ORIGINAL ARTICLE

Practical Utilization of Tooth and Implant Supported Prosthesis: A Critical Review of Literature

Faisal Moeen, Saleha Nisar, Nimra Tahir

ABSTRACT

Objective: Connecting implants to natural teeth as a prosthetic treatment design for the restoration of partial edentulism has been subjected to significant clinical considerations. Several studies have reported complications associated with Tooth and Implant Supported Prosthesis (TISP), while others have shown favorable outcomes. The use of TISP had been discouraged previously due to the difference in the mobility patterns of implant and teeth which can subject the prosthesis to increased stresses potentially leading to failure. However, the complications associated with TISPs seem to have been overstated. This article reviews animal studies as well as human clinical trials over the past 25 years, which have shown favorable results with TISPs. The article also discusses the questionable data which has discouraged the use of TISP. Guidelines which would aid in attaining predictable service life and fewer complications with TISPs have also been mentioned.

Key words: *Tooth and implant supported prosthesis (TISP), Complications, Clinical studies, Case reports.*

Introduction

Various prosthetic treatment modalities exist to replace lost teeth. The feasibility of any given treatment option depends upon a number of patient related and economic factors. Employing a prosthesis design that involved rigidly attaching both teeth and implants as abutments was considered technically impractical, since the implant would be subjected to unfavorable bending moments as a consequence of differences in mobility patterns.[1] It was believed that that such a biomechanical disparity in force distribution consequently lead to an increased failure rate of a tooth-implant supposed prosthesis (TISP) as opposed to an implant supported prosthesis (ISP).[1,2] It has since then been realized that these "potential" issues might have been prematurely expressed thereby making a TISP very much a viable option still.[3,4,5] The objective of this article is to identify the practical utility of a TISP in light of evidence presented in literature. Information was retrieved using PubMed and Medline, Google search engines and indexed journals. Search terms used were: tooth implant supported prosthesis, tooth-implant connection and tooth-implant splinting. Finite element analysis studies, clinical trials, case reports and reviews published in the past 20 years were included.

Correspondence:
Dr. Fasial Moeen
Associate Professor, Department of Dental Materials
IIDC, Riphah International University, Islamabad
E-mail: faisal.moeen@riphah.edu.pk

Ambiguity regarding Tooth-Implant Supported Prosthesis:

Connecting implant to teeth has been one of the most argued issues in the field of fixed partial dentures.[6] Their use has been historically controversial due to the difference in the mobility pattern of the implant and the tooth.[1] Such a difference, for example in a three-unit TISP, could produce a cantilever effect on the prosthesis leading to biological and technical complications due to increase in the amount of stresses on the implant.[7] Force of 0.1 N causes a healthy tooth to displace up to 200µm and an implant to displace <10µm.[8] Inspite of this 10-fold greater mobility of teeth compared to implants, certain factors such as resiliency in components of implant assemblies, natural elasticity of bone, cushioning effect of the cement layer and some force deflection in the superstructure of the prosthesis may allow accommodation of a TISP as feasible. Some studies also show that all occlusal forces are not transferred to the implant, infact they are shared by the teeth in a TISP. Hence the available data regarding TISP should be approached from all perspectives of theoretical concerns to technical faults and functionality over time. This would help in determining a better view of TISP's serviceability.

Advantages of TISPs:

Many clinicians avoid employing TISPs to circumvent the potential problems associated with them; however, certain studies have reported no adverse implications in connecting teeth to implant, concluding that the use of TISPs is beneficial.[9] The

use of TISP can be rational in the following situations:

- TISP is the supplements treatment options,[8] such as in a situation where the lack of bone support prohibits the placement of additional implants or when the patient is not willing to undergo a bone augmentation procedure.
- TISP would also allow stabilization of a mobile tooth by splinting it to an implant. This treatment option would reduce the amount of implant abutments required for the restoration, hence decreasing the overall cost of the treatment.
- Where stability against rotational forces is required.[10]
- Preserving the papillae is easier adjacent to a healthy tooth hence connecting an implant to a tooth in especially in the anterior zone can lead to better esthetics.[11]
- Presence of teeth ensures viability of proprioception and would also aid in supporting the overall occlusal load, hence decreasing the stress applied to the implants.[8,10]

Fundamental concerns with TISPs:

The fundamental problems associated with TISPs refer to the difference in the supporting mechanisms of tooth and implant.[1] The apical movement of a tooth is around 25-100µm and that of an implant is 3-5µm, with the same magnitude of force.[1] The periodontal ligaments allow greater movement of the tooth and this difference causes greater stress on the implant. Another cause of potential complications associated with TISP is the difference in survival rates of the tooth and implant. Compared to an implant, the tooth might decay or need endodontic treatment causing failure of the whole TISP system. Studies evaluating the survival and success rates of TISP show values between 80 and 100%.[8,12] These reasons can manifest either as technical complications or biological ramifications.

