Periodontal Aspects of Tooth Preservation Versus Implant Placement: A Systematic Review

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Abstract

Introduction

The objective of this systematic review was to evaluate and clarify the clinical dilemma regarding the tooth preservation or its replacement with dental implants.

Methods

A Cochrane, PubMed (MEDLINE), and ScienceDirect database was explored for randomized clinical trials, prospective or retrospective cohort studies, and cross-sectional studies performed between April 2007 and May 2017. Meanwhile, manual search from the available printed journals was also completed. Strength of Recommendation Taxonomy criteria was utilized to select the articles and to classify them into different levels of evidence.

Results

Based on our literature review of the selected articles, survival rate of single-tooth implants was shorter than the success rate of the distinct non-surgical or surgically treated single tooth. Nevertheless, among comparative studies, no significant dissimilarities between both treatment modalities were detected up to at least 6 years after the treatment. Severe forms of periodontal disease are related with higher rates of implant loss.

Conclusion

As a conclusion, the non-surgical or surgical periodontal treatment and the implant placement are valuable and corresponding options for oral rehabilitation. Even though, a level C recommendation can be stated. Our results mostly come from retrospective comparative studies and systematic review articles due to the fact that insufficient randomized clinical studies caused limitations comparing both types of clinician’s treatment preferences.

Keywords

Review Article; Periodontal Treatment; Dental Implants; Outcome

Introduction

Implants are widely used, as Misch [1] discussed in, “to restore the patient to normal contour, function comfort, esthetics, speech, and health, whether restoring a single tooth with caries or replacing several teeth. What makes implant dentistry unique is the ability to achieve this goal regardless of the atrophy, disease, or injury of the stomatognathic system.”
There is an everlasting dilemma regarding the implant long-levity and their ability to replace the natural teeth. It is well known that dental implants have a high success rate but even so, there are a lot of factors that can cause dental implants failure. Fatigue is very sensitive to many variables involved in this phenomenon. This paper takes a close look at fatigue analysis and explains a new method to study fatigue from a probabilistic point of view, based on a cumulative damage model and probabilistic finite elements, with the goal of obtaining the expected life and the probability of failure [2].

Among the factors described as possibly responsible for the failure of implant treatment due to mechanical etiology, it is the clinical phenomenon known as bruxism; the American Academy of Orofacial Pain (AAOP, 2008) defines it such as in “as a movement disorder of the stomatognathic system characterized.” The grinding and clenching of teeth, either day or night, are with a prevalence between 6 and 91% for both sexes in the general population, and the age range is between 18 and 49 years [3-5].

Many aspects of biocompatibility profiles established for dental implants have been shown to depend on interrelated biomaterials, tissue, and host factors, being associated with either surface and bulk properties. In general, the biomaterial surface chemistry (purity and surface tension for wetting), topography (roughness), and type of tissue integration (osseous, fibrous, or mixed) can be correlated with shorter and longer term in vivo host responses. Additionally, the host environment has been shown directly influence the biomaterial-to-tissue interface zone specific to the local biochemical and biomechanical circumstances of healing and longer-term clinical aspects of load-bearing function. The interaction at interface between recipient tissues and implanted material are limited to the surface layer of the implant and a few nanometers into the living tissues. The details of the interaction (hard or soft tissue) and force transfer that results in static (stability) or dynamic (instability or motion) conditions have also been shown to significantly alter the clinical longevity of intraoral device constructs [6].

Nowadays, placement of dental implants has become sufficiently commonplace that there is a need to exchange information amongst what we know about periodontal health and disease and what we know about health and disease relating dental implants. This review discusses the similarities and differences between teeth and dental implants with regards to anatomy, biology, physiology, and pathologic processes. The concept of biologic width is discussed in the context of interaction of periodontal and peri-implant tissues with microbial products produced by periodontal biofilms. The periodontal microbiome is discussed as networks of organisms interacting not only with periodontal and peri-implant tissues, but also with each other as networks of competing organisms [7].

Although favorable long-term results of implant therapy have been reported, infections occur. Until recently few reports included data on peri-implant infections, possibly underestimating this complication of implant treatment. It is possible that some infections around implants develop slowly and that with time peri-implantitis will be a common complication to implant therapy as an increasing number of patients have had their implants for a long time (>10 years). Data on treatment of peri-implant lesions are scarce leaving the clinician with limited guidance regarding choice of treatment. The long-term survival of dental implants depends, in part, on control of bacterial infection in the peri-implant region. Periodontal pathogens colonized implants symptomatic through infection, whereas the microbiota of successful implants was similar to that of periodontal health [8, 9].

