Prevalence, diameter and course of the maxillary intraosseous vascular canal with relation to sinus augmentation procedure: a radiographic study

O. Mardinger, M. Abba, A. Hirshberg, D. Schwartz-Arad

1Tel-Aviv University Savion, Israel; 2Tel-Aviv University, Israel; 3Department of Oral Medicine and Pathology, The Maurice and Gabriela Goldschleger Dental School, Tel-Aviv University, Israel; 4Department of Oral and Maxillofacial Surgery, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel-Aviv University, Israel

Abstract. The aim of the study was to characterize the prevalence, diameter and course of intraosseous anastomosis between the posterior superior alveolar artery and the infraorbital artery (bony canal) involved in the sinus floor augmentation procedure. Data from 208 sinuses were analyzed from reconstructed computed tomography (CT) images. The presence of the intraosseous anastomosis in the lateral antral wall was detected using sagittal plane sections, in addition, the intraosseous course and the diameter of the bony canal were examined. The bony canal was identified in 114 (55%) of the 208 maxillary sinuses, with a mean distance of 16.9 mm from the alveolar ridge. From the examined canals, in 7% the diameter was 2–3 mm wide, in 22% 1–2 mm and in 26% it was less than 1 mm wide. Because only in 50% of cases the vessel was large enough to be detected by a CT scan, it is recommended, to place the superior border of the osteotomy up to 15 mm from the alveolar crest in A to C type ridges to avoid penetration of the artery.

Key words: sinus floor augmentation; CT scan; posterior superior alveolar artery; infraorbital artery; complications; bleeding.

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Sinus augmentation has evolved into a predictable surgical modality for increasing the existing height with bone of sufficient quality to allow successful placement of dental implants. Sinus floor augmentation is a relatively safe procedure, but severe hemorrhage may occur as a result of arterial injury. Knowledge of the blood supply of the maxillary sinus is mandatory to avoid unnecessary complications. The blood supply to both the lateral wall of the maxillary sinus and the

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overlying Schneiderian membrane originates from the posterior superior alveolar artery (PSAA) and the infraorbital artery (IOA). Both vessels anastomose to a common vessel at the lateral antral bony wall, 18.9–19.6 mm from the alveolar margin. The common vessel runs in a canal which can be easily damaged whilst preparing the bony window for sinus augmentation. Transecting this vessel can cause minor to intense bleeding that may obscure vision and lead to perforation of the Schneiderian membrane. When the intra-bony course of the vessels is known, the osteotomy can be properly planned to avoid damage to the vessels and to maintain perfusion of the entire bone segment.

Anatomically, anastamosis between the PSAA and IOA is always found at the lateral antral wall. Whilst examining computed tomography (CT) scans of the maxillary sinus, ELIAN et al. detected the bony canal in only 53% of cases. They based the results on only 50 cases; the diameter and course of the canal as well as relations to neighbouring structures were not studied.

The purpose of the present study was to characterize the prevalence, diameter and course of the intraosseous vascular canal (the anastamosing PSAA and IOA) and to discuss its importance in the sinus floor augmentation procedure.

Patients and methods

The study group consisted of 104 CT scans from patients scheduled for implant-supported restorations in the posterior edentulous maxilla. Of the 104 patients, 69 were women and 35 men, age ranging from 24 to 76 years (mean 52.9 years). In the examined area, 66% were edentulous and 33% were partially edentulous.

Only maxillary reconstructed high-quality computerized images (CT) were included in the study; excluded were images of low quality such as scattering or inferior level of window exposure. For each case, both right and left maxillary sinuses were analysed. The CT scans were performed on an ELITE 2400 scanner (Elscint Co. Ltd., Haifa, Israel) operated at 120 kV and 33 mA. According to the manufacturer’s instructions this is a highly accurate scan with less than 1 mm deviation. Overlapping 1.2-mm axial cuts at 1 mm intervals and the axial images were reconstructed into cross sections (para-axial). The protocol used 2-mm-thick reconstruction algorithms.

