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IMPLANTS SPLINTED TO NATURAL TEETH- A REVIEW

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Abstract:

Background: *Implants splinted to natural teeth is one of the treatment modality for the management of partially edentulous patients. Even though lone implant supported prosthesis is advocated, the anatomical constraints may force the prosthodontists to splint the implant to teeth. The advantages of implants splinted to natural teeth includes increased mechanoreception and additional support for the force distribution throughout the dentition. It also reduces the cost for the teeth to be replaced and it avoids the use of cantilevers. But Combining implants and teeth creates a potential biomechanical mismatch of the supporting units as both display different patterns of mobility under the same physiological stresses. Hence the long-term prognosis of this treatment method is a matter of debate in dental literature. Other problems includes marginal bone loss and various complications like intrusion of the teeth, caries, mechanical failure, loss of occlusal contacts have been reported associated with this treatment approach.*

Methods: *A Medline search was conducted with the key words :Tooth implant supported prosthesis, Tooth implant connection, Stress distribution, Loading condition, Tooth intrusion, Prosthesis design, biomechanics. The research question was fabricated according to PICO criteria: Can an implant be splinted to a natural tooth? Search was limited to articles published in English from 2000 to 2019. Among them 28 articles were selected for review.*

Conclusion: *This article answers the research question by reviewing the various aspects of the biological and technical complications along with the long-term survival rates of tooth implant supported fixed prosthesis.*

Introduction

Numerous prosthetic techniques can be used for the rehabilitation of missing dentition.[1] The method of rehabilitation depends upon the number, arrangement, and status of residual teeth (eg, periodontal health, remaining tooth structure); cost; patient desires; and adequacy of the bone to support dental implants[1,2]. Implant connected to teeth has been considered as an efficient treatment modality. This treatment is considered when there is an anatomic limitation of space for implants or failure of an implant to osseointegrate[2].

The advantages of tooth implant supported prosthesis includes splinting of a natural tooth to an implant, increased mechanoreception, and additional support for the total load on the dentition. In addition, connecting teeth with implant broadens treatment possibilities for the restorative dentist, reduces the cost for teeth replacement, and avoids the use of cantilevers[1,2]. But the main problem which was believed that when implant connected to tooth, implant would be subjected to increased stresses because of difference in their mobility patterns[3]. Several studies reported the marginal bone loss or failure of implant to osseointegrate. Various complications like, intrusion of the teeth, mechanical failure, caries and loss of occlusal contacts have been reported in the literature[2].

The purpose of this article was to review the literature regarding the rationale, difference in the biomechanical behavior of the implant and

the natural teeth, nature of connection, potential complications associated and guidelines to be followed when connecting implants and natural teeth.

Materials and Methods

A Medline search was conducted with the key words: Tooth implant supported prosthesis, Tooth implant connection, Stress distribution, Loading condition, Tooth intrusion, Prosthesis design, biomechanics. A research question was fabricated according to PICO criteria: Can an implant be splinted to a natural tooth? Search was limited to articles published in English from 2000 to 2019. Among them 28 articles were selected for review. The inclusion criteria involved randomized clinical trials, prospective and retrospective clinical studies, in vitro studies, finite element analysis, reviews and biomechanical studies. Information regarding the survival rate, complication rate, incidence of tooth intrusion and type of connector used was collected from the clinical studies. Abstracts, opinion articles, and questionnaire based studies were excluded from the review process. Various aspects of the biological and technical complications along with the long-term survival rates of tooth implant supported fixed prosthesis was retrieved from the reviews.

