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Tooth – Implant Connection: A Review

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Abstract

Restoring function and esthetic in partial edentulous patients by the use of dental implants or fixed bridges supported by natural teeth is a common practice. The less common is the restoration using implants connected by the same prosthesis with the natural dentition, which has several advantages including: reduction of treatment cost, mobile teeth splint provided by the rigid implants, avoiding cantilever in the design of the prosthesis, decreasing the total implant number needed, and others. The mobility of natural tooth in its socket, and the rigid bone implant connection makes this prosthesis associated with many troubles. Branemark and colleagues recommended not joining implants and teeth by the same prosthesis due to biomechanical contrast. Later, several studies showed better prognosis when connecting implants and teeth in the same prosthesis. This problem of support difference between implant and teeth has been researched by many. The type of connection in the prosthesis supported by teeth and implants like rigid and non-rigid connection is also a matter of debate and still controversial. So, research of published literatures in research engines (google scholar, Pubmed, science direct, & etc...) aiming to carrying out a review involving research addressing the tooth implant connection types, complications, and recommendations or principles for these prostheses. In conclusion of this review, a prosthesis joining natural teeth and implants can be a viable solution with respect to the recommendations emphasized in this research.

Introduction:

Rehabilitating partial edentulous patients via prothesis supported by natural dentition and implants is not only cost-effective, but also provides many advantages including: splinting of mobile teeth to rigid implants, prosthesis proprioception supplied by the natural teeth, additional support for the dentition against total load, reduction of the number of implants needed for the restoration, avoiding the need for cantilever, and preservation of papillae adjacent to teeth for functional or esthetic concerns [(1)]. Brånemark was the pioneering recommender that dental implants and

natural teeth shouldn't be connected by the same prosthesis, due to biomechanical and anatomical differences [2]. The literature appears to be conflicting regarding this topic; there are many studies supporting Branemark's claim, such as Jemt et al., (1989) who revealed marked bone loss or even loss of osseointegrated implants, when the prosthesis is supported by implant and natural teeth [3]. Also, several in vitro studies Revealed high stress concentration around implants that are rigidly attached to natural teeth [4-8]. On the other hand, several studies demonstrated clinical cases of joining implants and natural teeth with the same prosthesis with a relatively good prognosis [9-11].
So, this research aims to review the literature to describe the problems associated with this type of prosthesis, the biomechanical concerns and the best way to avoid these complications.

Differences in Biomechanics of Natural Teeth and Dental Implants

The tissue covering natural teeth (periodontal tissue) acts like a shock absorber to decrease the inbound stress to the crestal region of bone [12]. On the other hand, bone implant connection isn't as flexible as in natural teeth; this is why stress from occlusion mayn't be spread out entirely, which mean overloading, which is detrimental to the bone in contact with the implant [12-14].
Occlusal trauma to natural teeth results in tooth mobility. Despite the size of tooth mobility, eliminating the occlusal trauma will return the tooth to its original relation. In the same way, implant mobility results in the difference from a natural tooth in that the implant may or may not return to its genuine rigid relation after removing the occlusal trauma. If implant mobility continues, the health of peri-implant tissue worsens, and resulting in the failure of the implant after a short time period [12,13]. The main differences are shown in Figure (1), and Table (1).

Complications associated with joining implants and teeth by the same prosthesis

Many studies examined stress that occurs around implants, when connected to natural teeth by the same prosthesis restoring partial edentulous patients. The majority of these studies used finite element analysis. The assumption of these studies is that the natural teeth have mobility because of the presence of periodontal ligament, which will result in the shifting of the greater portion of the masticatory load to the implant connected with the same prosthesis to natural teeth, which is obvious because implants are more rigidly anchored to bone. The stress that is concentrated on the implant is proportional to the natural abutment mobility and the size of the prosthesis [17-19]. Greenstein et al., (2009) [1] summarized the complications as shown in Table (2). The most common complication was tooth intrusion. Studies suggested that tooth intrusion occurred more in association with using non-rigid connectors than when using rigid connectors [20]. Palmer et al., (2005) showed no intrusion when rigid connectors were used [21]. However, in some patients with rigid connectors intrusion occurred when the abutment teeth were covered by telescopic crowns [22]. A possible mechanism of tooth intrusion is that when the load is applied, the tooth moves 28 μm, but only rebounds 8 μm, while the prosthesis immediately rebounds and the cement seal pulls the tooth. Eventually the seal of the cement is destroyed and the space is filled with air first, then saliva occupies this space, and during mastication hydraulic pressure continues forcing downward. Eventually, the tooth is submerged or intruded from the prosthesis [23].

Greenstein et al., (2009) [1] concluded that abutment tooth intrusion can be avoided by:

- Avoidance of its use in bruxism patients.
- Using rigid connecters
- Coping on abutment teeth should be avoided.
- Preparation of the abutment teeth should be parallel to increase resistance and retention forms.
- Using permanent cement.

Recommendations for joining implants and teeth

Resnik (2021) [(23)], described guidelines for joining implants to teeth, these guidelines include:

- Natural abutment without clinical mobility.
- No lateral forces on the prosthesis.
- Rigid attachment should be used.
- Implant as a pier abutment is contraindicated.

