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Orthodontic Microscrews for Stabilizing Surgical Guide in Edentulous Mandibular Patients

Microtornillos de ortodoncia para estabilizar la guía quirúrgica en pacientes edéntulos mandibulares

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ABSTRACT

Guided surgery has revolutionized dental implant procedures. However, severe mandibular ridge atrophy can compromise the stability of surgical guides, affecting the predictability of implant placement. This paper presents a novel technique that uses orthodontic microscrews to stabilize both radiographic and surgical guides, thereby improving implant accuracy and reducing neurological risks related to the localization of the mental foramen.

Introduction: Severe bone atrophy in edentulous mandibular patients poses a significant challenge for guided implant surgery, often compromising guide stability and making it necessary to use innovative solutions for precise implant placement. While digital planning enhances accuracy, factors such as mucosal resilience and guide misalignment can affect outcomes, with deviations in some cases reaching up to 2.00 mm at the cervical level and 2.41 mm at the apical level, with angular deviations reported at 4.98 ± 2.16° (Azevedo, 2024). This study proposes a technique employing orthodontic microscrews to stabilize guides during surgical procedures.

Technique: This technique involves fabricating removable dentures with designated spaces in the intaglio surface for orthodontic microscrew stabilization, enabling secure guide fixation during scanning. Radiopaque markers aid in aligning the guide, allowing for accurate 3D implant positioning. 3D-printed surgical guides, incorporating microscrew retentive spaces, ensure intraoperative stability and precise drilling.

Results: The technique demonstrates successful stabilization of both radiographic and surgical guides. Orthodontic microscrews act as fixed reference points for mental foramen localization, enhancing the accuracy of flap design and minimizing the risk of nerve injury.

Conclusion: Orthodontic microscrews offer a valuable solution for stabilizing guides in edentulous mandibular patients, reducing both surgical and planning complications. Further studies are needed to confirm the consistency and effectiveness of this technique.

Keywords: Guided surgery (GS), severe alveolar atrophy, orthodontic microscrews, mental foramina.

RESUMEN

La cirugía guiada revoluciona los procedimientos de implantes dentales. Sin embargo, la atrofia grave del reborde mandibular puede comprometer la estabilidad de la guía y afectar la previsibilidad del implante. Este artículo presenta una técnica novedosa que utiliza microtornillos de ortodoncia para estabilizar guías radiográficas y quirúrgicas, haciendo más precisa la posición final del implante y minimizando los riesgos neurológicos asociados con la localización del agujero mentoniano en pacientes con atrofia ósea severa de la mandíbula.

Introducción: La atrofia ósea severa en pacientes edéntulos mandibulares presenta un desafío para la cirugía guiada, lo que hace necesario soluciones innovadoras para la colocación precisa de implantes. Si bien la planificación digital mejora la precisión, factores como la resiliencia de la mucosa y la de la guía pueden afectar los resultados, con desviaciones en algunos casos de 2 mm para las desviaciones cervicales y de 2,41 mm para las apicales, con mayores desviaciones angulares registradas a 4,98 +- 2,16º (Azevedo 2024). Este estudio propone una técnica que emplea microtornillos de ortodoncia para estabilizar las guías durante los procedimientos.

Técnica: Esta técnica implica la fabricación de prótesis removibles con espacios de estabilización de microtornillos de ortodoncia en el intaglio, lo que permite una fijación estable de la guía durante el escaneo. Los marcadores radiopacos ayudan en la alineación de la guía, lo que permite un posicionamiento 3D preciso del implante. Las guías quirúrgicas impresas en 3D, que incorporan espacios de retención de microtornillos, garantizan la estabilidad intraoperatoria y una perforación precisa.

Resultados: La técnica demuestra una estabilización exitosa de las guías radiográficas y quirúrgicas. Los microtornillos de ortodoncia sirven como puntos de referencia fijos para la localización del agujero mentoniano, mejorando la precisión del diseño del colgajo y minimizando los riesgos de lesionar el nervio mentoniano.

Conclusión: Los microtornillos de ortodoncia ofrecen una solución valiosa para estabilizar guías en pacientes mandibulares edéntulos, reduciendo las complicaciones quirúrgicas y de planificación. Se necesitan más estudios para demostrar la consistencia y eficacia de esta técnica.

Palabras clave: Cirugía guiada (GS), atrofia alveolar severa, microtornillos de ortodoncia, agujeros mentonianos.

