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Screening for Torticollis and Plagiocephaly: The Role of the Pediatrician

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Screening for Torticollis and Plagiocephaly: The Role of the Pediatrician

by

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the requirements for the degree
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Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Science.

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ABBREVIATIONS

CMT	Congenital Muscular Torticollis
MT	Muscular Torticollis
PT	Positional/Postural Torticollis
SCM	Stenocleidomastoid
DP	Deformational Plagiocephaly
ROM	Range of Motion
CME	Continuing Medical Education

ABSTRACT OF THE DISSERTATION

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by

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Doctor of Science, Graduate Program in Physical Therapy
Loma Linda University, June 2014
Dr. Everett B. Lohman III, Chairperson

The purpose of this study was to examine the effects of providing a standardized screening examination to a group of attending and resident physicians on the rate of torticollis and plagiocephaly diagnoses, the age at time of diagnosis, and the attitudes and practice patterns of the physicians. All subjects were given a standardized screening procedure by verbal instruction and handout, and also completed a pre- and post-intervention questionnaire, which assessed the subjects' practice regarding the diagnosis and management of torticollis and plagiocephaly. A retrospective chart review was conducted to ascertain the changes in frequency and mean age of patients diagnosed by subjects over the 6-month intervention period compared to the previous 3 years. Pediatric residents reported significant increases in their frequency of diagnosing torticollis and plagiocephaly, their comfort level in screening for these diagnoses, and their frequency of referral to physical therapy for torticollis. Attending pediatricians reported significant increases in their diagnosis of plagiocephaly only. There was a significant increase in the percent of patients diagnosed with plagiocephaly at one of the six clinics during the intervention year. There was a significant decrease in the age at the time of diagnosis of torticollis patients at one of the six clinics during the intervention year.

CHAPTER ONE

INTRODUCTION

Torticollis in Latin means torsion (or twist) of the neck (collum), and "the finding of a torticollis deformity in a particular patient is a sign, rather than a specific diagnosis".[1] The classic presentation of cervical lateral flexion and asymmetrical rotation is usually associated with a range of motion (ROM) limitation of one of the sternocleidomastoid muscles, but can involve other lateral neck muscles such as scalenes and upper trapezius.[2,3] This asymmetrical posture of the head and neck is typically classified either as congenital muscular torticollis (CMT), muscular torticollis (MT), or positional/postural torticollis (PT).[4-9] Although typically muscular in origin, there are multiple causes of this asymmetrical positioning, including ocular torticollis (where the abnormal head position is assumed in order to maintain binocularity and/or to optimize visual acuity), osseous anomalies such as Klippel-Feil syndrome, and other non-muscular etiologies.[1,4,10]

Congenital Muscular Torticollis refers to an ipsilateral head tilt and a contralateral rotation of the cervical spine due to a thickened sternocleidomastoid muscle (SCM) or pseudotumor of infancy, which is known as sternocleidomastoid tumor of infancy or fibromatosis colli.[1,4-15] *Muscular Torticollis* is when the SCM muscle is tight, but does not present with a pseudotumor.[4-9,14] *Postural torticollis* describes those patients who demonstrate the classic head tilt but with no limitation

in passive range of motion and no pseudotumor in the SCM.[4-9,11,14] Golden et al[6] defined this as an SCM imbalance.

The incidence of torticollis in healthy newborns was reported to be 16% by Stellwagen et al,[16] challenging the previously reported incidence rate of 0.30 to 3.92%.[4,12] This significantly higher percentage likely is a more accurate representation because Stellwagen's study included any asymmetry of ROM, not just the presence of the classic pseudo tumor of infancy or thickening of one SCM musle.[16] Nonetheless, torticollis is the third most common congenital musculo-skeletal disorder, ranking behind clubfoot and developmental hip dysplasia. [1]

Deformational plagiocephaly (DP) is a deformity of an infant's head due to prenatal and/or postnatal molding forces, which are factors that influence the shape of the infant's head as they grow.[8,17-20] This deformity has been correlated to sleeping position, positional preference, neurological deficits, premature birth, restrictive intrauterine environment, and most commonly, torticollis.[8,17-20] The incidence of DP has been estimated at approximately 13% in healthy singleton infants but depending on the criteria used to make the diagnoses, has also been reported as high as 48%.[21,22] One study reported 61% of healthy newborns presented with asymmetry of the head.[16] In a large study by Cheng et al,[5] craniofacial asymmetry was documented in conjunction with congenital muscular torticollis in 90.1 % of patients. Oh et al[19] agreed, reporting 78.8%-82.5% of patients who had confirmed DP also demonstrated signs of torticollis. "Nearly every investigation on deformational plagiocephaly has reported an association with 'head rotational preference' or torticollis, although the stated incidence varies widely

between 3.2 -100%".[14] This evidence suggests that screening for both of these conditions is warranted in pediatric examinations due to relatively high incidence in all healthy newborns. If undiagnosed and untreated, torticollis can lead to cervical, thoracic and/or lumbar spine scoliosis, chronic pain, pelvic obliquity, limited vestibular, proprioceptive, and sensorimotor development, decreased visual awareness of the ipsilateral visual field, asymmetrical development of early reflexes and postures, and atypical development of motor milestones.[1,17,21,23,24] Torticollis can also lead to worsening or promoting of the plagiocephalic deformity, with possible facial deformities due to the lack of symmetrical neck ROM and increased time spent sleeping or laying on one side of the head.[17,18] Adult individuals who present with untreated DP can report chronic headaches, temporomandibular joint pain and dysfunction, visual abnormalities, and facial asymmetries. [1,25]

Conclusion

Torticollis and Plagiocephaly are relatively common musculoskeletal disorders that occur in the newborn and infant patient population, and these disorders can result in significant long-term effects if left untreated. These disorders can successfully be treated and resolved with therapy and other conservative treatment when addressed in the very early stages of life.

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CHAPTER TWO

TORTICOLLIS LITERATURE REVIEW

Introduction

Torticollis in Latin means torsion (or twist) of the neck (collum).[1] The classic presentation of lateral flexion and asymmetrical rotation is usually associated with a range of motion limitation of one sternocleidomastoid muscle, but can involve other lateral neck muscles such as scalenes and upper trapezius.[2,3] This asymmetrical posture of the head and neck is typically classified either as congenital (CMT), muscular (MT), or positional/postural torticollis (PT).[2-7]

Literature Review

Many studies on torticollis in the past have focused only on congenital muscular torticollis, which is defined as the presence of a shortened, thickened SCM muscle, which can present with a pseudotumor in the muscle, also known as fibromatosis colli.[8-10] Naturally, this is also what is typically passed on to physicians in medical education. Simply focusing on this narrow definition of torticollis, however, misses a large number of cases that present with the abnormal head position described above, but without the presence of a pseudo-tumor, or without a measurable thickening of one sternocleidomastoid muscle. These shortcomings lead other researchers such as Golden et al[5] to report another category of torticollis called sternocleidomastoid imbalance, otherwise known as postural torticollis. This

is likely the explanation of why Stellwagen et al[11] recently reported the incidence of torticollis in healthy newborns to be 16%, challenging the previously reported incidence rate of 0.3 to 3.92%.[1,12] This significantly higher percentage likely is a more accurate representation because Stellwagen's study included any asymmetry of ROM, not just the presence of the classic pseudo tumor of infancy or thickening of one sternocleidomastoid muscle.[11]

