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Letter to the Editor

Three-Dimensional Analysis of the Pharyngeal Airway According to Craniofacial Morphology

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Dear Editor in Chief

We investigated the association between craniofacial morphology and respiration. Various factors such as the arch, tooth eruption, and skeleton that form the craniofacial morphology affect the size of the pharyngeal airway space (PAS) (1). The PAS differs with sex according to the vertical facial morphology (2). However, the relationship between craniofacial morphology and PAS is still controversial due to the scarcity of relevant studies. Since the PAS is affected by respiration and proprioceptive stimuli, a three-dimensional (3D) analysis must be performed to obtain an accurate understanding of its volume and shape. Cone-beam computed tomography (CBCT) provides accurate visualization of the composite PAS, making CBCT suitable for measuring its volume and area (1).

In this study, the volume and area were measured by reconstructing the PAS as a 3D model based on subjects' CBCT data (Fig. 1).

Morphological differences of the PAS were determined according to various aspects of the craniofacial morphology with the values obtained through 3D analysis.

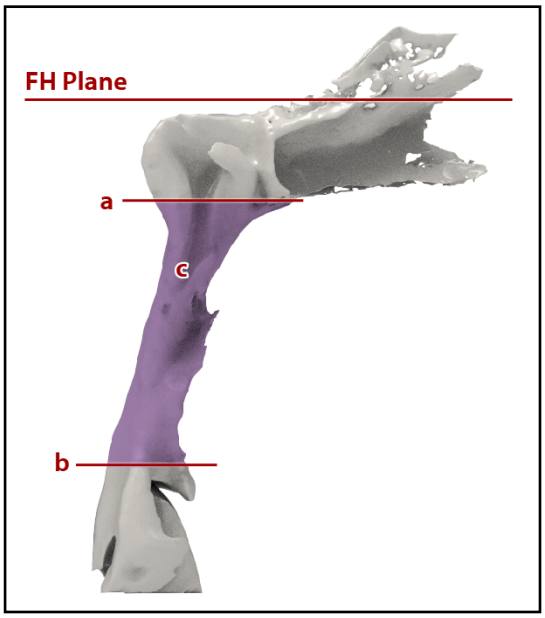

Fig. 1: Delimitation of the PAS volume, area in 3D models (A. Upper limit, B. Lower limit, C. Volumetric and area measurements)

This study was conducted with the approval of the Institutional Review Board at Dankook University Dental Hospital (DUDH IRB 2020-07-007).

The 114 subjects collected until 2020 had no systemic disease, and all 28 teeth were erupted and were not asymmetrical. The provided Digital Imaging and Communications file was imported into Mimics software (Materialise, Leuven, Belgium), reconstructed in three dimensions, and measured with 3-matic software (Materialise). Based on a previous study (1), vertical facial patterns were calculated as the bizygomatic length divided by the distance from the nasion to the menton, and categorized into three groups in which the volume and area of the PAS were measured. All specimens were evaluated in 3D models by two of the authors. The obtained results were analyzed using version 20.0 of SPSS (IBM Corp., Armonk, NY, USA) at a significance level of 95%.

The mean volume of the PAS differed significantly with the vertical facial pattern, being 16199.47 and 14755.37 for males and females, respectively, in the short facial pattern, 15263.74 and 12544.28 in the average facial pattern, and 12186.84 and 10562.68 in the long facial pattern (both P=0.028). The mean area of the PAS also differed significantly with the vertical facial pattern, being 610.00 and 522.74 for males and females, respectively, in the short facial pattern, 581.05 and 468.11 in the average facial pattern, and 467.37 and 411.79 in the long facial pattern (P=0.004 and P=0.001) (Table 1).

Table 1: Comparison of the pharynx of vertical facial patterns

Measurements	*Sex*	*Vertical facial patterns*	*Patients (n)*	*Average(mm2)*	*SD*	*P-value*
Area(mm^2)	Male	Short	19	610.00b	105.04	0.004**
		Average	19	581.05b	153.90	
		Long	19	467.37a	132.36	
	Female	Short	19	522.74b	136.01	0.001**
		Average	19	468.11b	100.83	
		Long	19	411.79a	94.73	
Volume(mm^3)	Male	Short	19	16199.47b	3664.55	0.028*
		Average	19	15263.74ab	5816.14	
		Long	19	12186.84a	4333.53	
	Female	Short	19	14755.37b	6098.84	0.028*
		Average	19	12544.28ab	3878.64	
		Long	19	10562.68a	3563.20	

* P-value were obtained by one-way ANOVA(P<0.05)

a-b. The same characters were not significant by Scheffe Comparisons in three group

The mean volume was 14550.02 and 12622.14 in males and females, respectively (P=0.004), while the mean area was 552.81 and 477.71 (P=0.039). We found that a shorter face was associated with larger volume and area of the PAS.

A difference in vertical facial patterns will mean that the growth of the mandible will proceed differently, so the shape of the pharynx is likely to be different. In particular, the dolichofacial type tends to be more affected by the narrow pharyngeal airway. Also, in the case of the brachyfacial and dolichofacial types of vertical facial growth patterns, the difference between the maxilla and the mandible is too large or too narrow, which is presumed to affect the PAS in the balance of breathing and airflow (3). The volume and area were significantly larger in males, which is attributable to males having larger faces than females as well as other anatomical differences (1). Since CBCT can distinguish the boundaries between hard and soft tissues, it is easy to reconstruct and visualize the PAS in three dimensions. In addition, the 3D model produced through CBCT data has no image distortion and is the same size as the actual structure. It also has ad-

vantages of higher resolution than computed tomography.

We measured and analyzed the PAS in three dimensions using 3D data. The results are expected to provide an accurate understanding of the shape of the pharynx according to the craniofacial morphology, which will be helpful in the diagnosis and treatment of surgical and orthodontic patients.

Acknowledgements

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Conflict of Interest

The authors declare that there is no conflict of interests.

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