Patients with a history of chronic periodontitis may exhibit significantly greater long-term probing pocket depth, peri-implant marginal bone loss and incidence of peri-implantitis compared with periodontally healthy subjects. Even though the short-term implant prognosis for patients treated for aggressive periodontitis is acceptable, on a long-term basis the matter is open to question. Alterations in clinical parameters around implants and teeth in aggressive periodontitis patients may not follow the same pattern, in contrast to what has been reported for chronic periodontitis patients [10].

To make this intellectual-logical process practicable, comprehensive, and representative, clinicians should be qualified to assess and understand the quality of accessible evidence, to support clinical decision-making. Moreover, within the outline of the evidence-based pattern, an articulated methodological approach is required in order to answer a explicit well-formulated question caused by ambiguity regarding a specified clinical situation. An evidence-based approach involves ascertaining, attaining, and understanding results from the best existing studies of options for a given clinical treatment. Additionally, it is necessary to consider the interaction between the clinician’s expertise and judgment and the patient’s preferences and standards.

The service conditions in the mouth are hostile,
both corrosively and mechanically. All intraorally placed parts are continuously bathed in saliva, an aerated aqueous solution of about 0.1 N chlorides, with varying amounts of Na, K, Ca, PO₄, CO₂, sulphur compounds and mucin. The pH value is normally in the range of 5.5 to 7.5, but under plaque deposits it can be as low as 2. Temperatures can vary ±36.5 °C, and a variety of food and drink concentrations apply for short periods. Loads may be up to 1,000 N (with normal masticatory force ranging from 150 N to 250 N), sometimes at an impact-load superimposed. Trapped food debris may decompose to create Sulphur compounds, causing placed devices discoloration. With such hostile conditions, biocompatibility of metallic materials essentially equates to corrosion resistance because it is thought that alloying elements can only enter the surrounding organic system and develop toxic effects by conversion to ions through chemical or electrochemical process [11].

The aim of this systematic review was to assess and simplify the clinical impasse regarding the tooth preservation or its replacement with dental implants.

Materials and Methods

As with every systematic review, the main concern is the proper validation of respectable research papers, review articles and editorial reports. Therefore, the imperative of our critical review exploration was to find reliable, and of course trustworthy tool to express the validity of research results of every each selected paper.

During our research, we have exploited Cochrane, PubMed (MEDLINE), and ScienceDirect database for randomized clinical trials, systematic review articles, prospective or retrospective cohort studies, and cross-sectional studies generated between April 2007 and May 2017. Meanwhile, manual search from the available printed journals was also completed. Strength of Recommendation Taxonomy Criteria was utilized to select the articles and to classify them into different levels of evidence [12].

Three parameters were used to determine the final quality and consistency of individual studies in the SORT, as follows:

a) Quality is the level of evidence for each study. Method used to determine the level of evidence for a study, which accounts for the extent to which an identified study minimizes the possibility of bias (synonymous with the concept of validity).

b) Quantity is the number of selected studies and subjects included in those studies.

c) Consistency is the consistency of data across all nominated studies; i.e., the extents to which findings are similar between different studies of the same topic. Numbers are used to distinguish the ratings for selected studies.

Level 1 evidence—High-quality studies (low risk of bias): systematic review/meta-analysis with consistent findings; large, well-designed, randomized controlled clinical trial (with a diverse patient population, adequate method of randomization, allocation concealment and blinding, intention-to-treat analysis, power of study/large sample size, and long-term follow-up >80%), cohort studies of prognosis (prospective study with follow-up >80%).

Level 2 evidence—Medium- and low-quality studies (moderate/high risk of bias): systematic review/meta-analysis of medium-/low-quality studies with no consistent findings; randomized controlled clinical trial (with unclear or inadequate method of randomization, allocation concealment and blinding, intention-to-treat analysis, sample size, and follow-up), cohort studies of prognosis (prospective study with follow-up 80%).

Level 3 evidence—Studies lacking quality; studies based on disease-oriented evidence, studies based on opinion or literature review with no systematic technique, in vitro research, usual practice, clinical experience, and case series studies.

Initially, 67 articles are selected for this study. After initial examination, only 49 published research papers between April 2007 and May 2017 are selected for further analyze by six contributors for this review article, firstly – decision-making on individual bases and later through additional discussion and compromise judgement regarding each paper.

