Correlation between signs of temporomandibular (TMD) and cervical spine (CSD) disorders in asthmatic children

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Neck accessory respiratory muscles and mouth breathing suggest a direct relationship among asthma, Temporomandibular (TMD) and Cervical Spine (CSD) Disorders. This study was performed to evaluate and correlate TMD, CSD in asthmatic and non-asthmatic. Thirty asthmatic children (7.1 ± 2.6 years old), 30 non-asthmatic predominantly mouth breathing children (Mouth Breathing Group - MBG) (8.80 ± 1.61 years) and 30 non-asthmatic predominantly nasal breathing children (Nasal breathing Group – NBG) (9.00 ± 1.64 years) participated in this study and they were submitted to clinical index to evaluate stomatognathic and cervical systems. Spearman correlation test and Chi-square were used. The level of significance was set at $p<0.05$. Significant frequency of palpatory tenderness of temporomandibular joint (TMJ), TMJ sounds, pain during cervical extension and rotation, palpatory tenderness of sternocleidomastoids and paravertabrae muscles and a severe reduction in cervical range of motion were observed in AG. Both AG and MBG groups demonstrated palpatory tenderness of posterior TMJ, medial and lateral pterygoid, and trapezius muscles when compared to NBG. Results showed a positive correlation between the severity of TMD and CSD signs in asthmatic children (r = 0.48). No child was considered normal to CSD and cervical mobility. The possible shortening of neck accessory muscles of respiration and mouth breathing could explain the relationship observed between TMD, CSD signs in asthmatic children and emphasize the importance of the assessment of temporomandibular and cervical spine regions in asthmatic children.

J Clin Pediatr Dent 29(4): 287-292, 2005

INTRODUCTION

Temporomandibular Disorders (TMD) is a collective term embracing all the problems relating to Temporomandibular joint (TMJ) and related musculoskeletal masticatory structures.[3] It refers to a cluster of disorders characterized by pain in the preauricular region or TMJ pain, limitation or deviations in mandibular range of motion and sounds in the TMJ during mandibular function.[8]

Its etiology is multifactorial.[32] TMJ trauma, malocclusion and occlusal interferences, speech and masticatory muscles functional alteration, rheumatologic problems, emotional stress, anxiety, depression and postural abnormalities[12,16,35] could be associated to the development of TMD.[21]

Many authors reported high frequency of clinical signs as well as subjective symptoms of TMD in children.[2,5,25,28,32] The reported prevalence vary greatly from 6% to 68%.[2,5, 25,28,32]

Cervical Spine Disorders (CSD) are common conditions affecting the cervical region and related structures with or without radiation of pain towards shoulders, arms, interscapular region and head.[7]

Many studies in the literature have reported associations between CSD and TMD in adults. In a previous research, Visscher *et al.*[34] reported that signs and symptoms of cervical spine alterations were significantly higher in both myogenous and/or arthrogenous TMD patients in relation to healthy controls. Pedroni *et al.*[22] used Fonseca anamnesis index to evaluate TMD in university students and verified that more than 60% exhibited cervical spine rectification and forward

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shoulder position. Fink *et al.*[12] and Stiesch-Scholz *et al.*[30] also reported associations between internal TMJ derangement and cervical spine alterations. However, there is a lack of studies, reporting signs of TMD and CSD in children with or without respiratory diseases like asthma.

Asthma is the most common chronic disease in childhood.[1] It results in widespread narrowing of airway cross-section diameter due to contraction of bronchial smooth muscle mediated by parasympathetic division of the autonomic nervous system.[17]

Analyses of the asthma clinical features suggest associations among asthma, TMD and CSD due to allergic symptoms related to asthma features and the following development of mouth breathing[10] leading to cervical[23] and stomatognathic[14] systems alterations, and by the use of cervical accessory muscles of respiration during the intra or inter-crises periods predisposing such children to postural alterations, TMD and CSD.[14]

Ribeiro *et al.*[23] reported higher electrical activity of respiratory neck muscles in mouth breathing children during nasal respiration in relation to oral respiration. Forward head posture showed to be significantly related to TMD in non asthmatic children in the mixed dentition.[15] Hruska *et al.*[14] reported that non-traumatic respiratory mechanical dysfunction with electrical hyperactivity of scalenes, sternocleidomastoids, upper trapezius may also result in forward inclination of the head and concomitant TMD in asthmatic patients. However, clinical studies reporting the associations between signs and symptoms of TMD and CSD have not been conducted yet in adult or children asthmatic populations.