INTRODUCTION

Planning full-arch implant-supported rehabilitation in patients with long-term mandibular edentulism often involves advanced vertical and/or horizontal bone atrophy (Kablan, 2020; Rocchietta, 2008). Severe bone resorption may position the mental nerve closer to the alveolar crest, posing significant challenges or even preventing implant placement due to the risk of nerve injury, which can result in paresthesia or anesthesia of the lower lip region (Greenstein & Tarnow, 2006).To reduce the risk of surgical complications, many clinicians opt for digitally planned guided surgery (GS). Advances in Cone Beam Computed Tomography (CBCT) and intraoral scanning now enable the combination of CBCT DICOM files (representing hard tissues) and STL files from intraoral scanners (representing soft tissues and teeth) via specialized software, resulting in the creation of 3D-printed surgical guides for precise implant placement and improved postoperative outcomes (Mistry, 2021; Monaco, 2020).

However, errors in CBCT imaging, image segmentation, or guide fabrication can affect the accuracy of guided surgery. In edentulous patients, mucosal resilience and alveolar bone loss may lead to guide misalignment. This misalignment may occur regardless of whether the guide is supported by mucosa, bone, or bite registration (Azevedo, 2024). Even the administration of local anesthesia has been shown to affect guide positioning (Camargos, 2022). Studies have indicated that deviations tend to be more pronounced in the mandible (Cunha, 2021).

This report presents a technique that uses orthodontic microscrews to stabilize both the radiographic guide during CBCT scanning and the surgical guide during implant placement, with the following objectives:

Prevent planning distortions caused by prosthesis mobility during radiographic scanning.

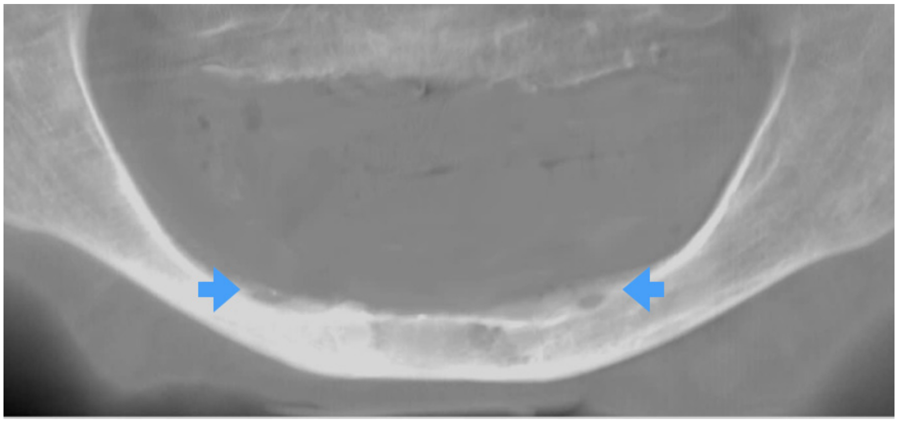
Ensure intraoperative stability of the surgical guide for accurate 3D implant placement.

Provide fixed anatomical reference points for precise localization of the mental foramen and proper flap design, minimizing risk to the mental nerve.

Potential risks and complications associated with orthodontic microscrews include cortical bone damage, screw fracture, and pain or discomfort during insertion; secondary bleeding and anchorage failure post-insertion; displacement, soft tissue trauma or coverage, and peri-screw inflammation under loading; and, during or after removal, miniscrew fracture, bone resorption, and—rarely—alveolar bone exostoses (Truong, 2022).

TECHNIQUE

The surgical plan involves the placement of four implants in a severely atrophic mandible where the mental foramina are located superficially in relation to the crestal ridge (Figure 1).



Source: own elaboration.

Figure 1. Panorex view showing the mental foramen in the upper zone of the ridge with blue arrows

Removable complete dentures are fabricated based on esthetic and functional parameters. Three 10-mm long, 1.6-mm diameter Dual Top™ JA orthodontic microscrews (Jeil Dual Top Anchor System, Jeil Medical Corp., Seoul, Korea) are inserted in the canine and mandibular symphysis regions, following the remaining bone ridge, aiming to achieve bicortical engagement and stable triangular anchorage. The head diameter must allow sufficient space for the prosthetic acrylic (Figures 2–3).

