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Research Paper
Dental Implants

Computed tomography and anatomical measurements of critical sites for endosseous implants in the pterygomaxillary region: a cadaveric study

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Abstract. The aim of this study was to obtain computed tomography (CT) and physical measurements of the pterygomaxillary region to determine the anatomical and radiographic landmarks that clinicians need for pterygoid implant placement. Seventy-eight hemi-heads with an atrophic posterior maxilla from 46 cadaveric samples were measured using CT. Twenty-one hemi-heads were selected randomly for physical measurements. CT measurements showed that the mean and minimum distance between the maxillary tuberosity point (MT) and the most lateral lowest point of the pterygomaxillary fissure (PF) were 18.7 mm and 10.0 mm, respectively. The mean and minimum distance between the alveolar crest point passing the extended line of the infrazygomatic crest and the PF were 22.7 mm and 14.7 mm, respectively. The mean and minimum distance between the PF and the greater palatine canal were 2.9 mm and 0.2 mm, respectively. Physical measurements showed that the mean and minimum distances between the MT and the descending palatine artery (DPA) were 19.4 mm and 12.7 mm, respectively, and those between the PF and the DPA were 3.7 mm and 0.0 mm, respectively. The results confirmed considerable variation in the values of the pterygomaxillary region measured at the specific sites. Therefore, careful and sufficient consideration is required in each case of pterygoid implant placement.

Key words: pterygomaxillary region; endosseous implant; bleeding; maxillary artery; pterygopalatine fossa.

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In the late 1980s, Tulasne introduced the tilted endosseous implant placement procedure from the maxillary tuberosity into the pterygoid process of the sphenoid bone for the treatment of the atrophic edentulous posterior maxilla[1]. Although this procedure has been applied widely since its introduction, it is also challenging[2–4].

Both Graves and Venturelli suggested that the implant be directed 45° to the occlusal plane[5,6]. In 1998, in an anatomical study, Yamaura et al. used a cadaveric maxilla to measure the angles of inclination of possible pillars of bone between the maxillary tuberosity and the pterygoid

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process[7]. In 2001, Lee et al. measured the pyramidal process of the palatine bone that is related to pterygoid implants in dry skulls[8].

On the other hand, Rodriguez et al. used clinical data and panoramic radiographic images of pterygoid implants to report that a mesiodistal inclination of a pterygoid implant at 70° to the Frankfort horizontal (FH) plane decreases the non-axial loads of rehabilitation and exhibits good long-term survival[2]. In 2014, Rodriguez et al. used cone beam computed tomography (CBCT) data of 100 cases and placed a virtual pterygoid implant in these; they reported that the mesiodistal inclination relative to the FH plane was $72.5 \pm 4.9°$ and the distance between the maxillary tuberosity and the pterygoid process was 22.5 ± 4.8 mm[9]. In 2016, a third study by Rodriguez et al. used CBCT data of 202 Caucasian adult patients and a virtual implant to report that the mesiodistal inclination relative to the FH plane was $74.19 \pm 3.13°$ and the distance between the maxillary tuberosity and the extremity of the pterygoid process was 22.15 ± 1.56 mm[10]. These studies by Rodriguez et al. provided information from indirect measurements using panoramic radiography and CBCT[2,9,10], while the previous cadaveric studies did not focus on vessel information[7,8].

This study aimed to obtain measurements for the branch sites of the maxillary artery using both CT data and cadaveric samples, to identify effective landmarks that clinicians require for pterygoid implant placement.

Materials and methods

Materials

Forty-six Japanese cadavers were obtained from the Department of Anatomy of Saga Medical School and were examined with the approval of the Ethics Committee of Saga Medical School. An atrophic posterior maxilla with all molars missing was chosen for the study (i.e., CT measurement showing ≤10 mm between the alveolar crest and the sinus floor in the molar region), as described by Rodríguez et al.[9]. Thus, 78 hemi-heads were selected (42 hemi-heads from 24 males and 36 hemi-heads from 22 females). The age range at time of death was 65–100 years (mean 81 ± 9.1 years). All the cadavers had been fixed in a 10% neutral formalin solution. Thirteen of the 46 cadavers (21 hemi-heads) were selected randomly for physical measurements. The head was detached from the neck in all cases.

