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IMPLANT THERAPY DECISION-MAKING FOR ENDODONTICALLY INVOLVED DENTITION

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Abstract

This article proposes an evidence based decision tree that serves to guide clinicians on the feasibility of endodontic treatment of a non-vital tooth. It is a reference that clinicians can use when deciding to save or extract a non-vital tooth. Several factors that are commonly encountered in daily practice are considered in this proposed decision-making process and they are history of endodontic treatment, status of previous endodontic treatment, presence/absence of active infection, size of apical radiolucency, periodontal status and patient's preference.

Keywords: endosseous dental implant, endodontic treatment, root canal, evidence-based science, decision-making

Introduction

In dentistry, preserving natural dentition is the primary goal of every clinician. However, dental diseases such as caries and periodontitis may influence the fate of the involved tooth. When caries or periodontitis affect pulpal health, endodontic therapy is required, whereby diseased pulpal tissue is removed and the root canal system is sealed from within the tooth. With current technology, 94 - 97% of endodontically treated teeth have remained functional over 3.5 to 8 years post treatment (1, 2), indicating high long-term success rates. Despite this, some clinicians may opt to extract the tooth and replace it with a dental implant. This is because heterogeneity in success criteria and methodology exist among studies resulting in a lack of conclusive evidence to support the favorable long-term prognosis of endodontically treated teeth (3). Studies with the strictest success criteria in endodontic treatment reported low success rates of 52 - 54% after 6 - 10 years (4, 5). The failure of endodontic teeth could be attributed to lack of sound tooth structure for cuspal protection, vertical root fracture, iatrogenic perforations and periodontal disease (6).

Prior to initiating endodontic therapy, the periodontal health and restorability of the involved tooth has to be evaluated. This is

because periodontal status can adversely affect the long-term survival of the tooth. Assessing the long-term prognosis of a tooth is complex because it is an interplay of a myriad of factors. As such, a decision tree that evaluated 6 different factors, namely initial assessment, severity of periodontal disease, furcation involvement, etiologic factors, restorative status, and other determinants, was proposed to help clinicians decide when it is preferred to save or extract a tooth (7).

It has been reported that financial considerations, and the belief that dental implants may offer better long-term stability are the main reasons for the choice of implants over endodontic treatment (6, 8). However, in certain clinical scenarios e.g. medically compromised patients, those who are at risk of osteonecrosis, sites that will require extensive surgical management in terms of hard and soft tissue augmentation after tooth loss, implant therapy may not be feasible. In these cases, clinicians may be more inclined to retain the involved with endodontic and prosthodontics therapies instead of removing the tooth and restoring with an implant prosthesis. Therefore, the purpose of this paper is to propose a decision tree, based upon current evidence, for determining when to proceed with endodontic treatment or tooth removal and replacing it with a dental implant.

