Comparison of Nonsurgical Root Canal Treatment and Single-tooth Implants

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Abstract

Introduction: The aim of this review was to compare the differences between nonsurgical root canal treatment and single-tooth implants. With the emerging field of implant dentistry gaining acceptance, the choice to retain a diseased tooth through the use of root canal therapy or extract it and replace the tooth with an implant-supported crown has become controversial. Many practitioners consider the single-tooth implant as a reasonable alternative to the preservation of a diseased tooth. **Methods**: An extensive search of the dental literature was accomplished to identify publications related to the differences in root canal therapy and dental implants. Several comparative studies were also considered. **Results**: The treatment modalities were reviewed with respect to outcome measures and study design, success/failure, functional rehabilitation and psychological differences, complications related to treatment, cost differences, and factors influencing treatment planning considerations. **Conclusions**: With the reviewed information in hand, the practitioner should be better prepared to determine which treatment option is most appropriate for each individual patient. *(J Endod 2009;35:1325–1330)*

Key Words

Implant-supported crown, root canal, root canal treatment, single-tooth implant, success-failure, treatment planning

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One of the fundamental goals of dentistry is the retention of a patient's natural dentition in a disease-free state. The use of surgical and nonsurgical endodontic treatment has historically been a key ingredient in the attainment of this goal. Extraction is often seen as a treatment choice of last resort as a result of limited restorative options and financial considerations. With the emerging field of implant dentistry gaining acceptance, the prevailing opinions on treatment planning for diseased teeth are changing. Many practitioners consider the single-tooth implant as a reasonable alternative to the preservation of the natural dentition. Thus, a practitioner is faced with a fundamental dilemma—should a tooth be retained through nonsurgical endodontic treatment, or should it be extracted and replaced with an implant-supported crown? The clinician must evaluate several factors to ascertain what treatment option is most appropriate. If treatment options are presented in a biased manner that favors one option over the other, the patient is more likely to select that treatment option (1). The purpose of this article is to review the differences between nonsurgical endodontic treatment and implant-restored crowns. The treatment modalities will be reviewed with respect to outcome measures and study design, success/failure, functional rehabilitation and psychological differences, complications related to treatment, a cost-benefit comparison, and factors influencing treatment planning considerations.

Outcome Measures and Study Design

Success and failure outcomes for endodontic treatment and implant therapy have been described in various fashions in the dental literature. As clinicians, our definition of success is largely based on clinical parameters including complete cessation of symptoms, radiographic healing of periapical tissues (2), and absence of inflammatory cells histologically (3). For patients, success might be measured on whether a tooth is functional in his/her mouth. This might be considered more a measure of survivability. In comparing success and failure studies, one must be careful to consider the definitions of success used in the outcome measures. Different study designs make comparison of outcomes among various studies somewhat confusing. Evidence-based protocols describe 5 levels of evidence in which studies can be evaluated and compared. Torabinejad and Bahjri (4) described the stratification of study designs that weigh various studies. The highest level of evidence (level 1) contained systematic reviews and randomized, controlled trials, and the lowest level (level 5) contained case reports, expert opinions without explicit critical appraisal, and literature reviews. In a systematic review of the literature, Torabinejad et al (5) examined articles relating to the success of endodontic treatments and found only 6 of 306 studies that were considered level 1 (randomized, clinical trials). Twenty-six were considered level 2 (low-quality randomized control trials, cohort studies), 5 were level 3 (case-control studies, systematic reviews of case-control studies), 82 were level 4 (low-quality cohort studies, case-control studies, case series), and 178 were level 5 (case reports, epidemiologic studies, expert opinions, literature reviews). In a systematic review of outcome studies involving root canal treatment and implant-supported single crowns, Torabinejad et al (6) found the quality of root canal treatment studies to be higher than implant studies, which consisted of case series analyses 64% of the time. Eckert et al (7) evaluated the quality of clinical performance provided by the 6 major American Dental Association–certified dental implant manufacturers by requesting from each company 10 references that validate their implant system. They found that the evidence supporting implants is generally derived from level 4 case series studies rather than higher level controlled clinical trials or cohort studies.

