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Research Article

Static Loading to Fracture of Standard Diameter vs. Narrow Machined Dental Implant

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Abstract

Purpose: The mechanical failure of dental implant is clinically related to a prosthetic overload dissipated on the fixture/abutment complex. The aim of this investigation was to evaluate the resistance to fracture under static loading strength of Regular and Narrow machined dental implant.

Materials and Methods: According to Standard ISO 14801 norm 2017, a total 10 Narrow Implant (Group I) and 10 Regular fixture (Group II) has been tested under a fracture static loading in this investigation.

Results: The fracture loading point was significatively higher in the Regular fixture (Group II) if compared to the Narrow Implant Group I. The study effectiveness showed the similar characteristics of fracture deformation between the two Groups.

Conclusions: Both of study groups implant showed high fracture strength after the static loading procedure compatible for a clinical applications.

Keywords: *Static Loading; Narrow Implant; Machined Surface; Iso 14801*

Introduction

The dental implant-supported rehabilitation represents a predictable long term option treatment of the jaws edentulism [1].

The success of dental implant restoration concerned with different factors such as surgical protocol, fixture design and surface treatments [2].

The achievement of dental fixture osseointegration produce an optimal distribution of the masticatory stress and occlusal forces to the bone tissue [3,4].

In this way, the alveolar bone follows a dynamic response under a non-pathological loading, that is able to induce the organization of the microstructure and trabeculae orientation, in order to support the masticatory function [5,6].

An overload, is able to produce resorption to the alveolar bone and potentially a failure of the implant-supported rehabilitation [6].

The prosthetic failure of dental implants by different events such as screw loose, screw of implant fracture, that are related to fatigue stress distribution or overload generated by biomechanical forces of masticatory function [7].

The fracture resistance of titanium dental implant is related to many factor such as: titanium grade, length and diameter, fixture micro and macro geometry, surface treatment and the prosthetic connection [8-10]. The titanium represent the primary dental implant material and it is produced in various grades, that are characterized by different mechanical, physical and chemical features [11].

An higher titanium grade is accompanied with an higher strength resistance and is commonly used as screw and abutment material and lower titanium grade presents increased elasticity and flexibility and a lower resistance to the fracture [12].

Narrow implant presents a diameter under 3.4 mm, and the regular implants present a range between 3.75 mm to 4.8 mm [13].

In the clinical practice, the choice of the dental implants implant diameter is related to the biomechanics, function and esthetic aspects of the rehabilitation [14].

Generally, narrow implants are indicated for central and lateral incisors, where an increased diameter is used in the molar and premolar region [13].

Mechanical static tests has been proposed to investigate the effect of the loading on dental implant devices following a standardized protocol without the influence of the oral environment [2,9].

The fracture mechanical loading is a non-repeatable destructive analysis for dental implant device functional simulation [15].

Purpose of the Study

The purpose of this investigation was to evaluate the fracture resistance of two different machined dental implant regular vs. narrow under a static loading.

Materials and Methods

The experimental evaluation was performed according the International Organization for Standardization protocol (ISO 14801, 2017) for endosseous dental implants.

A total of 20 dental implant, has been tested in this investigation: 10 Narrow Implant (Group I) and 10 Regular fixture (Group II).

The Group I Machined Narrow implant (TIZ-13, ISOMED srl, Albignasego PD, Italy) was characterized by a diameter of 2.9 mm and 13 mm length; the Internal Hexagon connection was screw-loaded with a titanium TMZI Abutment following the pre-loading torque manufacturer protocol (Figure 1).

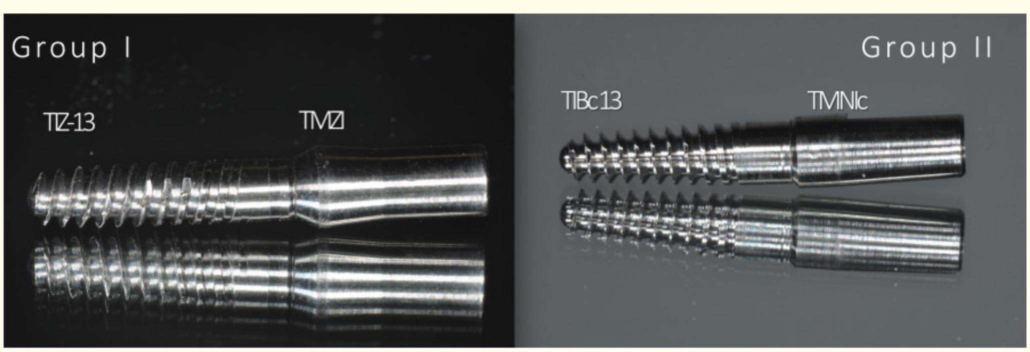

Figure 1: *Experimental groups specimens.*

The Group II Machined Regular implant (TIBc-13, ISOMED srl, Albignasego PD, Italy) was characterized by a diameter of 3.8 mm and 13 mm length; the Internal Hexagon connection was screw-loaded with a titanium TMNIc Abutment following the pre-loading torque manufacturer protocol (Figure 1).

