Research paper

In vivo evaluation of micro-rough and bioactive titanium dental implants using histometry and pull-out tests

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\textbf{ABSTRACT}

We report on the \textit{in vivo} histological and mechanical performance of titanium dental implants with a new surface treatment (2Step) consisting of an initial grit-blasting process to produce a micro-rough surface, followed by a combined chemical and thermal treatment that produces a potentially bioactive surface, i.e., that can form an apatitic layer when exposed to biomimetic conditions \textit{in vitro}. Our aim was to assess the short- and mid-term bone regenerative potential and mechanical retention of 2Step implants in mandible and maxilla of minipigs and compare them with micro-rough grit-blasted, micro-rough acid-etched, and smooth as-machined titanium implants. The percent of bone-to-implant contact after 2, 4, 6, and 10 weeks of implantation as well as the mechanical retention after 4, and 6 weeks of implantation were evaluated with histometric and pull-out tests, respectively, as a measure of the osseointegration of the implants. We also aimed to assess the bioactive nature of 2Step surfaces \textit{in vivo}. Our results demonstrated that the 2Step treatment produced micro-rough and bioactive implants that accelerated bone tissue regeneration and increased mechanical retention in the bone bed at short periods of implantation in comparison with all other implants tested. This was mostly attributed to the ability of 2Step implants to form \textit{in vivo} a layer of apatitic mineral that coated the implant and could rapidly stimulate (a) bone nucleation directly on the implant surface, and (b) bone growing from the implant surface. We also proved that roughness values of $R_a \approx 4.5 \mu m$ favoured osseointegration of dental implants at short- and mid-term healing periods, as grit-blasted implants and 2Step implants had higher retention values than as machined and acid-etched implants. The surface quality resulting from the 2Step treatment applied on cpTi provided dental implants with a unique combination of rapid bone regeneration and high mechanical retention.

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