To further complicate matters, endodontic clinical research has traditionally used healing/success as an outcome measure, whereas implant studies focus on survivability. Some of those implants that are characterized as surviving might have associated bone loss and periodontal defects (8). Endodontic clinical trials commonly define success by using clinical, subjective, and radiographic evaluations (2, 9) or histologic evaluation (3). Strindberg (2) proposed the parameters for endodontic outcomes in 1956 that required the absence of clinical symptoms and periapical pathology with a normal, intact periodontal ligament and lamina dura surrounding the apex. Success criteria have been established previously for dental implants. Albrektsson et al (10) proposed criteria for implant success in 1986 that included absence of mobility, absence of peri-implant radiolucency, absence of signs and symptoms, loss of marginal bone of less than 1.5 mm during the first year after insertion of the prosthesis and less than 0.2 mm annual bone loss thereafter, and a minimum 10-year retention rate of 80%. Smith and Zarb (11) further added the condition that implants do not preclude the placement of a crown or prosthesis with satisfactory appearance to the patient and dentist and maintain a minimum success of 85% after 5 years and 80% retention rate after 10 years. Spiekermann et al (12) also proposed a criterion for success that considers an implant to be failing if there is cervical bone loss of greater than one third of the implant length or more than 4 mm. Even when implant studies do use success as an outcome measure, their differences in criteria for assessment of outcomes and in relation to the baseline reference time differ (success from implant placement, loading, 6 months of healing, or 1 year of function), which excludes many early implant failures from analysis (13). Furthermore, many implant studies were reported as having a high risk of bias (13).

Another complicating factor in assessing outcomes in implant and root canal treatment studies is the experience levels of those providing the treatment. General practitioners provide a majority of the endodontic procedures (14, 15). Many studies in the endodontic literature were also conducted on patients treated by dental students (16). In contrast, most dental implants have been placed by specialists, but it is expected that more generalists will be placing and restoring implants in the future (15). Hull et al (14) examined claims data maintained by the Washington Dental Service for 1999. Of the 63,321 endodontic procedures, general dentists performed 64.7% of those procedures, compared with 33.7% for endodontists. In a survey of survivability of endodontically treated teeth completed by endodontists and general dentists, endodontists experienced significantly greater success (98.1%) than did general dentists (89.7%) (17). Likewise, Listgarten (18) cautioned that the high level of implant success rates might not be duplicated in the clinical setting by general dentists. These cumulative data suggest that the success rates of root canal treatment studies might be negatively biased as a result of the experience level of those performing a majority of the treatments compared with implants.

In addition, many implant success articles exclude patients with a high risk of implant failures such as smoking habits, alcohol abuse, inferior bone quality, poor oral hygiene, parafunctional habits, occlusal overload and medically compromised patients. Bain and Moy (19) found that the incidence of failure of implants was significantly greater in smokers than nonsmokers (11.28% versus 4.76%), with an overall implant failure rate of 5.92%. Doyle et al (20) found that smokers had less successful outcomes and more frequent failures in both implant groups and root canal treatment groups when assessing 196 matched pairs. Galindo-Moreno et al (21) showed that peri-implant marginal bone loss was significantly associated with daily consumption of more than 10 g of alcohol and tobacco use and concluded that daily alcohol consumption and tobacco use might have a negative influence on implant outcomes. Jaffin and Berman (22) demonstrated that the quality of bone was the single greatest determinant of implant loss, with 35% failure in type IV bone. The systematic review of implant outcomes in periodontal patients by Ong et al (13) suggested that patients treated for periodontitis might experience more implant loss and complications around implants than non-periodontitis patients. Occlusal overload is universally accepted as a major cause of early implant failure (23). These exclusion factors could definitely alter the outcomes in implant studies. The lack of standardization of outcome measures and methodology makes it difficult to assess implant success. The more lenient definition of survivability tends to be considerably higher than success when used as an outcome measure in both endodontic and implant studies (13, 24). In an article supported by the International Congress of Oral Implantologists Consensus Conference for Implant Success, Misch et al (25) called for an update and upgrade to what is considered implant success, implant survival, and implant failure. It was proposed that success of implants would be defined as no pain or tenderness on function, no mobility, no more than 2 mm radiographic bone loss from initial surgery, and no history of exudate. Other categories included satisfactory survival, compromised survival, and failure.