Specimens preparation and loading test

According with the ISO 14801 norm, all the experimental implants were embedded into the epoxy resin block following a standardized depth and angle.

The specimens blocks were fixed into the Lloyd 30K universal testing machine (Lloyd Instruments Ltd, Segensworth, UK) and the load was applied on the hemispheric cap cemented on the implant abutment following an angle loading of 30° ± 2 (Figure 2). Prior the static test, a preload of 5 N was applied at a speed of 0.5 mm/minute until the sample fractured or a reduction in force was indicated by the testing device. The experiment was conducted at controlled environment temperature 26 ± 2° and humidity 51%.

Statistical analysis

The fracture load values was evaluated by the statistical software Graph Pad Prism (Version 6.0, Graph Pad Software Inc., San Diego, CA, USA) for data analysis. A Student t-tests were conducted to detect significant differences fracture force between the experimental groups. The level of statistical significance was set at p = 0.05.

Results

Values of fracture loading values were extracted for all specimens. The fracture resistance value has been presented in table 1. There was no observable fracture of the acrylic blocks (Figure 2 and 3). The prosthetic screws of both of groups appeared fractured after the static loading application. Group I Machined Narrow implant showed a loading fracture point of 498.09 ± 90.3N. The Group II Regular Implant showed a final fracture load of 580.36 ± 55.79N.

	Mean	Standard Deviation	P value
Group I Narrow Implant	498.09 N	90.3 N	p = 0,042 (*)
Group II Regular Implant	580.36 N	55.79 N	

Table 1: *Fracture Loading values of the specimens.*

Figure 2: *Specimen after static mechanical loading.*

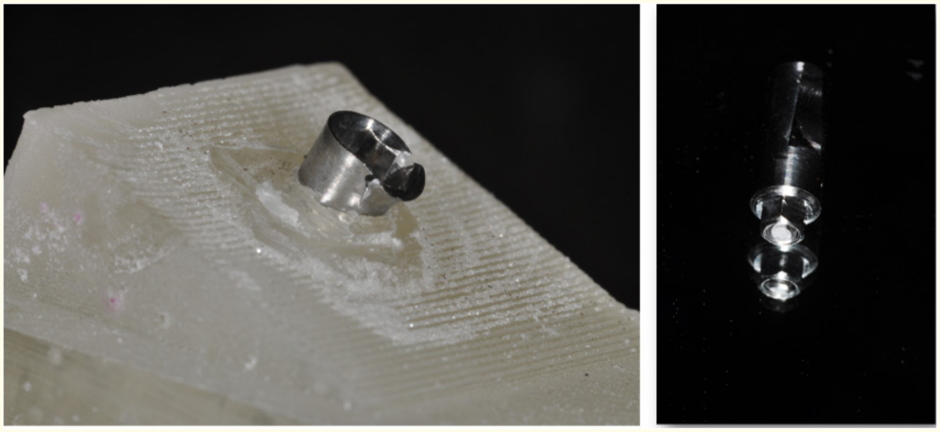

Figure 3: *Detail of the fractured specimen and the implant abutment.*

The statistical analysis showed a significant differences between the Group I and Group II of fracture loading point (p = 0,042).

Discussion

This investigation evaluated the fracture loading point of two different diameters machined dental implants focusing the implant/abutment interface.

The mechanical failure of dental implant is related with high stress structural tension under the pressure overload [15].

This event produces strong forces involved with the formation of micro-cracks on the implant/abutment interface and their components, such as the prosthetic fixation screw [16].

Scarano., *et al.* reported that the progression of these structural deformations produces the propagation of the tension lines until the fracture of the screw fixation complex [17].

The dental implant components fracture and screw loosening, as been reported as a consistent problem in implant dentistry [18].

An overload on dental implant restoration could depend from several critical causes: premature occlusal contact, involuntary rhythmic or spasmodic non-functional masticatory function, bruxism, grinding or clenching of teeth, and occlusal trauma [19]. The results of the present study reported that both of experimental dental implant investigated showed high-end response to the fracture loading for a clinical application for a single tooth rehabilitation.

The limit of the investigation was represented by the fracture resistance evaluated on a standardized model protocol, without the critical aspects related with the oral cavity environment, such as humidity and temperature that could influence the response of the device to the loading and to the failure mechanism [20].

Conclusion

In conclusion, within the limitations of this *in vitro* study and in order of a clinical application, both of machined dental implant groups, Regular and Narrow, showed high level of fracture resistance to the static loading protocol.

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