8) 116 (57.4) 28 (13.9) 1 (0.5)	147 (83.1) 117 (79.6*) 29 (19.7*) 1 (0.7*)
Elbow Right Left Bilateral	5 (2.5) 4 (2.0) 0 (0) 1 (0.5)	7 (4.0) 5 (71.4*) 1 (14.3*) 1 (14.3*)
Wrist Right Left Bilateral	10 (5.0) 6 (3.0) 3 (1.5) 1 (0.5)	12 (6.8) 7 (58.3*) 4 (33.3*) 1 (8.3*)
Fibula Right Left	10 (5.0) 9 (4.5) 1 (0.5)	10 (5.6) 9 (90*) 1 (10*)
Shoulder (sternoclavicular joint) Right Left	1 (0.5) 0 (0) 1 (0.5)	1 (0.6) 0 (0*) 1 (100*)
No Extremity Joint Dysfunction	49 (24.3)	49 (27.7)

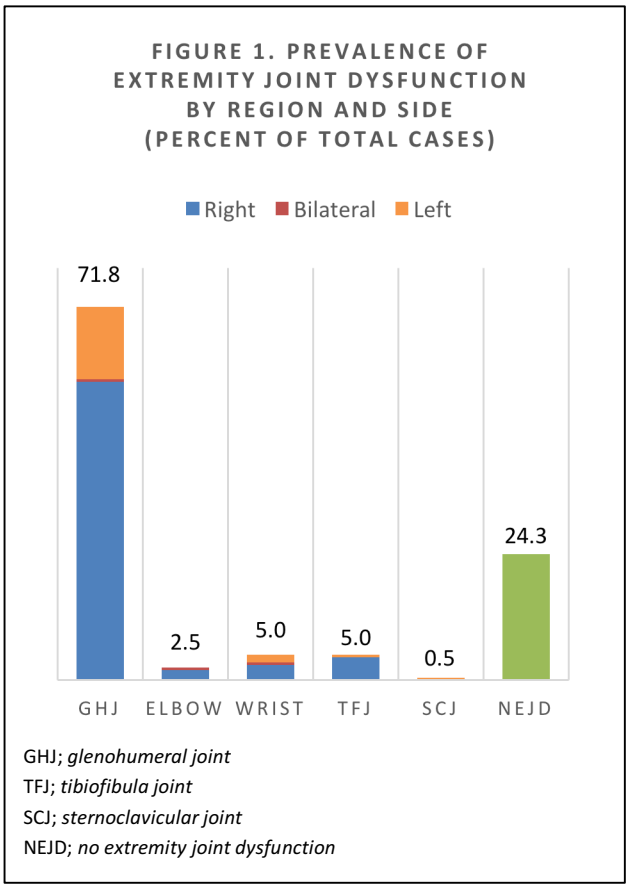
*Denotes percentage of region cases

Table 2. Prevalence of Extremity Joint Dysfunction by Age

Age	Cases with Extremity Joint Dysfunction (%)
0-1m (n=27)	19 (70.4)
1-2m (n=47)	36 (76.6)
2-3m (n=46)	32 (69.6)
3-4m (n=25)	23 (92.0)
4-5m (n=19)	15 (78.9)
5-6m (n=14)	9 (64.3)
>6m (n=24)	14 (58.3)

DISCUSSION

The prevalence of extremity joint dysfunctions within this cohort was high (75.7%) with the majority of dysfunctions involving the glenohumeral joint (71.8% of cases, Figure 1). It is the authors' opinion that the birthing process may be the main cause of neonatal shoulder joint trauma leading to dysfunction. There are three main timepoints at which extremity joint dysfunction may result during prenatal and neonatal development; in utero (foetal position and in-utero constraint), during the birthing process, and post-natal [8,9]. Each of these timepoints would contribute to the high prevalence of extremity joint dysfunction seen within this cohort (75.7%). Our impression is that the majority of shoulder joint dysfunction apparent in neonates and infants occurs as a result of shoulder joint trauma as the shoulder girdle crosses the symphysis pubis. Typically, about 90% of babies are delivered in an occiput anterior position, which is associated with the right shoulder girdle having to pass across the mother's symphysis pubis, and about 10% of babies being delivered in an occiput posterior position, which is associated with the left shoulder having to pass across the mother's symphysis pubis [10]. If this mechanism was the primary cause of shoulder joint dysfunction, then we would expect to find approximately 90% right shoulder involvement and 10% left shoulder involvement with vaginally delivered neonates and infants. In this study, there is a higher occurrence of right shoulder dysfunction (80%) compared with left (20%) which conforms with expected occurrence of shoulder joint dysfunction as a result of birth process. Reinforcing our impression that the birthing process is a key contributor of extremity joint dysfunction is the age data; the prevalence of extremity joint dysfunction presentation within each age bracket is consistent with the total prevalence suggesting a common aetiology while reducing the likelihood of post-birth trauma.



