# Numerical Prediction of Bone Density around Dental Implant

T.J Sego[1], Yung-Ting Hsu[2], T. Gabriel Chu[3], Andres Tovar[1]

1. Dept. of Mechanical and Energy Engineering, IUPUI, Indianapolis, IN, USA
2. Graduate Periodontics, University of Detroit Mercy School of Dentistry, Detroit, MI, USA
3. Biomedical and Applied Sciences, Indiana University School of Dentistry, Indianapolis, IN, USA

## Introduction

The influence of biomechanical overloading on peri-implant bone loss has been widely discussed in recent years **[1]**. However, bone remodeling and density distribution around dental implants often is not addressed in those models. The purpose of this project was to predict continuous bone remodeling surrounding dental implants using numerical simulation and to investigate long-term outcomes under biomechanical loading.

## Materials & Methods

Based on previous bone remodeling models **[2]**, we developed a continuous finite element-based bone remodeling model **[3]** to investigate the longitudinal biomechanical impacts around a dental implant in response to mechanical stimulus: 200 N axial load and 100 N lateral load (**Figure 1**).

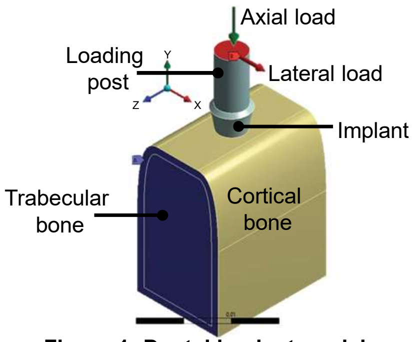


**Figure 1: Dental implant model**

The model assembly included a bone-level parallel dental implant, a single screw-retained implant-supported crown, and the peri-implant bone tissue. To model type III bone, the bone tissue model consisted of an outer layer of cortical bone (thickness of 1 mm) and an inner core of trabecular bone. The results of the finite element analysis (FEA), including equivalent strain distribution and the rate of bone density changes, were examined at different intervals within 24 months (720 days) after function.

## Results

Our model utilized the immediate change in the material state from microdamage accumulation due to excessive strains to predict the bone density distribution around the implant (**Figure 2**). For the oblique load, the cortical bone presented a significant increase in strain compared to the trabecular bone. Significant changes in bone density was observed at the beginning, indicating the initial bone remodeling following loading (**Figure 3**). The remodeling rates decreased and became steady at the end of the experimental period (**Figure 4**).

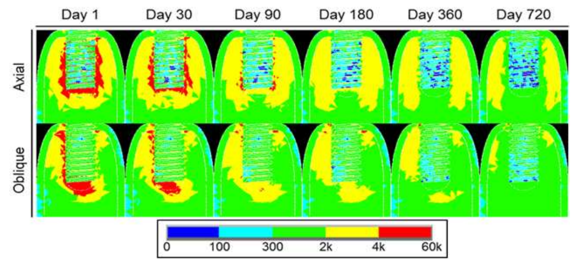


**Figure 2: Strain distribution under axial and oblique loads**

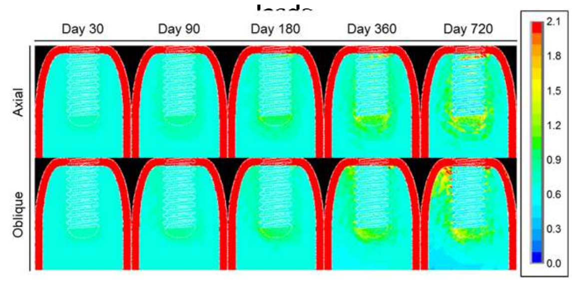


**Figure 3: Bone density distribution.**

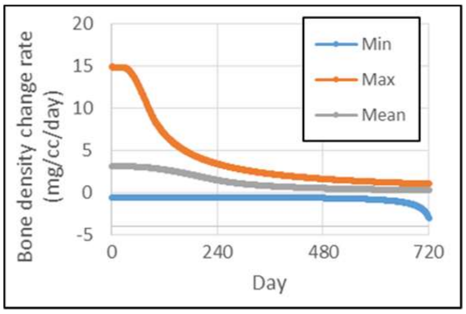


**Figure 4: Changes in bone density.**

## Conclusions

With aid of computer technology, the investigation on the longitudinal biomechanical effects on dental implants could benefit the prediction of long-term outcomes and prognosis. The preliminary results of the model suggested a phenomenon of bone tissue adaptation under functional loading, which confirmed the current understanding via FEA. Calibration with the existing data is currently under investigation.

## Acknowledgements

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## References

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[3] Sego, Hsu, Chu & Tovar, ASME IDETC, 2017