Do,[1] in his review on CMT, states that due to the prevalence of torticollis, "all newborn infants should have a complete evaluation that includes range of motion of the head and neck." Van Vlimmerren[13] and Bredencamp[14] suggested that all patients who were diagnosed with torticollis require referral to physical therapy for conservative intervention. Age at initiation of treatment is one of the determinants of success in conservative treatment for torticollis.[1,2,4-6,9,13,16,23,24] Most studies that provide therapy intervention for torticollis initiate treatment between 3 weeks and 3-6 months of age [1,4,6,7,9,13,16,23-26] and is expected to be most effective before 6 months of age.[1,4,6,7,16,23-25] "In case of the existence of a pseudotumor, a palpable mass centrally in the SCM related to CMT, physical therapy is indicated, even before 2 months of age, because of the negative influence on motor development."[13]

There is some concern that there is a link between torticollis and risk for developmental delay, as well as asymmetrical development of motor skills.[27] A recent study by Shertz et al[28] examined this relationship by testing infants with torticollis at a one-year follow up after treatment. They found that infants with torticollis did show an increased risk of early gross motor delay, but that these delays tended to normalize by one year of age.

Most patients are referred to physical therapy services by their pediatrician. Some are given home exercise instruction by the pediatrician when first diagnosed, and if the symptoms do not resolve by the next clinic visit (usually 2 months later), then a physical therapy referral is made. The critical role of the pediatrician, however, is not examined in the literature. "An absence of information exists regarding the current optimal care provided by these professionals". [29]

Fradette et al[29] found that in examining self-reported clinical decision making of pediatricians there was "unanimous agreement that intervention was required for all infants presenting with torticollis". However, we find in our practice that many children are not referred to physical therapy until 6-8 months of age or later. If the evidence indicates that the earlier age of initiation of treatment produces better results, and all pediatricians polled in a sample study agreed unanimously that intervention was required, why are some patients not referred to physical therapy during the ages when treatment will be most successful, or not at all?

One possible reason is that many newborns with torticollis are not recognized because of an incomplete examination. In a recent study regarding risk factors for deformational plagiocephaly, researchers failed to find limited neck passive ROM in infants 7 weeks old that presented with DP. However, they did find 17.9% of subjects demonstrated a positional preference, and the subjects active ROM was not measured.[18] Stellwagen's group asserts that the natural difficulty in assessing neck active and passive ROM in newborns has led to an underestimation of torticollis in infancy.[11]

Rogers et al[17] agreed that muscle palpation as a screening for SCM abnormality alone is confusing due to the natural lessening of fibrotic mass as the infant grows. They found that nearly all of the infants in their study had some degree of muscular imbalance, and that the findings of cervical imbalance are "easily missed".[17] They defined cervical imbalance as an intermittent head tilt, a difference in the rotation range of motion, and a history of rotational or positional preference.[17] They agreed with other investigators that the wide range of incidence of torticollis reflected differences in training and experience of the examiners.[17]

Another study that agreed with this opinion, Oh et al[21], examined the predictors of deformational plagiocephaly. They found that of 434 patients with deformational plagiocephaly, 78.8% of infants demonstrated a head tilt upon examination, and 82.5% had asymmetrical cervical rotation.[21] They explained that the "underdiagnosis" of torticollis has been noted in the literature, and they attributed this to "differences in training, inconsistent terminology, and failure to understand the dynamic nature of congenital muscular torticollis."[21]

To date, there is little agreement in the literature on a standardized examination procedure.[11] Many studies utilize some form of passive rotation range of motion (Rotation PROM) or active rotation range of motion (Rotation AROM) of the neck only.[4-7,16,17,29,22,25,30] Others also include lateral flexion passive or active range of motion.[3,5,9,11,12,15,18,23,31] The American Academy of Pediatrics issued a report on prevention and management of positional skull deformities. In the section related to confirming or ruling out torticollis, it mentions the use of the rotating-chair or stool test to examine rotation AROM of the infant's neck.[32] This test was also

utilized in studies by Pogliani et al[20] and Rogers et al.[17] However, this test is performed with the child seated on the lap of the examiner or parent, and children under 4 months of age may or may not be able to support their head fully in order to observe their full neck AROM in a sitting position due to the normal developmental achievement of trunk control for sitting upright typically developing between the 4th to 6th month. Furthermore, as previously mentioned, most studies suggest diagnosing torticollis in infants 4 months of age and under, due to the excellent outcomes achieved in infants who began therapy at this age. In the studies that examined neck range of motion in infants 4 months of age and younger, some utilized rotation PROM measurements and palpation only, some examined both PROM and AROM rotation measurements, and some only relied on ultrasonography to diagnose torticollis based on the presence of a thickened SCM muscle or pseudotumor in the SCM muscle.[4-7,9,11,15-19,22] Stellwagen's study not only found that torticollis is likely under-diagnosed due to differences in the definition of "restricted" rotation ROM, but also that in newborns, lateral flexion was more likely to show restricted movement than rotation.[11]

Conclusion

We believe that a thorough yet succinct screening examination needs to be developed that, once adopted, will standardize the way physicians and researchers screen for torticollis and plagiocephaly. This torticollis screening exam should include only the elements that are necessary and age-appropriate for the infant, while still able to capture any form of torticollis, whether it be postural, positional,

muscular, or sternomastoid tumor. An accompanying plagiocephaly and craniosynostosis differential exam sheet will further aid in recognition of this deformity.

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CHAPTER THREE

PLAGIOCEPHALY LITERATURE REVIEW

Introduction

Deformational plagiocephaly is a deformity of an infant's head due to prenatal and/or postnatal molding forces.[1-10,12-19] This deformity has been correlated to sleeping position, positional preference, neurological deficits, premature birth, restrictive intrauterine environment, and commonly, torticollis.[1-10,12-19] The incidence of deformational plagiocephaly has been estimated at approximately 13% in healthy singleton infants but depending on the criteria used to make the diagnoses, has also been reported as high as 48%.[15,16] One study reported 61% of 102 healthy newborns presented with asymmetry of the head.[7] In a large study by Cheng et al,[20] craniofacial asymmetry was documented in conjunction with congenital muscular torticollis in 90.1 % of patients. Oh et al[9] agreed, reporting 78.8%-82.5% of patients found to have signs of torticollis had confirmed plagiocephaly. "Nearly every investigation on deformational plagiocephaly has reported an association with 'head rotational preference' or torticollis, although the stated incidence varies widely between 3.2 -100%".[6]

Literature Review

In response to increasing concern regarding sudden infant death syndrome, the American Academy of Pediatrics initiated a widespread announcement in 1992

recommending supine sleeping position for all infants, which became known as the Back To Sleep campaign.[11] Since then, there has been a decrease in deaths related to sudden infant death syndrome, but a significant increase in deformational plagiocephaly.[1-10] The incidence of positional plagiocephaly has been estimated to be between 1 in 300 live births to 48% of healthy infants under 1 year of age.[3]

