Evaluating the anatomical changes of the incisive foramen due to the loss of central incisors

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Dental implant restoration has become a very common treatment. In the esthetic zone, the primary goal of implant treatment is to re-establish both esthetics and function. As generally accepted, the implant placement is always based on a restorative-driven philosophy. According to this philosophy, the three-dimensional ideal implant position has been determined. Buccolingually, the implant should be positioned slightly palatal to the incisal edge and 2mm of buccal bone is recommended. The optimal implant axis direction has to be taken into consideration making screw-retained prosthetics and preventing from excessive off-axis loading.

The incisive foramen and nasopalatine canal (NPC) is often an anatomical limitation for a maxillary incisor implant placement in an ideal position. The NPC is located posterior to the maxillary central incisors and connects the nasal floor with the oral cavity. The NPC contains the nasopalatine nerve, the terminal branch of descending nasopalatine artery, fibrous connective tissue, fat, and small salivary glands.

Placement of implant fixtures with invading into the incisive foramen or NPC may lead to direct contact with connective tissue and cause complications, including non-osseointegration of implant, hemorrhage during operation, short term sensory disturbance postoperatively, and nasopalatine duct cyst formation [1,2,3,4]. Through the examination of computed tomography images of 30 American patients, Kraut & Boyden studied the bone thickness of anterior to NPC and the morphology of NPC [5]. They reported that approximately 4% of NPC were an obstacle for the implant placement. So, it is very important to check the bone thickness and morphology of the labial side to incisive foramen and NPC in case of planning the implant placement in anterior maxilla.

Cone-beam computed tomography (CBCT) has been widely used for evaluation before implant surgery. Because it has the good capability of accuracy for three-dimension imaging, low radiation dose and relatively low costs. Moreover, virtual implant placement simulation using CBCT scan images can provide an overall evaluation of the implant position and anatomic structures peri-implant. Accurate three-dimensional anatomic information of the relationship between the implant fixture and surrounding anatomical structures can reduce the risk of complications.

Aim of this study is to investigate changes of the dimensions and location of the incisive foramen and the ridge contour of anterior maxilla of patients with or without both central incisors using CBCT images.

Methods : In this study, 44 patients who have lost their both central incisors in maxilla and 34 patients who have their both central incisors were randomly selected. CBCT scanning was performed using a standard exposure and patient positioning protocol. 3D CBCT images were carefully examined for the dimensions and location of the incisive foramen and morphology of nasopalatine canal by two independent observers.

Results : On palatal opening level, the average of the incisive foramen area (I) with /without both central incisors in the axial image was 7.9 (8.0)/12.5(9.3) mm², and the average of incisor foramen diameter (II) with /without both central incisors was 2.8 (3.1)/3.6 (3.3) mm. The bone thickness of labial side at incisor foramen level (IV) with/without both central incisors was 7.8 (7.7)/ 5.7 (6.1) mm.

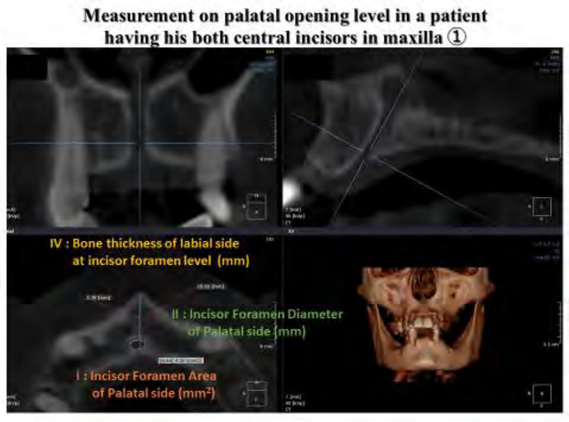
There was no difference in the height of nasopalatine canal with or without both central incisors (VI).

Discussion : Incisive foramen size and bone thickness anterior to the NPC are important factors for successful implant placement. They show important anatomical variations regarding dimension, location and morphology.

In this study, the bone thickness anterior to the NPC was measured in the axial view images at three levels: the incisive foramen level and middle level of the canal. The measuring results of this study would reflect the real implant procedure condition with accuracy. In the present study, the mean of bone width anterior to the NPC was 5.7 (6.1) mm at the incisive foramen level. The results were narrower than the bone width (7.2 mm) reported by *Tözüm et al. 2012*.