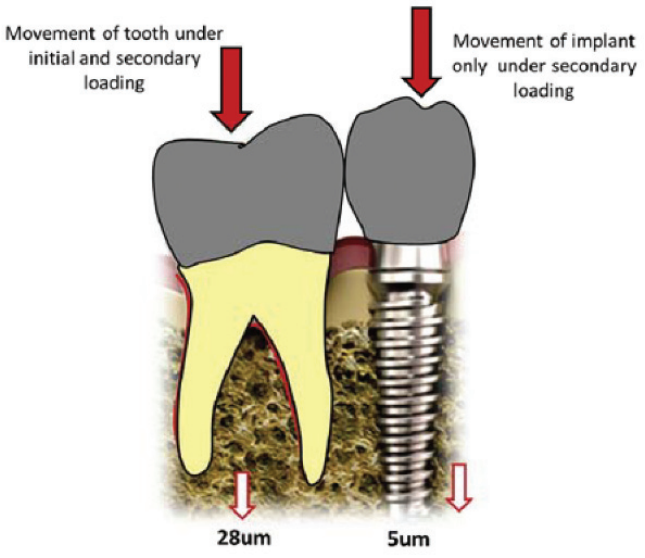
Results and Discussion

The Rationale for using tooth-implant connection can be summarized into five categories. They include Financial constraints[1], to gain support from either the tooth or implant[4,5], cases where bone augmentation and placement of implants is not possible[6], to preserve a tooth with good prognosis[4,5], to provide stability to prevent the rotational forces[4,7] and for esthetic reasons[4,5].

Biomechanics of natural tooth and tooth splinted to implants

The natural teeth are attached to the alveolar bone by means of periodontal ligament fibers; whereas osseointegrated implant is rigidly anchored to the bone. This difference creates a potential biomechanical mismatch of the supporting units[2]. The tooth exhibits normal physiological movement in vertical, horizontal and rotational direction. The primary factors influencing this movement include the health of periodontium, number, length, diameter, shape and position of the roots[7].

Due to lack of periodontal ligament, osseointegrated implants exhibit linear movement during the entire loading cycle without initial rapid movement. This movement is because of the viscoelastic nature of the bone[7]. A healthy natural tooth can move 200 μ in response to a 0.1 N force while an implant can be displaced 10μ or less[8]. The ratio of the amount of movement of the tooth in a healthy periodontium to that of an implant has been estimated to be 10:1 and 100:1[9]. It was suggested that physiologic movement of the natural tooth causes the prosthesis to act as a cantilever generating maximum resultant load up to two times the applied load on the implant[10,11]. Studies have also shown that teeth and implant share the occlusal load and all the forces are not transferred to the



implant[12,13]. Resiliency of implant component, cushioning effect of cement layer, and force deflection in superstructure may contribute to this phenomenon[12–14]. Therefore, biomechanical impact of mismatching of mobility pattern between the natural teeth and implant remains controversial[2]. When the applied load is concerned both magnitude and duration of the force has significant effect on the stress transferred to the bone around a tooth. This may be significant in patients with bruxism[7].

The advantages of splinting implant to tooth can be summarized as follows: 1) Splinting of teeth to implants broadens treatment possibilities such as in cases when anatomic limitations restrict the placement of implants (eg, maxillary sinus, mental foramen), when there is lack of bony support[15] and when patient not willing to undergo a bone augmentation procedure[2]. 2) Desire to splint a mobile tooth to an implant[7]. 3). Teeth provide proprioception[11]. 4) Reduced cost for teeth replacement[1]. 5) Additional support for the total load on the dentition[4]. 6) Reduction of the number of implant abutments needed for a restoration[5]. 7) Possibly avoid the need for a cantilever[6]. 8) To preserve the papilla adjacent to the tooth for esthetic or functional concerns such as phonetics[1].

Cavicchia reported that loosening and fracture of fixation screws and abutments, ceramic fracture and tooth migration seem to occur more frequently in free standing implants compared to the tooth connected restorations. This is due to the decrease bite force in tooth-implant supported prosthesis because of tooth related properioception[16].

Despite of this, several studies indicated that teeth in a TISP share the occlusal load and all the forces are not transferred to the implant. Therefore, various aspects of the data such as technical and physiologic problems, theoretical concerns and functionality of TISPs must be evaluated over a time period to determine the benefits of connecting teeth to implants[12,13].

The disadvantages can be broadly classified into technical and biologic problems[5,17–19]. The technical problems mainly includes tooth intrusion, intrusion of teeth with telescopic crowns, the Implant fracture, cement bond breakdown, abutment screw loosening, abutment tooth fracture, fracturing of veneers and prosthesis fracture. The biologic problems comprises of peri-implantitis, loss of an abutment tooth, loss of an implant, caries, endodontic problems, and root fracture.