There are two main types of plagiocephaly. *Deformational brachycephaly* is a flattening of the posterior occiput, which results in a symmetric flattening of the posterior skull. *Deformational plagiocephaly* refers to an asymmetrical flattening of the posterior skull, which is non-synostotic, and needs to be differentiated from synostotic plagiocephaly, which involves a premature closure of cranial suture.[9,10] The non-synostotic type of deformational plagiocephaly is very often associated with torticollis,[6] and can be conservatively treated in the infant with physical therapy and cranial molding or helmet therapy.[2]

The asymmetrical head shape of deformational plagiocephaly is typically recognized with a simple visual examination, but needs to be differentiated from unilateral lambdoidal or unilateral coronal craniosynostosis, which results from a premature fusion of cranial suture in the growing infant's head. The differentiation of the various forms of craniosynostosis from plagiocephaly is often done with imaging from a cranial radiograph or computed tomography scan. Those who present with non-synostotic plagiocephaly are usually referred for molding helmet therapy.[3] This treatment is the typical conservative management if at least two months of head repositioning has failed, and is most effective when applied between 4-12 months of age.[12,13] Molding helmet therapy after the age of 12 months is not

usually associated with a positive outcome, and is generally not recommended.[3,14] Those who are found to have craniosynostosis require surgery to release the prematurely fused suture and allow for normal cranial growth.[14]

Studies have established a relationship between plagiocephaly, intrauterine constraint, and postnatal positioning, which can perpetuate the asymmetry in cases with associated torticollis.[6-9] One study by Lee et al[21] found that risk factors for intrauterine constraint were highly associated with fibrosis in the sternocleidomastoid in torticollis. Risk factors for intrauterine constraint included history of breech presentation, oligohydraminos, large birth weight, male gender, assisted delivery, multiple pregnancy, and maternal uterine abnormalities.[1,7,21] Also the incidence of torticollis was reported to be higher when the baby was reported to be "stuck" in one position during pregnancy for more than 6 weeks.[7] Littlefield et al[15] agreed, finding that multiple-birth infants were at a higher risk for plagiocephaly, most likely due to intrauterine crowding. A study by Peitsch et al[16] found that in healthy newborns examined 24 to 72 hours after delivery, 13% of singleton births and 56% of twin births exhibited cranial flattening, and they suggested that this is a precursor to posterior deformational plagiocephaly. van Vlimmeren et al,[4] however, showed that of 380 healthy neonates, 75 developed deformational plagiocephaly after birth, whereas only 23 of the 380 children presented with deformational plagiocephaly at birth.

Conclusion

Posterior positional plagiocephaly and torticollis occur frequently in patients the practicing pediatrician will examine.[3] There are a number of similar factors that are associated with both asymmetries, and due to the high association between torticollis and plagiocephaly, an examination procedure that screens for both would be beneficial in all infant examinations. As many of these studies show, early recognition leads to positive outcomes in most, if not all cases.

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CHAPTER FOUR

SCREENING FOR TORTICOLLIS AND PLAGIOCEPHALY: THE ROLE OF THE PEDIATRICIAN

Introduction

To date, there appears to be a lack of consensus on how to reliably and efficiently assess infant cervical range of motion in the clinic. The American Academy of Pediatrics published a clinical report on the prevention and management of positional skull deformities in infants in 2011. In the report, they recommended the rotating-chair or stool test for use in diagnosis of torticollis. The examiner sits on a rotating chair or stool and holds the infant in sitting on their lap facing the parent. The parent attempts to maintain the attention of the infant while the examiner rotates to one side in the chair and observes the infant's neck movement.[26] This examination method of infant cervical rotation is mentioned and/or used in some studies,[14,19] while other studies utilized an arthrodial protractor to measure infant cervical rotation in supine.[5] Some studies only categorically quantified neck rotation with chin moves past shoulder (100%), to shoulder (90%), or to mid-clavicle (70%).[16] Many studies do not mention their method of cervical ROM assessment, only that the passive or active cervical ROM was assessed and documented.[2,15,28,29] Clinically, the chair rotation test is easy to utilize and does not require a measurement tool, but its specificity can be

questioned. This test only assesses a patient's active cervical rotation range of motion, in a supported sitting position. If applied to the infant who is less than 3-4 months, this tool may not reflect an accurate assessment of cervical available passive range of motion due to the naturally occurring underdevelopment of head control at these ages. This tool also does not assess limitations in cervical lateral flexion range of motion, which is often an associated sign of torticollis. In the recently published Clinical Practice Guideline on Physical Therapy Management of Congenital Muscular Torticollis by the American Physical Therapy Association Section on Pediatrics, the authors recommended further research was needed to develop a reliable, valid, and time efficient method of measuring infant cervical ROM. [21]

The purpose of this study was to develop a standardized examination technique for torticollis and plagiocephaly and to determine the effects of providing a handout outlining this standardized technique to a representative group of pediatric attending and resident physicians. We hypothesized that the total number of torticollis and plagiocephaly diagnoses will significantly increase, the age at time of diagnosis will significantly decrease, and the total number of physical therapy, craniofacial specialty, and orthotic referrals will significantly increase during the 6 months following the distribution of this standardized technique handout compared to the previous 3 years. Also, we hypothesized that the self-reported attitudes and practice patterns of these physicians will significantly improve regarding the diagnosis and management of torticollis and plagiocephaly after the distribution of this standardized technique handout.

Methods

Subjects

We recruited potential subjects from Loma Linda University Children's Hospital (LLUCH) Department of Pediatrics. These subjects were recruited at two different meetings, one for the resident LLUCH pediatricians and one for the attending LLUCH pediatricians. Separate meetings for the subjects were necessary due to the requirements of their departments and schedules. Prior to filling out the pre-intervention questionnaire, all subjects were required to complete an informed consent form. All subjects were assigned a number that was kept separate from their questionnaire answers to maintain confidentiality. All subjects completed the questionnaire in person or by e-mail. The questionnaire consisted of demographic information regarding the subject's practice and training, along with 12 multiple choice and Likert scale questions that assessed the attitudes, practice patterns, and background training of the pediatricians. Participation in this study was voluntary and attendance at these meetings was expected but not obligatory.

Instruments and Measurement

Phase one of this study involved an intervention with the subjects. At two respective meetings, one for attending physicians and one for residents, all participants completed a pre-intervention questionnaire, which attempted to assess the attitudes and practice patterns of the physicians regarding the diagnosis and management of torticollis and plagiocephaly. The questionnaire utilized 8 multiple

choice questions and 4 Likert scale questions that assessed the amount of previous training they had received in screening techniques for torticollis and plagiocephaly, how often they currently screen for or diagnose torticollis or plagiocephaly, how comfortable they felt with screening for and diagnosing these two disorders, and how often they refer these patients to either physical therapy or orthotics. Then, they were given an instructional in-service on how to perform this standardized screening examination procedure by lecture, verbal instruction, demonstration, and handout with pictures and written description. The attending physicians were given 3 months and residents were given 1 month (due to their residency rotation schedule) to utilize this training and examination procedure, after which all subjects completed a post-intervention questionnaire which attempted to assess the changes in attitudes and practice patterns regarding the diagnosis and management of torticollis and plagiocephaly utilizing similar questions to those on the previous questionnaire.