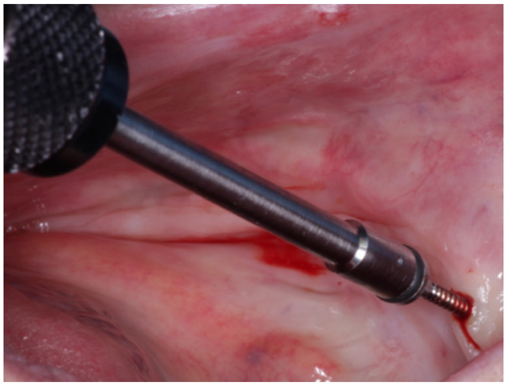


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Figure 2. Using a screwdriver from the Dual Top™ JA orthodontic Kit (Jeil Dual Top Anchor System, Jeil Medical Corp., Seoul, Korea), the self-drilling microscrew is inserted

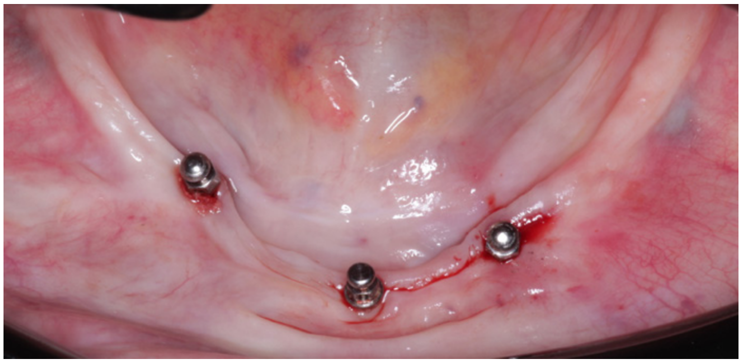

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Figure 3. Microscrews in the canine and symphysis región

The inferior prosthesis is prepared by marking the microscrew locations on the acrylic base, creating perforations, and filling them with permanent material for stabilization. Radiopaque markers are added using Supreme A2 3M fluid resin (Figure 4). CBCT (Planmeca ProMax® 3D Mid, Helsinki, Finland) is taken with the stabilized prosthesis in occlusion and microscrews in place.

Source: own elaboration.

Figure 4. Lower prosthesis with radiopaque markers made of fluid resin

DICOM data with hard tissue information and prosthesis radiopaque marks are obtained (Figure 5A). Scans of the prosthesis and intraoral mucosa with microscrews are performed (Figure 5C). Using BlueSky Plan 4 (BlueSkyBio, Libertyville, IL, USA) software, the STL of the rehabilitation planning is matched with the marks (Figure 5B) and microscrew heads (Figure 5B). A surgical guide is made using the occluded rehabilitation, stabilized by microscrew retentive spaces, to drill pin holes for lateral surgical guide stabilization (Figure 5D).

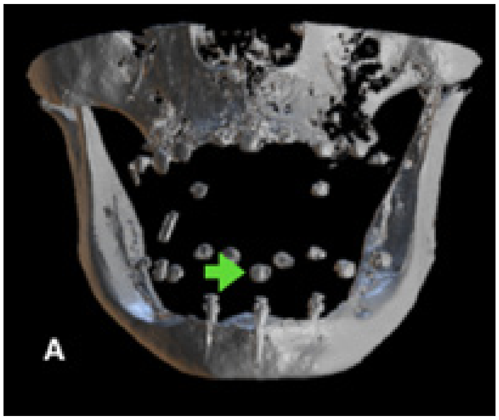

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Figure 5A. Radiopaque marks of the prosthesis are observed in the DICOM, highlighted in green

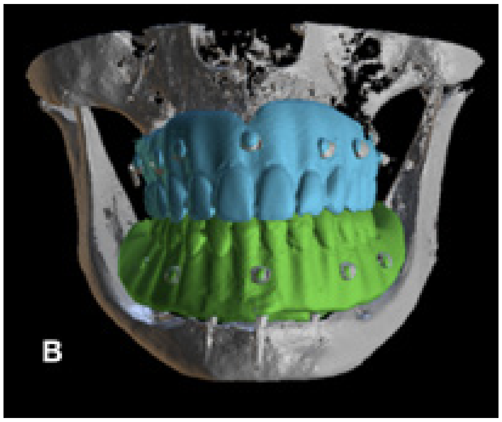

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Figure 5B. STL of the prosthesis, which also contains the markers, is superimposed on the DICOM

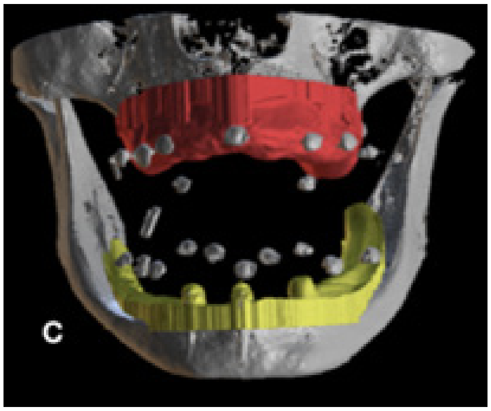

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Figure 5C. Intraoral patient's STL in yellow with the orthodontic microscrews. Source: own elaboration

