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REVIEW ARTICLE

Tooth Implant Connection

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ABSTRACT

The aim of this study was to carry out a review of all available literature addressing the tooth-implant connection and evidence-based understanding of the management of tooth-implant-retained restorations.

Connecting teeth to osseointegrated implants presents a biomechanical challenge. This is due to the implant being rigidly fixed to the bone and the tooth being attached to the bone with a periodontal ligament. This ligament acts as a shock absorber and allows teeth to take less stresses than implants. This leads to biomechanical failure of implants over a period of time.

In order to overcome this problem, various connection types such as rigid and nonrigid have been proposed. However, the mechanism of attachment and the perceived problem of the differential support provided by the implant and the tooth have been discussed by many authors, and the ideal connection type is still controversial.

Literature published was searched through science direct, Google and PubMed. The most relevant articles were evaluated, selected and systematically analyzed.

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INTRODUCTION

A variety of prosthetic techniques can be used to restore the dentition subsequent to loss of teeth. The method of rehabilitation depends on the number, arrangement and status of residual teeth (e.g. periodontal health, remaining tooth structure), cost, patient desires and adequacy of the bone to support dental implants.

Multiple missing teeth may possibly be restored with a conventional tooth-supported bridge, with a tooth-supported bridge with cantilevers, with a resin-bonded bridge, with implant-supported single crowns, with an implant-supported bridge or with a combined tooth-implant-supported bridge.

COMPARISON OF BIOMECHANICS OF IMPLANT AND TEETH

Relation of natural teeth with bone tissue is designated to minimize the forces which will distribute to crestal bone with different mechanisms. The Biomechanical designation of periodontal membrane, elastic modulus, nerve-blood vessels complex, occlusal material and type of supportive bone are effective in determination of load amount which is transmitted to supportive tissues. Tissue that covers the natural teeth acts as a viscoelastic shock absorber, which lessens the amount of stress inbound to bone structure in crestal region.[1,2]

Furthermore, direct integration of implant and the surface of bone is not as flexible as natural teeth. That's why an energy formed by occlusal load may not be distributed evenly. Thus, overloading on the bone which counterparts the implant region is fatal.[2,3]

Mobility of a natural tooth may increase with the occlusal trauma. With this action, stress is either distributed or conducted to prosthetic components and bone interface. However tooth may return to its position, after eliminating occlusal trauma regardless the size of the movement.[2,3]

Mobility of an implant may also increase under occlusal trauma. But after elimination of the factor, implant either returns into its original rigid position or the mobility continues jeopardizing the health of the surrounding tissue resulting in implant failure.[2,3]

THE RATIONALE OF USING TOOTH IMPLANT CONNECTION

The reasons for connecting the tooth to the implant are summarized as follows:

1. To gain support from the tooth or the implant: in patients with bruxism, proprioception of the tooth may help to reduce applied stresses to the implants.[4-6]
2. The absence of other options: due to systemic, local or financial limitations bone augmentation and insertion of additional implants may not always be possible.[1]
3. To preserve a key tooth or teeth with good prognosis.[4,5]
4. To provide stability against rotational forces.[4,6]
5. For esthetic reasons.[4,5]

PRINCIPLES OF IMPLANT AND NATURAL TEETH CONNECTION

It is specified that pronounced decrease in mobility is observed when mobile teeth, which are located in same arch, are splinted with fixed partial dentures.

Splinting of teeth will decrease long-term complications, provided the contacts in the posterior region are not hindered either with prosthesis or skeletally in lateral movement. In addition, connection of natural teeth abutments decreases the incoming load on each support by dissipation.[7,8] By increasing the number of teeth connected, movement of the prosthesis can be decreased. The key principles to decrease the mobility of the prosthesis are:

i. Terminal tooth should not be mobile.
ii. Terminal tooth should be retentive enough.[1,9]

The same principles apply in tooth-implant prosthesis too.

