BIO-MECHANICAL STUDY ON CONICAL IMPLANT-ABUTMENT CONNECTION STABILITY

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Abstract: *Introduction. The implant systems with two or more components are much more used today. The technical failure of the abutment – implant interfaces is more frequently encountered in the posterior crowns. Aim. The objective was to evaluate the behaviour of the abutment-implant interface under simulated masticator loadings as a function of the type of connection and of its structural implementation. Material and method. The mechanical behaviour of different connection types between implant-abutment was evaluated in vitro in conditions of simulated clinical loading. Results. Conical connection system were not detected micros-spaces or micro-movements at forces up to 200 N. The level of the forces as well as the design and precision of the integration as a functional structure are crucial factors which influence the implant abutment reaction at loading. Conclusions. It can completely prevent bone resorbtion systems using implants with a conical connection between the abutment and implant without micro movements.*

Cuvinte cheie: *conexiune conică, bio-mecanica conexiunilor, stabilitate conexiune implant-bont*

Rezumat: *Introducere. Sistemele de implanturi cu două sau mai multe componente sunt mult mai frecvente la ora actuală. Eşecul tehnic al interfeţelor bont-implant este mai frecvent întâlnit la coroane în zona posterioară. Scop. Obiectivul a fost evaluarea comportamentului interfeţei bont-implant sub încărcătura masticatori simulată ca o funcţie a tipului de legătură şi a implementării sale structurale. Material şi metodă. Comportamentul mecanic al mai multor tipuri de conexiuni bont-implant a fost evaluat in vitro în condiţii de încărcare clinică simulată. Rezultate. Cu sistemul conic de conexiune nu s-au decelat micromişcări sau microspaţii la forţe de până la 200 N. Nivelul forţelor, dar şi designul şi precizia integrării ca structură funcţională sunt factori cruciali care influenţează reacţia bont implant la încărcare. Concluzii. Se poate evita resorbţia osoasă în totalitate prin utilizarea sistemelor de implanturi cu o conexiune conică între bont şi implant fără micromişcări.*

INTRODUCTION

This paper tries to classify the implant abutment connections according to the presence or the absence of a self-locking mechanism. Today, the unidental restorations gain more and more importance within the restorations sustained by implants.

The implant systems with two or more components are much more used than the one single piece implants given the well known technical and clinical advantages. The technical failure of the abutment –implant interfaces is more frequently encountered in the posterior crowns. The implant- abutment interfaces situated on the crest or beneath the crest are often summit to the resorbtion of the bone crest after the connection with the abutment.

PURPOSE

The objective has been the evaluation of the behaviour of the implant abutment interface under simulated masticator loadings as a function of the connection type and of its structural implementation.

Micro movements have been detected between the abutment and the surface of the implant within the bone during the introduction of the dynamical loading, thus a causative relation can be established between the micro movement, the technical failure and the resorbtion of the bone crest.

METHODS

The mechanical behaviour of different connection types between the abutment and the implant has been evaluated in vitro in conditions of simulated clinical loading. The connections have been noticed during the dynamic loading in order to obtain quantitative and qualitative observations of any micro-movement in real time.

There have been investigated the implant –abutment connections for the following implant systems: Wital (Wielland, Germany), Implantium (Dentium Coreea), Semados (Bego, Germany).

This in vitro study examines the behaviour of the different designs of implant–abutment connections. The abutments have been loaded at an angle of 30 degrees with a force of up to 200 N. The distance of the point of application of the force from the implant platform, has been of 8 mm. the grading of the forge 0.3N/ms. The interface of the implant-abutment connection has been registered and measured through X rays using a high speed digital camera (1000 images /second). The results have indicated that, in clinically simulated conditions, the complex mechanisms are responsible of the presence or absence of the micro-movements. The implants and the abutments are currently connected through the rotation of a connection screw in an interface region to stabilize the components under pressure.

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This process creates static friction between the components. The level of the static friction depends on the joining area of the surfaces and on the proportion of the forces which act perpendicularly on them.

In mechanics the term „self-locking" indicates the fact that any relative dislocation or rotation of the two components is prevented through the static friction between their surfaces. The static friction is caused by the initial pressure applied on both the components one against the other. It can be overcome by external forces eliminating the „self locking" effect. The quantity of static friction – and thus of self locking „self locking" is determined by the geometry and the friction coefficients of the implied components and of the initial pressure of contact.

The implant abutment connections can also be classified through the determination of the presence of the absence of an index (rotational blockage) in the connection structure. An index will be responsible of a defined rotational position of the connection abutment. This defines the primary function of an index which is the transfer of the rotational position of the abutment between the final cast and the patient.