Methods

CT measurements

A multi-slice CT system (SOMATOM Emotion 16-slice configuration; Siemens, Germany) was used for CT measurements. The imaging parameters were the following: tube potential 130 kV, tube current 150 mA, scan time 1 s, gantry tilt 0, slice

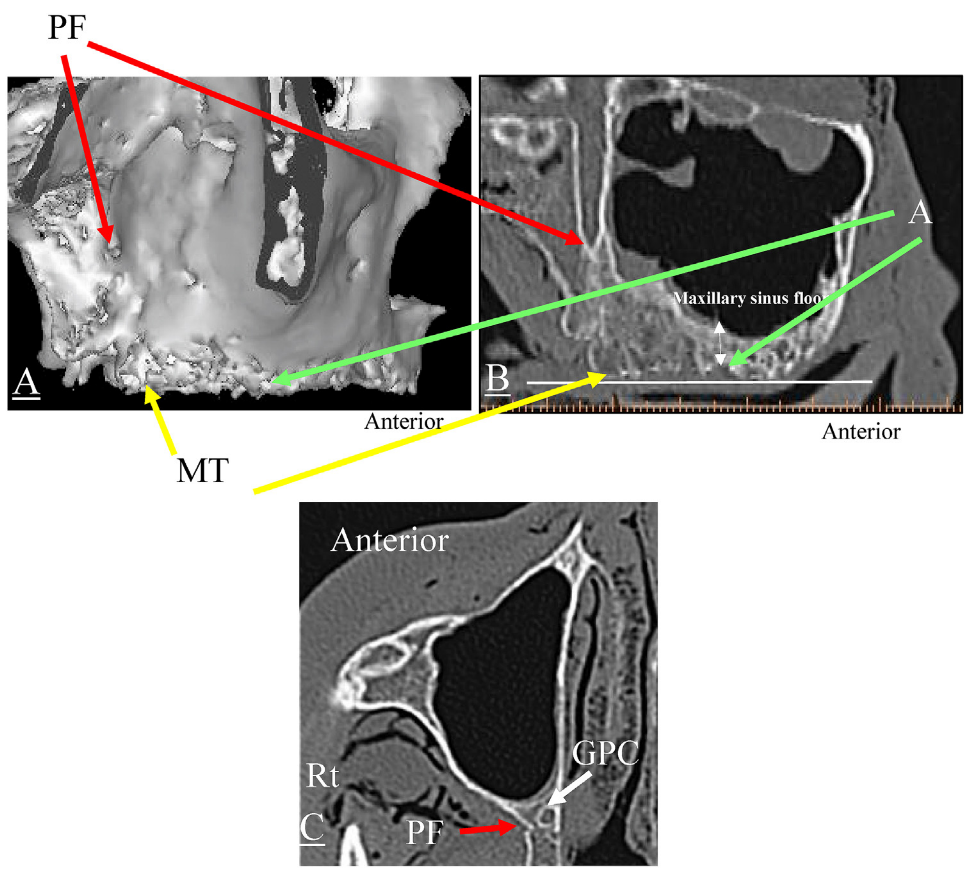

Fig. 1. Images of the area between the inferior orbital margin and the maxillary alveolar process: (A) three-dimensional, (B) sagittal, and (C) axial views at the zygomatic arch level. The yellow arrow shows the lowest posterior point of the maxillary tuberosity ‘MT’; the red arrow indicates the most lateral lowest point of the pterygomaxillary fissure ‘PF’; the green arrow shows the central lowest point where the alveolar crest passes through the extended line of the infrazygomatic crest ‘A’; and the white arrow shows the greater palatine canal ‘GPC’. The white horizontal line including point A in Fig. 1B indicates the plane parallel to the Frankfort horizontal (FH) plane. The white double-headed arrow (Fig. 1B) indicates the residual alveolar bone height, i.e. the linear distance from point A to the maxillary sinus floor on the line perpendicular to the FH plane including point A.