CT images were examined for the presence of a bony canal in the lateral antral wall using para-axial sections (Figs. 1–3). The measurements were done on the film using a caliper. The CT scans were divided according to the presence of the canal and its diameter into four categories: 1, no identification of bony canal; 2, diameter less than 1 mm; 3, diameter 1–2 mm; and 4, diameter 2–3 mm. The course of the canal was measured vertically from the alveolar crest in each sagittal reconstruction. The residual bony ridges were classified according to LEKHOLM & ZABRE and the vertical heights measured. The position of the canal antero-posteriorly (A-P) was measured from the lateral nasal wall. This distance (A-P) was divided into four sections according to tooth location, first and second premolars and first and second molars. The diameter of the canal was...
analysed with regard to age, gender, site (right or left) and the presence of teeth. Mean values and standard deviations were calculated. Statistical analysis was performed using the Pearson correlation test.

Results

A total of 208 CT images were examined of which the bony canal was identified in 114 (55%). The course of the bony canal formed a concave arch, with the most inferior site in the first molar area (Table 1, Fig. 4).

The diameter of the canal was less than 1 mm (category 2) in 26% of the cases, 1–2 mm (category 3) in 22.1% and 2–3 mm (category 4) in 6.7%. The diameter of the canal was constant throughout its course from the lateral nasal wall to the posterior antral wall. The vertical measurements related to residual bony height and the ridge classification are summarized in Table 2. The canal diameter was directly related to age: the older the patient, the wider the diameter (p = 0.031). No correlation was found with gender, presence of teeth and sinus site (right or left).

Discussion

According to the present study, an intraosseous vascular canal at the lateral antral wall has been identified in over 50% of examined CT images. The results correlate well with previous studies. In an anatomic study, TRAXLER et al. found intraosseous anastomosis between PSAA and IOA in all examined specimens. This contradiction means that an undetected intra-bony canal in a CT radiograph does not exclude its existence but merely that it is not visible, because of its small diameter.

Sinus floor augmentation procedures are mostly performed in the maxillary first and second premolars and first molar areas. In the present study, as well as in the anatomic study of TRAXLER et al., the anastomosis formed a concave arch, with the first molar area being the lowest point of the bony canal arch course. The distance of the canal from the alveolar ridge ranged between 5 and 29 mm (mean 16.9 mm); similar results were published by ELIAN et al., who found a mean distance of 16.4 mm. These results are somewhat shorter than previously reported by SOLAR et al. in an anatomic study; they found distances to be between 17 and 23 mm (mean 18.9 mm). The differences are probably because of the small number of cases examined compared to the present study.

There is a high probability of transecting the vessel whilst preparing the bony window. The height of the residual bony ridge appears to play a significant role in the location of the vessel: in classes A, B and C (LEKHOLM & ZARB classification), the vessel was found >15 mm from the alveolar crest, whilst in classes D and E at >7 mm (mean 10.4 mm). It is recommended, therefore, to place the superior border of the osteotomy up to 15 mm from the alveolar crest in classes A, B and C which is sufficient for sinus exposure and placement of long dental implants. In severely atrophic ridges, classes D and E, where the surgeon has a tendency to place the osteotomy of the sinus wall too far cranially, there is a high probability of transecting the vessel.

Damage of the bony vessel can cause intense bleeding, obscuring of vision and may lead to perforation of the Schneiderian membrane, which prolongs the operation and assessment of the sinus membrane reflection. On the CT scans, in 71% of the sinuses the bony canal was either missing or smaller than 1 mm (categories 1 and 2). In these cases, blood supply to the bone and graft is negligible and will not cause a surgical obstacle if transected. In 29% of the cases the canals were over 1 mm and therefore at risk of bleeding (categories 3 and 4). Variations exist in the position and diameter of the canal; only in 50% of cases the vessel was large enough to be detected by a CT scan. A dental CT scan is recommended, therefore, as an essential part of the pre-surgical evaluation and treatment plan for severely atrophic ridges, in order to avoid the occurrence of considerable arterial bleeding especially under local anaesthesia. CT is the most accurate tool to evaluate important anatomic parameters, such as the existence of a large diameter anastomosis, the width of the lateral antral wall and pathology of the Schneiderian membrane and sinus septa.
References


Address: Ofer Mardinger
Tel-Aviv University Savion
Israel
E-mail: oferanat1@isdn.net.il