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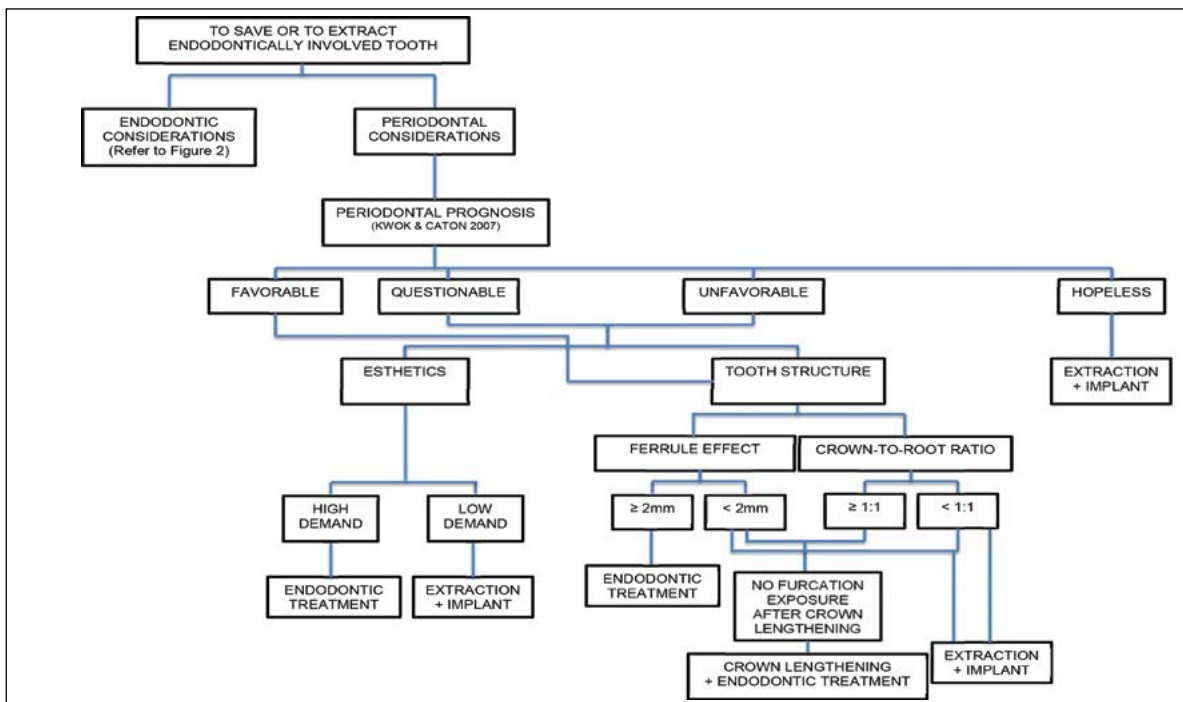


Figure 1. Factors influencing the decision to save or extract an endodontically affected tooth

Material and methods
Screening process

An electronic literature search for relevant articles published in English was conducted in the PubMed database from January 1990 to August 2013 by three examiners (AM, FS and CG). The key words used in the search included “dental implant”, “endodontic lesion”, “endosseous implant”, “periapical lesion”, and “root canal treatment”. Boolean operators, “OR” and “AND”, were used to combine the literature searches. Due to the heterogeneity among articles and lack of controlled studies, a narrative review was performed instead of a systematic review

Factors influencing the decision to save or extract an endodontically affected tooth (Fig.1)

Periodontal stability is a significant factor that influences tooth retention. A prognostication system proposes using the likelihood of achieving periodontal stability as the key consideration when assigning teeth to 4 prognosis categories, which are favorable, questionable, unfavorable or hopeless (Kwok and Caton, 2007). Generally, a tooth with a hopeless prognosis will be extracted and if tooth replacement is needed, a dental implant is a viable treatment option. On the other hand, a tooth with a favorable prognosis can be retained over time as long as proper periodontal treatment and maintenance are performed. Therefore, endodontic treatment should be attempted if the tooth is restorable. Restorability of an endodontically involved tooth is influenced by several factors. One key factor is

the amount of remaining sound tooth structure. A minimum axial wall height of 3mm for anterior teeth and premolars and 4mm for molars is recommended for retention of the crown (9). There should also be 1mm of sound dentine thickness with 2mm of sound tooth structure between the core material and the restorative margin (10). This provides the ferrule effect, which braces the tooth and is crucial in resisting dislodgement of the prosthesis and tooth fracture, thus providing a better long-term prognosis of the tooth (11). If 360° ferrule effect cannot be obtained, a partial ferrule can be considered (11, 12). It is important to have adequate ferrule at sites where lateral forces are exerted during functional loading. For example, in a typical Class I occlusion, palatal ferrule is needed for maxillary anterior teeth, buccal and palatal ferrule is needed for maxillary premolars and molars and buccal ferrule is needed for mandibular anterior teeth and premolars. The biologic width, defined as the soft tissue attachment coronal to the alveolar bone crest (13) is generally accepted to be 2.04mm (14). Violation of the biologic width, e.g. placement of the restorative margin close to the bone crest, results in chronic gingival inflammation (15), clinical attachment loss (16), bone loss (17), gingival recession and deeper pockets (18). Therefore, adequate biologic width must be maintained for periodontal health around a restoration. Crown lengthening or orthodontic extrusion can be performed to gain additional tooth height for the ferrule effect or to prevent violation of biologic width. However, it is important to avoid exposing the furcation, as it would increase the susceptibility of the tooth to progression of periodontal disease

