Biomechanical evaluation of miniscrew implants in vitro

Selectively demineralized bone technique

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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).
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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Literature

This Poster was submitted by Boonsiva Suzuki.
**BIOMECHANICAL EVALUATION OF MINISCREW IMPLANTS IN VITRO USING THE SELECTIVELY DEMINERALIZED BONE TECHNIQUE**

**INTRODUCTION**

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

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

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 both rib bones from adult pigs were selectively demineralized by timed immersion in 1% ethylenediaminetetraacetic acid (EDTA). Specimens were removed from the solution after 8, 16, 30 and 60 days. Quantitative of bone density was performed. Fifty miniscrew implants (3 mm x 1.4 mm) were inserted to evaluate maximum insertion torque and pull-out strength. Statistical analysis was performed using ANOVA and Pearson correlation coefficients.

**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 minimum insertion torque and pull-out strength.

**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 Broe 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.