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Association of Pediatric Headache and Head Roll in Southern Taiwan

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Abstract

Background: Pediatric headache is a multifactorial disease and may lead to substantial levels of disability. However, the ophthalmological factors in pediatric headache remained unclear. This study aimed to investigate the contribution of ophthalmological factors in pediatric headache in Taiwan.

Design: Retrospective, population based, cross-sectional study.

Participants: 2727 children, between age of 7 to15, in Yu-Lin and Chia-Yi counties, Taiwan, during the health promotion examination were included during 2012~2014.

Methods: General health examinations, including body weight, body height, visual acuity, and skeletal development, were recorded. Headache was assessed by questionnaire. The ocular alignment was measured by cover-and-uncover test. Ocular height, and head position were measured utilizing photographs of children in front of the modified Amsler grid.

Main outcome measures: The risk factors for pediatric headache were analyzed using univariate and multivariate comparisons.

Results: The prevalence of headache increased from 5.2% at the age of 7-9 group to 9.3% at the age of 10-12 group, and became 17.9% at the age of 13-15 group. Girls have a higher prevalence rate than boys (1.4:1). Headache was not associated with body height, body weight, or sleep duration. Head-roll and asymmetric ocular height were the significant predictors for the headache (p<0.001, 95% CI: 2.261-3.744; p=0.01, 95% CI 1.085-1.822, respectively). Children with myopia were at higher risk of headache then children with hyperopia and emmetropia (p=0.001, 95% CI 1.197- 2.059). Anisometropia was not related to headache.

Conclusions: Asymmetric ocular height and head roll resulted in excessive muscle strain around neck and head, which could contribute to headache. Adequate ophthalmological examination is suggested in assessing children with pediatric headache.

Keywords: Pediatric headache; Binocular alignment; Phoria adaption; Vertical vergence; Ocular tilt reaction

Introduction

Among the causes of absence from school, headache is the third most common illness and leads to substantial impairment in pediatric patients [1-5]. Patients with headache disorders often report a number of somatic and emotional disturbances, such as back pain, gastrointestinal symptoms, allergic disorders and even depression [6]. For headache disorders, tension-type headache (TTH) is the most common in both adolescents and children. TTH is characterized by bilateral, mild to moderate intensity, and non-throbbing, pressing/tightness pain that occurs anywhere on the cranium or sub-occipital region [7,8].

The pathogenesis of TTH is multifactorial, but the precise mechanism remains uncertain. Activation and sensitization of peripheral and central pain pathway may contribute to TTH. Persistent and chronic oversensitization of nociceptors in peripheral system will cause alteration in central pain pathway, and result in chronic type of TTH. Some factors, such as stress, mental tension and head/neck movement, have been noted to precipitate and aggravate TTH. The static eye position and dynamic horizontal component have been demonstrated to be related to neck muscle activity [9,10], however, the contribution from ophthalmologic aspect has rarely been addressed in field study.

Precise binocular alignment of the visual axes is one of the most important prerequisites for good vision [11]. One of the functions of the oculomotor system is to keep the two eyes properly rotated so that corresponding points of the tow images fall within Panum's fusional area. Rotation of the head about a naso-occipital axis (roll) produces counter-rotation of the eyes about the ling of sight (torsion) [12]. Because of orbital mechanics and the secondary action of the obliques (depression for the superior oblique and elevation for the inferior oblique) ocular counterrol (OCR) wound be accompanied by vertical skew deviations of the eye if left uncompensated by the oculomotor system. Additionally, superior and inferior oblique palsies cause head-poistion-dependent vertical phorias as do certain deficits in otolith-ocular pathways [2]. In order to keep the eyes properly aligned vertically in the face of these potential problems, it seemed reasonable to assume that the oculomotor system would be alter vertical eye alignment in relation to head roll.

The accurate coordination of binocular eye movements is of obvious importance to stereoscopic vision [13]. It has shown that accommodative stimuli combine with the activation of neck muscle proprioception. Also, motor units firing rate and recruitment increase when the gaze shifts the ipsilateral side [10]. Vertical and torsional binocular alignment can be adapted with respect to orbital eye position, horizontal vergence, and head rolling with respect to gravity and virtually any combination of the above. The coordination of head tilt, ocular counterroll and vertical vergence is maintained by adaptive mechanism to acquire clear single vision. When the head tilt to one side for the visual compensation or due to asymmetric skeletal development, the musculature on both side of neck and head is exerted differentially. It is possible that the asymmetric muscular tension and gravity might induce muscle strain in the neck, which further caused neck soreness and TTH. Our study aimed to investigate the association between head-roll and pediatric TTH.