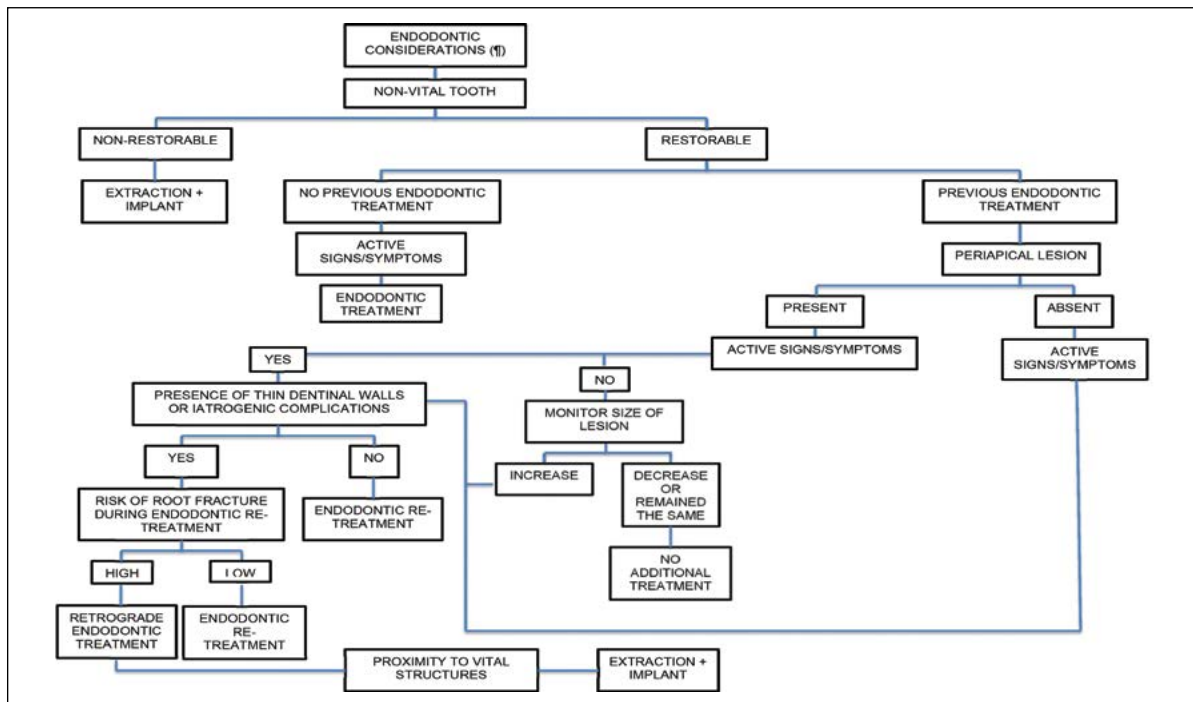


Figure 2. Decision-making for endodontic considerations

(7). The crown to root ratio achieved after these procedures will affect tooth mobility and its susceptibility to fracture (19). A crown to root ratio of 1:2 and 1:1 have been suggested as appropriate proportions in different clinical scenarios (20) but a ratio of 1:2 is rarely encountered. As there is no consensus or well-designed evidence-based studies analyzing the influence of crown to root ratio on teeth, it is believed that a crown to root ratio of 1:1 or greater is preferred. If the final crown to root ratio is less than 1:1, the tooth has an unfavorable long-term prognosis and hence extraction is recommended.