Figure 1: Exploration Course
Results

Based on our literature review of the selected articles, survival rate of single-tooth implants was shorter than the success rate of the distinct non-surgical or surgically treated single tooth. Nevertheless, among comparative studies, no significant dissimilarities between both treatment modalities were detected up to at least 6 years after the treatment. Severe forms of periodontal disease are related with higher rates of implant loss.

Discussion

We described early that only eight (8) studies in our systematic review article matched the Level A Strength of Recommendation Criteria based on SORT classification; in their study Papaspyridakos et al. concluded that implant-supported fixed complete dental prostheses were associated with a continuous rate of biologic and technical complications. Studies included at least 10 patients and use the prosthesis insertion as baseline. A minimum follow-up of five years was required. The overall complication rate was 24.6% (95% CI 22.7% to 27.5%) per 100 years. After five years 29.3% of prostheses (95% CI 26.5% to 32.2%) were complication free. After 10 years only 8.6% (95% CI 7.1% to 10.3%) were still complication free. The most common biologic complication was peri-implant bone loss greater than 2mm with about 4% of cases for every year exposed. The most common technical complication was screw fracture with an annual complication rate of 2.1% [13].

In another study, Da Silva and Kazimiroff conducted a study to determine the types, outcomes, risk factors and esthetic assessment of implants and their restorations placed in the general practices of a practice-based research network. The authors enrolled 922 implants and patients from 87 practices, with a mean (standard deviation) follow-up of 4.2 (0.6) years. Of the 920 implants for which complete data records were available, 64 (7.0 percent) were classified as failures when excessive bone loss was excluded from the analysis. When excessive bone loss was included, 172 implants (18.7 percent) were classified as failures. According to the results of univariate analysis, a history of severe periodontitis, sites with preexisting inflammation or type IV bone, cases of immediate implant placement and placement in the incisor or canine region were associated with implant failure. According to the results of multivariate analysis, sites with preexisting inflammation (odds ratio [OR] = 2.17; 95 percent confidence interval [CI], 1.41–3.34]) or type IV bone (OR = 1.99; 95 percent CI, 1.12–3.55) were associated with a greater risk of implant failure. Of the 908 surviving implants, 20 (2.2 percent) had restorations replaced or judged as needing to be replaced [14].

Table 1: Representative Research Papers (Level 1) Regarding Implant Survival Rate

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Journal</th>
<th>Clarification</th>
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<tr>
<td>Da Silva and Kazimiroff, 2014</td>
<td>J Am Dent Assoc.</td>
<td>A retrospective study by the Practitioners Engaged in Applied Research, authors enrolled 922 implants and patients from 87 practices, with a mean (standard deviation) follow-up of 4.2 (0.6) years</td>
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<tr>
<td>Papaspyridakos P., 2014</td>
<td>J Evid Based Dent Pract.</td>
<td>Retrospective cohort study</td>
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<tr>
<td>Salinas TJ et al., 2008</td>
<td>Int J Oral Maxillofac Implants</td>
<td>Review article, search of the MEDLINE, EMBASE, and Cochrane Collaboration databases was conducted to identify articles that compared survival and success of fixed partial dentures and single implant-supported crowns</td>
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Weber et al. in their systematic review article determined what scientific evidence exists regarding the influence of prosthotonic design features on the long-term outcomes of implant therapy (implant success and survival, prosthesis success and survival) in the partially edentulous patient; the survival and success of implants and prostheses as defined by the respective authors was retrieved from the included articles, entered into data extraction tables, and submitted for statistical analysis. The prosthesis success rate at the last reported examination (> 72 mo) was 93.2% for cemented and 83.4% for screw-retained restorations (P > .05). Regarding the type of support, implant success rates at the last reported evaluation were 97.1% for implant-supported fixed partial dentures (FPDs), 94.3% for single-implant restorations, and 89.2% for implant-tooth-supported FPDs. None of the differences reached statistical significance. Implant survival at the last examination (> 72 mo) was highest for implant-supported FPDs (97.7%), followed by single-implant restorations (95.6%) and implant-tooth-supported FPDs (91.1%). Differences were not statistically significant. Prosthesis success at the last examination (> 72 mo) resulted in overall lower percentage rates than implant success or survival (89.7% for implant-supported FPDs, 87.5% for implant-tooth-supported FPDs, and 85.4% for single-implant restorations; differences not statistically significant). Authors concluded that scientific evidence obtained from this review is insufficient to establish unequivocal clinical guidelines for the design of implant-supported fixed prostheses in the partially edentulous patient. This evidences are very similar to the results obtained from our study [15].