Mobile tooth adds on extra load on intact teeth instead of adding support. However tooth with a mobility value 0, can be connected to osseointegrated implant. Implant, bone and prosthesis will compensate the minor teeth movements. According to literature, implants can be connected easily to stable rigid tooth.[10,11]

Other criterion is to avoid possible lateral loads on abutment while designing a prosthesis. Lateral movements may increase teeth movements but may decrease the movement of implants. Lateral movements of natural teeth cause more stress than vertical movements especially in the crestal bone area affecting the implants.[3] Intact tooth has 8 to 28 µm physiological vertical movement, while this movement is 0 to 5 µm for implant.

Since horizontal movements are excessive than vertical movements, horizontal loads are usually conducted more to implants in anterior teeth connected designs than to implants in posterior teeth connected designs. In either case, it is possible to get excessive load on implant biomechanically, as the implant is connected to its mesial neighboring tooth.[1]

Since lateral forces increase the amount of stress on the bone that is around the implant connecting implants to posterior teeth may increase the success in implant-tooth supported restorations.

BENEFITS OF CONNECTING TOOTH TO IMPLANTS[12]

- Splinting teeth to implants broadens treatment possibilities
- When anatomic limitations restrict insertion of additional implants (e.g.: maxillary sinus, mental foramen)
- Lack of bone for implant placement
- Patient refusing bone augmentation procedure
- Desire to splint a mobile tooth to implants
- Teeth provide proprioception
- Reduced cost for teeth replacement
- Additional support for the total load on the dentition
- Reduction of the number of implant abutments needed for a restoration
- Possibly avoid the need of a cantilever
- To preserve the papilla adjacent to the teeth for esthetic or functional concerns.

TECHNICAL PROBLEMS AND BIOLOGIC COMPLICATIONS ASSOCIATED WITH CONNECTING IMPLANTS TO TEETH[12]

Technical Problems

- Implant failure
- Tooth intrusion
- Intrusion of tooth with telescopic crowns
- Cement bond breakdown
- Abutment tooth fracture
- Abutment screw loosening
- Fracturing of veneers
- Prosthesis fracture.

Biologic Complications[12]

- Peri-implantitis
- Endodontic problems
- Loss of an abutment tooth
- Loss of an implant
- Caries
- Root fracture.

Bone Loss associated with Tooth Implant Supported Prostheses

Biomechanical differences between tooth and implant were displayed by theoretical models and supported by most of scientific research which were published. Results of these studies have shown that excessive load is accumulated around the teeth and implants and the risk of marginal bone loss complications have been reported to be higher.[1]

Jemt et al, concluded that existing teeth supports move as a pontic on the osseointegrated abutment and increases the bone loss around the collar of implant because of their periodontium. For this reason, flexibility of implant, tooth and bone should be similar for distributing stresses equally and it was emphasized that periodontal ligaments of existing teeth has to be healthy when planning teeth-implant supported prosthesis.[13]

Akça et al,[14] concluded that amount of marginal bone surface resorption is negligible in rigid connection of fixed prosthesis.

There are lots of researches to refer and describe rigid implant-tooth connection in the current literature. Teeth-supported prosthesis with rigid connection have similar mobility with implant-tooth supported bridge, but there would be much more movement in the side of implant in tooth-implant- supported bridges with rigid connectors too. It was shown that the implants are exposed to much more loading during photoelastic and finite element analysis. [15] However this type of design is still preferred over teeth-supported restorations. The load on the implants increases especially with the increase in the number of pontics.[7,16]

Short-term clinical success in tooth-implant-supported and implant-supported prosthesis is similar. As a result of the 24-month follow-up, there was no resorption in the level of marginal bone of implants despite the load increase on the implant.[14]

Intrusion of Teeth associated with Tooth Implant Supported Prostheses

Intrusion incidence in implant-tooth-supported prosthetic designs may vary. The rate of intrusion is between 3 and 5.2% in the survey studies.[17] Rieder and Parel reported that the ratio of intrusion is nearly 50% in patients with parafunctional habits. It is also concluded that there was intrusion in rigid-connection as well.[18]

Many researchers pointed that intrusion is more common in patients with nonrigid connected restorations than rigid connected restorations, and it is explained that the cause of intrusion is the use of natural teeth as a female part of stress breaker.[1,18] Intrusion was also reported in restorations, which was supported with telescopic crowns.

