

# Evaluating the anatomical location of the posterior superior alveolar artery in cone beam computed tomography images

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**Abstract.** The purpose of this study was to examine the diameter, location, and frequency of the appearance of the posterior superior alveolar artery (PSAA) in preoperative cone beam computed tomography (CBCT) scans. Two hundred and eleven pre-implant CBCT scans were reviewed. The following criteria were considered in all subjects: (1) the location of the artery: intra-sinus or below the membrane (type I), intraosseous (type II), or superficial (type III); (2) the distance between the lower border of the artery and the alveolar crest; (3) the bone height measured from the floor of the sinus to the crest of the ridge; (4) the distance from the lateral wall of the artery to the medial wall of the maxillary sinus; and (5) the diameter of the artery (in millimetres). The distance between the artery and the medial sinus wall, as well as the diameter of the artery, were greater in patients with an alveolar bone height  $\leq 10$  mm than in those with a bone height  $> 10$  mm. The distance from the artery to the medial sinus wall and the diameter of the artery were positively correlated with the number of missing teeth. It was also found that the diameter of the PSAA increased with increasing age.

**Key words:** maxilla; posterior superior alveolar artery; bone; resorption.

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The maxillary artery is one of the branches of the external carotid artery and divides into five branches in the pterygopalatine fossa. The posterior superior alveolar artery (PSAA), or alveolar anterior artery, and the inferior orbital artery are two branches of the maxillary artery that run into the lateral wall of the maxilla and supply the maxillary sinus and the Schneiderian membrane.

They form extra- and intraosseous anastomoses in the lateral antral bony wall.<sup>1–4</sup>

The PSAA runs caudally, adjacent to the maxillary tuberosity, to reach the bone and periosteum.<sup>2</sup> The maximum diameter of these arteries may reach 3.0 mm.<sup>2,5</sup> Apart from the surgical technique, the risk of bleeding during surgery is directly related to the size of these arteries. The greater the

size of the artery, the greater the risk of bleeding during surgical manipulation.<sup>2,5,6</sup> Intraosseous branches of the PSAA are classified based on both the shape and location (position) of the artery.<sup>7–9</sup>

Alveolar bone resorption and maxillary sinus pneumatization decrease the quality and the amount of available alveolar bone in the posterior region of the maxilla.

Since successful dental implant insertions require sufficient bone density and height, these phenomena are of particular importance in patients who have lost their posterior teeth and need dental implants.<sup>10,11</sup>

Sinus floor elevation with grafting through a lateral maxillary osteotomy has been used frequently during recent years to restore alveolar bone.<sup>12</sup> This method, which is also known as sinus augmentation using autogenous bone or bone substitutes, was first pioneered by Boyne and James in 1980 to rehabilitate the atrophic posterior maxilla by increasing the alveolar bone height.<sup>13</sup>

While this procedure is relatively safe and predictable, the integrity of the PSAA is at risk during osteotomy in the lateral wall of the sinus.<sup>14</sup> Therefore, it is imperative to be familiar with the vascular supply of the maxillary sinus in order to minimize both intraoperative and postoperative complications of sinus augmentation and implant insertion, which include surgical bleeding, postoperative membrane perforations, and bone necrosis.<sup>2,15</sup>

Based on the classification of Misch and Judy, bone necessitates no augmentation when it is more than 10 mm in height, but compromised bone requires an osteoplasty and some form of hard or soft tissue augmentation based the extent of the defect when the height is less than 10 mm.<sup>16</sup>

Cone beam computed tomography (CBCT) is a dose-sparing technique compared with standard computed tomography (CT) for dental and maxillofacial imaging.<sup>17</sup> CBCT also provides accurate and reliable linear measurements for reconstruction and imaging of the dental and maxillofacial structures.<sup>18,19</sup> There are few studies showing the PSAA as the blood supply of the maxillary sinuses using CBCT.<sup>20,21</sup> The purpose of this study was to determine the frequency of detecting the PSAA, as well as its diameter and location, on preoperative CBCT scans of patients seeking dental implants. The perpendicular distances from the sinus floor to the edentulous alveolar crest and from the medial wall of the sinus to the endosseous vascular canal were also evaluated.