In view of such possible interactions among asthma clinical features, TMD and CSD and the lack of studies directed to analyze the interactions mentioned above the aim of this study was to compare and correlate clinical signs of TMD and CSD in asthmatic children when compared to non-asthmatic children with and without mouth breathing.

METHODS

Subjects

Ninety children, 45 female and 45 males were included in this study. The groups consisted of 30 asthmatic children (8.93 ± 2.58 years) with or without mouth breathing (Asthma Group - AG), 30 non-asthmatic predominantly mouth breathing children (Mouth Breathing Group - MBG) (8.80 ± 1.61 years) and 30 non-asthmatic predominantly nasal breathing children (Nasal Breathing Group – NBG) (9.00 ± 1.64 years). The children were matched by age and sex in relation to asthmatic children. All asthmatic should have a clinical diagnosis of asthma to inclusion.

To be considered a mouth breathing the children must have at least three diagnostic criteria: parents report of mouth breathing during day or night, open mouth posture or lip incompetence during interview and a clinical diagnosis of mouth breathing. Children were considered as non-asthmatic if they have obtained a score $\leq$ 4 in the questionnaire of the International Study of Asthma and Allergies in Childhood (ISSAC).[26]

This study was approved by the Ethics Committee in Research Clinics of Hospital from Medicine College of Ribeirão Preto - University of São Paulo (USP). Written informed consent was obtained from all participant parents. Asthmatic children with inconclusive asthma diagnosis, previous orthodontic or postural reeducation treatment, presence of general joint disorders that might involve head and neck region, history of jaw fractures or orthognathic surgery were excluded.

Clinical evaluation and anamnestic questionnaire

Clinical evaluation of respiratory conditions and associated conditions were performed. The observations were performed always by the same examiner. Mouth breathing severity was evaluated according to Emerson and Cordeiro’s Criteria.[10]

Parafunctional habits were confirmed during clinical examination. Clinical evidence of bruxism was indicated by the presence of tooth wear.[32] In addition, to children’s parents were administered a questionnaire to investigate the existence of oral parafunction and respiratory characteristics. Bruxism (grinding and /or clenching) was defined as non-functional mandibular movements with or without audible sounds during day or night.

Severity of TMD signs were evaluated according to Helkimo’s Clinical Craniomandibular Dysfunction (ICCMD) and Mandibular Mobility indexes (IMM)[13] and Severity of CSD signs were assessed as proposed by Wallace and Klineberg’s Clinical Craniocervical Dysfunction (ICCSD) and Cervical Mobility (ICM) indexes.[36] The ICCMD and ICCSD allowed classifying asthmatic children according to severity calculating the score obtained from each item of indexes, thus: 0 = clinically symptom free; 1-4 points = mild dysfunction; 5 – 9 points = moderate dysfunction and 10 – 25 points = severe dysfunction. Each question has three items and three possible answers (0, 1 e 5 points). In the same way, IMM and ICM allowed classifying range of motion (ROM) restrictions, considering the sum of scores: 0 = normal ROM; 1 – 4 points = reduced range of movement and 5 – 20 points = severely impaired range of movement.

Mandibular ROM during protrusion, mouth opening and lateral deviations to right and left was registered by a Mytutoio boley gauge according to Okeson.[20] Cervical ROM was registered using an universal goniometer according to Wallace and Klineberg.[36] Movements assessed were flexion, extension, lateral bending to right and left and rotations to right and left.

Each movement was repeated three times, by the same examiner, in order to obtain an average of the values.

Tenderness to palpation was assessed in the masticatory muscles (anterior and posterior temporal, masseter, lateral and medial pterygoid) and neck muscles (sternocleidomastoids, trapezius and cervical paravertebrae). Tenderness to palpation on muscles and in the lateral and posterior TMJ aspects was assessed on each side by unilateral palpation with firm pressure exerted by one finger at a pressure of approximately 1kg/cm^2/s. Only tenderness that triggered reflex blinking or flinching were considered.[4] Evaluation of palpatory tenderness of the posterior site of TMJ was performed through the meatus acusticus.[4]

Statistical analysis

Differences in the frequencies of clinical signs of TMD and CSD among the three groups were verified using Chi-square test. Spearman rank order correlation test was applied to correlate IDCCM and IDCCC scores in each group considered. The level of significance was set at $p \leq 0.05$.