Methods

Patients

From Sep 2012 to May 2014, 2,727 participants were enrolled from 8 elementary and junior high schools in Chia-Yi and Yu-Lin Counties, Taiwan. The informed consent was obtained from all parents or guardians. The research was conducted according the guidelines of the Tenets of the Declaration of Helsinki. We took the detailed personal history of each participant and conducted a general pediatric health examination, skeletal development survey, and an ophthalmological assessment. All participants were also inquired about headache history.

Procedures

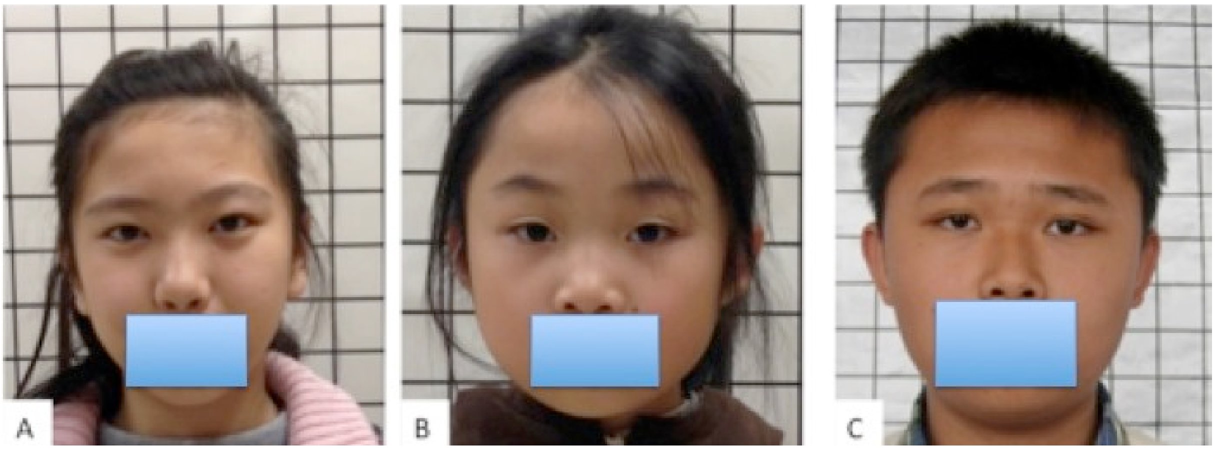

Figure 1: The ocular height. (A). The left eye ball is higher than then the right eye ball; (B). The both eyeballs are in the same height; (C). The right eye ball is higher.

The general health examination included the examination of body height and body weight. The body weight index (BMI) was derived from these two measures. The duration of sleep and the medication history were self-reported by the students. Assessment for headache was started by children's statement. When the children claimed they knew about headache and they have suffered from headache, further questionnaire about the characteristics and associated symptoms were addressed. According to diagnostic criteria for TTH, a short questionnaire was performed, as described by the international classification of headache disorders (3rd edition) [7]. Children were classified as suffering from TTH if they had experienced 10 episodes of headache in the life time, each lasting 30 minutes to 7 days, with bilateral location, non-pulsating quality, mild to moderate severity, not aggravated by routine activities and not accompanied by nausea, vomiting, photophobia and phonophobia. Adam's Forward Bend Test and a scoliometer were used to detect the degree of scoliosis. Normal spine development was defined as scoliometer inclination of less than 5°. If inclination was greater than 5°, the scoliometer result was recorded about the side and the degree of deviation. Posture analysis was taken by the photographing the students in their sitting position with a modified Amsler grid chat behind them. The ocular position was defined as the binocular eyes position based on the face symmetry (Figure 1).

The head rolling was evaluated from the neutral position of the patients (Figure 2). The ophthalmology examination included tests of visual acuity (with and/or without spectacles), intraocular pressure (IOP, ICare®, Tiolat Oy, Helsinki, Finland), auto-refraction status

(KR-7000; Topcon Inc., Tokyo, Japan), and stereo-acuity (Titmus test, Stereo fly test, Stereo Optical Co., Inc., Chicago, IL, USA). Ocular alignment was evaluated by cover-uncover test by the same ophthalmologist (Dr. LJ Lai) at the distance of one meter. Binocular alignment and head position were measured when the participant sitting in neutral position.

Figure 2: The head position of human body. (A). The head tilts to the right side; (B). The head does not tilt; (C). The head tilts to the left side.