Participation in this study was completely voluntary, and those who did not choose to participate in filling out the pre- and post-questionnaire were not denied access to the lecture or screening tool handout. All subjects who chose to participate in this study completed an informed consent form prior to filling out the pre-intervention questionnaire, and subjects could choose to remove themselves from the study at any time. Their names were kept separate from the answers on their questionnaire in a locked file cabinet in order to maintain confidentiality. There were no exclusion criteria.

In phase two of this study, a retrospective chart review was conducted to ascertain the total number of torticollis and plagiocephaly diagnoses made compared to the total number of all infants seen in the primary pediatric clinics involved over the first 6 months of each of the 3 previous years (January through June). Also, the ages of the infants at time of diagnosis for torticollis and plagiocephaly was collected, and the total number of those patients who were referred to physical therapy, craniofacial specialty team, and orthotics for molding helmets was examined for the same time period (the first 6 months) for each of the 3 previous years (2010-2012). The same data was also collected for the same first and second quarter (January through June) after the intervention was provided during 2013 in order to compare the changes in these data. Inclusion criteria were patients 2 years old and under seen at one of the 6 clinics affiliated with Loma Linda Pediatrics. Exclusion criteria included children concurrently diagnosed with Klippel-Feil syndrome, atlanto-axial subluxation/dislocation, rotary subluxation, C1-C2 articular malformation, Grisel's disease, Sandifer's syndrome, Syringomyelia, Distonia, Ocular torticollis, Paroxysmal torticollis, and Craniosynostosis. All patient data was de-identified and no protected patient information was collected or stored.

Data Analysis

Statistical analysis was performed using SPSS software, version 20 (SPSS Inc. 233 S. Wocker Dr. Chicago, IL 60606). Statistical significance was set at the conventional level of .05. We utilized a Wilcoxon Signed-Ranks test to examine the changes in the subjectively reported ordinal and Likert scale data from the

questionnaire. The answers from the attending physicians and the residents were analyzed separately to increase homogeneity among the subjects.

In order to analyze the intervention effects on physician rates of diagnoses of torticollis and plagiocephaly, we used a Pearson Chi Square test to compare the percent of patients diagnosed with Torticollis and Plagiocephaly at each of the 6 clinics our participants practice in. Data was collected during the first 6 months of each of the 3 previous years (2010-2012), and compared to the intervention year (2013). We used a Kruskal-Wallis non-parametric test and a Mann-Whitney test to analyze if, during the intervention year, the mean age of at time of diagnosis changed compared to the 3 previous years.

Results

Participants

Thirty-two of the 42 (76%) pediatric residents and attending physicians completed both pre-intervention and post-intervention questionnaires. The majority of residents had 1-4 years of experience in pediatrics, while the majority of the attending pediatricians who responded to the questionnaire had 11 or more years of experience. Residents spent on average 13 ½ half-days per month in their respective outpatient clinic setting, while attending pediatricians spent on average 7 half days per month in their primary outpatient clinical practice setting. On the questionnaire, the participants were asked how much training they had received on how to screen for torticollis and plagiocephaly as a part of their regular well-child exam. The answers they could choose from were, “none”, “a little in residency”, “I

was taught specifically how to screen in residency", "since residency via Continuing Medical Education (CME) or my own reading", and "though mentoring by colleagues in my practice". Most residents (69%) indicated on the questionnaire that they had received "a little" training on how to screen for torticollis and plagiocephaly in their residency training, while attending pediatricians stated they either received "a little training in residency"(33%), "specific training in residency"(50%), "after residency via CME/reading"(33%), or "through mentoring from colleagues"(33%). It should be noted that some respondents could answer more than one category in this question (**Table 1**).

Table 1. Participants' Practice Characteristics and Training in Torticollis and Plagiocephaly Screening

	Resident Physicians (n=26)	Attending Physicians (n=6)
Number of years of practice	< 1 year = 8 1-4 years –= 18	1-4 years = 1 5-10 years =1 11+ years = 4
Number of half-days in clinic per month	Mean = 13.5 Min = 2, Max = 41 SD = 13.5	Mean = 7.2 Min = 0, Max = 16 SD = 7.0
Training received in screening for torticollis	None = 4 A little in residency = 18 Taught specifically in residency = 3 After residency via CME/Reading = 0 Through mentoring from colleagues = 1	None = 0 A little in residency = 2 Taught specifically in residency = 3 After residency via CME/Reading = 2 Through mentoring from colleagues= 2
Training received in screening for plagiocephaly	None = 3 A little in residency = 16 Taught specifically in residency = 6 After residency via CME/Reading = 0 Through mentoring from colleagues = 2	None = 0 A little in residency = 2 Taught specifically in residency = 3 After residency via CME/Reading = 2 Through mentoring from colleagues = 2

Pediatricians' Practice Patterns and Attitudes

Table 2 shows the changes in the participants' responses to the pre- and post-intervention questionnaires. The group of pediatric residents demonstrated statistically significant changes in their self-reported frequency of screening and diagnosis for torticollis (p=.003) and plagiocephaly (p=.003) during their physical examinations in an average month after we provided the education and screening guide. The residents also demonstrated statistically significant changes in their confidence with screening for torticollis (p<.001) and plagiocephaly (p=.001). The residents reported a statistically significant change in the self-reported frequency of referrals to physical therapy for torticollis (p=.005), but no significant changes were found in self-reported referrals to orthotics or craniofacial team for plagiocephaly (p=.10). No significant changes were reported in how helpful the screening guides were for the group of residents in screening for torticollis (p=.30) or for plagiocephaly (p=.67). This is likely because on the pre-intervention questionnaire the residents indicated they would find a screening guide helpful if they were given one to use, and on the post-intervention questionnaire they responded that it was indeed helpful after utilizing it for the intervention time period.

The group of attending pediatricians demonstrated statistically significant changes in self-reported frequency of plagiocephaly diagnosis during an average month (p=.03). All other responses on the questionnaires of the attending pediatricians did not reach statistical significance (**Table 2**).

Table 2. Pre-and Post-Intervention Questionnaire Responses

	Resident Physicians	Attending Physicians
How often do you screen for Torticollis in your physical exam?	**.003***	.18
How often do you screen for Plagiocephaly in your physical exam?	**.003***	.08
How comfortable do you feel with screening and diagnosing Torticollis?	**<.001***	.10
How comfortable do you feel with screening and diagnosing Plagiocephaly?	**.001***	.16
How often to you diagnose Torticollis during an average month?	**.002***	.156
How often do you diagnose Plagiocephaly during an average month?	**.000***	**.03***
How often do you prescribe physical therapy for Torticollis in an average month?	**.005***	.16
How often do you prescribe a Plagiocephaly molding helmet or refer to craniofacial during an average month?	.10	.32
How helpful would you/did you find a Quick Guide to Screening for Torticollis?	.30	1.000
How helpful would you/did you find a Quick Guide to Screening for Plagiocephaly?	.67	1.000

***** Achieved statistical significance at .05% using Wilcoxon Signed Ranks test.

Chart Review - Frequency of Diagnosis and Average Age of Patient at Diagnosis

There was a significant increase in the percent of patients diagnosed with plagiocephaly after the intervention in Clinic 4 (p=.001), but no significant increase

in the percent of patients diagnosed with torticollis was observed in Clinic 4. The percent of patients diagnosed with plagiocephaly in Clinic 4 went from 0.5% in 2010, 0.3% in 2011, 0.3% in 2012, up to 0.9% in 2013. For all other clinics, there were no significant increases in the percent of plagiocephaly or torticollis diagnoses. Due to the high variability in the clinics percent of patients diagnosed with torticollis and plagiocephaly, we combined all clinics and examined the frequency of these diagnoses. There was no significant increase in either the percent of torticollis patients diagnosed (p=.51) or plagiocephaly patients diagnosed (p=.29).