RESULTS

Data obtained by clinical examination are presented in Table I. Parafunctional habits were observed in more than 60% of the children evaluated and more than 50% of asthmatic and mouth breathing children showed signs of bruxism. Finger or dummy sucking habits were not different among groups. A relevant data to be considered was the great number of predominantly mouth breathing children among asthmatic observed in this study. More than 70% could be consider as moderate or severe mouth breathing in both groups AG and MBG (Table I).

Table I. Topics of the clinical examination and questionnaire data (n = 90)

Respiratory topics	**AG (n = 30)**	**MBG (n = 30)**	**NBG (n = 30)**
Finger and dummy sucking habits	63.34%	60.00%	66.67%
Bruxism*	50.00%**	60.00%**	16.67%
Mouth breathing	96.60%	100.00%	0%
Mild	3.34%	13.34%	0%
Moderate	50.00%	50.00%	0%
Severe	43.34%	36.67%	0%
Rhinitis	93.34%	70.00%	23.34%
Sinusitis	33.34% **	36.67%**	23.34%

* Sleep bruxism (as reported by parents) associated with tooth wear
** p < 0.00001 chi-square
AG= Asthma Group, MBG= Mouth Breathing Group, NBG = Nasal breathing Group

A significant positive correlation (R=0.48, p=0.01,) was found between scores on Clinical Craniomandibular Dysfunction (ICCMD) and Clinical Craniocervical Dysfunction (ICCSD) Indexes for AG, however for MBG (R=0.34, p=0.06) and NBG (R=0.27, p=0.16) the correlation was not significant as illustrated by Table II.

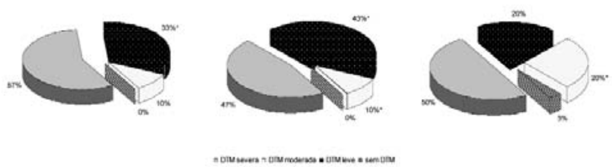
Table II. Correlation between indexes scores considering the three groups of this study (n = 90)

Indexes Correlations	AG (n = 30)	MBG (n = 30)	NBG (n = 30)
ICCSD and ICCMD	r = 0.48*	r = 0.34	r = 0.27

* p = 0.01, Spearman Correlation
AG= Asthma Group, MBG= Mouth Breathing Group, NBG = Nasal breathing Group, ICCMD = Index of Clinical Craniomandibular Dysfunction, ICCSD = Index of Clinical Craniocervical Dysfunction

According to ICCMD and ICCSD, asthmatic children were classified regarding to severity of TMD and CSD signs. Moderate TMD and moderate CSD (p = 0.002 and p = 0.01) were most common in MBG and AG and NBG group demonstrated a greater frequency of children with mild signs of TMD and CSD (p = 0.0005 and 0.009, respectively). Only one child from NBG was considered as normal in relation to clinical signs of TMD. It was verified in AG a greater frequency of children with severe TMD signs (more than 56%), although it was not significant. (Figures I and II)

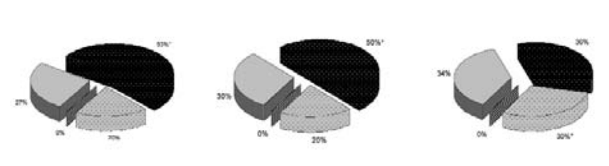
Significant frequency of pain during right lateral and left posterior palpation of temporomandibular joint (TMJ) (p=0.0001) and TMJ sounds (p=0.0001) were observed in AG. AG and MBG both demonstrated a significant frequency of pain during palpation of



AG (n=30) MBG (n=30) NBG (n=30)

* p,0.05, Chi-square test (comparisons of TMD severity frequencies among groups)

Figure I. Severity frequencies of Temporomandibular Disorders (TMD) signs in each group considered, respectively, AG (Asthma group), MBG (Mouth Breathing Group) and NBG (Nasal Breathing). (n = 90).



