

## EVALUATION OF A NEW TITANIUM-ZIRCONIUM IMPLANT

### A biomechanical and histological comparative study in minipigs

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#### Abstract

The osseointegration behavior of titanium-zirconium (TiZr; Straumann® Roxolid™) alloy implants with an SLActive® surface, specially designed for this study, was compared to Grade 4 titanium implants (Ti) with an SLActive surface after 4 weeks of healing in a minipig model. It was concluded that TiZr implants with an SLActive surface performed better than titanium implants with an SLActive surface in 2 out of 3 osseointegration parameters analyzed, i.e., removal torque and bone area, whereas the bone to implant contact was similar to that of the Ti implants.

#### Introduction

Ti implants have been in common use in modern dentistry for several years due to the favorable physical, chemical and biological properties (e.g., osseointegration) of the material. However, the mechanical properties appear to be limited in the case of narrow diameter implants or parts exposed to high strain forces. A TiZr alloy has been developed that shows 50% higher tensile strengths than pure titanium.\* Roxolid implants demonstrated higher fatigue strength than Straumann titanium implants. The aim of this study was to demonstrate that the combination of TiZr with SLActive shows a comparable osseointegration to the existing combination of Ti with SLActive.

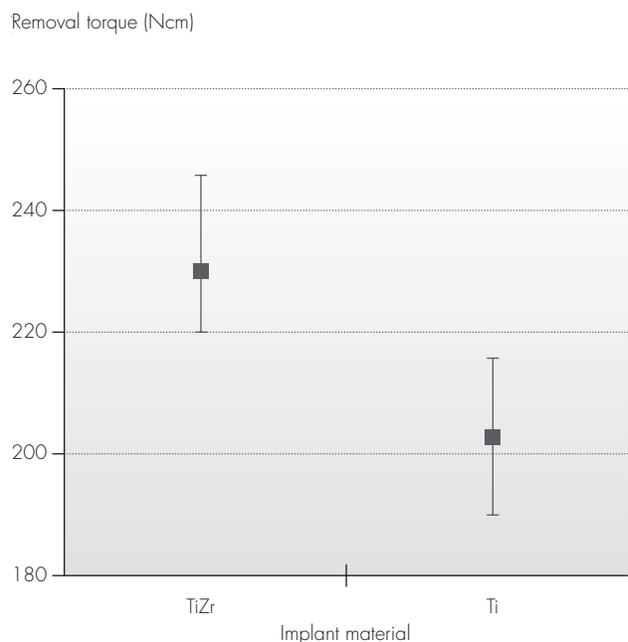
#### Material and Methods

In 12 miniature pigs, six specially designed implants (three modified for removal torque (RT) and three adapted for histological observations) made of Ti or TiZr were placed in each mandible. All implants had an SLActive surface. After 4 weeks of healing RT was evaluated. The histological analyses were conducted on non-decalcified sections stained with toluidine blue. All measurements were performed blinded and the following parameters were calculated:

- BATA – bone area in total area (i.e., bone filling within the chamber)
- BIC – bone-to-implant contact within the chamber

#### Results

Maximum RT was significantly greater for TiZr implants than Ti implants ( $231 \pm 22$  Ncm versus  $205 \pm 24$  Ncm;  $p=0.013$ ; Fig. 1). Histological analysis showed new woven bone with notable composite bone within the chambers for both implant types.



**Fig. 1:** Removal torque (mean  $\pm$  SD) of TiZr SLActive (left) and Ti SLActive implants.  $p=0.013$

\*The 50% is calculated from material strength properties of TiZr (according to internal specifications) and Ti Gr. 4 (according to minimal tensile requirements of ASTM F67)



**Fig. 2:** Histological analysis of bone structure with TiZr (left) and Ti (right) implants

Bone trabeculae followed the surface of the chamber towards its most centri-petal aspect (Fig 2).

Bone area in total area (BATA) was significantly higher at TiZr implants compared to titanium implants ( $45.5 \pm 13.2\%$  versus  $40.2 \pm 15.2\%$ ;  $p=0.037$ ). There was no significant difference in BIC ( $72.3 \pm 20.5\%$  and  $70.2 \pm 17.3\%$  at TiZr and Ti implants, respectively). However, today it remains unclear, if the differences are due to any surface property that might be different between TiZr SLActive® and Ti SLActive.

### Conclusion

TiZr implants with an SLActive surface further improved osseointegration compared to titanium implants with an SLActive surface, supported by 2 out of 3 osseointegration parameters analyzed, i.e., removal torque and bone area, whereas the bone-to-implant contact was similar to that of the Ti implants.

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