Abstract:

This paper describes a new approach for laser bone treatment according to a preoperative plan. The advantages of using laser systems are the free choice of the cutting geometry and the possibility of bone treatment without any severe thermal damage. On the other hand, the control of bone removal depth is difficult. Due to the lack of haptic feedback, it is only possible to control the bone removal visually. In addition, by selecting wrong laser parameters and incorrect handling, the tissue can sustain thermal damage. To solve this problem, an approach of navigated and model-based calculation of depth ablation has been investigated. The focus of this paper was to verify the feasibility of precise and safe laser bone removal by combining navigation information with mathematical and volumetric modeling. For the mathematical modeling, known approaches are used. On the basis of CT data, cavities in a bovine bone were planned with a navigation system. With an optical measurement system, the position of the laser handpiece was calculated relative to the bone. Using a mathematical model, the theoretical cavity depth was calculated for each laser pulse and displayed on the navigation screen. Thereby, the material removal was determined in a volume model. With this information, five cavities were created by the laser using constant energy settings. A final measurement of the cavities’ depths showed an error of less than 1 mm.