PARAMETERS OF IMPLANT-ABUTMENT INTERFACE RESPONSIBLE FOR CHANGING THE LONGEVITY OF IMPLANTOSUPORTED REHABILITATIONS: A LITERATURE REVIEW

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ABSTRACT

Since the discovery and dissemination of osseointegration principles many design of abutments have been developed due to the increasing demand for clinical applications of dental implants. Micromovements and vibrations from masticatory forces may be responsible for mechanical complications such as loosening screws and implants or abutment fractures. When analyzed in-vitro implant-abutment connections lead to several risk factors responsible for changing the survival rate of oral implant rehabilitations: distance between abutment surface and depth of the abutment insertion, number and shape of abutment guiding grooves, diameter of the abutment at the platform of the implant, size and material of abutment screw, preload screw and abutment material. This study aims to understand the biological and prosthetic complications from the implant-abutment interface that can affect the longevity of oral implant rehabilitations.

KEYWORDS: Dental implantation, dental prosthesis, osseointegration.

1. INTRODUCTION

Micromovements and vibrations from occlusal forces may be responsible for mechanical complications such as loosening screws and implant or abutment fractures. The reliability and stability of the implant-abutment interface considering its design is an important factor for long-term maintenance of a rehabilitation[1].

The prosthetic interfaces can be divided in two groups: butt joints or slip fit joints. These two groups were subdivided into internal and external connection[3.] On the internal connection, the abutment is fixed to the body of the implant however on the external connection the abutment is a part of the whole extension of the implant body[3].

The most frequent complications from the implant-abutment interface are biological and prosthetic. The most common biological complications are bone loss, excessive occlusal load transferred to the bone and development of microflora in the gap present at the implant-abutment interface and the prosthetic complications are loss or screw fracture and implant loss[4].

On every implant system, the efficiency of the fixation depends on several factors such as: component design, geometry of implant-abutment connection, torque, and physical- mechanical properties of the system components[4].

In this context, it is interesting explore the literature about implant-abutment interface showing the main factors that are responsible for complications that occurs in this interface during implant rehabilitation.

2. MATERIAL E MÉTODOS

A search was conducted using Pubmed® database and articles were selected from 2011 to 2016.

3. LITERATURE REVIEW

When analyzed implant-abutment connections point to several differences such as: abutment distance between the abutment surface and the implant platform (without friction vs. cone morse), depth of abutment penetration, presence of anti-rotation locking, abutment diameter, screw preload and abutment material (titanium, zirconia, zirconia with metals)[6,7].

These differences may have a profound impact on clinical protocols, chair time, laboratory costs, and incidence of complications. Therefore, the clinician should analyze the different biomechanical factors and understand their implications for making a rational choice between the internal and external connection system[6].

Canullo *et al.* (2011)[2] evaluated the biomechanical effect of implant abutment interface in a switching platform using the finite element method. The study demonstrated that the switching platform transfers less stress to the peri-implant bone because most of this stress has been transferred to the implant-abutment system.

Chun-Bo Tang *et al*. (2011)[1] investigated the effect of mechanical characteristics of the implant-abutment interface of three different systems using the finite element method. After application of a 170N load on the surface of the abutment it was found after analysis of strength and stiffness that the 3i System showed the lowest stress while the Branemark System showed the highest stress due to its lower stability from the abutment design.

Dittmer *et al.* (2011)[3] evaluated the effect of implant-abutment connection on the load capacity and implant failure mode. The authors concluded that the implant-abutment connection type has a significant influence on the loading capacity of the implants and the type of implant differs according to the implant-abutment connection design.

Saidin *et al.* (2012)[8] studied the micromovimentation and stress distribution using the finite element method (FEM) at the implant-abutment interface using four types of abutment: hexagon internal, octagon internal, conical internal and trilobular. It was found that the conical internal connection produced the highest micromovimentation and the hexagonal and octagonal connections produced similar patterns of micromovimentation and stress distribution due to its polygonal design. The trilobular connection produced the smallest magnitude of micromovement due to its design, but presented a high tendency of accumulation of stress in its vertices increasing the risk of fracture and formation of microgap.

Meleo *et al.* (2012)[9] used microtomography to measure gaps at the implant-abutment interface of internal conical connections in three implant systems. All analyzed systems did not show visible gaps (greater than 10μm) during microtomographic images acquisition.

Rismanchian *et al.* (2012)[10] evaluated the microgap size in the implant-abutment interface using SEM, and bacterial infiltration of this interface during 24, 48 and 14 days in 4 different abutments. All the evaluated systems did not show significant differences between them in bacterial infiltration at the implant-abutment interface.

Rack *et al.* (2013)[11] performed a pilot study in which they examined the stability of the abutment-implant 3 trademarks interface under different loads and incidence angles using the method of Synchrotron x-ray and x-ray contrast. The investigated abutments presented a continuous microgap independent of their design and the applied load. A load of 120N induced plastic deformation in the implants and abutments. The mechanical strength of the abutment to movement may be related to its design and degree of angulation.

Freitas-Júnior *et al.* (2013)[5] evaluated the failure mode of single tooth implants with conical internal interface of two implant systems. Fatigue was a potential factor for failure in both groups and the most prevalent complications were screw and abutment fracture.

Hogg *et al.* (2013)[12] investigated the stability of abutment position at 4 conical implant systems since the stable position of the abutment is essential to supporting structures and masticatory forces. The unstable position of the abutment was possible in all systems tested, the rotational degrees of abutment were different between the systems.