Success and Failure

In an epidemiologic study of more than 1.4 million patients assessed during a period of 8 years, Salehrabi and Rotstein (26) found that nonsurgical endodontic treatment, performed by both general dentists and endodontists, had a very predictable outcome, with 97% of the teeth retained. Most of the untoward events such as retreatment, apical surgery, and extraction occurred within 3 years of treatment. Of those teeth extracted, 85% had no full coronal coverage after endodontic treatment. In a similar epidemiologic study of nonsurgical root canal treatment outcomes, Lazarski et al (27) retrospectively assessed more than 110,000 nonsurgical root canal procedures completed by both general dentists and endodontists and found 94.44% of teeth remained functional during an average follow-up period of 3.5 years. Similarly, this study found a significant deleterious effect when a full coronal restoration was not placed, with the incidence of extraction increasing more than 4-fold (2.54% to 11.21%). In a study of more than 1.5 million teeth receiving nonsurgical root canal treatment in a population from Taiwan, Chen et al (28) found that 92.9% of the teeth were retained in the oral cavity 5 years after treatment.

Collectively, these lower levels of evidence epidemiology studies show the benefits and predictability of nonsurgical endodontic treatment as evidenced by a high level of survivability of endodontically treated teeth in a large population sample. Friedman and Mor (29) systematically reviewed the literature pertaining to endodontic outcomes and separated outcomes for healed, healing, and diseased. They characterized healed as absence of clinical signs and symptoms and periradicular lesions. Healing was defined as absence of clinical signs/symptoms and reduced radiolucency size. Diseased was defined as the persistence or enlargement of a radiographic periradicular radiolucency or the presence of clinical signs and symptoms regardless of radiographic appearance. In the absence of apical periodontitis, the probability that initial root canal treatment or orthograde retreatment would keep the tooth disease-free was 92%–98%. The chance that teeth with apical periodontitis would completely heal after initial treatment or retreatment was 74%–86%, whereas their chance to remain functional over time was 91%–97%. They found no systematic difference in outcomes between initial treatment and retreatment. The outcome of apical surgery was less consistent than nonsurgical treatment. The chance of apical periodontitis to completely heal after apical surgery was 37%–85%, with a weighted average of 70%. Even with the lower chance of complete healing, the chance for the teeth to remain functional over time was 86%–92%.

Single-tooth implants have also experienced a high rate of survival. In a case series study of 1377 posterior single-tooth implants, Misch et al (30) found a 98.9% survival rate at an average follow-up period of 61 months. In a review of the literature from 1981–2001, Goodacre et al (31) studied the incidence of complications with implants. Implant loss was greater in implants that were 10 mm or less in length (10%), compared with implants that were more than 10 mm in length (3%). In a systematic review of the literature, Salinas and Eckert (32) found a pooled success of single-implant restorations at 60 months of 95.1%. Holm-Pedersen et al (33) in a systematic review of the literature found that 2.5% of all implants are lost before loading. In addition, they found that between 0.5% and 1.3% are lost per year of function, resulting in an overall 10-year survival rate between 80% and 90%. The American Dental Association's Council on Scientific Affairs reported a mean survival rate of single-tooth implants of 96.7% when evaluating 10 studies involving more than 1400 implants (34).