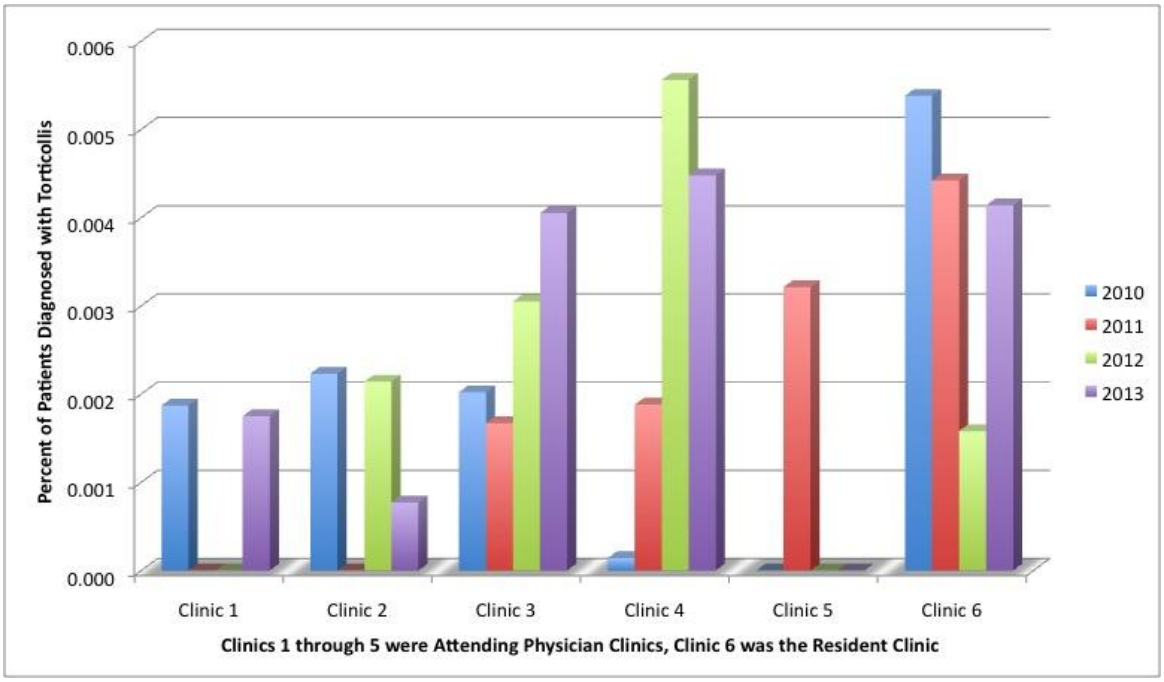

Figure 1. Percent of Patients Under 2 Years of Age Diagnosed with Torticollis

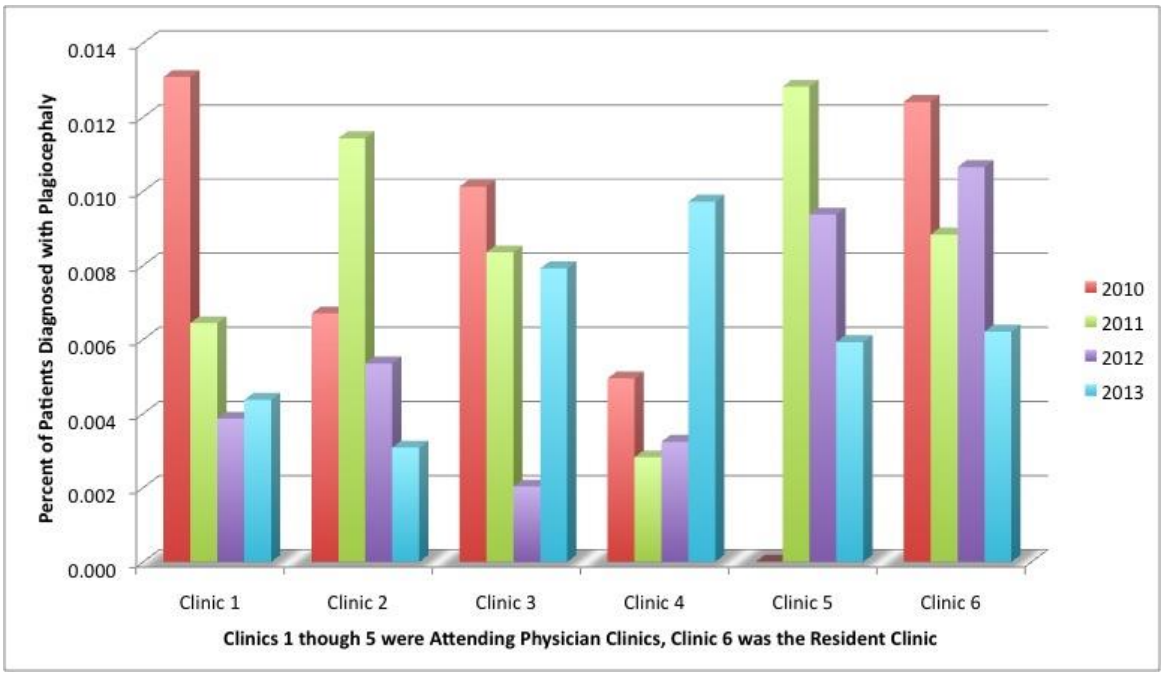

Figure 2. Percent of Patients Under 2 Years of Age Diagnosed with Plagiocephaly

We also examined the mean age of the patient at the time of diagnosis (Figure 3 and 4) in order to see if the intervention may have helped physicians to diagnose these two disorders earlier than previous years. The was a significant decrease in the mean age of torticollis patients at time of diagnosis in Clinic 6 (the resident clinic) when we compared 2011 (5 months of age) to 2013 (3.2 months of age) (p= .03) and 2012 (7 months of age) to 2013 (3.2 months of age) (p= .02). There were no significant decreases in the average age of torticollis patients at time of diagnosis in all other clinics.

