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Original Article

Accuracy of static-guided pterygoid implant placement using mucosa-tooth-supported resin templates: a retrospective cohort study

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ABSTRACT

Purposes: The aim of this retrospective cohort study was to evaluate the accuracy of pterygoid implant placement using static guides based on mucosa-tooth-supported resin templates in fully edentulous patients. In addition, the study assessed whether deviations at the neck and apex tended to compensate or amplify along the implant axis by introducing the differential parameters.

Methods: Thirty-four patients (mean age 63.7 ± 9.0 years) received 62 pterygoid implants between September 2022 and July 2023. Virtual implant planning was performed on cone-beam computed tomography (CBCT)-derived datasets, and 3D printed resin surgical guides were fabricated to transfer the plan to the surgical field. Postoperative CBCT scans were superimposed onto the virtual plan using voxel-based registration, allowing vertical and horizontal measurement of deviations at the implant neck (v^3, h_3) and apex (v_4, h_4), as well as angular discrepancies (θ). Compensation and amplification effects were analyzed by computing vertical and horizontal differentials Δv and Δh. Data were expressed as medians and interquartile ranges (iqr).

Results: At the neck level, median vertical deviation was −0.54(0.59) mm and horizontal deviation 0.78(0.60) mm. At the apex, median vertical deviation was −0.41(0.61) mm, while horizontal deviation increased to 1.06 (0.48) mm. The difference between h_3 and h_4 was significant ($p < 0.0001$), reflecting systematic amplification of horizontal misalignment. Angular deviation was low, with a median of 1.37(1.18) degrees. Analysis of Δv, about 0(0.31) mm, and Δh, +0.30(0.52) mm revealed that vertical errors were variably compensated apically, whereas horizontal errors tended to amplify. Quadrant analysis showed that while most implants displayed amplification, a subset exhibited partial or even double compensation when both vertical and horizontal deviations decreased apically.

Conclusion: Pterygoid implant placement with static guides based on mucosa-tooth-supported resin templates demonstrated high accuracy, with deviations lower than those reported in meta-analyses and angular discrepancies markedly reduced. The introduction of Δv and Δh provided a novel insight into error propagation, highlighting compensatory versus amplifying trajectories.

1. Introduction

Dental implant therapy has become one of the most reliable and predictable procedures in modern dentistry. An immediate functional and esthetic restorative outcome required meticulous preoperative planning, correct three-dimensional (3D) positioning of implants, and precise surgical execution [1].

The diagnostic and planning phase has been revolutionized by the introduction of cone beam computed tomography (CBCT) which provides high-quality 3D imaging of maxillofacial structures with significantly reduced radiation doses maintaining comparable accuracy [2].

Parallel to imaging innovations, rapid prototyping technologies such as stereolithography (STL) allowed the fabrication of surgical guides directly from digital implant planning data. Using computer-aided

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