Assessment of the Relationship Between Palatum Durum and Maxillary Bone in Patients with Nasal Polyp, Chronic Sinusitis or Septum Deviation

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Received: 8 October 2012 / Accepted: 19 February 2013 / Published online: 3 March 2013
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Abstract Nasal obstruction most commonly occurs due to mucosal abnormalities and those in cartilage-bone structure such as nasal polyp, septum deviation, concha hypertrophy and chronic sinusitis in adults. Adenoid vegetation is the most prominent cause in childhood. In the present study, we aimed to investigate whether maxillary and palatal bone developments continue in patients with abnormalities causing nasal obstruction. As computerized tomography is the optimal imaging modality in nasal cavity abnormalities, CT scan findings of patients with Control nasal polyp, chronic sinusitis and septum deviation were retrospectively evaluated; and palatal curve changes were compared. In our study, it was found that maxillary bone curve was widened in adult patients with nasal polyp; this angle was further narrowed in those with chronic sinusitis; and maxillary bone curve narrowing and increase in the distance to palatal bone was smaller in patients with septum deviation than those in chronic sinusitis. In the light of these findings, we concluded that, in adults, maxillary and palatal bone developments continue in certain circumstances including nasal polyp, chronic sinusitis or septum deviation.

Keywords Septum deviation · Palatal bone · Nasal polyp · Chronic sinusitis

Introduction

Nasal congestion is one of the most common complaints, which have been encountered by otolaryngologist. Nasal obstruction most commonly results from adenoid vegetation (AV) in children [1, 2]. However, most common causes include SD, NP, CS, concha bullosa and concha hypertrophy in adults [3]. Orofacial deformities may occur due to breathing from mouth because of the nasal obstruction [2]. Growth at lower parts of face is striking in the deformities caused by AV at childhood [4]. Morphological changes occur in palatal and maxillary bones in adult patients with disorders such as NP, SD or CS, even though development in facial bones is completed.

Nasal polyp is a clinical entity in which allergy and CS implied in etiology; however, its etiology hasn't been fully elucidated [5, 6]. There is an increased interalveolar distance (IAD) as a result of enlarged maxillary bone due to expansion of nasal cavity caused by polyps. This causes flattening of palatal curve [2]. On the other hand, dome-like palatal bone curve and decreased IAD develop in patients with septum deviation due to mouth breathing.

Pathology occurs at mucosal level in patients with CS, as mucosal thickening is seen mainly at maxillary bone as well as ethmoid and frontal bones. As a result, a decrease occurs in ciliary action over time; and if the pathology persists for long time, a decrease in the volume of the sinus (silent sinus syndrome) and thickening at wall of sinus become apparent [7]. In this study, we recruited patients with CS, who had a pathology limited to sinus mucosa without septum pathology causing nasal obstruction [8].

Parameters related to changes in maxillary and palatal bone was achieved by using CT, which is considered as optimal imaging modality for sinus disorders [8].

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In our study, we investigated whether facial bone development continues in patients with CS, NP or SD. For this purpose, we attempted to determine the changes by estimating interalveolar distance and angle between maxillary and palatal bone.

Patient and Methods

Fifty patients with NP that completely fill nasal cavity, 50 patients with SD, 50 patients with CS (in which infection was limited to mucosa and no prominent narrowing was present in nasal passage) and 50 patients with normal nasal cavity (control) were included to this study. Patients (≥ 17 years) were randomly selected among patients who were presented to ENT clinic with nasal obstruction and underwent PNCT between 2009 and 2011. NP, CS and SD diagnoses were made via retrospective evaluation of PNCT scans by radiologists and ENT specialists. We excluded patients who had either craniofacial or orofacial anomaly on CT images.

All the relative screenings of the patients were conducted in the same clinic using the same devices. CT scans were performed by a Toshiba Aquilion64® system at 120 kV and 75 mA with 5 mm intervals and a gantry tilt, a 2 s time and in the coronal plane (Bone window: WW = 2,700, WL = 350).

