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# Number and localization of the implants for the fixed prosthetic reconstructions: On the strain in the anterior maxillary region

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ABSTRACT

Resorption following tooth loss and poor bone quality affect the success of implants in the anterior maxilla. Inappropriate planning can cause implant loss and aesthetics problems that are difficult to resolve. There is a limited literature on the optimum number and location of implants in anterior maxilla for fabricating fixed prosthesis in biomechanical terms. This study investigated the effect of dental implant localizations in anterior maxilla on the strain values around implants using a three dimensional finite elements analysis method. Obtained strain values were compared to the data in Frost's mechanostat theory. The entire totally edentulous maxilla was modeled using computer tomography images and five models were prepared representing different implant localizations. The distribution of implants in the models was as follows: two canines in the first model, two canines and one central incisor in the second model, two canines and central incisor in the third model, two canines and one lateral incisor in the fourth model and two canines and two lateral incisors in the fifth model. Anatomic abutments with a gingival height of 2 mm and angle of 15° were used as the abutments to fabricate one piece cemented metal fused to porcelain restoration. A chewing strength of 100 N was applied to the cingulum of all crowns at a 45° angle. Maximum strain values in all models were measured in cortical bone in implant necks. The highest strain value was measured in the first model at the cortical bone area (3037 microstrain). Except the first model, all models showed micro strain values within 1000–3000 microstrain. The fifth model was the least risky method in biomechanical terms. The results of this study should be compared with different clinical scenarios (for example different implant designs and sizes). Due to the limitations of three-dimensional finite elements analysis studies, the findings of the study need to be supported by clinical studies.



## 1. Introduction

Implants in aesthetically important areas are defined as advanced or complex treatments [1]. Previous studies showed that the success of implants in the anterior maxilla was similar to that in other regions of the mouth [2,3]. However, there is a limited literature on the success of fixed implant supported prostheses in edentulous anterior maxilla. Furthermore, there is no consensus on the number and location of implants that should be placed in anterior maxilla. The bone in the vestibule sites of the teeth generally breaks during tooth extraction in anterior maxilla. Following the extraction, 25% is resorbed during the first year and 40–60% after 3 years [4]. Particularly due to these resorptions from vestibular to palatinal, it was necessary to localize narrow-diameter implants in more superior and palatinal locations than for natural teeth. The success of dental implants can also be affected by the spongiosis structure of the bone in the region in most cases, and by occlusal loads transmitted during movement of the mandible. Therefore, it is recommended that a minimum of three implants – two canines and one lateral or two canines and one central – should be applied on edentulous anterior maxilla [5,6].

Occlusal loads are transferred to the bone around the dental implants via the implant-supported prostheses. The loads that are transferred to the implants cause stress in the implant-bone contact area depending on the occlusal load type, size of implants, implant surface properties and structural characteristics of the bone on which the implants were applied; and implant location and prosthesis type [7]. Stress is defined as the force applied per unit area. The force that causes stress also causes strain. Strain refers to the resulting deformation or dimensional change in the bone relative to the real dimension of the bone [8]. Frost's mechanostat hypothesis proposed that mechanical stress applied to bone cells results in the constructing of new bone or resorption [9,10]. According to Frost, at 50–1500 microstrain, remodeling is balanced; when microstrain value is 1500–3000, mild overload occurs. At this stage, any damage occurring in the bone can