Salinas TJ et al. in their systematic review of the literature determined the long-term survival characteristics of single implant-supported crowns and fixed partial dentures. Inclusion criteria for implant and fixed partial denture articles included a minimum 2-year study, primary publication in the English language, a minimum of 12 implants, implants designed to osseointegrate, and inclusion of data regarding implant and prosthetic performance. Data were analyzed using cumulative proportions of survival and success for both prosthetic types and for individual implants. Wilson score method was used to establish 95% confidence intervals for each population. This systematic review of the scientific literature failed to demonstrate any direct comparative studies assessing clinical performance of single implant-supported crowns and tooth-supported fixed partial dentures. The analysis suggested differences at 60 months between survival of implant-supported single crowns and natural tooth-supported fixed prostheses when resin-bonded and conventionally retained fixed prostheses were grouped. This difference disappeared when implant-supported single crowns were compared with conventionally retained fixed partial dentures at 60 months [16].

In one representative study, Kinsel RP and Lin D evaluated the potential statistical predictors for porcelain fracture of implant-supported, metal ceramic restorations and the implant survivor rate and restoration endurance. The generalized estimating equation (GEE) approach was used for the intrasubject correlated measurements analysis of categorical outcomes (presence or absence of ceramic fracture).
observation period of at least 3 years the presence of complications are frequent [18].

For suprastructure-related complications, the cumulative incidence of screw or abutment loosening of implant fractures after 5 years was 0.14%. After 5 years, the 5-year observation period. The cumulative incidence of screw or abutment fracture, yielding a 5-year complication rate of 10.4% and a 10-year rate of 20.8%. The most frequent prosthesis-related complication was hypertrophy or hyperplasia of tissue around the IFCDPs (13.0% and 20.8%). The most frequent implant-related technical complication was chipping or fracture of the veneering material (33.3% at 5 years and 66.6% at 10 years). Based on this representative study, biologic and technical complications after the placement of IFCDPs occur continuously over time as a result of fatigue and stress. These events may not lead to implant/prosthetic failures, but they are significant in relation to the amount of repair and maintenance needed, time, and cost to both the clinician and patient [20-23].

The author Abt E in his descriptive review study explored Prospective or retrospective cohort studies of publications that combined findings for both implant-supported fixed partial dentures and single-tooth crowns were selected if they allowed for extraction of the data for the single-tooth crowns group. Twenty-six studies were included in the meta-analysis. Survival of implants supporting SC was 96.8% [95% confidence interval (CI), 95.9-97.6%] after 5 years. The survival rate of SC supported by implants was 94.5% (95% CI, 92.5-95.9%) after 5 years of function. The survival rate of metal-ceramic crowns, 95.4% (95% CI, 93.6-96.7%), was significantly higher (P 0.005) than the survival rate (91.2%; 95% CI, 86.8-94.2%), of all-ceramic crowns. Peri-implantitis and soft tissue complications occurred adjacent to 9.7% of the SC and 6.3% of the implants had bone loss exceeding 2 mm over the 5-year observation period. The cumulative incidence of implant fractures after 5 years was 0.14%. After 5 years, the cumulative incidence of screw or abutment loosening was 12.7%, and was 0.35% for screw or abutment fracture. For suprastructure-related complications, the cumulative incidence of ceramic or veneer fractures was 4.5%. As a conclusion the author showed that high survival rates of implants and implant-supported single-unit crown can be expected, but biological and, particularly, technical complications are frequent [18].

Aglietta M et al. demonstrated that after an observation period of at least 3 years the presence of fractures) to determine which patient- and implant-specific factors would predict porcelain fracture (alpha=.05). Data were collected from 152 patients representing 998 dental units (390 single crowns and 94 fixed partial dentures) supported by 729 implants. Porcelain fractures of 94 dental units occurred in 35 patients. The fractures were significantly (P<.05) associated with opposing implant-supported metal ceramic restorations, bruxism, and not wearing a protective occlusal device. Metal ceramic prostheses (single crown or fixed partial dentures) had approximately 7 times higher odds of porcelain fracture (odds ratio (OR)=7.06; 95% confidence interval (CI): 2.57 to 19.37) and 13 times greater odds of a fracture requiring either repair or replacement (OR=13.95; 95% CI: 2.25 to 86.41) when in occlusion with another implant-supported restoration, as compared to opposing a natural tooth. In addition, patients exhibiting bruxism or not wearing an occlusal device had approximately 7 times higher odds (OR=7.23; 95% CI: 3.86 to 13.54), and 2 times higher odds (OR=1.92; 95% CI: 1.01 to 3.67) of porcelain fracture [17].

