



Prognosis of Furcation Involved Teeth: Cost-Effectiveness over Implant Placement

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Abstract

The severe intrusion of dental implants in everyday clinical practice tends to replace conservative therapeutic approaches of maintaining teeth with dubious prognosis. Furcation-involved (FI) molars pose a great dilemma to the clinician, as in most cases their treatment requires significant effort using surgical interventions as well. Prognosis for multi-rooted is usually worse than single-rooted teeth and additionally, furcation degree III is associated with significantly increased rates of tooth loss. However, clinical studies have shown that retention of teeth with poor prognosis have little effect on the proximal bone loss around adjacent teeth and possibly can be maintained over 10 years in patients who receive regular supportive periodontal treatment. The decision to retain furcation involved teeth is complex and based on multiple aspects such as the extent of dental caries, the remaining tooth structure, the extent of previous reconstructions, post and core build-ups, the extent of periodontal destruction, and the risks associated with endodontic therapy. On the other hand, implant therapy is not panacea. Implants which have been placed in periodontal patients are possible to develop peri-implantitis after 5 years of function, with multiple factors to be associated with the prevalence of disease. The purpose of the current review is to determine the cost-effectiveness of furcation involved molars replacement with dental implants. Many studies, which have been carried out recent years, indicated that maintenance of a furcated-molar with severe bone loss and the patient's compliance to the supportive periodontal treatment is of paramount importance in order to establish their retention in patient's dentition. Recent studies have been shown that maintenance of molars with FI is less costly than their replacement with implants and the treatment they might later require, regardless patient's risk profile. When peri-implantitis occurs, initial and follow-up therapies generate further and high costs. Therefore, dentists should reconsider the benefits regarding effortless extractions and implant replacements and measures in order to preserve the permanent dentition.

Keywords

Teeth; Implant; Cost effectiveness; Periodontal treatment; Root scaling

Introduction

Multi-rooted teeth with furcation involvement constitute a daily challenge for a clinician. Plethora of therapeutic procedures could be implemented in order to maintain those teeth in the dentition.

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However, nowadays a great dilemma emerged, regarding their maintenance, or extraction and implant placement, due to their dubious prognosis.

Usually, molars present many anatomic abnormalities. These areas consist an anatomic factor that plays a crucial role in prognosis of those teeth. There is a great difficulty in sub gingival debridement from root surface. Clinical and experimental studies have shown that typical root scaling is not sufficient for total removal of dental plaque and calculus in furcation defects degree II & III. The remaining calculus rises up to 33% and 54% for non-operated and operated sites respectively.

The presence of cervical enamel projections (CEPs), concavities and convexities, as also the shallow width of the furcation area can affect the effective removal of the microbial load from the root surface. According to Bower's study, more than that, 81% of all furcation entrances have a diameter of less than 1 mm, while 58% present a diameter less than 0.75 mm (63% maxilla molars and 50% mandibular molars with entry width of less than 0.75 mm) [1]. As a result of that, instrumentation of those areas is not sufficient, due to the fact that all available curettes present a cutting edge which ranges from 0.75-1.10 mm. Bacterial biofilms can accumulate and therefore, are difficult to be removed with the daily means of oral hygiene, as well as professional instrumentation.

For all the above mentioned reasons, multi-rooted teeth with furcation involvement exhibit lower success rates in periodontal treatment in comparison with single-rooted teeth [2-5]. Nonetheless, periodontal compromised teeth under strict supportive periodontal treatment (SPT) are rarely lost due to periodontal reasons [6,7].

Although extraction of them and implant placement is a costly procedure initially [8], it is very common procedure among dental practices. Regarding that long-term retention of furcation involved molar teeth may cause further bone loss and there will be a deficient bone site to place an implant, it is easily decided to preventively extract those teeth [9].

In this review, it will be analyzed if furcation involvement is a reason to extract a tooth and place an implant, in regard of long term cost effectiveness of one decision over the other.