Several articles have attempted to directly compare outcomes of implants with initial root canal treatment and deserve more discussion (6, 16, 20, 24, 35). In a systematic review of the literature, Torabinejad et al (6) attempted to answer the question as to whether initial nonsurgical root canal treatment, compared with extraction and replacement of the missing tooth with an implant-supported restoration, resulted in a better or worse outcome. The review, which included 46 implant-supported crown and 24 root canal therapy articles that met the inclusion criteria, grouped clinical outcomes into 3 follow-up intervals: 2–4 years, 4–6 years, and more than 6 years. When compared with implant studies, the outcome measures for endodontic studies were found to be more rigorous. Evaluators of outcome measures in implant studies differed from the operator in only 13% of the studies compared with root canal studies (88%). The quality of the studies, on the basis of maximum score of 17 points, also favored the root canal literature, with an average quality score of 10 compared with 7 for implant studies. In their quality assessment, the evaluators assigned 4 points for randomized clinical trials, 3 points for nonrandomized clinical trials, 2 points for clinical trials with no controls or cohort, 2 points for case-control or case series, and 1 point each for total number of enrolled subjects stated, sample size predetermined, operator experience stated, demographic description included, treatment procedures completely described, measurements standardized, evaluation methods clearly described, intention to treat stated, and the description and appropriateness of statistical techniques and stratification. Root canal treatment outcomes were also found to be more stringent than implant studies because most root canal outcomes measures were described as success, whereas most implant studies provided survival rates. Another variable noted was that implant treatment was mostly provided by specialists, whereas root canal treatment was largely provided by generalists or students. The authors attempted to compare the 2 treatment modalities by reporting success and survival rates for each. The authors found that the long-term (6+ years) survival rates of root canal treatment and implant therapy were both 97%. The long-term success rate of implant therapy was found to be greater than root canal treatment (95% versus 84%), but the authors were quick to note that the differences in defining success between the 2 modalities limit the value of this observation. The authors concluded that endodontic therapy should be given priority in treatment planning for periodontally sound single teeth with pulpal or periapical pathology, whereas implants should be given priority in teeth that are planned for extraction.

Hannahan and Eleazer (35) retrospectively studied the outcomes of 129 implants followed an average of 36 months and 143 endodontically treated teeth followed an average of 22 months. Implants were placed by periodontists in a group practice, and root canal treatment was provided by endodontists in a group practice. Success was recorded if the implant or tooth was intact and functional. Failure was defined as removal of the tooth or implant. Implants were recorded as uncertain if they exhibited class I or greater mobility, radiographic signs of bone loss, or needed an additional surgical procedure. Endodontically treated teeth were classified as uncertain if they exhibited mobility, had a periapical index score of 3 or greater, or required apical surgery. Implants had a success rate of 98.4%, and endodontically treated teeth had a success rate of 99.3%. When uncertain findings were added to the failure group, the success of implants dropped to 87.6% and endodontically treated teeth to 90.2%. No statistical differences were noted.

One of the biggest factors in outcome assessment of root canal–treated teeth is the placement of an appropriate coronal restoration after root canal treatment (26, 27, 36). To account for this difference, Doyle et al (24) compared 196 implant restorations and 196 matched initial nonsurgical root canal treatment teeth with coronal restorations in patients for 4 possible outcomes—success, survival, survival with subsequent treatment intervention, and failure. Although both groups had an identical number of failures (6.1%), the root canal treatment group had a greater rate of success (82.1% versus 73.5%) and survival (90.3% versus 76.1%). The implant group had more outcomes categorized as survival with intervention (17.9% versus 3.6%). Location of the restoration in the mouth did not affect the outcome. The authors concluded that both treatments had similar failure rates, but the implant group had a significantly greater incidence of postoperative complications requiring subsequent treatment interventions. In a subsequent article with the same data, the authors found that smoking resulted in significantly more failures and less success in both groups, whereas diabetes, age, and gender had no affect on outcomes (20). The length of the endodontic obturation, presence of a periradicular lesion, and placement of a post significantly affected the success of root canal treatment, whereas the length and width of an implant did not significantly affect success.