When a tooth has a questionable periodontal prognosis, certain local and/or systemic factor/s that contribute to the disease may or may be controlled. During initial phase therapy, mechanical debridement with or without chemotherapeutics will be performed to remove or control the etiological and/or contributory factors. If periodontal treatment is successful, restorative treatment will be considered. Conversely, if periodontal treatment is not successful, extraction of the tooth is considered. It is suggested that a tooth with unfavorable prognosis, have uncontrollable etiological or contributory factors resulting in progression of periodontal breakdown. In this situation, extraction is usually recommended.

For patients with high or unrealistic esthetic demands, retaining a restorable endodontically involved tooth with a questionable or unfavorable periodontal prognosis via restorative treatment may be a preferred option. This is because soft and hard tissue remodeling after removal of a periodontally involved tooth may result in a residual ridge that has horizontal and vertical deficiencies. Recreation of the lost tissue to the

pristine state for an implant restoration may be technically challenging. As such, performing endodontic treatment may be a better alternative. Endodontic therapy has been shown to be more cost effective when compared to tooth extraction and replacement with an implant supported prosthesis (21). However, 10% of teeth with residual periapical lesions after conventional endodontic therapy often require additional surgical intervention (22). Implants too require secondary interventions (23). Therefore, it is on the clinician to provide the patient with information on the risks, benefits and cost of each treatment option before coming to a definitive restorative plan.

Decision-making for endodontic considerations (Fig. 2)

This decision tree was developed by considering the following factors: history of endodontic treatment, presence of periapical lesion and any active signs and symptoms e.g. tenderness to percussion, periapical abscess, and discharging sinus tract. It serves as a reference for clinicians managing endodontically involved teeth.

- No previous endodontic treatment

A restorable non-vital tooth with no history of endodontic treatment could present with active signs and symptoms e.g. periapical radiolucency, tenderness to percussion, pain on chewing, discharging sinus tract etc. In this case, conventional endodontic treatment will be recommended. Indications for endodontic treatment include teeth with necrotic pulps or irreversible pulpitis but have optimal periodontal conditions, favorable C/R ratio and restorable crowns (8). Studies (12,

24, 25) have demonstrated that as long as all the above factors are carefully addressed, endodontic treated teeth will display high survival rates. On the contrary, if these factors are not respected such as crowns placed on compromised teeth, the survival rate will be negatively impacted (26).

From a restorative perspective, the decision-making process to restore or to extract a tooth is straightforward; if the tooth can be successfully restored then the endodontic treatment is recommended. If the tooth cannot be successfully restored then the extraction with implant placement is suggested. However, numerous factors must be evaluated to determine the restorability of the tooth. Within them, the residual tooth structure is of paramount importance in determining the treatment approach (27). Zitzmann considered a tooth with a predictable prosthetic prognosis when it has 4mm of remnant height with an appropriate occlusal convergence angle (15-20°) and a circumferential ferrule of at least 1.5mm (28). On the other hand, a residual wall height of less than 3mm with or without a convergence angle of 25° represents a tooth with questionable prognosis. Furthermore, a hopeless prosthetic prognosis is characterized by an insufficient tooth structure for a circular ferrule (<1.5mm) without the possibility of a crown lengthening or orthodontic extrusion (28). In addition, the morphology of the root canal has also to be considered when a post is required for the retention of a crown. If the post cannot be placed then the extraction is often recommended. On the other side, cracked tooth refers to an incomplete fracture line extending from the occlusal surface apically without the separation into two segments (29, 30). Hence, the prognosis of such tooth depends on the severity and extension of the fracture line. While visible fracture involves only the enamel, fractured cusp is often associated with large restorations and is limited to the crown but it can involve both dentin and enamel. A split tooth and a vertical root fracture are the two forms of real separate tooth segments, the first extending in a mesio-distal orientation while the latest has an apico-coronal orientation. The extension and location of the fractures could aid in selecting the most proper treatment modality. Generally, asymptomatic cracked tooth does not need any treatment except occlusion assessment and adjustment if needed. When fracture is limited to the crown of the tooth with no periodontal involvement; restorations combined with root canal therapy are oftentimes preferred. On the other hand, vertical tooth fractures are recommended for extraction due to a poorer prognosis.