Therapeutic approaches of furcation involved teeth

Regardless of the degree of the furcation defect, the therapeutic approach always begins with the initial phase of periodontal treatment, which includes all the necessary guidelines for proper self-performed oral hygiene, extraction of hopeless teeth, supragingival and sub gingival debridement. As initial healing of soft tissues accomplished, a re-evaluation after 6-8 weeks is carried out. When residual defects are detected, we proceed to the surgical correction phase, which may be depending on the degree of furcation involvement and other topical anatomical factors. More specific the clinician can proceed to:

1. Open flap debridement in combination with osteoplasty -odontoplasty. However, excessive root substance removal may lead to hypersensitivity; it also may increase the risk of caries development. Odontoplasty may aid in the treatment of degree I and shallow grade II furcation defects through reducing post-

operative plaque accumulation and improving patient access for oral hygiene [10,11].

2. Tunnel preparation is used for lesions with deep degree II and III furcation involvement. Survival rates over five years range between 57% to 92% [12] and most of the teeth are lost due to carious lesions.
3. Surgical removal of all or a part of root. These techniques can be classified either as root amputation or hemisection, depending if part of the crown is removed or not (American Academy of Periodontology 1992). Root separation is frequently used for deep degree II and III defects accompanied with severe loss of the supporting bone in on or two roots. The most common reason of failure is referred to be root fracture, followed by caries, with periodontal failures accounting for only 0–10% of the total failures [13,14]. Long-term success rates range from 62–100%.
4. Regenerative techniques. Clinical improvement can be achieved in the treatment of degree II lesions in the buccal aspect of upper and lower molars, regenerative materials such as barrier membranes in combination with osseous grafts or enamel matrix derivatives [15,16].
5. Extraction and replacement with an implant. Clinical and experimental studies have shown that residual calculus, still remains after root debridement using close technique, but also after open flap debridement [17,18]. Therefore, treatment of teeth with degree II and III may most of the times be surgical. It can be expected high long-term success rates if the chosen technique is the appropriate and SPT is kept strict [19]. Technique decision and the long-term prognosis may differ, depending on the degree of the furcation defect, morphology of the roots and the osseous defect.

Long term prognosis of furcation involved teeth

The anatomic particularities of furcation involved molars constitute niches of biofilm accumulation. Most of the times the total removal using daily self-performed oral hygiene or professional instrumentation at recall visits are not possible. This is a serious reason to compromise their long-term prognosis.

McGuire and Nunn [20] evaluated retrospectively the influence of different clinical parameters on the survival prognosis of teeth, including FI assessed after completion of active periodontal therapy. They described that teeth with FI degree II and III had a statistically significant inferior survival rate than non-furcated teeth, over the averaged follow-up of 9.97 years. No significant differences regarding survival rate could be observed between teeth without FI and degrees I and II FI during the first 5 years of SPT. After 5 years the survival curve of teeth with degrees II separated from that with no FI and degree I.

Hirschfeld and Wasserman [21] examined retrospectively the periodontal conditions of 600 patients who had been previously treated in a private practice for 15 to 53 years (mean 22 years). A total of 76.5% of the patients had been initially classified as having advanced periodontal disease, whereas 16.5% had disease of intermediate severity and only 7% exhibited early signs of periodontitis. The well-maintained group accounted for 499 (83.2%), the downhill group 76 (12.6%) and the extremely down- hill group 25 (4.2%) of the sample. The results clearly indicate that furcated teeth have significantly greater chances to be lost than non-furcated molars, regardless of the response to treatment, with only exception the extremely downhill

group. In another study, the percentage of extractions of multi-rooted teeth due to periodontal reasons was higher (79.5%), compared with that of single-rooted teeth (20.5%), over a mean SPT period of 10 years [22].

In contrary, in a systematic review [23], it has been shown that the effect of periodontal therapy on the survival rate and multirouted teeth with furcation involvement after an observation period of at least 5 years seems to be encouraging. Teeth which had received guided tissue regeneration techniques exhibit survival rates 83, 3-100%. Moreover, teeth undertaken root respective therapy have survival rates 62-100% and teeth received tunneling technique exhibit survival rates 42,9-92,9%. Most of complications affecting their survival where root fractures, caries and endodontic failures. Periodontal breakdown seems not to be often.