While of a much lower prevalence, it is of our opinion that the wrist joint dysfunctions are likely due to limb prolapse compound presentation or a degree of upper limb mal-position. This would explain the low percentage of wrist joint dysfunctions within this cohort (5.0% total cases) in comparison to shoulder dysfunction as hand prolapse is infrequently observed [11,12]. The higher occurrence of right wrist dysfunctions (58.8% instances of right wrist dysfunction compared to 33.3% left) may also suggest a potential co-morbidity with right shoulder dysfunctions. This is likely due to similar mode of trauma during an occiput anterior presentation with the right side passing the mothers' symphysis pubis on delivery. An interesting observation from our data is the strong bias to right-sided upper and lower extremity joint

dysfunction. In our data, a total of 77.9% of extremity joint dysfunctions were right-sided compared to 20.3% left-sided. This is likely due to the passing of the right side against the mother symphysis pubis on delivery with the more common occiput anterior presentation.

The majority of upper extremity joint dysfunctions are likely to be a result of birthing trauma, whereas dysfunction of the proximal and distal tibio-fibular joint is more consistent with an *in utero* constraint. This pathogenesis is similar to that of various foot deformities, consequently we would expect to see a relatively low occurrence of this joint dysfunction, and this is consistent with our finding of 5.0% of this cohort. However, the absence of joints dysfunction identified in joints typically associated with in utero constraint – the hips and the joints of the feet – suggests an inconsistency regarding aetiology.

Presentations without obvious indication of pathology, such as joint dysfunction, are easily overlooked due to relative hypermobility of infant joint articulations and increased clinical skill needed to identify joint dysfunction in neonates. This is further complicated by limited data describing normal infant joint range of motion. A recent analysis of mobility patterns in preschool children highlighted this issue, stating “the parameters and criteria currently used for evaluating joint mobility are the same for all age ranges, and adults and children are included in the same group” [13]. This may lead to misinterpretation of motion palpation findings, especially by the inexperienced practitioner when exposed to a case with extremity dysfunction, or a bilateral extremity presentation which may be assessed as “normal” due to absence of asymmetry.

Joint dysfunction has direct orthopaedic considerations and also increasing evidence of neurological ramifications. Multiple studies have demonstrated cortical changes, specifically in the motor and somatosensory regions of the brain, as well as the cerebellum in response to alterations of proprioceptive afferentation due to joint dysfunction, peripheral restraint or limb loss [14,15,16,17]. While not as severe as amputation, peripheral joint dysfunctions still result in alterations to afferentation with as little as 10 hours of immobilisation found to create changes to cortical function [15]. Studies by Haavik and Murphy [18] and Lelic et al [19] have demonstrated that dysfunctional joints of the cervical spine results in changes to the function of the somatosensory cortex, which can be normalised with corrective spinal manipulation. Avanzino et al [15] was able to demonstrate similar changes within the motor cortex after 10 hours of limb immobilisation which could be reversed by providing proprioceptive stimulation to the immobilised limb. While the form of afferentation in this study was via proprioceptive and tactile vibration, the form of afferentation provided by manual therapy (adjustment/manipulation) would create similar results due to activation of similar neuronal pathways.

Under-appreciation of extremity joint dysfunction may have other long-term consequences: the shoulder has been shown to be susceptible to cartilaginous and osseous changes due to joint dysfunction associated with brachial plexus injury [20,21] and there may be changes to shoulder joint architecture and structure as a result of less pronounced joint dysfunction which may predispose to instability.

In addition to neurological changes in the cortex, biomechanical changes to normal joint function may also cause increased nociceptor activity due to improper

mechanical loading. Recent research has demonstrated that infants perceive painful stimuli in a manner similar to that of adults [22]. This is significant in regard to extremity joint dysfunction as it may be an overlooked or under-appreciated component of an infants' presentation, with axial dysfunction more commonly being attributed as the cause of infant behaviour changes*. A significant proportion of this cohort (75.7%) presented with one or more peripheral joint dysfunctions which would likely produce increased nociceptor input.

This study is strengthened by the use of experienced paediatric trained clinicians as well as the use of four practitioners but is limited as it is a retrospective analysis. Repeating the study as a prospective study would generate more reliable data. Further research comparing various methods of extremity joint assessment in neonate and infants as well as inter and intra practitioner reliability, clinical presentations associated with extremity joint dysfunction in neonates and infants, and the long-term outcomes or behavioural impact of extremity joint dysfunction is needed.

CONCLUSION

Extremity joint dysfunction is common and frequently overlooked significant issue in neonates and infants. All neonates and infants attending a chiropractor should be assessed to identify the presence of extremity joint dysfunction and receive appropriate treatment.