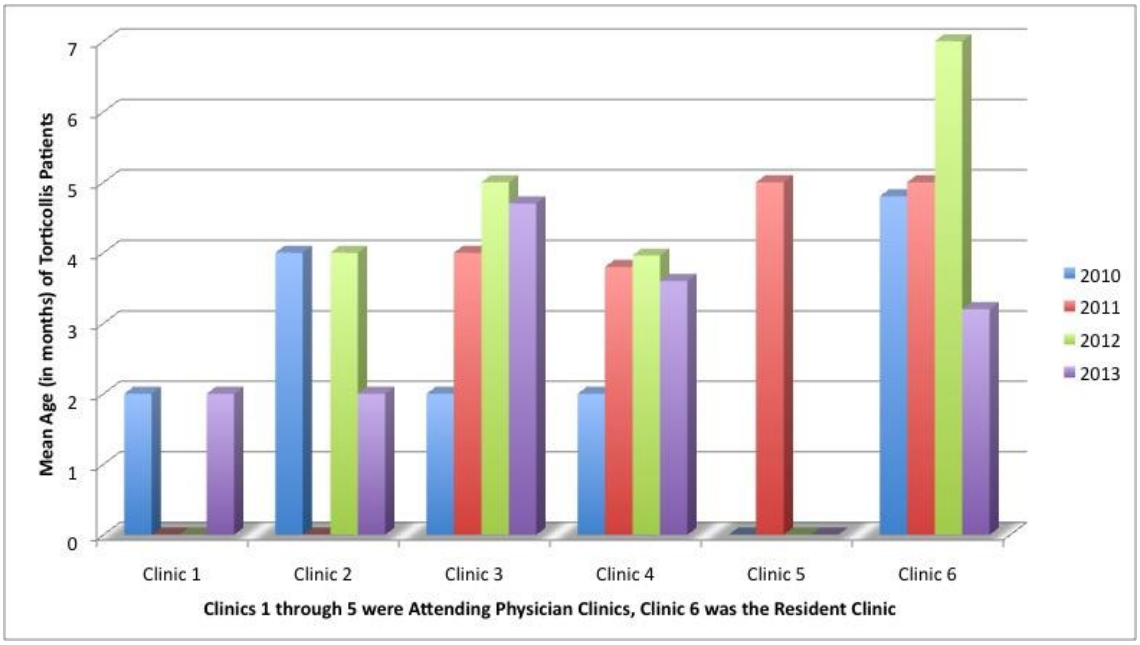

Figure 3. Mean Age of Torticollis Patient (in months) At Time of Diagnosis

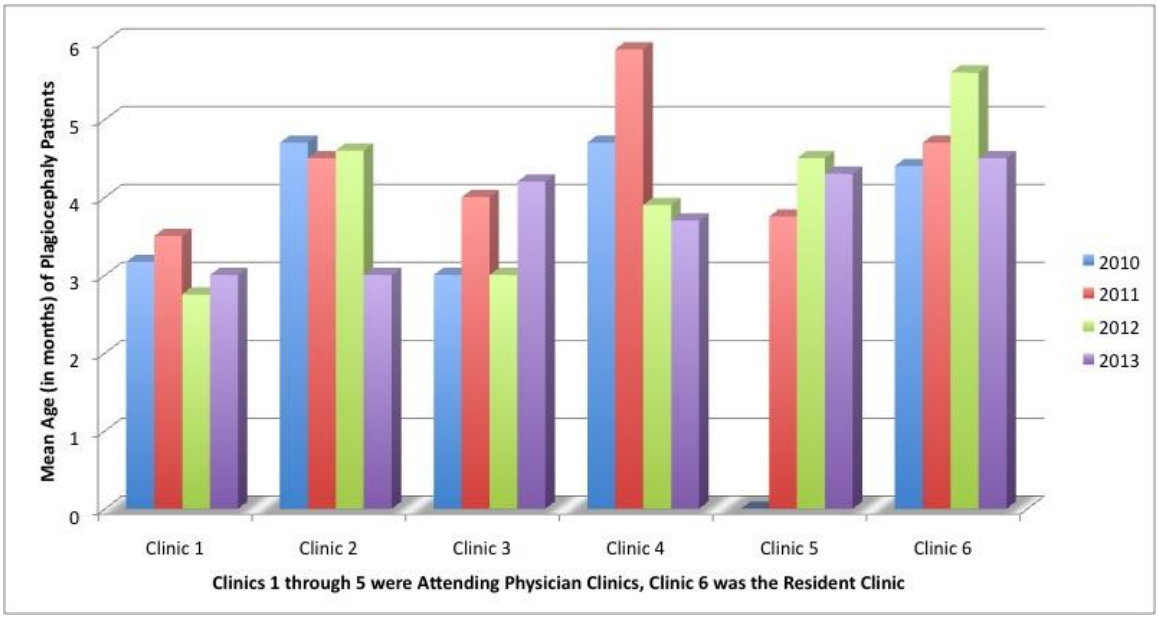

Figure 4. Mean Age of Plagiocephaly Patient (in months) At Time of Diagnosis

We planned to examine if the number of physical therapy referrals for torticollis and the number of referrals for cranial molding helmets/craniofacial team specialty changed after the intervention. Upon chart analysis, we realized that during the years between 2010-2012, it was possible for a referral to be made by phone request, not during an office visit, and was not consistently recorded in the chart notes which were largely utilizing paper documentation during this period. Therefore, we concluded that this data could not be reliably compared to the intervention year, due to the variability in record keeping.

Discussion

This study is the first to examine the effects of providing a standardized screening procedure for identifying patients with torticollis and plagiocephaly. Both attending and resident pediatricians subjectively reported their estimated number of plagiocephaly diagnoses increased after utilizing the screening handout, while the resident pediatricians subjectively reported their estimated number of plagiocephaly and torticollis diagnoses increased. Also, the resident pediatricians reported a significant increase in their confidence when screening for torticollis and plagiocephaly, and that the screening handout was helpful in their practice. This data supports our hypothesis that the subjectively reported practice patterns of the physicians in our study would improve regarding the diagnosis and management of torticollis and plagiocephaly. There was a significant increase in the total number of plagiocephaly patients diagnosed at one Attending Clinic after subjects were given the screening handout, thus supporting part of our hypothesis that the number of

plagiocephaly diagnoses would significantly increase. In addition, the mean age at time of diagnosis significantly decreased in the Resident Clinic after the intervention. This data supports our hypothesis that the standardized technique would help physicians, especially resident physicians, to diagnose torticollis and plagiocephaly at an earlier age for the patient. This screening procedure is most likely going to be most useful in educating pediatric residents on how to identify patients with torticollis and plagiocephaly more precisely and in a more timely manner, thus improving outcomes and providing better management of these disorders.

A possible reason why the screening handout did not produce a more significant change in the rate of torticollis and plagiocephaly diagnoses across all clinics may be the lack of uniform exposure to the education and handout by all those practicing in all clinics. Attendance at the educational sessions and receipt of the screening handout was voluntary. Participation in the study was less than or at best 50% of physicians employed at each of the six clinics we analyzed. It is possible that if more or all physicians treating at each of the six clinics were able to attend a required meeting where the same education and instruction would be provided along with the screening handout, a more uniform exposure to the intervention for each group would be achieved, thus potentially producing a more significant effect. The same would be true regarding reducing the mean age of the patients at time of diagnosis.

In analyzing the effects of the standardized screening procedure, it did not appear to produce an "over-diagnosis" effect in our study. This can often be a

novelty effect of learning a new examination technique or method or concept that could over-inflate the rates of diagnosis. This did not happen when our subjects utilized this standardized screening procedure, indicating that this procedure does not cause users to over-diagnose these types of patients.