Intrusion of tooth

Intrusion of the tooth is one of the most controversial topics in the literature. Intrusion of the tooth in TISP has been reported particularly with nonrigid connectors or coping[5]. When implants were connected to natural teeth to support a fixed partial denture, the incidence of tooth intrusion varied[20]. Studies indicated that intrusion on an average occurred in 3% to 5.2% of the cases[4].

An assessment was conducted by Reider and Parel where they found that 50% of intrusions happened in individuals with parafunctional habits, specifically bruxism. They also noted that it usually occurred in patients with nonrigid semi-precision attachments[21]. Many authors reported that stress-breaking connectors were associated with more intrusion than rigid connections[1]. Some authors discussed the causes of intrusion which consists of:

- Differential energy dissipation[7]
- Friction between the matrix and patrix wall in nonrigid connectors[5].
- Debris accumulation in nonrigid connectors[5]
- Impaired rebound memory of the tooth[5]
- FDPs flexure[22]
- Disuse atrophy of PDL[23]
- Mandibular flexure (average value: 0.9 mm)[22]
- Transfers of microshock waves to the natural

tooth[23].

Some authors reported that no intrusion of teeth associated with rigid connectors[17]. Nickenig et al, demonstrated that when rigid connectors were used, results did not show any differences as if restorations were screw- or cement-retained[24]. Srinivasan et al has a contradictory opinion and concluded that 'the forces should be light, continues and controlled to bring about intrusion without damaging the tooth, in tooth-implant connection it is not the case[25].

Other technical problems

The technical problems were related to the preparation of abutment tooth, configurations and dimensions of the bridge, cements employed, opposing dentition, screws types, types of implants and so on. Several studies reported more technical problems associated with TISPs than ISPs. Naert et al studied on 140 ISPs and 140 TISPs and came to the conclusion that an ISP is more preferable because of an increased number of technical problems associated with a TISP. The complication rate for a TISP was 5% to 10%(5). Brägger et al reported that after 5 years, TISPs did not have a higher risk of technical or biologic complications compared with ISPs. However, after 10 years, TISPs had more failures than ISPs[19]. Lang et al determined in their metaanalysis that most of the technical complications associated with TISPs occurred when there was a nonrigid connection between abutment teeth. They also concluded screw-retained restorations needed more maintenance than cemented crowns[17].

Biological complications

The amount of bone loss around abutments is considered to be a critical determinant to evaluate the durability of TISPs and ISPs. Isidor et al reported that implant overloading can lead to implant failure, which can progress to bone loss at a later stage. It was also concluded with the animal studies which have shown occlusal load may contribute to complete loss of osseointegration or marginal bone loss[26]. Naert et al reported more bone resorption around rigid than around nonrigid connectors. However, the total additional bone loss (0.7 mm) occurred over 15 years[5]. According to Albrektsson et al, amount of bone loss is within the acceptable standards. This was based on a criteria, which was <1.5-mm bone loss the first year after implant insertion followed by <0.2-mm per year in subsequent years[27].

Hosny et al determined the amounts of marginal bone loss around free standing and tooth-connected implants did not differ significantly. They reported 1 mm of bone loss in the first 3 to 6 months after abutment connection and then 0.015 mm annually for 14 years(33). Bone levels around the implants were found to be stable suggesting that excessive loads did not occur to implant when they were connected to teeth. Gunne et al and Lindh et al also reported bone resorption around implants incorporated in a TISP was similar to bone loss adjacent to implants in an ISP when assessed within the same individual[15]. In another study, conducted by Block et al concluded that there was no difference in the amount of bone loss around implants that employed a rigid or nonrigid connection. They noted that teeth around a rigid connection was tend to have more bone loss[8].

Various methods of tooth to implant connection

CelsoHita-Carrillo has classified the methods of connection into two main groups: Rigid and nonrigid connection[29].