In another systematic review aimed at studying the differences in outcomes of restored endodontically treated teeth compared with implant-supported restorations, Iqbal and Kim (16) evaluated the literature pertaining to the survival of both modalities after restoration with crowns. Fifty-five studies related to single-tooth implants and 13 studies relating to restored root canal–treated teeth were included. Their main outcome measurement was survival rate. The median follow-up period for implant studies was 5 years and 7.8 years for restored root canal–treated teeth. The authors found no difference in the survival rates between the 2 modalities. The reported survival rates at the last follow-up exams were 96% for implants and 94% for endodontically treated teeth. The authors concluded that the decision to treat a tooth endodontically or replace it with an implant must be based on factors other than treatment outcomes. It was recommended that priority should be given to treatment modalities aimed at preserving the natural dentition before considering extraction and replacement.

Function and Psychological Factors

The loss of teeth and their replacement might have a significant functional and psychological impact on dental patients. Whereas endodontically treated teeth maintain the original proprioceptive mechanisms of the natural tooth, implants lack a periodontal ligament and the ability to perceive functional loads as well as the shock-absorbing function of the periodontal ligament (37). Trulsson (38) reported that humans use periodontal afferent signals to control jaw actions associated with intra-alveolar manipulation of food rather than exertion of jaw power actions. He concluded that patients who lack information from periodontal receptors, such as implant patients, show an impaired fine motor control of the mandible. Klineberg and Murray (39) proposed osseoperception as the sensory mechanism for implants. Osseoperception is mechanoreception in the absence of a functional periodontal ligament that is derived from mucosal and/or periosteal mechanoreceptors to compensate for the loss of periodontal mechanoreceptors (39). Klineberg and Murray postulated that the sensory and motor capabilities do not appear to match those of dentate individuals. Schulte (37) also found that the propriception of natural teeth at biting and chewing loads cannot be substituted by ankylotic retained implants.

Woodmansey et al (40) attempted to compare the masticatory function in patients with endodontically treated teeth and single implant–supported prosthesis. This study used maximum bite force, masticatory performance, contact area between teeth with endodontic treatment and single implant crowns to assess masticatory function. Twenty-five endodontically treated teeth and 25 implant crowns were compared with function on the contralateral natural tooth in the mandibular molar region. When compared with contralateral controls, implants were found to have significantly lower maximum bite forces, reduced chewing efficiency, and smaller occlusal contact and near contact areas. Endodontically treated teeth were similar to contralateral controls in all parameters. In a subjective evaluation of both groups, patients were equally satisfied with their dental treatment and ability to chew. The authors concluded that endodontically treated teeth provided more effective occlusal contact during masticatory function compared with implant-supported restorations, leading to more efficient mastication. A possible explanation for the reduced masticatory function of implants is related to the common recommendation that posterior implant-supported restorations should be fabricated slightly out of occlusion to compensate for the axial compression of the periodontal ligament in adjacent natural teeth on loading (41, 42).

Torabinejad et al (6) revealed that tooth retention through root canal therapy and restoration or tooth replacement with an implant resulted in superior clinical outcomes psychologically than did extraction without replacement. The resultant inferior esthetics and psychological trauma associated with tooth loss, such as self-image, were cited as factors for these inferior psychological outcomes. Esthetics plays a key role in a patient's satisfaction and is the most frequent problem with implants in the anterior region (43). The esthetic gingival response to a single-tooth implant will depend on the tissue biotype (44). Thin scalloped tissue will react poorly to surgery and recede, whereas thick flat tissue will respond by inflammation without recession (44). Depending on the type of tissue and the height of the smile line, changes in the marginal gingival height and interdental papilla might create esthetic complications that will be objectionable to patients (44). Immediately placed implants with an esthetic provisional restoration might help overcome this esthetic consequence (45). Another difficult clinical situation to manage is the replacement of 2 adjacent anterior teeth with implant restorations. Implants must be placed a minimum of 3 mm apart to preserve the interdental bone between the implants (46). Because only 3–4 mm of soft tissue will form coronal to the inter-implant crestal bone, in many clinical situations this might result in the loss of the interdental papilla, creating a black triangle with an unesthetic appearance (47). Thus, retention of a natural tooth, even if compromised restoratively and endodontically, assists the esthetic appearance by maintaining the proximal crestal bone and papilla (48).