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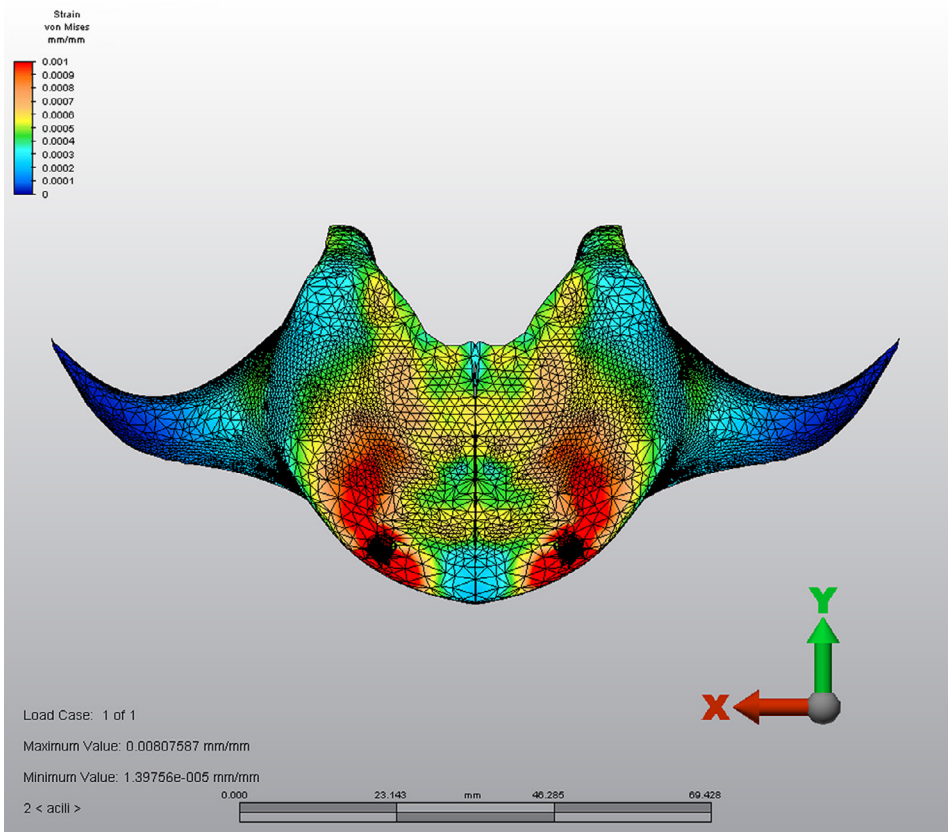


**Fig. 1.** Strain distribution in the Model 1. Implants were placed in both canine sites.

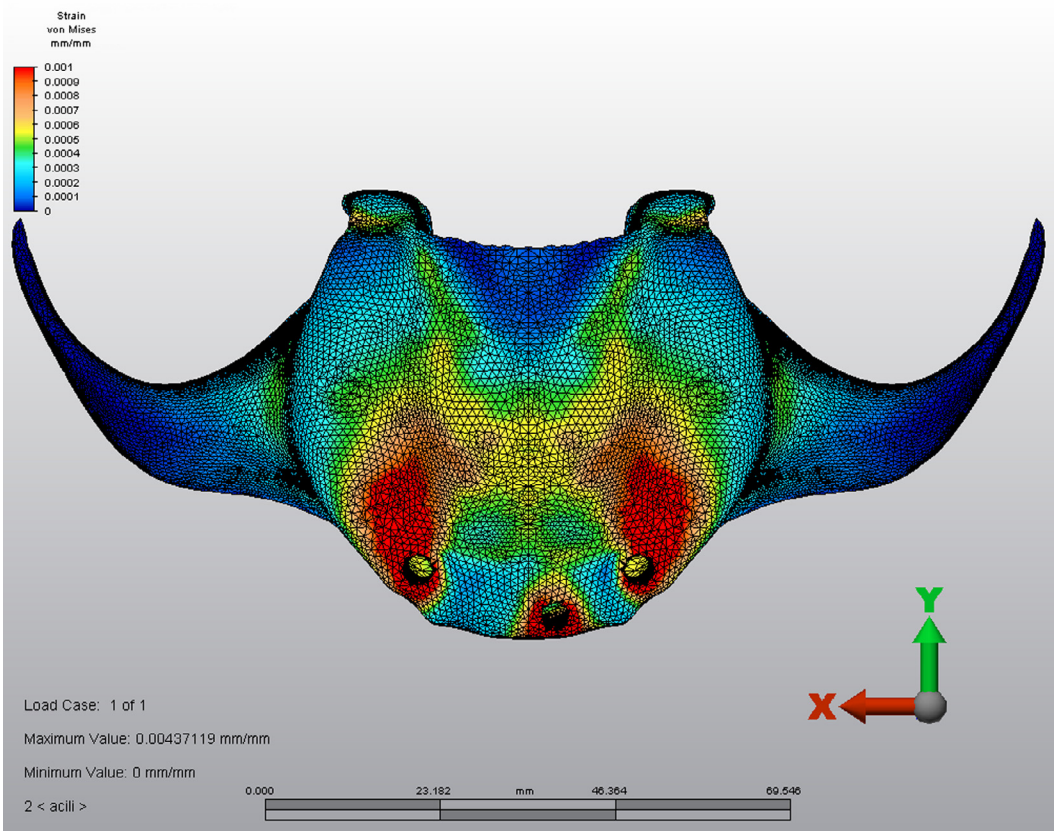


**Fig. 2.** Strain distribution in the Model 2. Implants were placed in both canine sites and one central incisor sites.