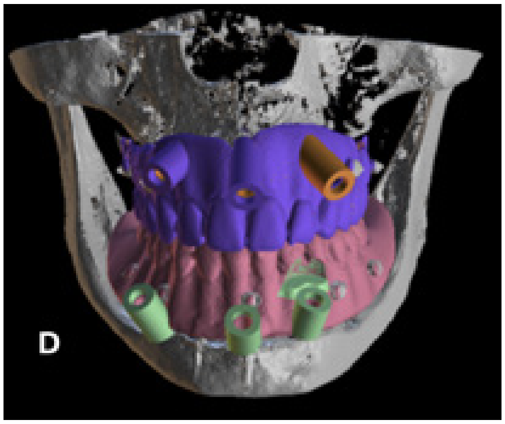

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Figure 5D. Planning of the guide for pins in pink

An identical guide to the prosthesis, with internal undercuts for microscrew heads and tubes for lateral pin guides, is 3D printed (Halot-One, Creality, Shenzhen, China) using resin (Standard Resin Plus, Creality, Shenzhen, China) (Figure 6). Then another guide for implant placement, with three tubes in the same positions as the previous guide, is printed (Figure 7).

Source: own elaboration.

Figure 6. Guide identical to the prosthesis for drilling fixation pins

Source: own elaboration.

Figure 7. Surgical guide

The first guide is positioned in occlusion and on the microscrews. Pin holes are drilled (Figure 8).

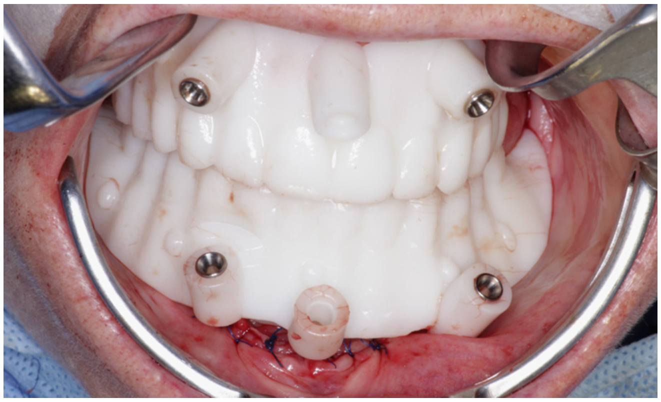

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Figure 8. Lower guide in occlusion and stabilized internally with the orthodontic microscrews

Microscrews are removed (Figure 9) and the surgical guide is placed for implant osteotomy and positioning as planned (Figure 10). In this case, the BioHorizons Guided Surgery Kit® was used to place four BioHorizons Tapered Internal® implants of 3.8 mm in diameter and 10.5 mm in length.

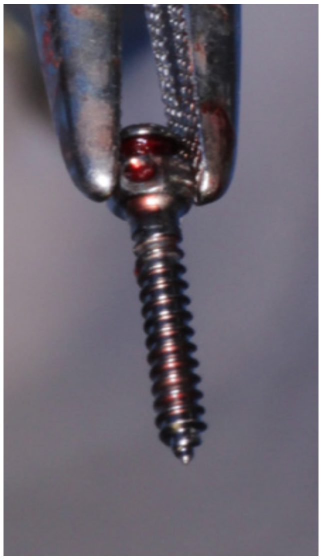

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Figure 9. Removal of the microscrews

Source: own elaboration.

Figure 10. Fixation of the surgical guide with pins

A control panoramic X-ray is taken (Figure 11).