Statistical analysis

Numeric data was expressed in mean and standard deviation. Occurrence of headache, head rolling, tilting was given in percentage. The relationship among risk factors for headache was explored by Spearman correlation test. Univariate chi-square or Fisher exact tests were first performed for all risk factors. Variables showing at least a marginally significant associated in univariate analyses were considered candidates for subsequent forward stepwise multiple logistic regression analyses. Tests of interaction were completed by a product term in the multivariate model for head tilt, binocular position, or ocular alignment. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported for the significant independent risk factors included in the final model. All statistical analysis was performed using SPSS software version 17.0 (SPSS Inc., Boston, USA) and a significant level of defined less than 0.05.

Results

Descriptive Data

The age of these 2,272 school children ranged from 7 to 15 years. The ratio of male to female was equal. Half of the children (53.7%) had normal body weight (within 85 percentile), 31.4% of the children were over-weighted and 14.9% were underweighted. More than 80% of investigated students had adequate sleep time (>8 hours/day).

A number of 291 participants (10.6%) reported their headache experience, which was consistent with the diagnosis of TTH (Table 1). Measurement of ophthalmological parameters was summarized in Table 2. For refraction condition, 57% children were myopia, 4% were hyperopia, and 37% were emmetropia. For ocular alignment, orthophoria was noted in 63.5% children, exotropia was 2.1%, esotropia was 0.8%, exophoria was 27.6%, esophoria was 0.5%, heterophoria was 1.3% and combined heterophoria and exophoria was 3.8%. A number of 1,750 children (64.2%) had the same height eyeball position. The head position was normal in 69.5%, and head roll was found in 30.5% of children. Prevalence rate of headache increased with age: 5.2% at aged 7-9, 9.3% at aged 10-12,and 19.6% at aged 13-15 (Figure 3). Headache was slightly more prevalent in female. The majority of the students reported that their headache was related to stress at schools and alleviated by sleep or taking time off school. Only 1.3% of the school children needed medication for pain relief and 8.85% of the children hadever consulted pediatric doctors for headache.

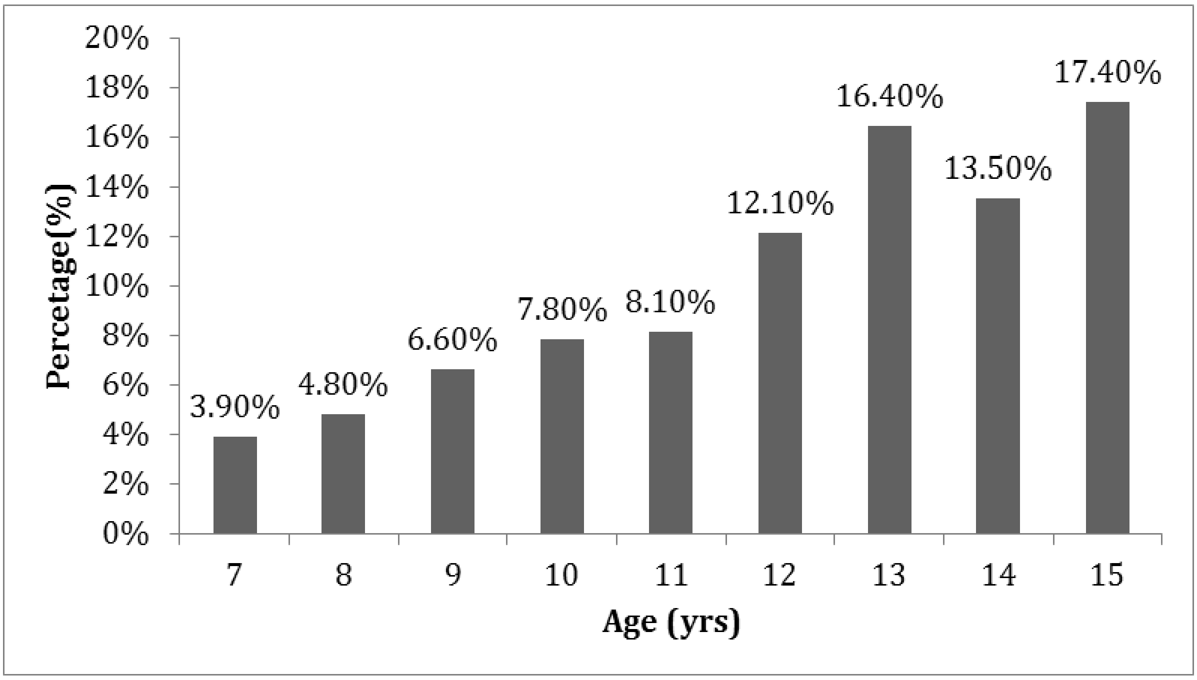

Figure 3: The prevalence of pediatric headache in Taiwan.