- Previous endodontic treatment

As aforementioned, restorability of a non-vital tooth must be established prior to the start of treatment.

If the tooth is non-restorable, it should be extracted and replaced with a dental implant. Endodontic re-treatment of previously treated teeth has a poorer prognosis compared to non-vital teeth with no history of endodontic treatment (31), especially if a periapical lesion is present (32). However, in contemporary Endodontics, same survival rates might be obtained (33-35). Orthograde endodontic re-treatment is recommended for a restorable previously treated tooth with active signs and symptoms. However, considerations must be given prior to commencement of the endodontic re-treatment. Oftentimes, these teeth would have been restored with a post core restoration. Removal of the post is technically challenging and when done improperly could lead to root fracture and the eventual loss of the tooth. Therefore, in cases with large post, misaligned post, excessive cleaning and shaping resulting in thin dentinal walls, iatrogenic complications e.g. presence of broken endodontic files within the root canal system, orthograde endodontic retreatment may not be the best option. Retrograde endodontic treatment is preferred in attempt to minimize the risk of root fracture, (33-35). Based upon Ng et al. (2008) findings, we propose that if the apical radiolucency is present and is < 5 mm then the endodontic treatment might be preferred (36). If, on the contrary, the lesion size extends \geq 5 mm, location should be considered before making the decision. For instance, if the surgical site is close to vital structures such as the inferior alveolar nerve, mental nerve, maxillary sinus, retrograde endodontic treatment may not be possible. Therefore, extraction of the involved tooth will be indicated.

It is important to control all the factors that might play a role on endodontically treated teeth to determine its prognosis and consequently, its treatment approach. Zadik et al. examined the extracted teeth after endodontic treatment and showed that most of the treatment failures were due to non-restorable caries (61.4%), following by endodontic treatment failure (12.1%), vertical root fracture (8.8%), iatrogenic perforations (8.8%) and less likely but non negligible, periodontal diseases (4.6%) (6). Conversely, others have shown the periodontal diseases might be the primary reason for extraction (37-39). One interesting point to mention is most of these studies examined the mandibular molars; however, it is important to know that maxillary molars often have lower success rate due to the complexity of tooth anatomy (40).

Conclusion

The proposed decision tree serves to guide clinicians in selecting the most predictable treatment modality for endodontically involved teeth.

Disclaimer: The authors do not have any financial interests, either directly or indirectly, in the products or information listed in the paper. This clinical decision-making represent only author's guideline based upon their expertise and evidence-based dentistry; thus, the decision-tree proposed do not necessarily display other clinicians or our institutions thoughts.

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Questions

Which of the following factors is not relevant in deciding the type of treatment (conservative-endodontic versus extraction + implantation) in the case of a non-vital tooth?

- a. The tooth's position within the dental arch
- b. The presence of previous endodontic treatments
- c. The periodontal status
- d. The presence of a peri-apical radiolucency

Which is the lowest percentage of success for endodontic treatments, after at least 6 years, reported by the strictest studies in the literature?

- a. 86%
- b. 52%
- c. 34%
- d. 21%

What is the mean value of the biologic width in the case of natural teeth?

- a. Around 0.5 mm
- b. Around 2 mm
- c. Around 4 mm
- d. Around 6 mm

When is it better to extract the non-vital tooth and replace it with an implant-supported restoration, instead of endodontically treating it?

- a. The patient has high aesthetic demands
- b. The tooth presents tenderness to percussion
- c. The periodontal treatment was not successful
- d. The crown-to-root ratio is 1:1