Importance of supportive periodontal treatment (SPT)

Supportive periodontal treatment has been described of paramount importance for the prevention of disease recurrence and tooth loss [24].

The main objectives of SPT are:

- (1) To prevent or minimize the recurrence and progression of periodontal disease in patients who have been previously treated for gingival, periodontal or peri-implant diseases
- (2) To prevent or reduce the incidence of tooth loss and any prosthetic replacement of natural teeth, by monitoring dentition
- (3) To increase the probability of locating and treating other diseases or conditions found within the oral cavity (AAP 1998).

The efficacy of periodontal treatment and the long-term maintenance of the therapeutic outcome depend on patient compliance of with the regular SPT appointments. Dannewitz et al. [25] have shown that during maintenance phase, the percentage of tooth loss was about 15.2% over a mean period of 13.2 years. These results are in accordance with Salvi et al. [26], who found a mean percentage of tooth loss 13.7% over 11.5 years of follow-up. Furcation involvement of degree III was found to be the most relevant tooth-related factor for loss of molars during SPT [26]. Patients who do not participate in a regular recall program may tend to lose 5 times more teeth than patients who comply with the prescribed supportive periodontal care [27]. Although, aggressive periodontitis patients, should be considered as high risk subjects for disease recurrence. Although, tooth loss in patients with aggressive periodontitis with a regular supportive therapy does not appear to differ significantly from patients with chronic periodontitis [28,29]. In contrast, cigarette smoking should be considered as a risk factor for disease progression. Tonetti et al. [30] reported that during the SPT period, smokers might present a significant increase in the prevalence of bleeding pockets when compared with previous smokers and non-smokers [30].

Consequently, supportive periodontal treatment phase plays the key role in long term prognosis and maintenance of furcation involved teeth. Smoking and diagnosis of aggressive periodontitis may or should be considered as factors to affect the frequency of recall appointments.

Long-term implant prognosis

Although implant treatment success rates are very high during the first years, there is a question about the biological complications that appear after 5 years of function [31,32]. In recent years, there is

increasingly literature about high incidence of peri-implant diseases in patients with a history of periodontal disease [33-35]. A plethora of studies have proved that in partially edentulous, or even totally edentulous patients, periodontal pathogens may be transmitted around implants and colonize their surfaces [36].

Generally, poor oral hygiene, smoking and patients with a history of periodontitis who do not comply with the regular recalls, consist severe markers for development of peri-implantitis [37]. It is of importance to highlight those periodontally compromised patients, who do not completely adhere to the SPT, are found to present a higher implant failure rates over the years. Implant survival rates for non- periodontal patients are about 96.6%, while bone loss of <3mm after 10 years of function exists in 4, 7% of patients. Moderate and advanced periodontal patients reveal bone loss of >3mm at 11, 2% and 15, 1% of cases at 10 year follow up [38].

Cigarette smoking consist another major risk factor for biological complications. After a 5-year follow-up period, Wennstrom et al. [39] reported that smokers exhibited statistically significant higher mean peri-implant marginal bone loss than non-smokers (0.76mm vs. 0.22mm, respectively). Baelum & Ellegaard [40] reported that implants explanted in periodontally compromised smokers were 2.6 times higher rate than in periodontally compromised non-smokers. Periodontally compromised smokers were 1.8- 2.4 times more likely to exhibit a first occurrence of peri-implant pocket depth 4-6mm with bleeding on probing, as compared with periodontally compromised non-smokers [41].

The great impact of biological complications and especially the high incidence rates of peri-implantitis after 5-10 years of implant function, results in questioning about placing an implant in high risk patients like periodontal, non- complaint, smoker subjects. The question becomes more complicated if someone has to choose to maintain a furcation involved compromised tooth or extract it and place an implant. Which choice of the offers a better long term prognosis? What are the costs of treating and maintaining a furcation involved tooth and what are the costs in case of placing an implant and maintain it over the years? A cost-effectiveness analysis may help us approximate better this dilemma.

