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Biomechanical evaluation of miniscrew implants in vitro

Selectively demineralized bone technique

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Poster Award
Outstanding Poster Award - 1st place

Introduction

Bone quality plays an important role in the success of orthodontic miniscrew implants. (1, 2) The mechanical properties of bone are highly related to the mineral content, which varies widely according to function and histology. However, in vitro methods for evaluating biomechanical properties of miniscrew implants have not been reported.

Objectives

The aim of this study was to assess the biomechanical performance of miniscrew implants using bone samples which were demineralized by timed chemical immersion to alter the mineral content. (3)

Material and Methods

Sections of fresh rib bones from adult pigs were selectively demineralized by timed immersion in 1 % ethylenediamine-tetraacetic (EDTA). Specimens were removed from the solution after 0(control), 6, 10, 16, 30 and 50 days and embedded in acrylic blocks (Figs. 1-4). Quantification of bone density was performed using radiographic images processed with Photoshop software (Figs. 5 and 6). Fifty miniscrew implants, 8 mm long and 1.5 mm in diameter (BMK - Biomaterials, Korea) were inserted. Maximum insertion torque was recorded with a toque gauge. Pullout strength was tested using an Instron Universal testing machine (Figs. 7 and 8). Statistical analysis was performed using the Kruskal-Wallis Test and Spearman correlation coefficients.

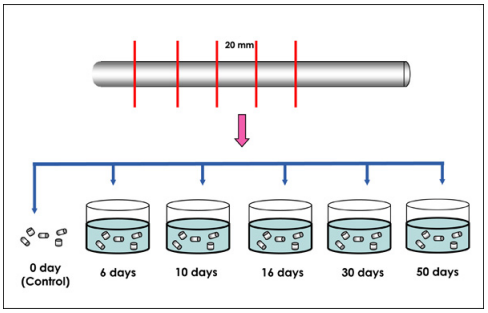


Fig. 1: Diagram of the selectively bone demineralization technique. Bone samples were demineralized by timed chemical immersion to alter the mineral content.

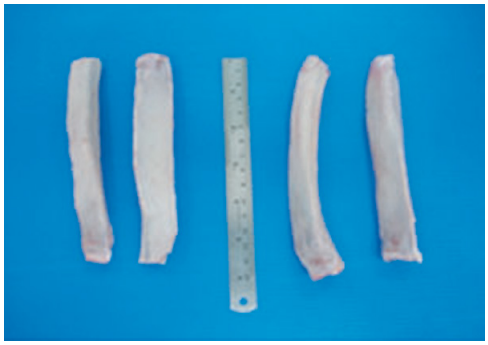


Fig. 2: Sections of fresh rib bones from adult pigs were selectively demineralized by timed immersion in 1 % EDTA.

Figs. 3 and 4: Sections of fresh rib bones from adult pigs were selectively demineralized by timed immersion in 1 % EDTA.

Fig. 5: Radiographic images of each bone sample were obtained

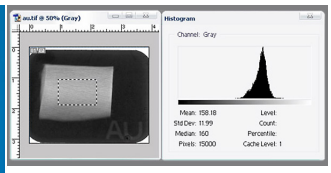


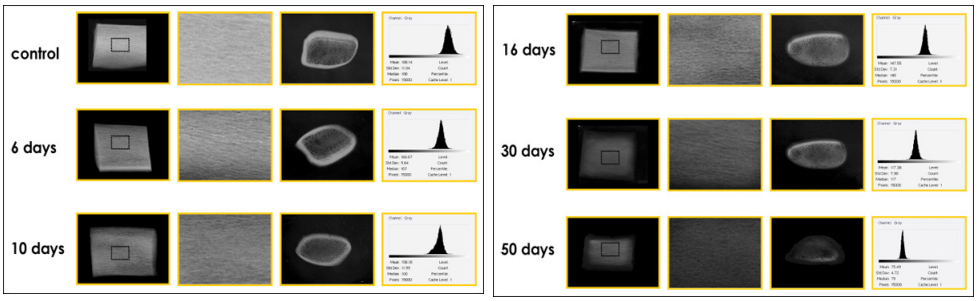
Fig. 6: Quantification of bone density was performed using radiographic images processed with Photoshop software

Fig. 7: Maximum insertion torque and pullout strength were assessed

Fig. 8: Maximum insertion torque and pullout strength were assessed

Results

The selectively bone demineralization was successfully performed (Figs. 9 and 10). There was a systematic decrease in bone density that was followed by a significant decrease in the biomechanical properties of the miniscrews. High correlation (r = 0.91) was observed between maximum insertion torque and maximum pullout strength (Figs. 11-13).



