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MAIN ARTICLE

Relationship between conductive hearing loss and maxillary constriction

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Abstract

Objective: To evaluate the relationship between conductive hearing loss and maxillary constriction.

Method: A total of 120 people, aged from 7 to 40 years, who were referred to an audiologist when taking out health insurance or for school pre-registration check-up, were selected for this study. A total of 60 participants who had hearing threshold levels greater than 15 dB in both ears were chosen as the conductive hearing loss group. The remaining 60, with normal hearing thresholds of less than 15 dB, were used as the control group. All participants were referred to an orthodontic clinic. Participants who had a posterior crossbite and high palatal vault were considered to suffer from maxillary constriction.

Results: There were no significant differences between the sex ratios and mean ages of the groups. However, participants with conductive hearing loss were 3.5 times more likely than controls to suffer from maxillary constriction.

Conclusion: Patients who suffer from conductive hearing loss are likely to show a maxillary abnormality when examined by an orthodontist.

Key words: Hearing Loss, Conductive; Maxillary Expansion; Malocclusion; Crossbite

Introduction

Hearing loss is broadly classified into two types: conductive and sensorineural. Audiological tests such as comparative measurements of air and bone conduction thresholds help to distinguish conductive hearing loss from a sensorineural-type disorder.[1] Conductive hearing loss is affected by physical changes imposed on the mechanical system of the outer or middle ear. Braun reported that maxillary constriction, which may be associated with mouth breathing, can affect the eustachian tubes and the middle ear, resulting in hearing loss.[2] Maxillary constriction concomitant with a high palatal vault is a manifestation of a skeletal development syndrome. This syndrome is associated with rhinological and dental characteristics. Features include (1) decreased nasal permeability resulting from nasal stenosis, (2) elevation of the nasal floor, (3) mouth breathing, (4) bilateral dental maxillary crossbite along with a high palatal vault, and (5) a decrease in nasal airway size resulting from enlargement of the nasal turbinates.[3,4] A possible association between conductive hearing loss and maxillary constriction has been reported.[3] Rapid maxillary expansion is frequently used in the treatment of maxillary constriction with a bilateral posterior crossbite. It has been suggested that rapid maxillary expansion may improve auditory function in patients with conductive hearing loss. According to Laptook, the orthopaedic effect of rapid maxillary expansion is to improve hearing levels in patients with maxillary deficiency.[3] Timms reported that patients' hearing levels improved after rapid maxillary expansion.[5] Villano *et al.* found that hearing improvements after rapid maxillary expansion occur directly after the expansion period for higher frequencies only, and after a retention period of eight months for both higher and lower frequencies.[6] Some studies have also evaluated the long-term effects of maxillary expansion on conductive hearing loss.[1] In contrast, Ceylan *et al*. reported a significant hearing improvement after the active treatment period, which was reversed at the end of the retention period.[7]

The contradictory results of numerous studies into the effects of rapid maxillary expansion on conductive hearing loss prompted us to determine the odds ratio for the relationship between conductive hearing loss and maxillary constriction. Therefore, we aimed to assess the relationship between conductive hearing loss

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without visually identifiable causes (such as wax impaction, otitis media and ear infection) and maxillary constriction.

Materials and methods

Ethical approval was obtained for this study from the Islamic Azad University Local Research Ethics Committee. The study was carried out in accordance with the ethical standards of the 1964 Declaration of Helsinki. Informed written consent was obtained from each patient or a parent or guardian.

The sample comprised 120 participants aged from 7 to 40 years who were referred for auditory evaluation by insurance companies when acquiring health insurance or by schools for pre-registration check-ups. Individuals who had undergone any medical treatment in the previous six months and those with history of congenital hearing loss, surgery, ear trauma, allergy, sinusitis, ear infection, wax impaction and orthodontic treatment were excluded from the study. Participants had all of their permanent posterior teeth, and none had a dental prosthesis. Sensorineural hearing loss patients were excluded from the study. Hearing levels were evaluated by an audiometrist using pure tone audiometry.

A total of 60 participants with hearing thresholds of 15 dB and lower in both ears were selected as the control group, and 60 participants with hearing thresholds higher than 15 dB in both ears were selected as the conductive hearing loss group. All participants were examined by a private orthodontist in a blinded manner. Those with posterior upper divergent teeth with at least two teeth in the posterior crossbite position and a high palatal vault were considered to have maxillary constriction.

Statistical Package for Social Sciences version 20 (SPSS Inc, Chicago, Illinois, USA) was used for data analysis. The chi-square test was used to evaluate inter-group data and the odds ratio between groups was determined.

Results

The control group consisted of 32 men and 28 women, with a mean age of 20.3 ± 9.8 years. The conductive hearing loss group consisted of 31 men and 29 women, with a mean age of 21.8 ± 9.6 years. There were no significant differences between the sex ratios and mean ages of the groups (Table I).