AG (n=30) MBG (n=30) NBG (n=30)

* p,0.05, Chi-square test (comparisons of CSD severity frequencies among groups)

Figure II. Severity frequencies of Cervical Spine Disorders (CSD) signs in each group considered, respectively, AG (Asthma group), MBG (Mouth Breathing Group) and NBG (Nasal Breathing). (n = 90).

medial (p=0.05) and right lateral pterygoid muscles (p=0.0008) and left posterior TMJ (p=0.0001). (Table III)

Table III. Frequency of Temporomandibular Disorders (TMD) signs for the groups evaluated. (n = 90)

Signs of TMD	AG (n = 30)	MBG (n = 30)	NG (n = 30)
Pain during mouth opening	13.33	13.34	16.67
Pain during lateral deviation			
R	16.67	16.67	16.67
L	20.00	13.34	16.67
Pain during protrusion	23.34	20.00	36.67
Palpatory tenderness of lateral TMJ			
R	56.67*	30.00	30.00
L	63.34*	36.67	40.00
Palpatory tenderness of posterior TMJ			
R	43.34	33.34	40.00
L	50.00	40.00	36.67*
TMJ sounds during opening	20.00*	3.34	3.34
Palpatory tenderness of masseter muscle			
R	43.34	46.67	56.67*
L	53.34	53.34	60.00
Palpatory tenderness of anterior temporalis			
R	43.34	53.34	56.67
L	36.67	53.34	46.67
Tenderness to posterior temporalis palpation			
R	26.67	43.34	43.34
L	33.34	50.00*	36.67
Palpatory tenderness of medial pterygoid			
R	90.00	86.67	76.67*
L	80.00	90.00	73.34*
Palpatory tenderness of lateral pterygoid			
R	70.00	83.34	63.34*
L	66.67	83.34	70.00
Index of Mandibular Mobility			
Normal	16.67	23.34	20.00
Reduced range of motion	73.34	66..67	63.34
Severly impaired range of motion	10.00	10.00	16.67

* p< 0.05, chi-square test (comparisons among groups)
AG= Asthma Group, MBG= Mouth Breathing Group, NBG = Nasal breathing Group, R= right and L= left

For Craniocervical Dysfunction signs AG presented significant frequency of pain during extension (p=0.0008) and left rotation (p=0.0001), pain during sternocleidomastoideus (p=0.0001) and cervical paravertebrae palpation (p=0.001) and a significant percentage of children in AG were classified as severly impaired range of cervical motion (p = 0.02) when compared to the other groups. Both AG and MBG demonstrated a significant frequency of pain during right trapezius muscle palpation (p=0.0009) (Table IV).

Table IV. Frequency of Cervical Spine Disorders (CSD) signs for each group evaluated. (n = 90**)**

Signs of CSD	AG (n = 30)	MBG (n = 30)	NG (n = 30)
Pain during flexion	10.00	6.67	10.00
Pain during extension	20.00*	13.34	10.00
Pain during rotation			
R	13.34	6.67	10.00
L	20.00*	3.34	10.00
Pain during lateral flexion			
R	20.00	23.34	23.34
L	16.67	16.67	23.34
Palpatory tenderness of sternocleidomastoids			
R	53.34*	26.67	20.00
L	46.67	26.67	26.67
Palpatory tenderness of trapezius muscle			
R	53.34*	53.34*	36.67
L	70.00*	46.67	46.67
Palpatory tenderness of cervical paravertebrae			
R	40.00*	16.67	26.67
L	50.00*	16.67	30.00
Index of Cervical Mobility			
Normal	0	0	0
Reduced range of motion	66.67	80.00	80.00
Severly impaired range of motion	33.33*	20.00	20.00

* p< 0.05, chi-square test (comparisons among groups)
AG= Asthma Group, MBG= Mouth Breathing Group, NBG = Nasal breathing Group, R= right and L= left

DISCUSSION

A positive correlation between scores on the TMD and CSD indexes was observed in this study only in asthma group (r=0.48) and could be explained by a number of factors. Increased lower respiratory tract and nasal resistance,[31] that could lead to mouth breathing habit and postural modifications of head position,[12,27] as well as, mechanical respiratory dysfunction associated to hyperactivity of neck muscles could be associated to the development of cervical spine alterations,[27] which in turn could lead TMD and CSD signs.

Recently, the association between TMD and CSD have been mentioned in the literature in adult populations. Visscher *et al*.[35] reported that in TMD patients the presence of cervical spine alterations was significantly greater in relation to a control group. Using an anamnestic index to evaluate TMD in young Brazilian college students non patients Pedroni *et al*.[22] had observed cervical spine rectification and forward shoulders position in a great proportion of the sample evaluated classified as severe TMD. Fink *et al*.[12] and Stiesch-Scholz *et al*.[30] also verified the presence of cervical spine alterations in TMD patients with internal TMJ derangement.