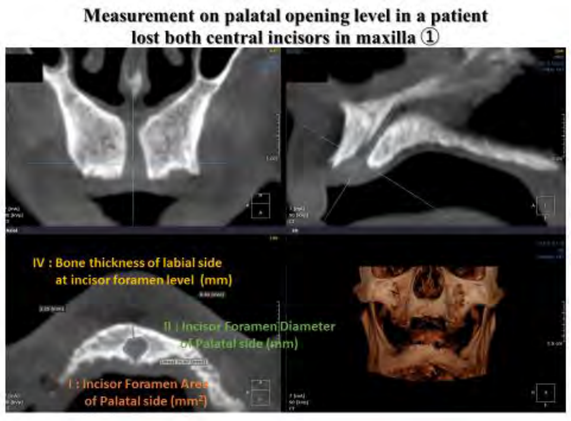
Conclusion : Accurate implant placement in the anterior maxilla is essential in achieving optimal prosthetic rehabilitation with proper function, and in acceptable esthetic and phonetic demands. Cross-sectional imaging may be advocated to determine canal morphology and dimensions and to evaluate anterior bone width for potential implant placement in buccal side of the nasopalatine canal. In this study, bone resorption anterior to the NPC at the incisive foramen level has been suggested to be promoted by the missing of central incisors and has affected the dimensions and morphology of the incisive foramen and nasopalatine canal.

Measurement on palatal opening level in a patient having his both central incisors in maxilla ①

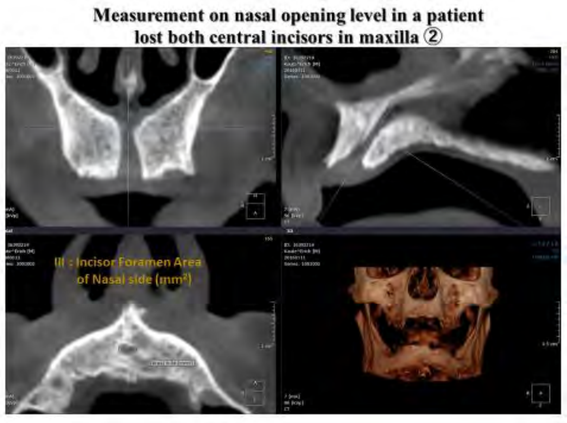


Measurement on nasal opening level in a patient having his both central incisors in maxilla ②

Measurement on palatal opening level in a patient lost both central incisors in maxilla ①



Measurement on nasal opening level in a patient lost both central incisors in maxilla ②



First Analyst

	Total (n=78)	having their both central incisors (n=34)	lost their both central incisors (n=44)	*P* value
Age (mean)	64.3	60.7	67.1	*P*=0.04
Gender (n)				
Male	38	17	21	
Female	40	16	23	
I : Incisor Foramen Area of Palatal side (mm²)		7.9	12.5	< 0.05
Male		8.8	13.6	
Female		7.0	11.6	
II : Incisor Foramen Diameter of Palatal side (mm)		2.8	3.6	< 0.05
Male		3.0	3.9	
Female		2.7	3.4	

	having their both central incisors (n=34)	lost their both central incisors (n=44)	*P* value
III : Incisor Foramen Area of Nasal side (mm²)	8.5	12.5	< 0.05
Male	9.1	15.0	
Female	7.9	10.1	
VI : Height of Nasopalatine Canal; NPC (mm)	7.0	6.8	*P*=0.42
Male	7.4	7.9	
Female	6.6	5.8	
IV : Bone thickness of labial side at incisor foramen level (mm)	7.8	5.7	< 0.05
Male	8.3	5.5	
Female	7.4	6.0	
V : Bone thickness of labial side at middle level of the canal height (mm)	9.3	7.3	< 0.05
Male	9.5	7.0	
Female	9.1	7.5	

Second Analyst

	Total (n=55)	having their both central incisors (n=29)	lost their both central incisors (n=26)	*P* value
Age (mean)	62.8	61.6	64.2	*P*=0.4
Gender (n)				
Male	30	14	16	
Female	25	15	10	
I : Incisor Foramen Area of Palatal side (mm²)		8.0	9.3	*P*=0.17
Male		9.4	9.7	
Female		6.8	8.5	
II : Incisor Foramen Diameter of Palatal side (mm)		3.1	3.3	*P*=0.19
Male		3.4	3.4	
Female		2.8	3.1	

	having their both central incisors (n=29)	lost their both central incisors (n=26)	*P* value
III : Incisor Foramen Area of Nasal side (mm²)	6.4	9.4	*P*=0.06
Male	6.6	10.5	
Female	6.1	7.6	
VI : Height of Nasopalatine Canal; NPC (mm)	6.5	5.9	*P*=0.34
Male	6.7	6.6	
Female	6.3	4.8	
IV : Bone thickness of labial side at incisor foramen level (mm)	7.7	6.1	< 0.05
Male	8.0	6.1	
Female	7.4	6.1	
V : Bone thickness of labial side at middle level of the canal height (mm)	9.4	7.4	< 0.05
Male	9.3	7.3	
Female	9.5	7.4	

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