TABLE I
CHARACTERISTICS OF CONTROL AND CHL GROUPS

Group	Sex (*n* (%))		Age (y)
	Male	Female	
Control	32 (53.3)	28 (46.7)	20.3 ± 9.8
CHL	31 (51.7)	29 (48.3)	21.8 ± 9.6
p value	<0.8		<0.4

CHL= conductive hearing loss; y = years

TABLE II
MAXILLARY CONSTRICTION IN CONTROL AND CHL GROUPS

Maxillary constriction	Control group (*n* (%))	CHL (*n* (%))
Absent	53 (88.3)	41 (68.3)
present	7 (11.7)	19 (31.7)
p value		<0.008
Odds ratio		3.5

CHL = conductive hearing loss

In all, 7 members (11.7 per cent) of the control group and 19 members (31.7 per cent) of the conductive hearing loss group had maxillary constriction ($p < 0.008$), while 53 members (88.3 per cent) of the control group and 41 members (63.8 per cent) of the conductive hearing loss group did not suffer from maxillary constriction. Patients with maxillary constriction were more likely than control group participants to have conductive hearing loss (odds ratio 3.5; Table II).

Discussion

This study showed a significant correlation between maxillary constriction and conductive hearing loss. Individuals suffering from conductive hearing loss not caused by wax impaction, otitis media, ear infection or other visually identifiable causes were 3.5 times more likely to suffer from maxillary constriction than those with normal hearing. Maxillary constriction, together with a high palatal vault, is characteristic of skeletal development syndrome.[3] Other features of this syndrome were described by Laptook as (1) decreased nasal permeability resulting from nasal stenosis, (2) elevation of the nasal floor, (3) mouth breathing, (4) bilateral dental maxillary crossbite with a high palatal vault and (5) enlargement of the nasal turbinates causing a reduction in the nasal airway.[3] Braun reported that maxillary constriction is a cause of nasal stenosis, which can be associated with mouth breathing and also affect the eustachian tubes and middle ear, resulting in hearing loss.[2] According to Fingeroth, maxillary deficiency frequently results in decreased nasal permeability, with mouth breathing, and may lead to the development of conductive hearing loss.[8] Impaired eustachian tube function may cause pathological changes in the middle ear that can, in turn, lead to hearing loss and/or other complications such as otitis media.[9,10] Rapid maxillary expansion is a well-established correction procedure for transverse discrepancies of the maxillary arch. It has been routinely used for treating posterior crossbites, crowding, abnormal breathing pattern, and conductive hearing loss in growing children with maxillary constriction.[11] After rapid maxillary expansion, stretching of the levator and tensor veli palatini muscles opens the pharyngeal orifice of the eustachian tube, allowing air to enter and leave the middle ear. By allowing air to pass through the eustachian tube, pressure on either side of the tympanic membrane is balanced and the ossicular chain can vibrate freely and function normally.[3,9,11]

- **Maxillary constriction correlated significantly with conductive hearing loss**
- **Conductive hearing loss patients were 3.5 times more likely to suffer from maxillary constriction than normal individuals**
- **Conductive hearing loss patients should be referred to an orthodontist to rule out maxillary constriction**
- **Rapid maxillary expansion may improve hearing in conductive hearing loss patients with maxillary constriction**

In this study, we found that patients who suffer from conductive hearing loss without any visually identifiable cause may also suffer from a degree of maxillary constriction that affects their eustachian tube. Therefore, we suggest that these patients should also be referred to an orthodontist for further examination and treatment.

References

1 Taşpinar F, Uçuncü H, Bishara SE. Rapid maxillary expansion and conductive hearing loss. *Angle Orthod* 2003;**73**:669–73
2 Braun F. A contribution to the problem of bronchial asthma and extension of the palatine suture. *Rep Congr Eur Orthod Soc* 1966;**42**:361–4
3 Laptook T. Conductive hearing loss and rapid maxillary expansion. Report of a case. *Am J Orthod* 1981;**80**:325–31
4 Seto BH, Gotsopoulos H, Sims MR, Cistulli PA. Maxillary morphology in obstructive sleep apnoea syndrome. *Eur J Orthod* 2001;**23**:703–14
5 Timms DJ. A study of basal movement with rapid maxillary expansion. *Am J Orthod* 1980;**77**:500–7
6 Villano A, Grampi B, Fiorentini R, Gandini P. Correlations between rapid maxillary expansion (RME) and the auditory apparatus. *Angle Orthod* 2006;**76**:752–8
7 Ceylan I, Oktay H, Demirci M. The effect of rapid maxillary expansion on conductive hearing loss. *Angle Orthod* 1996;**66**: 301–7
8 Fingeroth AI. Orthodontic-orthopedics as related to respiration and conductive hearing loss. *J Clin Pediatr Dent* 1991;**15**:83–9
9 Bluestone CD. Studies in otitis media: Children's Hospital of Pittsburgh, University of Pittsburgh progress report – 2004. *Laryngoscope* 2004;**114**:1–26
10 Jury SC. Prevention of severe mucosecretory ear disease and its complications in patients with cleft lip and palate malformations. *Folia Phoniatr Logop* 1997;**49**:177–80
11 Kilic N, Kiki A, Oktay H, Selimoglu E. Effects of rapid maxillary expansion on conductive hearing loss. *Angle Orthod* 2008; **78**:409–14

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