List of Abbreviations

GHJ; glenohumeral joint, SCJ; sternoclavicular joint, TFJ; tibiofibula joint, NEJD; No Extremity Joint Dysfunction

Declarations

Ethics Approval and Consent to Participate

This study, as defined by section 5.1.8 of the National Statement of Ethical Conduct of Human Research (2007), carries only negligible risk and as such the authors would request waiver of Ethics Approval. Furthermore, it done in accordance with the Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/).

In accordance to Section 2.3.10 (Waiver) guidelines put forward by the National Health and Medical Research Council, this research:

- Does not carry any higher than negligible risk
- Does not carry any risk of harm from not having obtained consent
- May have difficulty in obtaining consent from all records involved
- Does not disclose any identifiable information
- Includes a strong plan for protecting patient privacy
- Does not deprive the patient of any financial benefit

REFERENCES

1. Dezateux C, Rosendahl K. Developmental dysplasia of the hip. Lancet 2007; 369(9572):1541-52

2. Alfonso DT. Causes of neonatal brachial plexus palsy. Bulletin NYU Hospital Joint Dis 2011;69(1):11-16

3. Phelan N, Thoren J, Fox C, O'Daly BJ, O'Beirne J. Developmental dysplasia of the hip: incidence and treatment outcomes in the southeast of Ireland. Ireland J Med 2015;184(2)

4. Magee DJ. Orthopaedic physical assessment, 4th Edition Philadelphia, PA: Saunders;2002

5. Bickley LS, Szilagyi PG. Bates' guide to physical examination and history taking, 8th ed. Sydney: Lippincott Williams & Wilkins; 2003.

6. Peterson DH, Bergmann TF. Chiropractic technique: principles and procedures, 2nd Ed. St. Louis, MO: Mosby; 2002

7. Davies NJ. Chiropractic pediatrics: a clinical handbook, 2nd ed. Sydney: Churchill Livingstone; 2010

8. Slobogean BL, Tredwell SJ. The epidemiology of nonaccidental trauma in children. Clin Orthop Related Res 2011;469(3):759-767

9. Akangire G, Carter B. Birth injuries in neonates. Pediat Rev 2016;37(11): 451-462

10. Edmonds DK. Dewhurst's textbook of obstetrics & gynaecology, 8th Edition. West Sussex: Wiley-Blackwell; 2012

11. Bhose L. Compound presentation: A review of 91 cases. J Obstetrics Gynaecol 1961;68(2):307-314

12. Weissberg SM, O'Leary JA. Compound presentation of the fetus. Obstetrics Gynecol 1973;41(1):60-64

13. Lamari NM, Chueire AG, Cordeiro JA. Analysis of joint mobility patterns among preschool children. Sao Paulo Med J 2005;123(3):119-123

14. Ngomo S, Leonard G, Mercier C. Influence of the amount of use on hand motor cortex representation: Effects of immobilization and motor training. Neuroscience 2012; 220:208-214

15. Avanzino L, Pelosin E, Abbruzzese G, Bassolino M, Pozzo T, Bove M. Shaping motor cortex plasticity through proprioception. Cerebral Cortex 2014; 24(10):2807-2814

16. Williams L, Pirouz N, Mizelle JC, Cusack W, Kistenberg R, Wheaton LA. Remodeling of cortical activity for motor control following upper limb loss. Clin Neurophysiol 2016;127(9):3128-3134

17. Cirstea CM, Choi IY, Lee P, Peng H, Kaufman CL, Frey SH. Magnetic resonance spectroscopy of current hand amputees reveals evidence for neuronal-level changes in former sensorimotor cortex. J Neurophysiol 2017; 117(4):1821-1830

18. Haavik H, Murphy B. The role of spinal manipulation in addressing disordered sensorimotor integration and altered motor control. J Electromyography Kinesiol 2012;22(5):768-776

19. Lelic D, Niazi IK, Holt K et al. Manipulation of dysfunctional spinal joints affects sensorimotor integration in the prefrontal cortex: A brain source localization study. Neural Plasticity 2016; 2016:3704964, doi: 10.1155/2016/3704964

20. van der Sluijs JA, van Ouwerkerk WJR, de Gast A, Wuisman PIJM, Nollet F, Manoliu RA. Deformities of the shoulder in infants younger than 12 months with an obstetric lesion of the brachial plexus. J Bone Joint Surg 2001;84(3): 551-555

21. Chagas-Neto FA, Dalto VF, Crema MD et al. Imaging assessment of glenohumeral dysplasia secondary to brachial plexus birth palsy. Radiologica Brasileira. 2016;49(3):144-149

22. Goksan S, Hartley C, Emery F et al. fMRI reveals neural activity overlap between adult and infant pain. eLIFE. 2015 Apr; 4:e06356