The explanation of each of these criteria is very important in understanding the biomechanics of joining implants to teeth. Natural tooth moves vertically, and horizontally; vertical tooth movement can be classified into primary movement which occurs in the periodontal tissue, and secondary movement, which is the viscoelastic effect of the bone [(24)]. Implant vertical movement is similar to secondary tooth movement; this is why a prosthesis connecting the implant and teeth should have occlusion modified so that the initial occlusal contacts will be on the natural tooth, which will prevent the implant from bearing the majority of occlusal load [(25)]. Natural tooth movement horizontally is greater than vertical movement. The healthy non-mobile posterior tooth has a movement in the range of 56 to 75 μm, while the anterior teeth exhibit greater horizontal mobility which ranges from 90 to 108 μm in healthy teeth. Compared to 40 to 115 μm range of implant horizontal movement. When load is applied to a prosthesis connecting a healthy non-mobile posterior tooth to an implant, the implant moves 3 to 5 μm vertically, and 40 to 115 μm mesially; and a 6 μm mesiodistal movement of metal fixed prosthesis if having one pontic. So, the movement of a natural tooth that is connected to the implant can be compensated by the movements of the implant, bone, and the prosthesis. In other words, implants can be connected to healthy non mobile posterior teeth, but cannot be connected to anterior teeth, because: 1) the anterior tooth movement is ten-fold the movement of the implant, 2) during excursion of mandible, lateral movement is transmitted to the implant and natural abutment [(23)].

Using a non-rigid connecter is contraindicated; because the pontic will be cantilevered from the implant without any support from the tooth, also, an implant should never be connected to a mobile tooth even if the connecter is rigid; because a mobile tooth acts as a cantilever from the implant, which will increase the stress on implant cement or screw; and after loosening of the prosthesis from the implant, the natural mobile abutment will be subjected to greater stress [(23)]. The implant should not be connected to natural teeth, it acts as a pier abutment, the opposite situation is much better. If the implant is a pier abutment, it acts as a fulcrum in class I lever; this may cause complications even when non mobile natural teeth are connected as terminal abutments. When the implant acts as a fulcrum, the most common complication is decementation of the terminal abutments (usually the least retentive abutments), and the second most common complication is caries occurrence. On the other hand, if a natural tooth is splinted into two terminal implants, the natural tooth acts as a living pontic. The implants in this situation will absorb the load because they're more rigidly attached to the bone than natural teeth which won't contribute to the support of the prosthesis. The proprioception provided by the periodontium is the advantage of keeping the tooth in this situation [(23)].

Discussion

Even though a tooth is potentially more mobile than an implant, the rigid connection between teeth and implants is reasonable. Particularly when the anatomy dictates a contraindication for the placement of an additional implant, or if there are economic concerns [(32)]. Many studies assessed the survivability of prostheses supported by tooth and implant. Short follow-up studies didn't provide accurate results, while long term studies (5 to 10 years) had a better view of this subject. These studies revealed that in the first 5 years, no significant complications were associated with prosthesis supported by implant and teeth; however, after 10 years, tooth-implant supported prosthesis had a decreased survival rate when compared to tooth supported or implant supported prosthesis [26-30]. These studies were conducted on old implant systems (ITI, Branemark, Bioceram) no longer used or remade with surface modification. So, the prosthetic failure, loss of bone, and survivability of implants in these studies may not be relevant to modern implants with improvement in the surface and its connection with the abutment.

Mamalis et al., (2012) concluded that the survivability of implant – tooth supported prosthesis is 94.73% in the first 5 years, and 77.77% in 10 years [31]. In a systematic review published by **Lang (2004),** on survivance and side effects of joining implants and teeth by the same fixed prosthesis, this systematic review included 13 studies with at least 5 years of follow-up; the estimated survival rates after 5 years were 90.1%, and 82.1% after 10 years. The survivance of the rigid prosthesis joining implant and teeth was 94.1% after 5, and 77.8% after 10 years of function [33]. In a study conducted by **Nickenig et al., (2006),** included 83 patients with 84 tooth – implant connected prostheses (132 abutment teeth, and 142 implant abutments), with a follow- up period from 2.2 to 8.3 years. They revealed that 10% of prostheses joining teeth and implants already had a technical modification within 5 years, and nearly 13% of prostheses were adjusted following 8 years [34]. Another study by **Nickenig et al., (2008)** which included 229 prostheses (fixed or removable). The follow up period ranged from 2-10 years. 14% of prostheses were subjected to technical adjustment at the finish of different monitoring periods, without statistical significance between fixed and removable types of prostheses [35].

Fobbe (2019), compared the success and survival of solely implant-supported removable dentures (retained by double crown) and those supported by implant and teeth. The study included 126 patients, with 139 double crowns retained removable dentures on 412 implants and 239 teeth. 53 implant-supported dentures; and 86 tooth-implant supported. After a follow-up period of up to 11.2 years, 99.5%, and 93.4% were the survival rates of implants in tooth-implant supported group and solely implant supported group respectively; With a 97.2% aggregate success [36].