Technical problems

Fracture of teeth or implant components, fracture of the whole prosthesis or of the veneer, breakdown of the cement bond and intrusion of the teeth are some of the commonly encountered technical complications of TISP.[8] Certain modifications in prosthesis designing have been made to reduce these complications. For example a non-rigid connector or telescopic crown was suggested in order to reduce the bending movements on implants caused by a rigid connector between the tooth and the implant.[12] But non-rigid connections lead to another complication of tooth intrusion. Studies have shown that the incidence of intrusion in TISP occurs in around 3%-5.2% of the cases.[7] Studies have also shown that 50% of intrusions occurred in patients with para-functional habits and usually occurs in non-rigid semi-precision attachments. The intruded tooth usually had the female portion of the keyway.

Authors have reported more intrusion in prosthesis with a stress breaking connector as compared to rigid connector, whereas others reported no intrusion of teeth with rigid connectors.[7,11] Intrusion was reported in patients with rigid connectors with telescopic crowns on abutment teeth. The possibility of intrusion of teeth in a TISP cannot be overlooked but at the same time TISP as a treatment choice for these specific reasons should not be disregarded. The complications can be avoided by meticulous treatment planning, proper patient selection, refraining from placing copings on teeth used as abutments, using rigid connectors, appropriate tooth preparation(parallel walls) to increase resistance and retention form and permanent cementation.[13] Various studies have showed that TISP's are associated with more technical problems as compared to ISP's. One Hundred and forty ISP's and 140 TISP's were monitored by Naert et al for a period of 1-15 years. The study showed that TISP[11] had a complication rate of around 5%-10% and the incidence of the complications included tooth fracture (0.6%), extraction due to caries or periodontitis (1%), periapical lesions (3.5%), crown cement failure (8%), and framework fracture (2.1%). Whereas in the ISP group only 2 abutment screws fractured. The data presented in this study could be misleading as some ISP's provided overall additional support for the prosthesis due to the use of multiple implants. It has been signified in literature that mechanical complications in TISP can be reduced to the level of complications in ISPs by using rigid connectors between teeth and implants. This statement, however, is based on the studies that were conducted for different lengths of time[11,15] and many studies did not provide a long term follow-up on technical complications.

Biological complications:

The biological complications include peri-implantitis, loss of an implant or an abutment tooth, caries, endodontic problems and root fracture.[3,11,15] Evaluation of the durability of TISPs and ISPs is often done by assessing the amount of bone loss around the abutments. The prevalence of this occurrence is discussed in the light of four different points of views:

1. **Amount of osseous bone resorption around free standing implants:** Studies have shown that the average bone loss around freestanding dental implants is around 0.14-1.6mm during the first year and 0-0.2mm annually.[16] This data poses a question as to whether bone loss around a TISP would be more than that around a freestanding implant or not.
2. **Effect of occlusal load on bone loss:** Literature showed conflicting information regarding the effects of occlusal over loading on implant failure. Some authors state that implant failure is associated with occlusal trauma, while others indicate that this relationship is not clearly demonstrated.[17] Hence on the basis of information provided by literature, it can be stated that peri implant bone can be affected by occlusal forces but several confounding variables (bone density, magnitude of occlusal loading) make the prediction of its occurrence difficult.
3. **Bone loss around TISP:** More bone resorption was reported around rigid connectors by Naert et al.[11] Their study showed a total additional bone loss of 0.7mm over a period of 15 years, A study was conducted by Akca et al[15] showed that the marginal bone levels around dental implants showed stability even after 2 years in function when a rigid connector was used. An another study also concluded that there was not much difference in the amount of bone loss around TISP and a free standing implant.[13] Data presented in literature suggests that the bone loss around the abutments in TISP or ISP is within an acceptable range.
4. **Endodontics:** No conclusion can be drawn from the limited and conflicting data present in literature regarding the survivability of TISP with endodontically treated abutment teeth.[14]

Evidence in literature regarding survivability of TISPs:

Both animal and human trials have their significance in providing information regarding the serviceability of TISPs. Histological data can be obtained through animal studies (difficult to obtain in humans) and clinical trials provide a good comparison of performance of TISP and ISP over a period of time. Based on the histological evidence provided by animal studies[18] it can be concluded that no periodontal ligament atrophy is present around the abutments in a TISP. The performance of a bridge supported by natural teeth is comparable to that of a TISP and functioned successfully even if rigid connections are used.[18] While interpreting these results, the duration of the observation of the studies should be considered. Numerous clinical studies have shown successful results regarding long term functionality of TISP.[11.13.14.19] Different types of studies have been carried out: some compared same size TISP and ISP intra-individually while others compared different sample sizes, evaluating several combinations of implant and teeth. Trends shown by similar studies with comparable treatment methods can be summarized by a meta-analysis.The durability of both ISP and TISP was evaluated after careful assessment of systematic and methodical reviews, which demonstrated a high incidence of TISP failures[17] after 10 years of insertion as compared to ISP. Many a flaws were brought to light after a careful re-evaluation of these meta-analysis like a minimal number of trial subjects/patients monitored for the study, usage of primordial implant systems, employment of outdated technology and superseded dental materials to name a few.A randomized controlled trial compared the use of TISP with ISP.[20] A three unit TISP was placed on the mandibular posterior side and the contralateral side received a three unit ISP, opposed by a denture. The prosthesis were evaluated for a period of ten years and the results showed no statistically significant difference with regard to bone loss or implant failure, nor did TISP show any increase in technical or biological complications. The total marginal bone loss for ISP was 0.6-0.7 mm and for TISP 0.5mm. Length of the implants made no difference to the results. This small study lacked the power to appreciate small differences between the control