Figs. 9 and 10: The selectively bone demineralization was successfully obtained

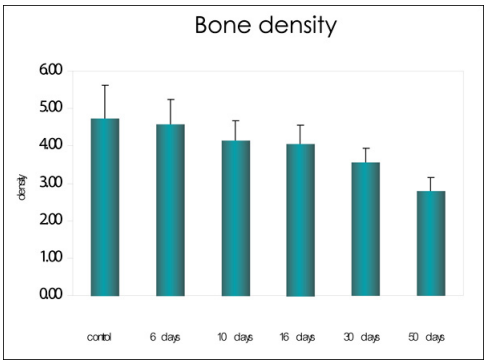


Fig. 11: Bone density values

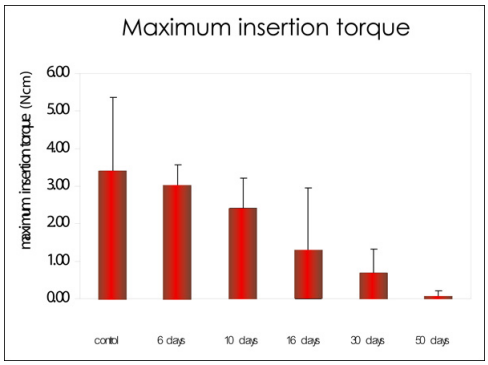


Fig. 12: Maximum insertion torque values

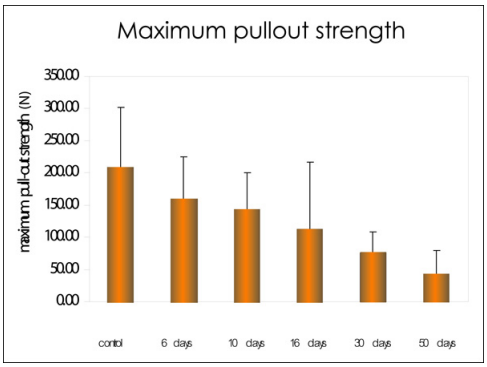


Fig. 13: Maximum insertion torque values

Conclusions

The biomechanical properties of miniscrew implants can be evaluated in vitro using bones obtained from a single species prepared with the selectively demineralized bone technique. The proposed method can be used to facilitate comparison between different miniscrew implant systems, avoiding the inaccuracy observed in conventional methods.

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This Poster was submitted by Boonsiva Suzuki.

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Poster Faksimile:

BIOMECHANICAL EVALUATION OF MINISCREW IMPLANTS IN VITRO USING THE SELECTIVELY DEMINERALIZED BONE TECHNIQUE

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INTRODUCTION

The use of miniscrew implants has become a common place procedure to allow the orthodontist to address a wide variety of problems. Bone quality plays an important role in the implant's success rate. However, the mechanical properties of bone are highly related to the mineral content, which varies widely according to function and histology.

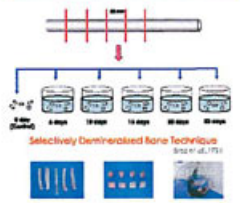
Problem In vitro methods for evaluating biomechanical properties have not been reported.

How to solve ? The aim of this study was to assess the biomechanical performance of miniscrew implants using bone samples which were demineralized by timed chemical immersion to alter the mineral content.

MATERIALS & METHODS

Sections of fresh rib bones from adult pigs were selectively demineralized by timed immersion in 1 % ethylenediamine-tetraacetic (EDTA). Specimens were removed from the solution after 0, 6, 10, 16, 30 and 50 days. Quantification of bone density was performed. Fifty miniscrew implants (8 mm X 1.6 mm) were inserted to evaluate maximum insertion torque and pullout strength. Statistical analysis was performed using ANOVA and Pearson correlation coefficients.

1. Specimen preparation

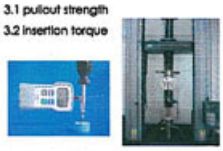


2. Evaluation of Bone Density

Radiographic images of specimens were processed with Photoshop software

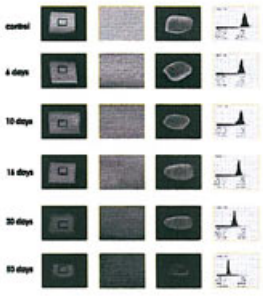
3. Mechanical test

3.1 pullout strength
3.2 insertion torque

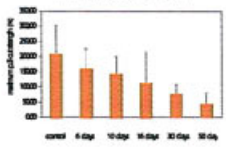


RESULTS

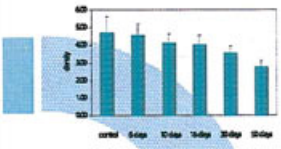
There was a systematic decrease in bone density followed by a significant decrease in biomechanical properties of the miniscrews. High correlation (r= 0.91) was observed between maximum insertion torque and pullout strength.



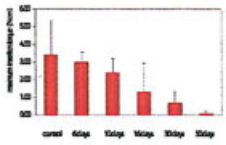
Maximum pullout strength



Bone density



Maximum insertion torque



DISCUSSION

Systematic bone demineralization was successfully performed. The bone density correlated with torque and pull-out. The finding of the study was in agreement with Braz et al. This is the first attempt to develop an in vitro model for the biomechanical evaluation of miniscrew implants

CONCLUSION

The biomechanical properties of miniscrew implants can be evaluated in vitro using bones obtained from a single species prepared with the selectively demineralized bone technique. The proposed method can be used to facilitate comparison between different miniscrew implant systems, avoiding the inaccuracy observed in conventional methods.