Zafiropoulos et al., (2021) observed that 91 partially edentulous patients were treated with tooth implant-fixed partial dentures for a mean period of 11.8 years. At 5 years, 90% of patients were biological complications free, and 65% were technical complications free. After 10 and 15 years. 76% and 61% were complications free patients (biological and technical respectively) [37].

Conclusion and Suggestions

Within the recommendations highlighted earlier, it is valid that fixed prosthesis supported by teeth and implants could be used in partial edentulous cases, and this may extend the treatment options by reducing both cost and extensive bone augmentation procedures. Studies of greater extent and greater patients numbers and longer observation periods are needed.

Conflicts of Interest

The authors have no conflicts of interest.

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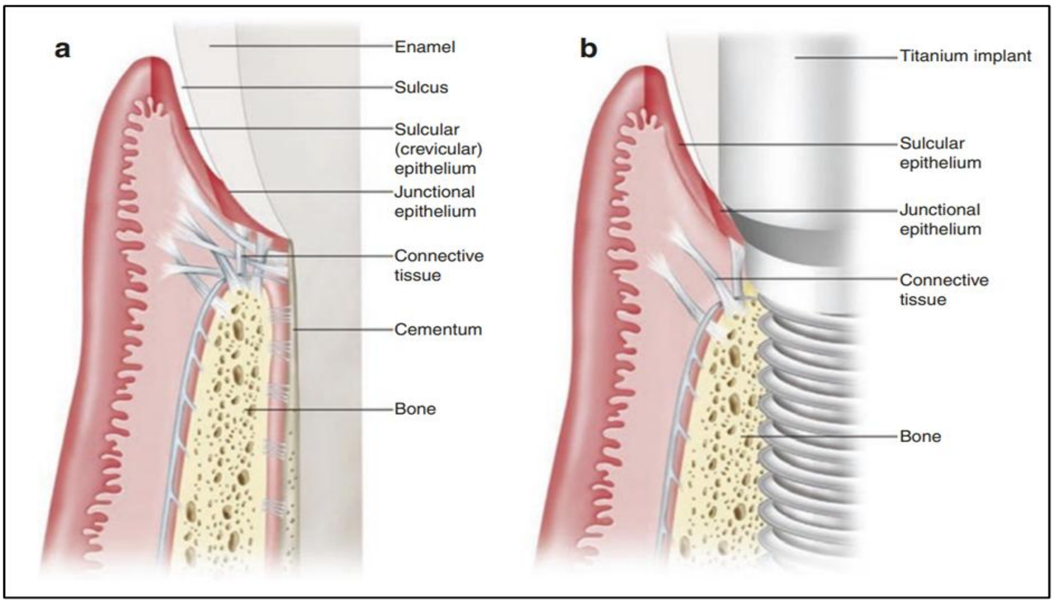

Figure (1): Hard and Soft tissues around implant and tooth, a Schematic illustration. A: Natural teeth. B: Dental implant. (16)

Table (1): Variation of implants and teeth (15).

	Teeth	Dental implants
Periodontal fibers	Insert into cementum on the root surfaces of natural teeth (13 groups)	Extend parallel to the surface of the implant and/or abutment (2 groups)
Connection	Periodontal ligaments	Osseointegration
Connective tissue	A lower percentage of collagen fibers Higher percentage of cells More vascular	A higher percentage of collagen fibers A lower percentage of fibroblasts. It looks very similar to scar tissue Less vascular
Blood supply to surrounding gingiva	Three different sources (the periodontal ligament space, the interdental bone, and the supraperiosteal region)	Two different sources (the supraperiosteal vessels and a few vessels from the bone)
Periodontal ligament space	Present	Absent
Resistance to mechanical and microbiological insults	More resistant	Less resistant
Biological width	JE: 0.97–1.14 mm CT: 0.77–1.07 mm BW: 2.04–2.91 mm	JE: 1.88 mm CT: 1.05 mm BW: 3.08 mm
Sulcus depth	≤ 3 mm when healthy	It could be >3 mm depending on multiple factors
Proprioception	Periodontal mechanoreceptors	Osseoperception
Tactile sensitivity	High	Low
Axial mobility	25–100 µm	3–5 µm
Fulcrum when lateral forces were applied	Apical third of the root	Crestal bone
Possible relief	Pressure absorption, distribution	Pressure concentration on the crestal bone

JE: Junctional Epithelium, CT: Connective tissue, BW: Biological Width.

Table (2): Complications associated with tooth implant connected prosthesis [1]

Technical Problems	Biologic Problems
1. Tooth intrusion	1. Peri-implantitis
2. Implant fracture	2. Endodontic problems
3. Intrusion of teeth with telescopic crowns	3. Loss of an abutment tooth
4. Cement bond breakdown	4. Loss of an implant
5. Abutment tooth fracture	5. Caries
6. Abutment screw loosening	6. Root fracture
7. Fracturing of veneers	
8. Prosthesis fracture	

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