The second function of the index is the protection of the abutment against the rotation in the absence of another non rotational mechanism such as the static friction or the pasting which can be used in the implant- abutment connection.

A very common type of implant abutment connection is given by two pressed against each other, perpendicularly on the implant axis – here it is the prosthetic platform which is pressed against the abutment floor. An additional feature of this flat interface is the overlapping between the abutment and the implant along the implant axis and in the centre of the implant. An internal connection appears if the abutment is created with a key which goes inside the internal hole of the abutment.

This telescoped system with parallel walls will require a narrow space between the joined surfaces to avoid the friction. If the connecting screw from the flat connection is released, there won't be contact pressure between the perpendicular surface on the implant axis, (between the implant platform and the abutment floor).

The application of an extra-axial loading will determine a relative movement between the abutment and the implant if the connecting screw is released. Without a very tight connection screw, the abutment and the implant cannot be fixed to each other against the relative movements.

The internal connections will allow the presence of the long keys in the abutment which will act as a blocking mechanism. They prevent the complete tilting of the abutment even in the absence of a connecting screw during the extra axial loading.

The external connections such as the external hexagonal ones have a key in the implant which id too short to prevent the tilting of the abutment.

The „non self locking" connections will allow relative movements even when the connection screw is tight. Relative movements between the components will emerge if the extra axial forces surpass the contact pressure which the connection screw creates between the implant and the abutment . The cone is situated on the abutment (the external cone) while the corresponding conical key is localized within the implant (the internal cone). The conical surfaces of the connection will form a a positive frictional fixation as the space between the components disappears due to the conical geometry and to the contact pressure.

If the connection cone of the abutment is joined to the implant body within the bone and is axially loaded through the tightening of the connecting screw or through the functional loading, the connection cone will make its way through the implant self locking. In this process, the circumferential material around the cone (the titanium) will suffer an elastic expansion of submicrometers. The restoration force of the elastic expanded material will maintain the static friction level between the two components. If the connection screw would be removed, the static friction created by the recovering force would prevent the relative movements between the two components. This phenomenon is known as the „self locking" effect. It will prevent the detachment of the components and the micro movements between them.

The static friction is increased by the inevitable rough surface. A very slight roughness cannot be obtained in the moment of production. The „self locking" level can be determined with approximation: if a conical connection is not loaded (by removing the connection screw or by eliminating the functional loading) the friction coefficient between the implant and the abutment multiplied with the restoration force of the implant is equal to the static friction required for the separation of the conical connection in the direction opposed to the insertion way. Thus the level of the separation force will depend on the cone angle, on the initial loading the connection screw.

Even if the connection force remains the same, the smaller angles of the cone are associated with the increasing contact pressure between the conical surfaces of the connection. Consequently the „self locking" effect will increase once the angle of the cone is reduced.

The conical connection will be weakened if an extra axial force is opposed to the insertion area of the cone while the level of static friction is overcome. Still such a force will only appear in the presence of an extra axial force applied on the surface of the cone at an angle higher than 90 degrees. Additionally, the rotation is also capable of reducing the static friction.

RESULTS AND DISCUSSIONS

The registrations show the relative movements between the implant and the abutment. The basic line of their position has not been completely restored due to the permanent changes from the bone crest. A usual modification of 36 ųm has been found at a maximum level of the forces of only 100 N.

In exchange, with the Implantium conical connection system no micro-movements or micro-spaces have been noticed at forces of up to 200 N. The contact between the two elements was present only at the basis of the cone.

The formation of the micro-spaces depends mainly on the total force to which an abutment is exposed. The following clinical situations will reduce the complete force which acts on the implant abutment connections:

- the rigid immobilization of the implants
- the presence of numerous teeth type implant-abutment
- narrow molar occlusal surfaces in oral-vestibular way
- the absence of the bruxism

The extreme extra-axial forces appear in the presence of:

- canine or molar unidental restorations
- the minimal number of required implants
- excessive bruxism

Reactions of the tissue

The implant platforms localized on the crest or beneath the crest can cause bone resorbtion after the attachment of the abutments. This resorbtion of 1,5-2,5 mm has been analyzed in multiple investigations. In the frontal segment the bone loss affects the esthetic of the soft tissue se. the modifications of the papilla will depend on the quantity of the vertical bone.

CONCLUSIONS

Another effect should be taken into consideration since the resorbtion of the bone crest is noticed around the unidental implants as well with a uniform diameter. The conical connections imply a border between the implant platform and the conical abutment. In the presence of the extra-axial loading, the forces will be directed from the crest interface bone-implant to the space between the implant platform and the abutment.

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