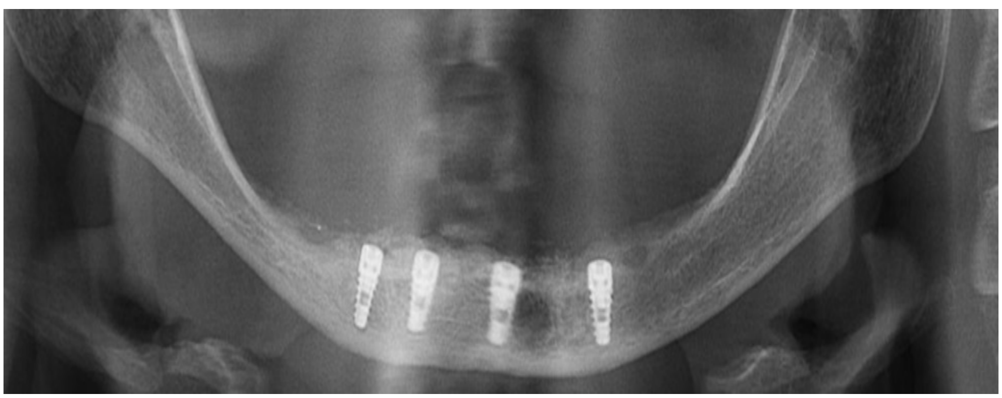

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Figure 11: Control panoramic X-ray

Another use for the microscrews in this technique is that they can serve as fixed reference points for accurate measurement of mental foramen locations on axial CBCT slices (Figure 12), aiding in flap design to avoid nerve damage during surgery (Figure 13) if necessary.

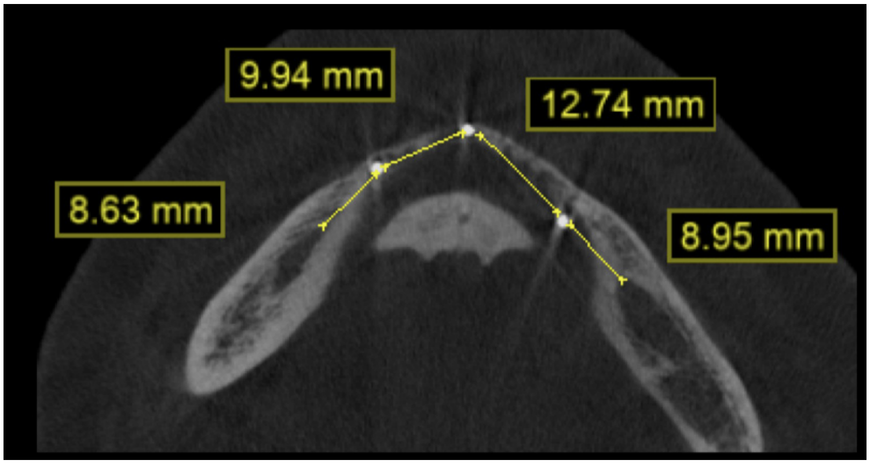

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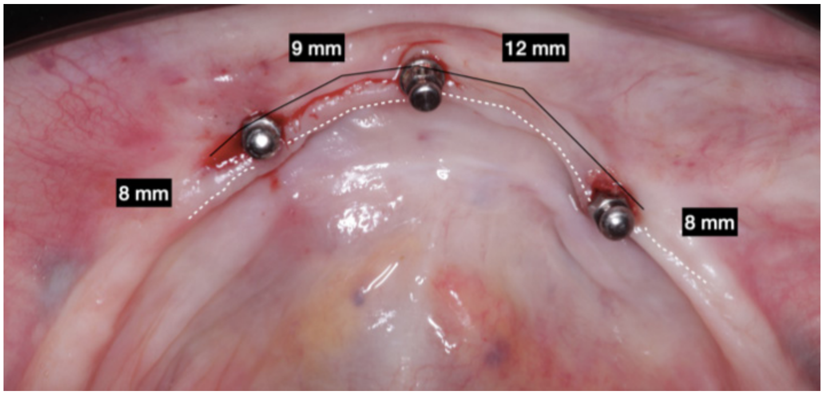
Figure 12. Measurements on the axial slice from the microscrews to the mental foramen



Source: own elaboration.

Figure 13. Flap planning, avoiding the mental nerve

CONCLUSIONS

The use of orthodontic microscrews can be beneficial in cases of severe mandibular atrophy in edentulous patients, providing stabilization of the radiographic guide during CBCT, particularly in cases with significant ridge resorption where the risk of prosthetic displacement is higher. We prefer to use microscrews with rounded heads and no retentive features such as linear or cross slots, making it easier to remove any adhered resin. Orthodontic microscrews with these characteristics are widely available on the South American market at low cost from various brands.

This technique also facilitates the superimposition of gingival surface scans onto mandibular DICOM data. Microscrews stabilize the surgical guide during stabilization osteotomies and assist in accurately locating critical anatomical structures that may be at risk during surgery.

In conclusion, this technique may offer clinicians a cost-effective solution for achieving more accurate digital planning in guided surgery, helping to reduce intraoperative complications and allowing for more conservative flap design when needed.

Conflicts of Interest: The authors declare no conflicts of interest.

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