This study is limited by the retrospective chart review being performed in one group of 6 clinics affiliated with one hospital system. It would be most beneficial to re-examine the impact of this standardized screening procedure in a multi-center study. It is important to note the low range of incidence of torticollis and plagiocephaly patients overall for all clinics which participated in this study (torticollis range= 0.0%-0.6%, plagiocephaly range = 0.0%-1.3%) in comparison to the range of incidence reported in the literature (torticollis = 0.3%-3.9%, plagiocephaly = 13%-48%).[4,12,21,22] This was not, however, due to a smaller sample size. The patients in our study were diagnosed out of a relatively large pool of patients (for total patients under 2 years of age seen at all clinics for all diagnoses, n=33,517). This would indicate that our sample would be appropriate to apply an intervention aimed at increasing diagnostic skill and accuracy. Our intervention, however, failed to significantly change the percent of torticollis and plagiocephly diagnosis over all clinics. It is possible that a live demonstration in more detail on how to utilize the screening method at the time of presentation would show a more effective outcome and increase the accuracy of learning.

Another limitation is that many of the clinics involved in this study utilized paper notes and referrals during the study period in our chart review. Analyzing a group of clinics which all utilize electronic documentation for all patient visits and

referrals would remove any record keeping errors and accurate data could be collected.

Due to the overall lack of significant increase in the percent of patients diagnosed with either torticollis or plagiocephaly across all clinics, it would be beneficial for future studies to examine the effects of this standardized screening procedure in other pediatric academic, community, or clinical settings. Studying the effects of this method of identification and diagnosis in a group of pediatric residents with a control group may further illustrate its use in the education of pediatricians. Another more experimental design would be to pre-screen a group of pediatric patients, establish those who have torticollis and plagiocephaly based on a group of 2-3 expert examiners, then allowing a group of physicians recently educated with the intervention method to examine the same group of children, after which a comparison of diagnostic frequency and accuracy could provide more validity to the screening method.

Conclusion

This study showed that providing a standardized examination technique for torticollis and plagiocephaly significantly improved resident physicians' confidence and self-reported practice patterns regarding the diagnosis and management of these two disorders. Also there was a significant increase in the diagnosis rates of plagiocephaly in one of the six clinics analyzed, as well as a significant decrease in the mean age at diagnosis of torticollis in one of the six clinics we examined. We believe this standardized examination technique can be useful in educating resident

pediatricians on how to diagnose torticollis and plagiocephaly in a more accurate and timely manner. Further studies on the effectiveness of this standardized screening procedure are warranted.

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APPENDIX A

PRE-LECTURE QUESTIONNAIRE

1. How often do you screen for Torticollis in your physical exam? (Please circle only one answer)
    a. ☐ I don't screen for torticollis in my regular physical exam
    b. ☐ I screen if the child's parent mentions a concern regarding head tilt
    c. ☐ I screen when I see the child's head tilting to one side
    d. ☐ I screen for torticollis nearly every physical exam

2. How often do you screen for Plagiocephaly in your physical exam? (Please circle only one answer)
    a. ☐ I don't screen for plagiocephaly in my regular physical exam
    b. ☐ I screen if the child's parent mentions a concern regarding head shape
    c. ☐ I screen when I see the child's head is abnormally shaped
    d. ☐ I screen for plagiocephaly nearly every physical exam

3. How comfortable do you feel with screening and diagnosing Torticollis?

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Comfortable | Somewhat Comfortable | Very Comfortable

4. How comfortable do you feel with screening and diagnosing Plagiocephaly?

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Comfortable | Somewhat Comfortable | Very Comfortable

5. How often do you diagnose Torticollis during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

6. How often do you diagnose Plagiocephaly during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

7. How often do you prescribe physical therapy intervention for Torticollis during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

8. How often do you prescribe a Plagiocephaly Molding Helmet and/or refer to the Craniofacial Clinic during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

9. What training were you given on how to screen for torticollis as a regular part of a well-child physical exam? (Circle all that apply)
    a. ☐ None
    b. ☐ A little in residency
    c. ☐ I was taught specifically how to screen in residency
    d. ☐ Since residency via CME or my own reading
    e. ☐ Through mentoring by colleagues in my practice

10. What training were you given on how to screen for Plagiocephaly as a regular part of a well-child physical exam? (Circle all that apply)
    a. ☐ None
    b. ☐ A little in residency
    c. ☐ I was taught specifically how to screen in residency
    d. ☐ Since residency via CME or my own reading
    e. ☐ Through mentoring by colleagues in my practice

11. How helpful would you find a Quick Guide to Screening for Torticollis in your practice?

0	1	2	3	4	5
☐	☐	☐	☐	☐	☐
Not Helpful		Somewhat Helpful			Very Helpful

12. How helpful would you find a Quick Guide to Screening for Plagiocephaly in your practice?

0----------1----------2----------3----------4----------5

☐ ☐ ☐ ☐ ☐ ☐

Not Helpful | Somewhat Helpful | Very Helpful

13. Please indicate how many years you have been practicing in Pediatrics._____

14. (Attending physicians) Please indicate the number of half-days you work per month in your primary care practice (not resident clinic)? _____

15. (Resident physicians) For this month, please indicate the number of half-days you will work at the PTO or Sac-Norton Clinic?_____

APPENDIX B

FOLLOW-UP QUESTIONNAIRE

1. How often do you screen for Torticollis in your physical exam? (Please check only one answer)
    a. ☐ I don't screen for torticollis in my regular physical exam
    b. ☐ I screen if the child's parent mentions a concern regarding head tilt
    c. ☐ I screen when I see the child's head tilting to one side
    d. ☐ I screen for torticollis nearly every physical exam

2. How often do you screen for Plagiocephaly in your physical exam? (Please check only one answer)
    a. ☐ I don't screen for plagiocephaly in my regular physical exam
    b. ☐ I screen if the child's parent mentions a concern regarding head shape
    c. ☐ I screen when I see the child's head is abnormally shaped
    d. ☐ I screen for plagiocephaly nearly every physical exam

3. How comfortable do you feel with screening and diagnosing Torticollis? (Please check the box under the corresponding number)

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Comfortable — Somewhat Comfortable — Very Comfortable

4. How comfortable do you feel with screening and diagnosing Plagiocephaly? (Please check the box under the corresponding number)

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Comfortable — Somewhat Comfortable — Very Comfortable

5. How often did you diagnose Torticollis during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

6. How often did you diagnose Plagiocephaly during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

7. How often did you prescribe physical therapy intervention for Torticollis during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

8. How often did you prescribe a Plagiocephaly Molding Helmet and/or refer to the Craniofacial Clinic during an average month? (Please circle only one answer)
    a. ☐ Less than 1 time/month
    b. ☐ 1-5 times/month
    c. ☐ 6-10 times/month
    d. ☐ 11 or more times/month

9. How helpful did you find the Quick Guide to Screening for Torticollis in your practice?

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Helpful — Somewhat Helpful — Very Helpful

10. How helpful did you find the Quick Guide to Screening for Plagiocephaly in your practice?

    0----------1----------2----------3----------4----------5

    ☐ ☐ ☐ ☐ ☐ ☐

    Not Helpful — Somewhat Helpful — Very Helpful

APPENDIX C

SCREENING GUIDE TO TORTICOLLIS AND PLAGIOCEPHALY

LOMA LINDA UNIVERSITY HEALTH

Torticollis Quick Screening Guide

(By Lisa Hwang, DPT, DSc Candidate)

Torticollis Exam: Ages 0-4 months

1. Palpation of bilateral SCMs

Palpate along the muscle belly of the SCM on each side, checking for a mass or thickening of the SCM.