Wang *et al.* (2013)[13] determined the maximum deflection and the forces responsible for the failure of implants with zirconia and titanium abutments simulating a marginal bone loss of 1.5mm and 3mm using scanning electron microscopy (SEM). They concluded that implants with marginal bone loss of 3mm showed lower maximum deformation compared to implants with 1.5mm of bone loss and zirconia abutments supported occlusal loads applied on bone losses of 1.5mm and 3mm.

Schwarz *et al.* (2013)[14] evaluated through a systematic review the placement of the implant platform and the microgap size in the implant-abutment interface is responsible for remodeling the bone crest in implants placed on or above the alveolar crest.

Jae-Young Jo *et al*. (2014)[15] evaluated the influence of the manufacturing material of the abutments on the stability of the implant-abutment interface on the conical type internal connections. Abutments manufactured from commercially pure titanium grade 3, titanium commercially pure grade 4 and titanium alloy (Ti-6 Al-4 V) were tested. In this study, the compressive load resistance before and after the abutment torque was investigated to investigate the influence of the abutment material on the stability of the implant-abutment interface. The group which titanium alloy composite abutment was used showed the highest values of compressive strength followed by groups of pure grade 4 titanium and pure grade 3 titanium. The authors recommend using materials with high strength and low coefficient of friction to improve the stability of the implant-abutment interface.

Shim *et al.* (2014)[16] evaluated the influence of implant abutment connection design and the diameter of the implant stability of this connection. Abutments with hexagonal external connections and morse internal connections were used in standard platform (4mm) and wide (5mm) platform implants. The initial torque for removal of abutments and post-load torque was measured after a cycle of 100,000 load cycles at 150 N and 10 Hz where pre and post load torque rates were calculated to verify the influence of the implant diameter and abutment design. The results showed that the external connection showed better results in relation to the morse connection in the removal torque in the post-load period and the wide platform showed advantages because there was less torque loss compared to the standard platform.

Silva Neto *et al.* (2014)[17] evaluated bacterial microleakage on abutment-implant interface on morse taper for 24 h and 7 days. The authors found that there was no microleakage in any of the samples during the periods tested.

Sahin *et al.* (2014)[18] studied the correlation between microleakage and torque loss in different types of implant-abutment connection measuring the torque value before and after the microleakage test. Three different types of abutment were evaluated: titanium abutment with internal hexagon connection, zirconium abutment with internal hexagon connection and titanium abutment with Cone morse connection. The authors found a high rate of microleakage in zirconia abutment with internal hexagon connection. Among the groups cone morse and internal hexagon with titanium abutment there was no significant difference. The Spearman Correlational Test ($\alpha = 0.05$) revealed that there is a correlation between microleakage and screw torque loss, so it can be inferred that there is a directly proportional relationship between microleakage and the potential loss of screw torque.

Rismanchian *et al.* (2015)[19] compared the effects of blasting with abrasive micro and nano particles to make rough surface of abutments and the consequent increase in retention of cemented copings. The first group was blasted with Al_2O_3 microparticles of 50 µm size; the second group was blasted with Al_2O_3 nanoparticles with average size 80 nm; and the third group was considered control. The samples were cemented with temporary cement and the tensile strength of the cemented copings was evaluated in a universal test machine after thermocycling process. The results showed a significant difference between all groups ($p < 0.001$) and the first group showed the highest mean value of strength (207.88 ± 45.61 N) with significant differences in relation to the other groups ($p < 0.001$). As predicted, the control group had the lowest resistance value (48.95 ± 10.44 N). Sandblasting with micro or nano particles has proven to be an effective way of significantly increasing bond strength.

Sarfaraz *et al.* (2015)[20] studied two implant-abutment interfaces: passive interface and friction interface and dimensions of the occlusal table in relation to the stress distribution pattern in the implant and alveolar bone crest. The results demonstrated that conical connection distributed most of the stress to the implant body and dissipated less stress to the adjacent bone. The narrow occlusal table considerably reduced stress on the implant, implant-abutment interface and adjacent bone.

Tripodi *et al.* (2015)[21] showed bacterial microleakage on morse taper implants under load and without load. The cone-morse implants were tested on 120N of cyclic loads to simulate masticatory efforts and no significant differences were found between implants under and without loading.

Khorshidi *et al.* (2016)[22] studied in-vitro bacterial microleakage of the implant-abutment connection of the external and internal type for a period of 14 days. After this period, it was verified that there were no cases of bacterial infiltration on the internal connection and on the external type connection group there were 7 infiltrations on the third day, 1 on the eighth day and 5 on the thirteenth day. The authors concluded that the internal connection interface is more advantageous when sealing the implant-abutment interface compared to the external connection.

Gehrke *et al.* (2016)[4] investigated the effects of different torques at the implant – abutment interface of conical connections by scanning electron microscopy (SEM). The study indicated that the higher torque induces a higher linear area of contact between the implant-abutment interface, reducing the gap between the parts.

4. CONCLUSION

Based on this review it can be concluded for a longevity of implant-supported rehabilitation dentist must have clinical and scientific knowledge to choose the prosthetic system for each case since the abutment material, design and rotational freedom are some of the factors that can lead to instability of the prosthetic system and serious consequences such as screw or implant fracture.

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