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DESIGN, DEVELOPMENT AND VALIDATION OF AN INNOVATIVE HYBRID MINISCREW IMPLANT FOR PROVISIONAL PROSTHESES

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ABSTRACT

A hybrid miniscrew implant has been developed via a bioengineering project, from its initial phase of study up to the status of utility model for clinical use and implementation on the market, within an R&D, Innovation and Entrepreneurship framework.

Keywords: Microimplants, bioengineering applied to implantology and dentoalveolar surgery.

INTRODUCTION

Hypodontia (dental agenesis) is a relatively frequent alteration in the number of teeth. The teeth mainly involved in dental agenesis are the third molars, the upper lateral incisors and the second premolars. The congenital absence of a tooth is known as dental agenesis. Its effects on the child population can lead to aesthetic, functional or psychological issues.

Dental implants are a treatment of choice for patients with agenesis; an implant can preserve tooth structure and alveolar bone in addition to providing aesthetics and function. Dental implants are a complex treatment and require extreme care when choosing the parts and materials used in the implants. For instance, the implant designed for this purpose must be durable, though not abrasive or harmful to the area where it is going to be implanted.

Miniscrew implants in the alveolar ridge have already been used in growing patients as the support for a resin crown, replacing other alternatives such as Maryland bridges, removable devices used to maintain the space resulting from dental agenesis.

In our experience, the success rate, based on the ability of these implants to prevent bone loss in the alveolar ridge, both vertical and vestibule-palatal, and maintain agenesis space is almost 70%. However, the miniscrew implants usually employed, manufactured by various companies, are not designed to incorporate a resin crown.

To improve these results, a hybrid miniscrew implant has been developed via a bioengineering project, from its initial phase of study up to the status of utility model for clinical use and implementation on the market, within an R&D, Innovation and Entrepreneurship framework.

RESULTS AND CONCLUSION

A retrospective study was conducted on 18 patients between 13 and 17 years of age who presented agenesis of one or both lateral incisors. After the orthodontic treatment was completed and following the opening of spaces in the areas of agenesis, 24 miniscrew implants manufactured by different companies were implanted in all. The provisional crowns were made of composite materials with polycarbonate preforms via a direct moulding process. A descriptive statistical analysis was carried out with the obtained data.

As a continuation of this work and in the absence of a specific miniscrew implant on the market to cover this need, an initial search and subsequent selection of information sources of the miniscrew implants currently most widely-used were performed. A virtual prototype was then implemented in 3D (using the SolidWorks software), followed by its analysis, validation, design review, kinematic and dynamic verification of the implant, optimization analysis, actual prototype and final analysis, Figure 1.

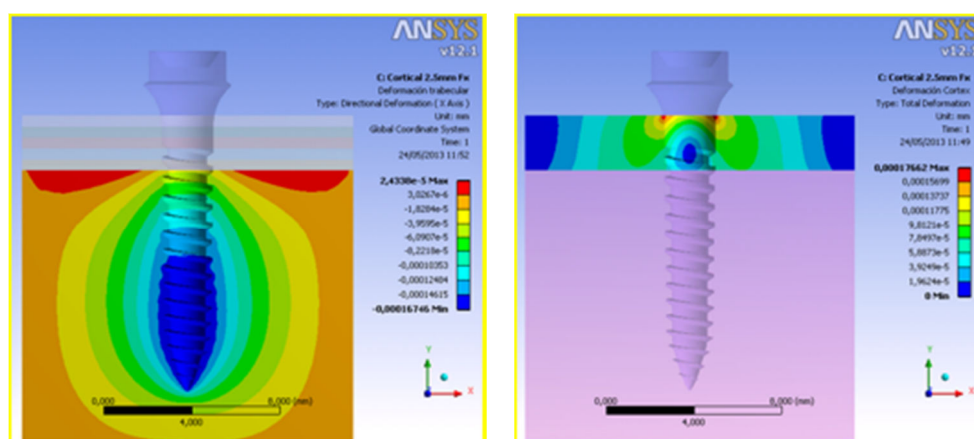
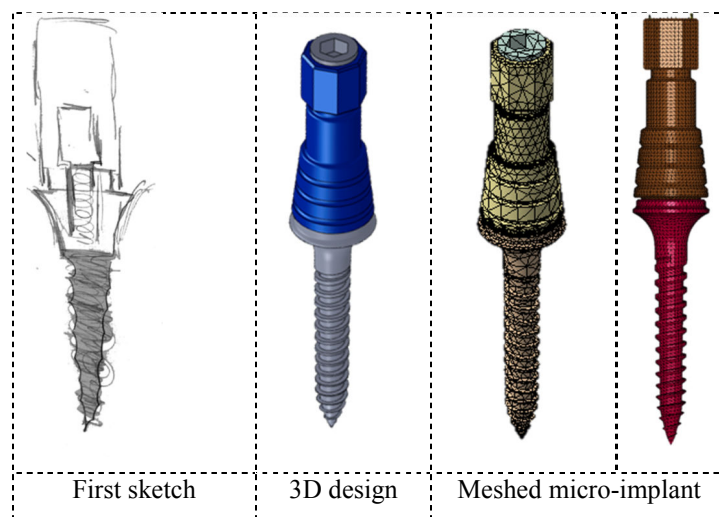


Fig. 1 - Finite Element Method. Cortical and trabecular screenshots at 2.5mm Fx for design validation.

The results of the 24 commercial miniscrew implants used are shown with respect to their permanence (at least 36 months) before proceeding to the placement of a definitive implant, showing a 66.8% success rate. Based on the experience acquired, we proceeded to design and develop an innovative self-tapping hybrid miniscrew implant, with minimal osseointegration,

for the treatment of tooth agenesis between the ages of approximately 12 and 18 years. This miniscrew implant enables maintaining the alveolar ridge with a high success rate until its removal and the placement of a definitive implant. The steps of the different processes that led to the development of this new model of hybrid miniscrew implant are shown, up to its subsequent patenting and clinical implementation

The mechanical properties developed from the study using the finite element method (ANSYS program) were a success, as was the prototyping and manufacturing phase. It has already been evaluated in patients, complying with all the regulations. The four hybrid miniscrew implants have currently been implanted for more than 46 months fulfilling the requirements for their implementation.

Due to its innovative design, the tendency of the miniscrew implant to rotate increases with respect to the embedding area of greater rigidity (cortical zone), inversely allowing its removal prior to the placement of the definitive implant.

New biomaterials are being studied for the development of the prototype according to the granted utility model no. 2017 31 223 *Micro-implants for provisional dental prostheses*.

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