2. Supine rotation AROM/PROM

With the child placed in supine, the examiner stands above the head, and provides a visual or auditory stimulus for the child to rotate their head towards. If the child does not fully turn to one side, the examiner gently rotates the child's head slowly to the side while stabilizing the shoulders, looking to see if the chin reaches to the midline of the shoulder. The test is repeated on the contralateral side.

3. Supine lateral flexion passive ROM

With the child placed in supine, the examiner stands above the head, and gently tilts the child's head to the side while stabilizing at the shoulder, looking to see if the amount of lateral flexion is equal to the opposite side. The test is repeated on the contralateral side.

Torticollis Exam: Ages 4-6+ months

1. Palpation of bilateral SCMs

Palpate along the muscle belly of the SCM on each side, checking for a mass or thickening of the SCM.

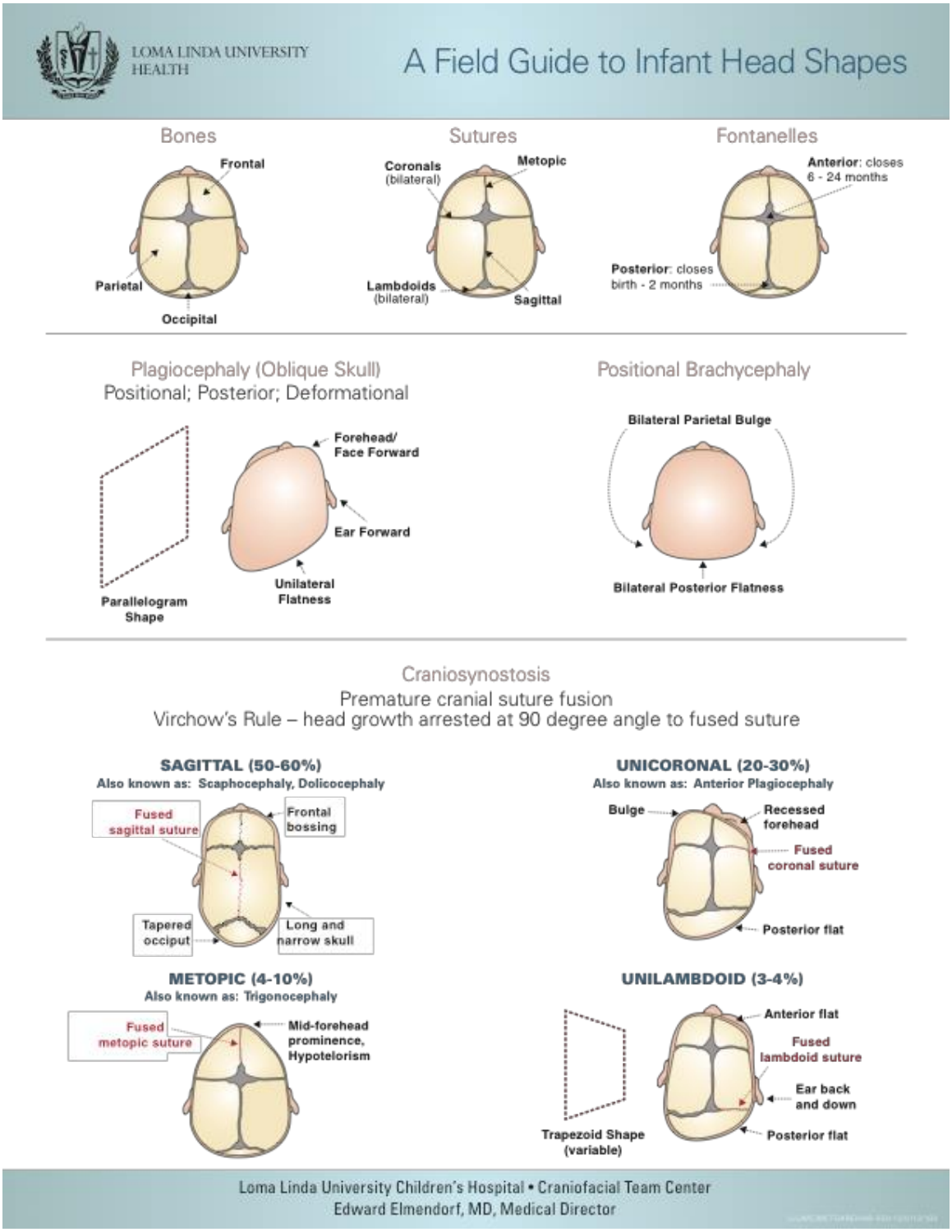
2. Seated chair rotation test

With the child placed in sitting on the lap of the parent, the examiner provides a visual stimulus while the parent rotates in the chair until the child is looking over their shoulder. The examiner is looking to see if the chin reaches all the way to the midline of the shoulder, with the nose aligned vertically. The test is repeated on the contralateral side.

3. Optical righting test

With the child seated on the knee of the parent, the examiner instructs the parent to tilt the child's body to approximately a 45 degree angle, while providing a visual stimulus. The examiner is looking to see if the child is able to maintain their head up, with the eyes horizontal and the nose vertical while the body is being tilted. The test is repeated on the contralateral side.

Please check our our video here, by scanning this QR Code on your QR App.


LOMA LINDA UNIVERSITY HEALTH
A Field Guide to Infant Head Shapes
Bones
Frontal
Parietal
Occipital
Sutures
Coronals (bilateral)
Metopic
Lambdoids (bilateral)
Sagittal
Fontanelles
Anterior: closes 6 - 24 months
Posterior: closes birth - 2 months
Plagiocephaly (Oblique Skull)
Positional; Posterior; Deformational
Parallelogram Shape
Forehead/ Face Forward
Ear Forward
Unilateral Flatness
Positional Brachycephaly
Bilateral Parietal Bulge
Bilateral Posterior Flatness
Craniosynostosis
Premature cranial suture fusion
Virchow's Rule – head growth arrested at 90 degree angle to fused suture
SAGITTAL (50-60%)
Also known as: Scaphocephaly, Dolicocephaly
Fused sagittal suture
Frontal bossing
Tapered occiput
Long and narrow skull
UNICORONAL (20-30%)
Also known as: Anterior Plagiocephaly
Bulge
Recessed forehead
Fused coronal suture
Posterior flat
METOPIC (4-10%)
Also known as: Trigonocephaly
Fused metopic suture
Mid-forehead prominence, Hypotelorism
UNILAMBDOID (3-4%)
Trapezoid Shape (variable)
Anterior flat
Fused lambdoid suture
Ear back and down
Posterior flat
Loma Linda University Children's Hospital • Craniofacial Team Center
Edward Elmendorf, MD, Medical Director