

# Clinical Comparison of Primary Implant Stability between Short Zirconium-dioxide & Titanium Dental Implants Using Resonance Frequency Analysis: Pilot Study

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## Background

Primary implant stability (PIS) is believed to play an essential role in successful osseointegration. This initial implant stability is defined as stability at the time of implant placement. PIS is only a mechanical phenomenon and depends on the direct contact between the implant and the bony bed. Different factors may contribute to initial implant stability. The degree of PIS subsequent to implant placement has been related to local factors, implant factors, patient characteristics, and surgical technique.

Ever since osseointegration revolutionised implant therapy, titanium (Ti) has demonstrated outstanding mechanical properties, biocompatibility, and excellent scientifically documented clinical success.<sup>1</sup> Commonly discussed limitations of Ti in implant therapy are the resultant surface and galvanic corrosion,<sup>2,3</sup> (Fig. 1) and Ti hypersensitivity<sup>4,5,6</sup>. Galvanic corrosion may go as far as initiating a cytotoxic reaction that may induce peri-implant bone resorption and assist in fatigue crack initiation, according to some authors.<sup>7</sup> Normally, titanium alloys would express excellent resistance to corrosion due to the naturally-forming stable oxide layer. However, when this stable layer is broken down, titanium alloys become as corrosive as many other base metals.<sup>3</sup> However, the most important disadvantage of Ti implants, as the world of dentistry booms in the direction of aesthetics today, is a resultant greyish-blue discoloration visibly seen through gingiva of thin biotype (Fig. 2).<sup>8</sup>

With the above mentioned drawbacks of titanium, zirconia surely makes a timely entrance into the world of implant dentistry. After zirconia was used as part of the Ti-Zr alloy for superior mechanical properties to Ti alloys in short diameter implants,<sup>9</sup> the use of Zirconia as a ceramic began to take place.

This comparative study was inspired by the lack of literature shedding light on the difference in PIS between different implant materials.



Figure 1. Corroded titanium implant surface following placement.



Figure 2. Grayish-blue gray shade of titanium implant clinically observed through the thin gingival biotype.



Figure 3. Osstellä mentor used for the RFA measurements



Figure 4. SmartPeg attached to the implant for measurements.

## Material & Methods

Forty patients (31 females & 9 males, average age of 51.5± 3.7; min 20 and max 63) with indications for single tooth replacement in the posterior mandible and maxilla were randomly assigned to treatment with zirconium-dioxide (test) or titanium (control) dental implants. Forty-four implants (22 zirconium dioxide Ø4.0, length 8mm and 22 titanium with SLA surface Ø4.1 length 8mm) were analysed in this study. All implants, Axis and Straumann, are tissue level implants. They all have the same diameter (4.0mm vs. 4.1mm), length (8mm), and number of threads (7). Both analysed implant systems have similar surface roughness (1.6 microns vs. SLA).

The implant stability quotient (ISQ) was measured immediately following implant insertion. All procedures were performed at the RAK College of Dental Sciences and Advance Europe Medical Centre, Sharjah, UAE.

The implants were placed according to the respective company's surgical guidelines. A total of 10 and 12 zirconium dioxide implants (Axis Biodental, Les Bios, Switzerland) were inserted in the upper and lower jaw, respectively. An equal number of titanium implants (SLA Straumann®; Straumann AG, Basel, Switzerland) were also distributed in the control group.

Resonance frequency analysis (RFA) measurements were performed immediately following implant placement using Osstellä mentor (Integration Diagnostics AB, Göteborg, Sweden) according to the manufacturer's recommendations (Fig. 3). The measuring device (SmartPeg) was attached to the implant using 10Ncm of torque (Fig. 4). All measurements were performed with the probe (Osstell mentor Probe II) from a buccal direction. The probe was held at a distance of 2–3mm until the instrument displayed the implant stability quotient (ISQ) value. Two ISQ values were recorded and used as a mean value for statistical analysis.



## Results

The mean value of primary implant stability was 65.02 ± 2.85 ISQ (range of 55 to 76) in the test group and 62.62 ± 4.12 (range 66 to 78) in the control group. No statistically significant differences were found between the analysed groups where p<0.005 (Tab 1). Statistically significant differences were present in both the control (p=0.000) and test (p=0.001) groups, between implants placed in the upper and lower jaw.

Study Group	Jaw	ISQ	P Value
Control (Titanium)	Maxillary	62.31 ±2.73	P= 0.000
	Mandibular	69.93 ± 3.70	
Test (Zirconia)	Maxillary	60.25 ± 3.72	P= 0.001
	Mandibular	69.78 ± 2.46	

Table I. Results of the clinical trial.

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## Discussion

Although titanium has shown unrivalled dominance and suitability as an implant material, it also has presented some complications that may be avoided with an alternative material. Titanium dental implants have shown some degree of corrosion, ion release and hypersensitivity, and poor esthetic outcome in patients with thin gingival biotype, some of which may have a direct inversely proportional relationship with implant osseointegration. It is quite evident that zirconia implants are the alternative to make up for the aesthetic failure of titanium in thin gingival biotypes; however, can zirconia implants compare or even possibly surpass titanium in its physical, mechanical, and biological performance in similar clinical settings?

The latest, although still scarce, literature on zirconia as an implant material put to the clinical test shows quite promising, possibly breakthrough-worthy, results.<sup>10</sup> However, despite clinical trials with the use of zirconia dental implants reporting high success and survival rates, none of the parameters in most of the documented studies include implant stability. Marginal bone loss has been discussed, but our study remains among the first few that has discussed the parameter most accurate in assessment of implant success: implant stability. The results of this pilot study show that the type of implant material (zirconium-dioxide vs. titanium) does not influence the value of primary implant stability. In order for such conclusions to be confirmed, however, further randomised control trials with much larger samples should be performed, especially with the inclusion of a focused comparison of the healing phases of both types of dental implants.