

## The study of the alveolar antral artery canal in using cone beam computed tomography

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**Objective:** To evaluate both the frequency of the appearance and the location of the alveolar antral artery canal in four posterior maxillary teeth areas in a group of Thai population using cone beam computed tomography (CBCT).

**Materials and methods:** Posterior maxillary teeth areas (671) of 184 maxillary sinuses from CBCT images were included. The radiolucent artery canals presenting in the lateral wall of the maxillary sinus was evaluated while the distance between the lower border of the artery and the alveolar crest was measured.

**Results:** alveolar antral artery canal was detected in 111 of total 184 sinuses (60.3%). The mean distance of artery canal from alveolar crest was  $24.62 \pm 3.55$  mm,  $20.35 \pm 4.74$  mm,  $15.82 \pm 4.09$  mm and  $15.93 \pm 3.57$  mm at first premolar, second premolar, first molar and second molar appropriately and the statistically significant difference among them was P value  $<0.001$ , ANOVA. Even though all arteries situated in premolar areas were more than 15 mm from alveolar crest, arteries located less than 15 mm from alveolar crest were observed in 59 out of 126 molar areas (46.8 %).

**Conclusion:** Although all maxillary premolar teeth areas evaluated were safe from accidental hemorrhage in lateral osteotomy of sinus lift surgery, performing surgery in molar areas should be careful since 46.8% of the location of artery was below 15 mm from the alveolar crest.

**Key words:** alveolar antral artery, maxillary sinus, cone beam computed tomography

**How to cite:** Mung San Aung C, Panmekiat S, Pimkhaokham A. The study of the alveolar antral artery canal in a group of Thai population using cone beam computed tomography. M Dent J 2017; 37: 63-69.

### Introduction

Three branches of maxillary artery; infraorbital artery, posterior lateral nasal artery, and posterior superior alveolar artery supply nutrition to the maxillary sinus [1]. Posterior superior alveolar artery anastomoses intraosseously and extraosseously with infraorbital artery [2]. Intraosseous branch of the posterior superior alveolar artery also known as alveolar antral artery supplies halfway of the lateral wall of the maxillary sinus, maxillary sinus

membrane and posterior teeth [3]. It is also very important role in vascularization of the grafted bone material placed in sinus lift procedure [4].

While performing antrostomy in the lateral window approach of sinus lift surgery, hemorrhage by accidental cutting alveolar antral artery embedded in the lateral wall of the maxillary sinus can be faced [1,3]. Although bleeding from this artery can be usually controlled, it can obstruct the surgical field, disturb the procedure, displace the grafted material, inhibit the neoangiogenesis

process in grafted bone area, and provide postoperative hematoma [3,5,6]. Because of its location, 20% of this artery can be injured during the procedure [2]. Bleeding is 2% of all complication in maxillary sinus lift procedure [3]. Therefore, understanding of this artery is important because the above complications could be occurred if the location of the artery is unknown.

Regarding our literature review, the frequency of the appearance and location of the alveolar antral artery varied from country to country [7-11]. Most of the results from previous studies were obtained from evaluation of this artery in selected posterior maxillary teeth areas. Meanwhile, studying this artery on Thai people has not been noticed yet. Therefore, the objective of this study was to evaluate the frequency of the appearance and location of this artery in four posterior maxillary teeth areas in a group of Thai population using cone beam computed tomography (CBCT).

## Materials and methods

### 1. Materials

Maxillary CBCT images from patients who underwent implant placement were retrospectively selected. Our research was approved by The Human Research Ethics Committee of Faculty of Dentistry, Chulalongkorn University.

The selection criteria were as follows; 1. CBCT volumes that cover all maxillary teeth and maxillary sinus were included. 2. Pathology that could affect the measurement were excluded. 3. Poor quality of CBCT volume such as artifact was excluded. 4. The first premolars anterior to the maxillary sinus were also excluded.

Regarding the selection criteria, 184 maxillary sinuses of CBCT images were included. Out of 184 maxillary sinuses, 91 were in dentate maxilla, 93 were in partial or fully edentulous maxilla. Out of total 736 posterior maxillary teeth

areas, 671 areas were included according to selection criteria. Out of 671 areas, 563 were in dentate and 108 were edentulous.

### 2. Methods

All CBCT images were acquired using 3D Accuitomo 170 (J Morita MFG. CORP., Kyoto, Japan) with 90 kVp, 5 mA and 17.5 seconds exposure time and a field of view 10 x 10 cm. Images were reconstructed with a voxel size of 0.25 mm. All the reconstructions and measurements were accomplished with the use of One Volume Viewer software (J Morita MFG. CORP., Kyoto, Japan). Appropriate background lighting and a computer (Intel(R) Core(TM) i3-3120M CPU @ 2.50GHz) (Samsung Electronics Co. Ltd, Korea) screen were used for the analysis of the images.