To avoid this dilemma Clarke et al, has advised:[19]

i. Selection of the appropriate patient.
ii. The use of rigid connections.
iii. Avoid making coping on teeth which will be used as an abutment.
iv. Preparing the abutment to ensure maximum retention and resistance.
v. Permanent cementation of prostheses.

The use of nonrigid connection is advised for homogenous load distribution.

The basis for this approach is the movement of teeth apart from implants.[20]

In contrast, finite element analysis shows successful results for nonrigid connections.

These results are also supported by photoelastic studies, however it should be kept in mind that *in vitro* studies cannot be imitated in the vivo conditions.

For that reason intrusion of teeth was observed in clinical studies.[21]

There are lots of theories to explain intrusion phenomenon. One of the hypothesis is 'Effect of Rachet'.[21] It is referred that Rachet effect is teeth not returning to its original position after occlusal loading due to the friction resistance of the parts of attachment between the rigid connectors.

One other theory is 'Debris impingement', which explains that micro jamming of food particles at the bottom of the matrix cause a similar intrusion as impaction of particles prevent the tooth from reconnecting to its original position. However, this theory is not fully explained.

Intrusion as a result of the atrophy of the periodontal ligaments was popular in the past. However, tooth may be extruded rather than being intrused in hypofunction.[22]

Use of telescopic copings and overdentures is alternative to tooth-implant connections.[23,24] Theoretically, the stress caused by occlusal trauma trigger osteoclastic activity causing intrusion, the solution is to integrate a vertical lock screw into the cemented doping.

OTHER COMPLICATIONS

Other reasons for complications include planning of the restoration and preparations, dentition in the opposing arch and the type of implant and screws used.

Therefore, it is not possible to talk about a set of technical complications that may arise in a certain case, as these factors vary according to the case and the dentist.[17]

Several studies have shown tooth-implant supported prosthesis show more technical complications compared to implant supported prosthesis.

Naert et al, noted that there is 5 and 10% complication risk in tooth-implant supported prosthesis.[10]

In recent literature, it has been reported that the use of tooth-implant supported prosthesis significantly reduces the risk of mechanical complications when compared to implant supported prosthesis. However, none of these studies include a long-term follow-up period.[17]

Excessive loading on implants and/or the supporting bone is risky. When implant components are continuously exposed to excessive stress, it either affects or fractures the components due to metal fatigue.[11]

CONCLUSION

Despite the fact that the potential mobility between a tooth and implant are different and the precise etiology of tooth intrusion is unknown, it is reasonable to rigidly connect a tooth and an implant. This is particularly true if the anatomy dictates that the placement of an additional implant(s) is contraindicated or if there are economic concerns. This deduction is based on almost every study that addressed this issue and found the survival rates were similar when tooth implant supported prostheses and implant supported prosthesis were compared. Dental literature reported that intrusion can be prevented by using rigid connectors while bone resorption can be reduced by using nonrigid connector in tooth-implant connection.

As a result, undesirable cases can be avoided with some precautions:[25]

i. Using the teeth, which have healthy periodontium and dense bone.
ii. When connecting a tooth and an implant, using stress breakers instead of one-piece casting, which will increase rigidity.
iii. A rigid connection should be used for preparation of implant and tooth, and parallelism should be taken in to account.

iv. Permanent cementation should be preferred.
v. Using short bridge rather than long bridge (When using a long bridge, tooth-implant connections should be avoided as much as possible).
vi. Occlusal forces must be distributed to all supported teeth in occlusion as evenly as possible.
vii. Generally, use of implant-tooth connection should be avoided in patients with Para functional habits. If we have to then maximum implant must be used.
viii. Cantilever extensions must be avoided.
ix. To be noted that the fixed prostheses with minimum abutment support have high failure rate.
x. Implant supported restorations are preferred.
xi. Tooth-implant connection should be established by using the posterior tooth support as far as possible.
xii. Using more than one natural tooth support increases the success rate in tooth-implant connection.

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