Discussion-cost/effectiveness of Retaining Furcation Involved Molars over Implant Placement

The belief of implants yielding a better long-term prognosis than teeth seems to be rejected due to recent knowledge from comparative studies and systematic reviews. Many studies have reported that even compromised teeth due to periodontal disease or endodontic problems may have a longevity that surpasses implant survival [14,26,42,43]. Discussing the prognosis of furcation involved teeth, it can be said that the most frequent complications following surgical treatment, which potentially result in tooth loss, are caries in the furcation area (when tunneling procedures have been performed), vertical root fractures, and endodontic failures after resective procedures. Although, prognosis of tunneled molars was found to be improved when regular periodontal maintenance and continuous exposure to fluoride were applied [44]. In addition, among resected molars, those resected because of non-periodontal problems (tooth fracture, dental caries, and endodontic problems) had lower survival rates than molars resected because of periodontal problems. Residual bone support of more than 50% of for the remaining roots was found to be a good predictor for tooth survival [45]. Fugazzotto et al. [46] investigated resected molars and single tooth implants and resulted in similar success rates of 96% after

11-13 years of function. Moreover, retaining molars with furcation problems may be the treatment of choice, in sites with proximity to anatomical areas (such as maxillary sinus, mandibular canal) which limit the amount of bone available for dental implants, and/or if the patient's medical situation prohibits multiple reconstructive surgical procedures [47]. In cases of enhanced risk of implant failure (such as in heavy smokers, patients with a history of aggressive periodontitis, or patients under intravenous bisphosphonate medication for more than 2 years), tooth preservation is preferred and extraction and further implant surgery is avoided. In contrast, in patients with high risk for caries development, possibly related to dry mouth, less effort should be made to maintain a questionable tooth and implant treatment may be flavored. A dry mouth is a common side effect of several medications (such as anti-hypertensives, diuretics, anti-depressants, atropine, anticonvulsants, anticholinergics used as spasmoly-sants, and appetite suppressants [48].

The problem of maintaining a furcation involved tooth becomes bigger when that tooth constitutes an abutment in a fixed partial denture. As soon as multiple risk factors are identified for an abutment tooth, complexity increases.

In contrast, several authors have addressed the issue about maintaining questionable prognosis molars with advanced furcation involvement. When implant therapy is considered to take place, the insufficient bone volume of these molars and therefore, the anatomical limitations of these areas, pose a critical risk factor for implant placement. Advanced surgical techniques should be used to ensure sufficient bone housing for implant fixture placement [49,50].

Implant prognosis can be affected from many risk factors. While initial implant fixation following placement is simply derived from mechanical stabilization, osseointegration with an intimate contact between the living bone and the titanium surface requires several weeks for direct bone apposition on the implant surface and subsequent structural adaptation in response to mechanical load [51]. Early implant failures occur primarily during the first weeks or months after implant placement and are frequently related to surgical trauma, complicated wound healing, insufficient primary stability, and/ or initial overload [52]. Late implant losses occur after initially successful osseointegration and are caused by microbial infection, and functional overload [53]. Microbial infection initiates peri-implant mucositis and may progress into peri-implantitis [54]. The majority of long-term studies reported implant survival rates in patients with a history of chronic periodontitis well above 90% [33,39,55].

Talking about economics, Fardal et al. [56] implies that the cost of maintaining implants was much higher than the cost of maintaining teeth. However, these results were obtained in a single private practice in a particular geographic area with a relatively small, heterogeneous sample with a large proportion of smokers. Implant-supported prostheses may be clinically effective but are more expensive than other prosthodontic alternatives [57] and the maintenance of periodontally or endodontically compromised teeth [58]. Therefore, implant overall economic effectiveness is a matter of discussion. Considering the rising economic problems of people who have access to implant therapy, it has to be shown if this kind of treatment is more effective than retaining periodontally compromised teeth over the years. A comprehensive economic analysis will address cost-effectiveness considerations by comparing the incremental costs and benefits of one treatment with any alternatives over a significant period of time [59]. The benefits for the patient of receiving an implant-supported restoration to replace a periodontally compromised tooth

should exceed the costs of such an intervention and their ratio should be superior to that produced by periodontal treatment provided to maintain this tooth.