## Materials and methods

This study was approved by the Medical Ethics Committee of Shiraz University of Medical Sciences. For this cross-sectional study, the pre-implant CBCT scans of 150 patients who had received dental implants were retrieved from the archives of a private oral and maxillofacial radiology clinic. These were reviewed using NNT v. 2.0 software (NewTom) in the Oral Radiology

Department of Shiraz University of Medical Sciences. Subjects were eligible for inclusion if they had undergone CBCT for a sinus augmentation procedure and implant insertion in the posterior maxilla between 2 December 2012 and 2 March 2014.

According to the proximity of the PSAA to the location of sinus augmentation, the detection of the definitive location of this artery can be useful in order to avoid excessive bleeding during the implantation surgery process.

The right and left quadrants were considered separately if there were any missing teeth; thus, a total of 211 sinus CBCT scans from the 150 patients were included in this study (116 from men and 95 from women). CBCT images of maxillary sinuses that were damaged by tumours or severe trauma were excluded from this study. All images were acquired using a NewTom VGi high-resolution cone beam scanner (NewTom QR s.r.l., Verona, Italy).

All 211 images were evaluated for the following items in the edentulous region: (1) the location of the artery: intra-sinus (below the membrane) (type I), intraosseous (type II), or superficial (type III) (Figs 1–4); (2) the distance between the lower border of the artery and the alveolar crest; (3) the bone height from the sinus floor to the crest of the ridge; (4) the distance from the artery to the medial sinus wall; and (5) the diameter of the artery.

In accordance with the classification of Misch and Judy, the edentulous alveolar ridge was classified on the basis of bone height as  $\leq 10$  mm or  $> 10$  mm.<sup>16</sup>

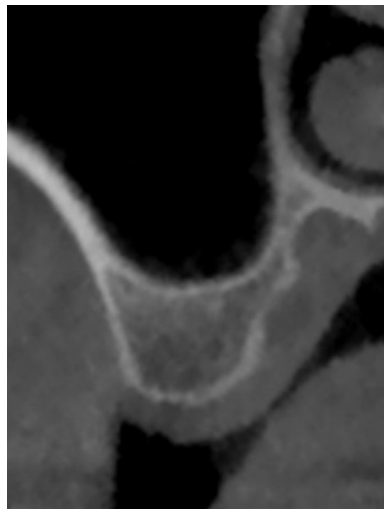


Fig. 1. Transverse view of the CBCT scan of a sinus in which the posterior superior alveolar artery was not detected.



Fig. 2. Transverse view of the CBCT scan of a sinus showing the posterior superior alveolar artery below the Schneiderian membrane (type I).

For intra-examiner calibration and determination of the reliability and reproducibility of the measurements, the images were re-evaluated and approved by the same observer 2 weeks after the initial evaluation.

The aforementioned anatomical criteria were assessed in relation to age, sex, and the number of lost teeth.

## Statistical analysis

The statistical analysis was performed using SPSS software v. 15 (SPSS Inc., Chicago, IL, USA). Normally distributed data were recorded as the frequency (%) or as the mean  $\pm$  standard deviation (SD).

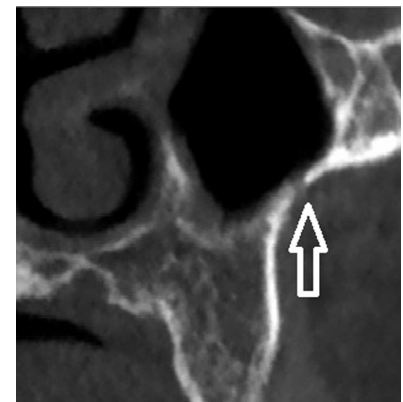


Fig. 3. Transverse view of the CBCT scan of a sinus showing the posterior superior alveolar artery inside the bone (type II).

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