In the study patients, following measurements were performed on coronal PNCT sections, in which perpendicular lamina of ethmoid bone and beginning of septum appeared (Figs. 1, 2, 3, 4):

- (a) Angle between alveolar process of maxillary bone (MBAP) and palatal bone (at both left and right side): Protractor was advanced from alveolar process to

Fig. 1 In CS **a** Left maxillopalatal angle, **b** Right maxillopalatal angle, **c** Maxillary spin distance, **d** Inter-alveolar distance

Fig. 2 In SD **a** Left maxillopalatal angle, **b** Right maxillopalatal angle, **c** Maxillary spin distance, **d** Inter-alveolar distance

Fig. 3 In NP **a** Left maxillopalatal angle, **b** Right maxillopalatal angle, **c** Maxillary spin distance, **d** Inter-alveolar distance

- junction of maxillary and palatal bones, then angle was measured between alveolar process and line which is perpendicular to palatal bone at junction site.
- (b) Inter-alveolar distance: Distance at the medial margins of alveolar process was measured at the dentation level.
- (c) Distance from palatal bone to inter-alveolar distance: After measurement of inter-alveolar distance, nasal spin distance was measured at perpendicular plane to this line.

Statistical analyses were performed by using SPSS software One Way Anova Tamhane test was used to compare mean of variables in nonhomogenous groups. $p < 0.05$ was considered as statistically significant.

Fig. 4 In control **a** Left maxillopalatal angle, **b** Right maxillopalatal angle, **c** Maxillary spin distance, **d** Interalveolar distance

Results

There were 116 men (58 %) and 84 women (42 %) with a mean age of 32.91 ± 15.6 (min: 17, max: 73). At the right side, angle between alveolar process of maxillary bone and palatal bone was measured as 106.08 ± 4.01 in control, 96.91 ± 3.14 in CS; 102.25 ± 4.41 in SD and 120.93 ± 3.52 in NP, while same angles were measures as 107.72 ± 6.30 , 97.46 ± 4.77 , 103.76 ± 4.91 and 119.20 ± 16.38 , respectively, at left side. Mean angle was estimated as 106.90 ± 4.64 in control, 97.18 ± 3.39 in CS, 103.01 ± 3.95 in SD and 120.06 ± 8.18 in NP (Table 1). Compared with control group a significant difference was found in CS, SD and NP between right and left groups in terms of angle between MBAP and palatal bone (PB) ($p = 0.001$).

Interalveolar distance (IAD) was 38.10 ± 2.58 in control 31.94 ± 3.27 in CS, 35.35 ± 2.75 in SD and 45.60 ± 2.81 in NP (Table 2). IAD findings were considered as significant in CS, SD and NP compared with control ($p = 0.001$); and it was found that IAD when it compared with control was widened in NP, while narrowed in CS and in SD it was between NP and CS. Ratio of IAD to MSD was 2.97 ± 0.52 in control, 1.47 ± 0.26 in CS, 2.36 ± 0.41 in SD and 4.18 ± 0.70 in NP (Table 2).

Discussion

Sixty percentage of craniofacial development has been completed within the first 4 months and it reaches up to 90 % around age of 12 years [1]. Adenoid vegetation, in which allergy is implied in etiology, may cause recurrent upper respiratory tract infection via acting as a reservoir for bacteria and viruses due to its localization and dysfunction of Eustachian tube and recurrent otitis media by mechanical obstruction [9]. It is also suggested AV causes snoring and sleep with open mouth and may cause, at long term, dentofacial and orofacial changes, particularly in children [10]. Effects of environmental and structural factors on these changes cannot be omitted. Nasal obstruction causes open mouth sleeping and snoring. However, the effect of this condition on dentofacial development is unknown in adults [10].

Computerized tomography, first-line imaging modality in the assessment of paranasal sinuses, was employed to determine changes in maxillary and palatal bones of the patients [8]. Also, it can adequately identify mucosal pathologies in patients with CS.

Septum and mucosa abnormalities are the main reasons of nasal obstruction in adults. Among these, SD, NP, CS, concha hypertrophy and concha bullosa are the most commonly encountered entities. Nasal septum consists of two components, namely cartilage and bone. Deviation may occur at cartilage, bone or both. SD may develop due to coups to nose at childhood (deviation usually develops at maxillary crest), concha bullosa, middle concha defects and cartilage changes at growth period [3, 11, 12]. In our study, SD involved bone, cartilage or both. Clinically, SD may cause symptoms such as mouth breathing or snoring. In a study, Kim YM et al. [13] reported that there was a significant association between septum deviation and asymmetric facial development. In SD, it was found that there was a narrowing at maxillary curve and decrease in IAD. It was also found that palatal bone depth was increased in SD more than that occurs in NP, but less than in CS.