The cost of an implant-supported restoration should include (besides the direct and indirect costs of actual implant placement) all the costs arising before (e.g. tooth extraction, sinus lift, ridge preservation or ridge augmentation) and after (e.g. maintenance, treatment of possible biological or technical complications) the procedure. Similarly, periodontal treatment of furcation involved teeth should include all the direct (active periodontal therapy) and indirect or induced costs (e.g. periodontal supportive therapy, treatment of hypersensitivity) [60,61,62]. Pretzl et al. [58] indicated that the cost of a bridge/patient is clearly cheaper than placing an implant. It may, however, be more expensive than a removable partial denture (based on reported cost estimates of 1650 euros for fixed partial denture, 2050 euros for a single implant restoration and 790–960 euros for a removable denture for 1-12 teeth).

Schwendicke et al. [63], demonstrated that retaining furcation involved molars via periodontal treatment might be more cost-effective than replacing them with implant supported crowns (ISCs). ISCs are initially expensive [58], and despite requiring retreatments less often-these re-treatments generate further and usually high costs [56]. Whilst survival rates of implant have nevertheless been found to be similar or even higher than those for FI molars [46], the high costs associated with initial and follow-up treatments of ISCs compromise their cost-effectiveness versus single implant placement.

The outcome of periodontal supportive therapy was better when provided by specialists than by general practitioners, but this implies higher cost [64]. The results of these studies however, should be interpreted with caution because a comparison of just the costs of a treatment intervention, without taking into consideration the resulting patient benefits in quality of life. Economic factors alone are not sufficient to support whether or not a specific treatment is more efficient than a treatment alternative [62].

The extraction of a periodontally compromised tooth and its subsequent replacement with a dental implant, as opposed to its retention by means of comprehensive periodontal therapy, is one of the most complex and debatable decisions that a dentist must face during every day clinical practice. Usually, the decision to extract a tooth is based on multiple patient and site risk factors, determined according to periodontal, endodontic and restorative criteria, which are also associated with the strategic role of the tooth in the dentition. Clinical decision-making will be guided not only by cost-effectiveness, but by setting and patients' or providers' priorities such as predictability, access, treatment time per visit and number of visits, surgical or non-surgical approach, provision of technical equipment and quality of life provided. Sometimes, removal of problematic teeth and no restoration of the area, like shortened dental arch, might result in sufficient functionality and subjective oral health at limited costs as well [65].

According to the editorial of Giannobile and Lang [66] we should bear in mind that "we do a disservice to our patients and ourselves without carefully weighing the advantages and disadvantages of such options in providing the optimal oral health care delivery to our patients. We have been trained to preserve teeth. Let us face the challenge. If we select an "early removal of compromised teeth" paradigm, the dental profession will lose most of its expertise in preserving a functional dentition for a lifetime."

Conclusion

The decision to extract a dubious prognosis tooth may be sometimes very difficult and is dependent upon many interrelated, interdisciplinary considerations. In particular, within the scope of a comprehensive treatment plan, a periodontally compromised tooth may be extracted even though it may be technically feasible to treat or to maintain it for a longer period. These considerations include: (i) the amount of residual periodontal support and the ability to stabilise the residual attachment at the individual tooth; (ii) the extent and the severity of periodontal destruction within the dentition; (iii) the strategic value of a compromised tooth in relation to the overall treatment plan and to the residual masticatory function; (iv) the presence of concomitant carious, endodontic and restorative problems; (v) aesthetics; (vi) the predictability, the function and the cost-benefit ratio of the available treatment alternatives [67,68].

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