Rigid connection

Chee et al believe that rigid connection of the teeth to the implants is not rational due to the adverse effects on the implant in long-term. It will produce greater marginal bone loss, with a corresponding increase in probing depth around the supporting

abutment[27]. Several studies suggest that the tooth and bone implant components were able to undergo some deformation to compensate for the differences in the implant and tooth resiliency under functional load[28]. Several authors concluded that rigid connection achieves better outcomes with regard to avoiding dental intrusion. Lin et al conducted a Finite element anaysis and showed greater stress concentrated on the neck of the implant and the connector near the tooth[29].

Non-rigid connection

Intermobile elements: Some studies reported that these elements provide flexibility to compensate for the mobility of the tooth. An in vitro study conducted by Chee et al, concluded that intermoblie elements did not contribute to the flexibility of the system and the bending force was transmitted to the retaining screw of the implant abutment[7].

Attachments: Several studies demonstrated that the attachments reduced the level of stresses in the bone, because it breaks the stress transfer process. It compensates for dissimilar mobility of the tooth and Implant. But there were instances of intrusion in 3 to 4% of the cases which lead to cantilever formation on the implant increasing the unfavorable stress formation on the implant and the prosthesis[30].

According to Hoffmann and Gregory, in 2012 reported that nonrigid connections drastically reduce the stress on the superstructure while increasing the forces on the supporting teeth and implants[3].

Survival rate

Hosny et al compared different combinations of abutment teeth: single tooth and single implant, multiple teeth connected to an implant, and multiple implants connected to a tooth and reported that no prostheses demonstrated adverse results. The cases were monitored for 1 to 14 years. No implants were lost, and no differences in marginal bone loss were observed between the treatment groups[28]. Lindh et al conducted a 2-year follow-up of various maxillary prostheses. One side received an ISP and the other a TISP. Author concluded that there was no difference in the failure rate of implants (88% cumulative survival rate) with different prosthetic designs and no bone loss was seen with the TISP(30). Naert et al also monitored patients with TISPs and ISPs. It was found that the cumulative success rates of the implants for TISPs and ISPs were 95% and 98.5% respectively. No significant differences was observed with regard to loss of implants even though the implants lost were more with TISP. With regard to the cumulative success rate of the prostheses, no statistically significant differences between ISP (98.4 %) vs TISP (94.9%) were noted[5].

The following guidelines (by Greeinstein et al) which can prevent intrusion of teeth and enhance patient care when contemplating fabricating a TISP can be considered[1]:

1. Select healthy teeth

2. Connect the tooth and implant rigidly (no stress breakers)

3. Avoid telescopic crowns (no copings)

4. Enhance resistance form with boxes and retention grooves if the clinical crown is not long

5. Parallelism of the implant abutment to the tooth prepared and use of a rigid connection.

6. Use permanent cementation

7. The bridge span should be short.

8. Occlusal forces should be directed to the opposing arch.

9. Do not use TISPs in patients with parafunctional habits. If treated with TISPs, it can be maximizing the number of implants and splinting.

10. Cantilever extensions may be employed when

tooth or implant support is adequate

11. TISPs should be avoided in patients with uncontrolled caries

12. Teeth with extensive missing coronal structure or difficult post and core situations should not be used in a TISP

13. In the esthetic zone, if a papilla or papillae is crucial for esthetics or function (eg, phonetics), considering Tooth implant supported prostheses because the supracrestal gingival fibers associated with healthy teeth will provide interproximal soft-tissue support.

14. Appropriate case selection principles are applied, then combining implants and natural teeth may permit segmentation of a prosthesis into smaller sections, which may provide an alternate treatment plan to a large one-piece bridge.

Conclusion

Connecting implant to tooth was found to be a controversial topic with literature showing both success and failure rates for this condition. Only limited long term clinical studies exist to substantiate the results. No conclusive studies were available to show the best prosthesis span length which can be supported by connecting implants to teeth. Despite the non rigid connectors showing a more favourable force distribution, rigid connectors achieve achieve better outcomes with respect to long term stability, complications and tooth intrusion. Though the incidence of marginal bone loss around implants is still greater. Various guidelines have been suggested by different authors which aim toward increasing success for such type of prosthesis. The risk and benefits should be thoroughly analysed for each scenario. Further research is still required for improvement in the design pattern for facilitating usage of such implant connected to tooth systems.

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