NP is caused by allergy, chronic sinusitis, ciliary dysfunction and auto-immunity and is one of the most common reasons of nasal obstruction [14]; however, its etiology hasn't been fully elucidated. NP is usually seen at

Table 1 Right–left–mean maxillopalatal angle in control, CS, SD, NP

Groups	Right maxillopalatal angle (°)	<i>p</i>	Left maxillopalatal angle (°)	<i>p</i>	Mean maxillopalatal angle (°)	<i>p</i>
Control	106.08 ± 4.01	0.001	107.72 ± 6.30	0.001	106.90 ± 4.64	0.001
CS	96.91 ± 3.14		97.46 ± 4.77		97.18 ± 3.39	
SD	102.25 ± 4.41		103.76 ± 4.91		103.01 ± 3.95	
NP	120.93 ± 3.52		119.20 ± 16.38		120.06 ± 8.18	

Table 2 Interalveolar distance (IAD), IAD/MSD in control, CS, SD, NP

Groups	Interalveolar distance (IAD) (mm)	<i>p</i>	Interalveolar distance/maxillary spin distance (MSD) (mm)	<i>p</i>
Control	38.10 ± 2.58	0.001	2.97 ± 0.52	0.001
CS	31.94 ± 3.27		1.47 ± 0.26	
NP	45.60 ± 2.81		4.18 ± 0.70	
SD	35.35 ± 2.75		2.36 ± 0.41

Fig. 5 Maxillary bone curve **a** NP, **b** Control, **c** SD, **d** CS

adulthood, but it may be seen as antrochoanal polyp or in association with Kartegener syndrome [14, 15]. Polypoid tissues exhibit an expansive growth beginning from osteomeatal complex with causing deformation in nasal bones and expand to nasal cavity [14]. In our study, polyp tissue was completely filled the nasal cavity.

In the study on patients with NP and healthy subjects, Serter et al. [2] found that there was an increase in IAD and decrease in palatal bone depth in NP similar to our findings. In addition to these findings, we found that IAD was decreased; palatal bone depth was increased and these values were more prominent in patients with CS than those with SD. In a study on adults, Günhan et al. [16] reported that maxillary bone structure continued to develop in certain cases such as polyp; thus development hasn't been completed at childhood.

CS may cause thickening and polypoid changes at sinus mucosa. In CS, loss of aeration in sinuses causes to decrease in sinus volume over time [17]. Main symptoms include nasal congestion, facial pain, headache and thick, purulent secretion from nose. Inflammation, allergy, gastro-esophageal reflux, current smoking, smoke exposure, septum deviation, inadequate treatment of sinusitis and ciliary dysfunction are all implied in etiology [18]. In a study on adults with CS, Cho et al. [7] suggested that maxillary bone wall was thickened as well as sinus volume

was reduced in patients with CS. This volume depletion causes increase in convexity of maxillary bone curve and elevation of palatal bone to replace the reduced sinus volume. In our study, it was found that interalveolar angle was increased more in patients CS than those with NP or SD, while height of maxillopalatal arch was increased.

Conclusion

In our study, it was found that IAD was increased in SD relative to CS; and maxillary bone curve was widened and palatal bone depth was decreased in SD, while IAD was decreased in SD relative to NP and control; and maxillary bone curve was narrowed and palatal bone depth was increased in SD (Fig. 5).

In CS, it was found that IAD was decreased relative to NP, SD and control; and maxillary bone curve was narrowed and palatal bone depth was increased. In the light of these findings, we concluded that, in adults, maxillary and palatal bone developments continue in certain circumstances including Nasal Polyp, Chronic Sinusitis or Septum Deviation. Together with these findings, it should be suggested that maxillary bone development continues during adulthood.

Conflict of interest We have no conflicts of interest to declare.

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