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Detection of the posterior superior alveolar artery in the lateral sinus wall using computed tomography/cone beam computed tomography: a prevalence meta-analysis study and systematic review

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Abstract. A systematic search of MEDLINE, Embase, and Proceedings Web of Science was undertaken to assess the prevalence of the posterior superior alveolar artery (PSAA) in the lateral sinus wall in sinus lift patients, as identified using computed tomography (CT)/cone beam computed tomography (CBCT). For inclusion, the article had to report PSAA detection in the bony wall using CT and/or CBCT in patients with subsinus edentulism. Studies on post-mortem findings, mixed samples (living and cadaveric), those presenting pooled results only, or studies performed for a sinus pathology were excluded. Heterogeneity was checked using an adapted version of the DerSimonian and Laird Q test, and quantified by calculating the proportion of the total variance due to between-study variance (Ri statistic). Eight hundred and eleven single papers were reviewed and filtered according to the inclusion/exclusion criteria. Ten studies were selected (1647 patients and 2740 maxillary sinuses (study unit)). The pooled prevalence of PSAA was 62.02 (95% confidence interval (CI) 46.33–77.71). CBCT studies detected PSAA more frequently (78.12, 95% CI 61.25–94.98) than CT studies (51.19, 95% CI 42.33–60.05). Conventional CT revealed thicker arteries than CBCT. It is concluded that PSAA detection is more frequent when CBCT explorations are used. Additional comparative studies controlling for potential confounding factors are

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needed to ascertain the actual diagnostic value of radiographic explorations for assessing the PSAA prior to sinus floor elevation procedures.

Key words: maxillary sinus; artery; posterior superior alveolar artery; sinus floor elevation; meta-analysis.

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Perforation of the sinus membrane is the most frequently reported intraoperative complication of sinus floor elevation (SFE) procedures, arising in up to 19.5% (range 0–58.3%) of cases.[1] The second most common undesired event is severe bleeding, occurring mostly when performing the antrostomy using rotary instruments.[2] As accidental blood vessel damage may cause massive bleeding,[3] careful surgical planning is paramount,[3,4] particularly because the intraosseous anastomosis between the posterior superior alveolar artery (PSAA) and the infraorbital artery (IOA) has been linked to potential haemorrhagic complications.[5,6] The intraosseous branch of the PSAA within the lateral sinus wall usually describes a straight or U-shaped course,[7] forming a concave arch whose closest point to the osseous crest is located near to the first molar.[8,9] This anastomosis supplies the Schneiderian membrane, periosteum, and the anterolateral sinus wall,[6–10] while contributing to graft integration and healing of the surgical wound.[11]

Accidental damage to these vessels is reported to account for up to 20% of major bleeding events,[4,5] although some case series have described lower incidences.[12] Experimental SFE studies in edentulous cadaveric material have reported that intraosseous arteries are involved in up to 83% of cases when the antrostomy is performed at the level of the first and second molars.[13] As severe postoperative haemorrhages have also been described after transcrestal SFE procedures,[14] the accurate identification of vascular structures before surgery is essential to avoid undesired complications.[12]

Anatomical studies have consistently detected the intraosseous PSAA anastomosis in every maxillary sinus,[6,7,11] but computed tomography (CT) scans have failed to identify these structures in many patients,[5] and their use for this purpose has been discouraged.[15] Nevertheless, multiple imaging studies have been developed since this evidence-based review article was published,[15] showing an increased capability of CT and cone beam computed tomography (CBCT) for detecting the PSAA within the sinus wall.[10] These circumstances appear to justify the need for a systematic review and meta-analysis aimed at assessing the prevalence of the PSAA in the lateral sinus wall of SFE patients using CT/CBCT.

Materials and methods

The methods of analysis and the inclusion criteria were detailed in the study protocol to ensure homogeneous criteria amongst all researchers during the study. The aforementioned protocol was initially conceived for radiological identification of the PSAA within the bony sinus wall.

A systematic search was undertaken in July 2014 of MEDLINE, Embase, and Proceedings Web of Science (Conference Proceedings Citation Index-Science; CPCI-S), using the following strategy: ((''blood supply'' OR ''maxillary artery'' OR ''arterial supply'' OR ''vascular'') AND (''maxillary sinus'' OR ''sinus floor elevation'' OR ''sinus lift'' OR ''sinus augmentation'')), with both medical subject headings (MeSH) and free text words. This search strategy was reviewed independently, discussed by all authors, and supplemented with an additional handsearch[16] performed using the library catalogue of the study institution, considering both books and relevant journals (Fig. 1).

Studies were considered if they fulfilled the following eligibility criteria: (1) provided data on the detection of the PSAA anastomosis within the sinus lateral bony wall using CT and/or CBCT; (2) reported on samples of patients with subsinus edentulism. No language restrictions were applied. Studies were excluded if they reported post-mortem findings, used mixed samples (living and cadaveric specimens), presented pooled results only, or were radiographic studies performed for a suspected sinus pathology.

Data were retrieved by two investigators (MLG and JS) in a standardized manner using a custom-made extraction sheet. Disagreements were resolved by consensus.

Quality assessment

Quality was evaluated by means of a five-item binary scale (yes/no) designed specifically for this study and based upon the STROBE guidelines for reporting observational studies[17,18]: (1) Does the report give details about study participants? One point if the study detailed adequate demographic information about the sample. (2) Have the aim and the outcome of the study been clearly defined? One point when the aim of the study was clearly stated and the number of outcome events was detailed. (3) Was the sampling frame a true or close representation of the target population? One point if the radiographic examinations were undertaken for SFE purposes. (4) Was the measuring instrument adequately described? One point if the equipment, software, and measuring instruments were clearly stated. (5) Does the report give a cautious overall interpretation of the results? One point when both surgical implications and existing evidence were discussed.

When information on a specific item was not provided by the authors, the item was graded as 'no'. The quality score was graded independently by two investigators (JS and BT).

Data analysis

The prevalence of the PSAA in the lateral wall of the maxillary sinus for each study was computed by dividing the number of sinuses in which the artery was detected by the total number of sinuses examined. To determine the 95% confidence intervals (95% CI), the exact method proposed by Newcombe and Altman was used.[19] The study-specific prevalence estimates were then weighted by the inverse of their variance to compute a pooled prevalence and its 95% CI. Both fixed-effects and random-effects pooled estimates were calculated. When heterogeneity is detected, the random-effects model gives more reliable results than the fixed-effects model, including a more conservative (wider) CI. To check for heterogeneity, a version of the DerSimonian and Laird Q test, adapted to small samples, was used. To quantify this heterogeneity, the proportion of the total variance due to between-study variance (Ri statistic) was calculated.[20] In the meta-analysis, due to the presence of a considerable amount of heterogeneity between studies, the fixed-effects pooled