The most frequent implant-related technical complication reported with implant-supported metal ceramic restorations, bruxism, and not wearing a protective occlusal device. Metal ceramic prostheses (single crown or fixed partial dentures) had approximately 7 times higher odds of porcelain fracture (odds ratio (OR)=7.06; 95% confidence interval (CI): 2.57 to 19.37) and 13 times greater odds of a fracture requiring either repair or replacement (OR=13.95; 95% CI: 2.25 to 86.41) when in occlusion with another implant-supported restoration, as compared to opposing a natural tooth. In addition, patients exhibiting bruxism or not wearing an occlusal device had approximately 7 times higher odds (OR=7.23; 95% CI: 3.86 to 13.54), and 2 times higher odds (OR=1.92; 95% CI: 1.01 to 3.67) of porcelain fracture [17].

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Aglietta M et al. demonstrated that after an observation period of at least 3 years the presence of maxilla or mandible does not jeopardize the marginal bone levels of implants supporting SCs or short-span FDPs after a mean observation period of at least 5 years. Seventeen subjects with 19 implant-supported SCs and 21 subjects with 21 implant-supported FDPs fulfilled the inclusion criteria. All FDPs were supported by two implants and had a span of 3-4 units. The mean observation period was 78.1 ± 34.5 months for SCs supported by one implant and 67.8 ± 29.8 months for FDPs supported by two implants. No implant loss occurred, yielding a 100% survival rate. At baseline, the mean radiographic bone levels ± SD were 2.6 ± 0.3 mm for implants supporting SCs, 2.6 ± 0.3 mm for implants of FDPs adjacent to the cantilever extension, and 2.4 ± 0.5 mm for implants of FDPs distant from the cantilever extension. At follow-up, the corresponding mean bone levels ± SD were 2.7 ± 0.4, 2.7 ± 0.5, and 2.8 ± 0.5 mm, respectively. No statistically significant differences (P > 0.05) were observed comparing the mean marginal bone loss between the three groups [19].

Papaspyridakos P et al. in his systematic review article assessed the incidence and types of biologic and technical complications associated with implant-supported fixed complete dental prostheses (IFCDPs) for edentulous patients. In their study, a total of 281 one-piece IFCDPs (mean exposure time of 9.5 years) and 653 complication events, the complication rate was estimated at 24.6% per 100 restoration-years. The cumulative rates of "prosthesis free of complications" after 5 and 10 years were 29.3% and 8.6%, respectively. The most common implantrelated biologic complication was peri-implant bone loss (> 2 mm), at rates of 20.1% after 5 years and 40.3% after 10 years. The most frequent implant-related technical complication was screw fracture, yielding a 5-year complication rate of 10.4% and a 10-year rate of 20.8%. The most frequent prosthesis-related biologic complication was hypertrophy or hyperplasia of tissue around the IFCDPs (13.0% and 26.0% after 5 and 10 years, respectively). The most common prosthesis-related technical complication reported with IFCDPs was chipping or fracture of the veneering material (33.3% at 5 years and 66.6% at 10 years). Based on this representative study, biologic and technical complications after the placement of IFCDPs occur continuously over time as a result of fatigue and stress. These events may not lead to implant/prosthetic failures, but they are significant in relation to the amount of repair and maintenance needed, time, and cost to both the clinician and patient [20-23].
Conclusion

As a conclusion, the non-surgical or surgical periodontal treatment and the implant placement are valuable and corresponding options for oral rehabilitation. Even though, a level C recommendation can be stated. Our results mostly come from retrospective comparative studies and systematic review articles due to the fact that insufficient randomized clinical studies caused limitations comparing both types of clinician’s treatment preferences. Also, because of the sample size, our study was not designed to determine differences in success rates between different implant manufacturers and implant surface characteristics; rather, our objective was to provide an estimate of implant outcomes in various study designs.

Finally, when evaluating the results of retrospective studies involving the use of patient records data, we should keep in mind that the types, extent and quality of clinical data entered into patients’ records (in majority of studies) were not standardized because the procedures performed predated the study.

References