Intra-examiner variance was measured using randomly selected CBCT images of 50 maxillary sinuses which were evaluated twice, separated by at least one month by one reviewer under the close supervision of an experienced radiologist and an oral and maxillofacial surgeon. The Pearson correlation test of intra-examiner variance was 0.987.

The measurement reference points were the center of the first premolar, second premolar, first molar and second molar mesiodistally and bucolingually at the level of the alveolar crest in the axial view. To locate the reference points in the edentulous maxilla, equal distance from the adjacent tooth of the dentate side was applied according to Park et al. [8].

In the coronal view, the radiolucent artery canal embedded fully or partially in the lateral wall of maxillary sinus in four posterior maxillary teeth areas was examined. To distinguish the "artificial defect" generated while reconstructing CBCT images from the actual artery canal, axial, sagittal and coronal images were evaluated simultaneously to reconfirm that the regions contain artery. (Figure 1.)

Then the following parameters were evaluated.

a. The frequency of the appearance of the alveolar antral artery canal of the maxillary sinus

According to Apostolakis & Bissoon [12], artery canal investigated at least one of four posterior maxillary teeth areas represents the prevalence of artery canal of maxillary sinus.

b. The location of the alveolar antral artery from alveolar crest

If there was an artery canal present, the distance from lower border of artery canal to the lowest point of the buccal alveolar ridges at the center of tooth areas was measured vertically regarding Guncu et al. [10]. (Figure 2.)

### 3. Statistical Analysis

All data were analyzed using the statistical software SPSS 22.0 (IBM, NY, USA). The frequency of the appearance of the artery was compared according to the type of jaw using Pearson chi-square test. A significant correlation among the mean value and standard deviation of the distance of the artery from the alveolar crest of four teeth areas were tested by ANOVA. The mean and standard deviation of the distance of the artery canal from alveolar crest of four teeth areas were compared between dentate and edentulous maxilla via independent t test.

## Results

The frequency of the appearance of the alveolar antral artery canal of the maxillary sinus

The alveolar antral artery canal was detected in 111 of total 184 sinuses (60.3%). Comparison of the prevalence of artery canal of maxillary sinus between dentate side (54 out of 91 samples, 59.3%) and edentulous side (57 out of 93 samples, 61.3%) was not statistically significant in difference (P=0.880, Pearson chi-square test).



**Figure 2.** Measurement between alveolar antral artery and alveolar crest  
 A = horizontal line of the lower border the artery  
 B = horizontal line of the lowest point of alveolar crest  
 C = measurement of location of the artery from the alveolar crest



**Figure 1.** Reconfirming the actual artery canal in three view. (a) axial view, (b) coronal view and (c) sagittal view

The location of the alveolar antral artery from alveolar crest

The mean distance between artery canal and the alveolar crest in four posterior maxillary teeth areas were mentioned in (Table 1). Even though arteries situated in premolar areas were more than 15 mm from alveolar crest, arteries located less than 15 mm from alveolar crest were observed in 59 out of 126 molar areas (46.8 %); those were 25 out of 55 (45 %) at first molar and 34 out of 71 (47 %) at second molar. The average mean distance of four posterior maxillary teeth areas was  $18.12 \pm 5.05$  mm (range from 5.44 to 37.08). Comparison of the mean distance between in dentate ( $18.32 \pm 5.06$  mm) and in edentulous teeth areas ( $17.25 \pm 4.94$  mm) was not statistically significant. ( $P=0.236$ , Independent t-test) (Table 2).

## Discussions

Frequency of the appearance of alveolar antral artery canal of maxillary sinus

When the range of the frequency of the appearance of the alveolar antral artery canal was from 47 to 89.3% in the previous studies [2,5,8, 10,12-14], artery canal was evaluated in 111 of total 184 maxillary sinuses (60.3%) in our study. Although our result in Thai people was relatively lower than the foregoing three reports revealing higher detection rate; 78% [15], 82% [12] and 89.3% [11] conducted in Turkish and Greece people, our result was very similar to the results from Korean displaying 52% [9], 52.9% [8] and 64.3% [14]. With regard to these, artery canal was investigated less high via CBCT in Asian than European and Turkish.

**Table 1** Distance between alveolar antral artery and alveolar crest

Tooth area	Measurement (Mean $\pm$ SD) mm
1 <sup>st</sup> premolar	24.62 $\pm$ 3.55
2 <sup>nd</sup> premolar	20.35 $\pm$ 4.74
1 <sup>st</sup> molar	15.82 $\pm$ 4.09
2 <sup>nd</sup> molar	15.93 $\pm$ 3.57
Average 4 areas	18.12 $\pm$ 5.05