and the test groups.[7] A two year follow up of 26 patients who received ISP on one side and TISP on the contra lateral side, was carried out by Lindh et al.[19] Different prosthesis were designed for the patients according to their requirements. The researchers found no difference in the rate of implant failure with different prosthetic designs, nor was there any additional bone loss with TISP. Different combinations of abutment teeth ranging from single tooth/implant to multiple teeth/implants connected to a tooth or implant were evaluated by Hosny et al. [21] patients in total received either TISP (test group) or ISP (control group), each within the same jaw. The cases were evaluated over a period of 1to 14 years. The results showed that no difference in marginal bone loss between the two groups, nor was there any loss of implants. Two groups of patients were monitored for a period of 4-5 years by Bragger et al.[22] One group was given 40 ISPs and the other 18 TISPs. Each group lost one prosthesis and survivability for ISP was 97.5% and for TISP was 95% over a period of 5 years and after 10 years the survivability percentages were 93.9% for ISP and 68.2% with TISP. Loss of crown retention on teeth caused failure of four abutments (out of 22) due to which a smaller percentage of the prosthesis survived over a period of 10 years.

Two groups of 123 patients each having 140 prosthesis were monitored by Naert et al. The average loading time for TISP was 6.5 years and for ISP is 6.2 years. The success rate of implants for TISP was 95% and 98.5% for ISPs. The success rate of the prosthesis did not show much statistical difference between ISP (98.4%) and TISP (94.9%).Comparison between 56 rigid and 28 non rigid connections in various sizes of TISPs which were in service for 2.2-8.3 years was made.[23] Straumann and Branemark system implants were used. 8% of the abutment teeth required periodontal therapy or a restoration after 5 years. The researchers found an increase in the incidence of technical problems with non-rigid connections. 3 out of 56 TISPs with rigid connections showed technical problems; hence the authors concluded a higher success rate is achieved with TISPs with rigid connection.The use of non-rigid connectors to compensate for the different mobility patterns of implant and the tooth under axial forces has been found even in recent literature.[24] However, their use breaks the stress transfer and increases the amount of unfavorable stresses applied on to the prosthesis. It is important to point out that disparity between[4,25] the studies in terms of the duration, number of patients and the type of clinical cases has made comparison of data over ambitious.[3] Lin CL et al studied the biomechanical interaction of TISP using Finite Element Analysis with different type of connections and variations in the number of splinted teeth.[25] They concluded that the main factor affecting the stress concentrations in the bone, were the type of loading conditions. The stresses in the prosthesis were increased by four times with non rigid connections. Adding a tooth to the TISP made the prosthesis more resistant to lateral occlusal forces. They also found out that non-rigid connections compensate for the different mobility patterns of the teeth and implant but increase the risk of subjecting the prosthesis to more axial occlusal forces.

Gross and Laufer suggested that if periodontally stable and immobile natural teeth positioned close to an implant are splinted, it would result in a less destructive TISP.[26] They cited several studies showing good success rates of TISPs. Tooth intrusion was reported as a complication with non-rigid connections.

The study of Naert et al,[11] analyzed rigid and non-rigid connections for 123 cases of TISP for around 15 years, showed a survival rate of 98.4%for ISP and 94.9% for TISP. They however stated that TISP showed more technical complications as compared to ISPs.

Conclusion

Literature supports the idea of rigidly connecting a tooth and an implant, despite the fact that there exists a difference in mobility pattern between the two bodies upon loading. If the placement of additional implants is not possible due to anatomic limitations or economic reasons, rigid connection of TISP can be considered the treatment of choice. Most studies that addressed identifying problems found that the survival rates of TISPs and ISPs were similar. However, certain guidelines have to be followed to prevent the complications associated with TISPs.5[,8,27,28] A periodontally stable tooth surrounded by dense bone should be selected as an abutment and should be rigidly connected to the

implant with large resilient joints to enhance rigidity. TISPs are contraindicated in patients with parafunctional habits, uncontrolled caries, endontontically treated teeth with inadequate retention and resistance form.

Screw retention or temporary cementation should be avoided and the span of the bridge should be restricted to not more than one pontic between two abutments. Multiple adjacent pontics, double cantilevered pontic or prosthesis with minimal abutment support are considered to have a higher risk of failure. TISP should be preferred in esthetic zone as the supracrestal gingival fibers associated with a healthy tooth would provide inter-proximal soft tissue support. Proper patient selection and an adhering to the above mentioned guidelines acquired from literature, should allow a clinician to successfully and predictably use TISPs. Utilizing TISPs adds to wider the range of treatment options available and therefore helps the clinician in deciding the best suited treatment plan for the patient.

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