	N=2727; mean (SD)
Gender	
Male	n=1371(50.3%)
Female	n=1356(49.7%)
Age	10.80 (2.31)
Body Height (BHt, cm)	139.55 (13.35)
Body Weight (BWt, Kg)	38.17 (13.68)
Body Mass Index (BMI)	19.04 (4.11)
Sleep duration	
≥8 hours/ day	n=2208(80.9%)
<8 hours/ day	n=519(19.1%)
Scoliosis	
≤5 degree	n=2229(81.7%)
>5 degree	n=204(18.3%)
Headache	n=291(10.6%)
BMI=BWt(Kg)/ BHt^2 (M)	

Table 1: Baseline Demographics of Patients in Taiwan.

	N=2727 (%)
Refraction Status	
Myopia	n=1550(57%)
Hyperopia	n=117(4%)
Emmetropia	n=1060(39%)
Head position	
Normal	n=1896(69.5%)
Head tilt	n=831(30.5%)
Ocular height	
Normal	n=1750(64.2%)
Un-symmetric	n=977(35.8%)
Ocular alignment	
Orthophoria	n=1732(63.5%)
Horizontal shift	n=865(31.7%)
Vertical shift	n=130(4.8%)

Table 2: Ophthalmologic data of Children in Taiwan.

Statistic Data

The headache prevailed in children with a head roll and symmetric ocular height. ($p<0.01$) (Figure 4). The headache was also correlated with head position ($p<0.01$), ocular height ($p<0.01$), ocular alignment ($p<0.01$) and refraction ($p<0.01$) significantly (Table 3). Children with myopia tended to have higher chance of headache ($p=0.001$). Anisometropia was not related to theheadache ($p=0.799$). The body

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mass index (BMI) did not correlate with headache (p=0.798); nor did the sleep duration (p=0.216).

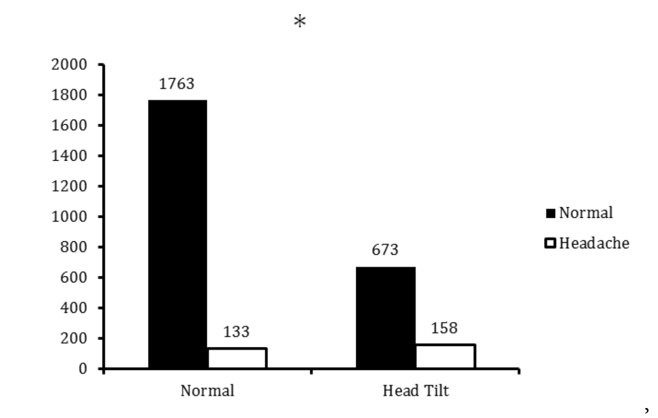

Figure 4: The relationship of headache and head roll.

Logistic regression analysis showed that head position, ocular height and refraction were independent predictors for headache, with a 95% CI of 2.261-3.744, 1.085-1.822, and 1.97-2.059, respectively (Table 4).

	Headache	HP	OH	OA	Ref	Ani	BMI	Sleep
Headache	1.00							
Head position (HP)	.18**	1.00						
Ocular height (OH)	.14**	.60**	1.00					
Ocular alignment (OA)	.09**	.16**	.22**	1.00				
Refraction (Ref)	.08**	.026	.03	.22**	1.00			
Anisometropia (Ani)	-.01	.00	-.01	-.02	-.01	1.00		
BMI	.01	-.05*	.03	.06**	.09**	.05*	1.00	
Sleep	.03	-.03	.01	.05*	.05*	.00	.10**	1.00
**p value 0.01; * p value 0.05								

Table 3: The correlation of between headache and head position(HP), ocular height(OH), ocular alignment (OA), refractory status (Ref), Anisotropia (Ani), body mass index (BMI), sleep were demonstrated.

	β† ± SE#	P value	95% CI
Head position (HP)	1.068±0.129	.00*	2.261,3.744
Ocular height (OH)	0.341±0.132	.010*	1.085,1.822
Refraction	0.451±0.138	.001*	1.197,2.059
†β, standardized partial regression coefficient. #SE, standard error. *p value <0.05			

Table 4: Effect of risk factors of headache.