However, few studies that verified the association between the presence of TMD and CSD signs in children were found in the literature, especially evaluating asthmatic or mouth breathing children. Widmalm *et al*.[38] evaluated 525 pre school children and reported that 13% had recurrent TMJ pain and 11% had recurrent neck pain. Sonnesen *et al*[28] evaluated non-asthmatic children and reported a moderate correlation between TMD signs and symptoms and forward inclination of upper cervical spine, as well as, increased craniocervical angulation.

In the present study, it was observed that 90% of the asthmatic children was classified as mouth breathing and more than 80% had presented allergic rhinitis. Such data are in agreement with Corren[6] that reported a prevalence of 78% of nasal symptoms in asthma children. Venetikidou[34] had also observed significant frequency of mouth breathing habit in asthmatic children when compared to non-allergic controls. Thus, it could suggest that the improvement of TMD and CSD signs in asthmatic children are associated with mouth breathing.

Adoption of mouth breathing could be related to the development of a great number of cervical spine alterations. Stomatognathic system alterations were observed by Miller *et al.*[19] that induced mouth breathing in a sample of *Rhesus* monkeys and had observed an inferior displacement of the mandible, electromyographic alterations of suprahyoid muscles and upper lip muscles shortening. Ribeiro[23] *et al.* evaluated electromyographic cervical muscles alterations in mouth breathing children when compared to nasal breathing children. The authors observed increased electromyographic activity of cervical muscles (upper trapezius and sternocleidomastoids) during nasal breathing in mouth breathing children. In the same way, in a recent study, Ribeiro[24] *et al* found a lower activity of the same muscles during maximal voluntary contraction. Gonzalez and Manns[12] also suggested alterations in craniocervical posture and forward head position in mouth breathers.

TMD signs were observed equally in both AG and MBG in this study (table III), on the other hand, frequency of CSD signs were significant more frequent in AG in relation to the other groups (Table IV), suggesting that the mouth breathing could be directly related to the development of TMD signs, while asthma by the other hand must contribute to concomitant development of TMD as well as CSD signs, considering the correlation between TMD and CSD signs verified in this study and the significant frequencies of lateral TMJ palpatory tenderness and joint sounds (Table III) and significant frequencies for the majority of CSD signs evaluated mainly in AG (Table IV). The absence of significant correlation between scores on TMD and CSD indexes in MBG and NBG emphasis the hypothesis that specific features of asthma, in association with mouth breathing, contribute to manifestation of TMD and CSD signs in childhood.

In asthmatic children, overuse of the accessory respiratory muscles of respiration (externocleidomastoids, scalenes and upper trapezius) to breath during bronco-constriction crisis[29] and maintenance of these muscles in a shortening-tension maximal relationship can contribute to a posterior cranial rotation and forward head position, largely because of their mechanical relation to the cervical and suboccipital region,[14] collaborating for the development of TMD and CSD signs in asthmatic children. In turn, forward head posture leading to biomechanical upper cervical spine alterations could compress suboccipital and trigemino-cervical regions, contributing to cervical and orofacial pain symptoms.[18]

A great number of asthmatic children, more than 50%, demonstrated parafuncional habits such as bruxism, although it was not significantly different among groups, suggesting that such oral parafunction habit could not be a contributor factor to TMD and CSD correlation verified in this study. Egermark-Eriksson *et al.*[9] reported a strong correlation between parafuncional habits or the tooth wear and TMD signs in non asthmatic children, however correlation between TMD and CSD signs was not mentioned in that study.

This study suggests that the assessment of stomatognathic and cervical spine regions must be done in asthmatic children. In view of such findings future studies must be directed to a better understanding of the factors involved in the correlation between TMD and CSD signs in asthmatic children.

CONCLUSION

Results of the present study demonstrated a significant correlation between TMD and DCC signs in asthmatic children and evidenced that TMD severity is directly related to alterations of cervical spine and, or vice and versa. In view of these findings clinical evaluation of asthmatic mouth breathing children could not be restricted to respiratory system, but it must include a detailed evaluation of stomathognatic and cervical spine systems.

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