P value < 0.001, ANOVA

**Table 2** Distance between alveolar antral artery canal and alveolar crest between dentate and edentulous maxilla

Tooth area	Measurement (Mean $\pm$ SD) mm		P value*
	Dentate	Edentulous	
1 <sup>st</sup> premolar	24.73 $\pm$ 3.51	23.87 $\pm$ 4.49	0.706
2 <sup>nd</sup> premolar	20.18 $\pm$ 4.91	21.62 $\pm$ 3.10	0.454
1 <sup>st</sup> molar	15.98 $\pm$ 4.16	15.53 $\pm$ 4.08	0.697
2 <sup>nd</sup> molar	16.00 $\pm$ 3.45	15.47 $\pm$ 4.48	0.679
Average 4 areas	18.32 $\pm$ 5.06	17.25 $\pm$ 4.94	0.236

\*Independent t-test

The possible other reasons of less detection rate than those three studies were due to different materials and methods as well as different CBCT machines. Although artery canal was evaluated in all posterior maxillary teeth areas in our study, selected posterior maxillary teeth areas were used in the previous studies. More over the frequency of the appearance of the artery was 100% in the former cadaver studies [16, 17], our result showed only 60.3% because less than 0.5 mm diameter artery could not be identified in CBCT image that was comparable with Rahpeyma et al. [7].

While higher frequency of the appearance was noticed in dentate than edentulous maxilla [11], there was no significant difference between them in our study. This is a limitation of our research that we did not know when the tooth was lost. The longer duration of tooth loss, the more bone resorption on that area [18]. Less blood supply and very small size of artery can be found in atrophic jaw bone and very small size of artery canal cannot be detected via CBCT [7,11].

The distance of alveolar antral artery from alveolar crest of four posterior maxillary teeth areas

Artery canal was situated  $24.62 \pm 3.55$  mm,  $20.35 \pm 4.74$  mm,  $15.82 \pm 4.09$  mm and  $15.93 \pm 3.57$  mm from the alveolar crest at first premolar, second premolar, first molar and second molar respectively in our study. The course of artery canal was curved with the most inferior site in first molar area and the most superior site in first premolar area. Location of the artery canal at first premolar area was the safest for doing lateral osteotomy of sinus lift because of the highest distance from the alveolar crest among four posterior maxillary teeth areas.

The nearest location of artery canal from alveolar crest was first molar area in our study and this was the same with Yang & Kye. [19] and Kurt et al. [15];  $15.6 \pm 4.06$  mm and  $24.6 \pm 7.9$  mm from alveolar crest respectively. To compare with the result from Turkish people via Kurt et al. [15], artery canal was found closer to the alveolar crest

at first molar in Asian than Turkish via our study based on Thai and Yang & Kye. [19] conducted on Korean. In the lateral window approach of sinus lift surgery, the horizontal inferior and superior osteotomy are made at approximately 3 mm and 13 to 15 mm from the alveolar crest appropriately for preparation of 13 to 15 mm length implant placement [2]. Therefore, artery canal have to be above 15 mm from the alveolar crest to avoid the accidental damage of the alveolar antral artery [13,14]. Although all premolar teeth areas were safe for surgery with regard to our result, we found that the location of artery canal was below 15 mm from the alveolar crest in molar areas in 59 out of total 126 (46.8%); those were 25 out of 55 (45.5%) in first molar area and 34 out of 71 (47.9%) in second molar area respectively. Therefore to avoid intraoperative bleeding during the lateral window approach of sinus lift, CBCT is still necessary prior to perform surgery to locate the artery canal in individual. Once location of artery canal (less than 15 mm from alveolar crest) is realized, alternative surgical approaches such as double window and ligation of artery techniques can be planned [6,20].

The distance between artery canal and alveolar crest was statistically higher in dentate than edentulous maxilla in the studies of Rosano et al. [5], Park et al. [8] and Ilguy et al. [11]. However, the statistical significant difference was not found in our study. The possible reasons of no difference between dentate and edentulous maxilla in our study was limitation of study that we did not know when the tooth was lost. The longer duration of tooth loss, the more the bone resorption on that area [18]. And there was correlation between bone resorption and location of artery canal that was closer to the alveolar crest [11]. Another reason was the images of the patients scheduled for sinus lift surgery were used as samples in the previous study [5]. But we utilized images from the patients who planned for implant placement. Therefore, quality and quantity of remaining bone may be different in between the previous studies

and our study. The last reason was that although our results come from the measurement in four posterior maxillary teeth areas, selected posterior maxillary teeth areas were used in order to do calibration in previous studies.

In conclusion, all premolar areas were safe from intraoperative hemorrhage in lateral anrostomy of sinus lift surgery. CBCT is still required in order to investigate the location of artery in the first and second molar areas because 46.8 % of alveolar antral artery canal were situated below 15 mm from the alveolar crest in these areas.

## Acknowledgement

We are extremely thankful to Assoc. Prof. Dr. Somchai Sessirisombat, head of Department of Oral and Maxillofacial surgery, Faculty of Dentistry, Chulalongkorn University for providing us the encouragement to do this research.

We also would like to express our sincere appreciation to Dr. Ruben Pauwels, lecturer of Department of Radiology, Faculty of Dentistry, Chulalongkorn University for sharing technical knowledge of CBCT.

**Funding:** None

**Competing interests:** None

**Ethical approval:** None

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