Discussion

Headaches are one of the most commonly reported health complaints in school children [13,14] and the most frequently reposted pain in these age groups [15,16]. Our study shows that prevalence of TTH increase with increaing age. Girls have a higher prevalence rate than boys. Head-roll and asymmetric ocular height are the significant predictors for the TTH. Furthermore, children with myopia were at higher risk of headache then children with hyperopia and emmetropia.

Numerous epidemiological of headache in children and adolescents have been conducted over the last decades in various countries and societies [5,17]. Survey conducted in Scandinavia, Holland and Taiwan also indicated that school-aged children report frequent headache with increasing prevalence rate [18,19]. Our study confirms some observation that there is an increasing prevalence of frequent headache with increasing age [2,3]. Gabmann et al. (2009) reported that 2.6% of 8-year-old and 10.7% of 15-year-old children had at least one headache weekly [20]. Other studies conducted in Canada, Southern England and Italy also show the same trends [21-23]. It has shown that body weight and sleep time are related to certain type, but not all of primary headache. Pakalnis and Kring found that a higher proportion of children and adolescents in the pediatric headache group as a whole were overweight than in the general population [24]. Furthermore, they also noted a closer link between chronic migraine and obesity, but not a link with chronic TTH and obesity. The same association between overweight and migraine, but not TTH, was also observed [25]. Similarly, Waldie et al found that reduced sleep duration was associated with migraine, but not with TTH [26]. Our study also demonstrate that occurrence of TTH is not correlated to BMI and sleep time.

For refrection condition, Akinci et al. found a high prevalence of uncorrected and miscorrected refractive errorsamong children 8 to 18 years old with headache in whom an evaluation by a pediatric neurologist [27]. Dotan et al. showed uncorrected ametropia was a possible cause of headache [28]. Gil-Gouveia et al. found that headache was more common in individuals with uncorrected refractive errors compared to matched controls without this refractive abnormality [29]. In the study of Robaei et al. children wearing glasses without having a significant refractive error in either eye were more likely to have eye-strain or headache complaints compared to all other children [30]. Our study suggested that children with myopia have a higher prevalence of TTH relative to children with hyperopia. Anisometropia did not have correlation with headache. Based on the results above, children with headache who wearing glasses or contact lenses should be similarly evaluated for wearing the proper correction.

Our study confirmed that ophthalmologic and musculoskeletal risk factors correlate with pediatric headache. Currently, activation and sensitization of myofascial nociceptors are thought to be the most likely of major importance in TTH. However, the continuous nociceptive input from peripheral myofascial structures caused by head roll has rarely noted. When the binocular position is in different horizontal plane, the head tends to have a degree of roll to achieve binocular visual function precisely [31]. Such binocular visual feedback is used to calibrate binocular eye alignment continually so that the retinal images of the two eyes remain in correspondence. The head roll induces the gravity of the head to move to the side with the eye in lower position, and further leads to different muscle tension in neck. The imbalance in weight bearing and muscle strain, similar to other nociceptive stimulation of supraspinal structures, is one of the possible contributions in children with TTH.

Several limitations should be acknowledged in the current study. First, the subtype of TTH cannot be classified precisely in these school children. Differential diagnosis between migraine and tension-type headache was not certainly made. It was difficult to distinguish these two kinds of pain in children during a very short time of interview. Meanwhile, children seldom experienced from any kinds of pain that the VAS scale became too subjective for children to the severity of their headache. The variation from children to children was too difficult to be qualified statistically. Further study should be addressed on the associated aggravation symptom (such as nausea, vomit, abdominal pain, photophobia, or phonophobia), or relieving factors such as sleep or medication. Second, the current study was an observation study that the interaction between the severity of headache and the degree of head roll was not fully investigated. Further study is warranted to evaluate this association. It is possible that the visual function can be corrected, at least in part, by prism adaption to decrease its role in headache.

In conclusion, this study suggests that the binocular height and head position, though a mechanism not yet well known, is likely to be correlated to the primary headache. Health providers such as teachers and parents can evaluate the children's head position and ocular alignment to survey the headache. This is a work in progress; in face we intend to continue the study by expanding the case series, posture vision analysis, and using the study of functional neuroimaging, with the aim of investigating more thoroughly the possible overlaps between the primary headache and uncompensated oculomotor system. Further studies are necessary not only to improve the diagnostic approach to children headache, but also to improve non-pharmacological therapeutic intervention.

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Contributors

All authors were involved in the study concept and design, data collection, standardized re-assessment of patient information, study conduct, data summary and analysis, literature search, and writing of the report.

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