Another measure of patient treatment satisfaction might be reflected in the rate of malpractice claims. In Australia the incidence of malpractice claims is currently 4 times more for implants than endodontics, with the average cost of an implant claim 4 times the average claim of all dental cases, whereas an endodontic claim is only slightly above the average claim size (49).

Complications

There are 2 major types of implant therapy complications, biologic and technical (mechanical). Biologic complications consist of disturbances in the function of the tissues supporting an implant and include implant loss and reactions in peri-implant hard and soft tissues. Technical complications refer to mechanical damage of the implant or implant components and suprastructures. In a systematic review of the incidence of biologic and technical complications of implant studies of at least 5-year duration, Berglundh et al (50) found that implant loss before functional loading had an incidence of 2.5%. Implant loss during function occurred in about 2%–3% of implants supporting fixed reconstructions, whereas in overdenture therapy greater than 5% of the implants were lost. Most of the articles reported an incidence of persisting sensory disturbances of 1%–2%. There was limited information regarding the occurrence of peri-implantitis and implants exhibiting bone loss greater than 2.5 mm. The limited data exhibited an overall frequency of peri-implantitis of 5%–8% for selected implant systems. Berglundh et al found that only 40%–60% of the articles considered biologic complications, and only 60%–80% of the studies considered technical complications. They concluded that the incidence of biologic and technical complications might be underestimated in the literature.

Goodacre et al (31) reviewed the literature pertaining to complications associated with implants and implant prostheses between 1981 and 2001. Although they were unable to calculate an overall complications incidence for implant prostheses, the available studies suggested that there are more complications associated with implant prostheses than conventional prostheses. Of the conventional prostheses compared, conventional fixed partial dentures had an incidence of complications of 27%, resin bonded prostheses 26%, conventional crowns 11%, post and cores 10%, and all-ceramic crowns 8%. The most common surgical complications related to implants were hemorrhage-related events (24%), neurosensory disturbances (7%), and mandibular fracture (3%). Esthetic complications occurred with a mean incidence of 10%, and phonetic complications occurred with a mean incidence of 7%. Implants 10 mm or less (10%) and placement in type IV bone (16%) were associated with greater implant loss. The findings of Goodacre et al show that complications are relatively common in implant prostheses.

Endodontic complications are usually measured within endodontic outcome studies and treated as failure, rather than being reported as separate complication categories (15). Complications such as caries, bacterial microleakage as a result of poor coronal seal, and periodontitis that might cause tooth loss would be reported as failures in outcome studies. In a study reviewing the records of more than 1.4 million dental patients receiving initial root canal therapy, only 0.47% required retreatment, and only 0.45% required apical surgery, suggesting that the complications after initial root canal treatment are minimal (26). In a study comparing complications between 196 matched pairs of endodontically treated teeth with coronal restorations and implant-supported crowns, Doyle et al (24) found the incidence of complications to be 5 times greater for implants than endodontically treated teeth. Hannahan and Eleazer (35), comparing 129 implants followed an average of 36 months and 143 endodontically treated teeth followed for an average of 22 months, found that 12.4% of implants required interventions, whereas only 1.3% of endodontically treated teeth required interventions. They concluded that implants require more postoperative treatments to maintain them compared with endodontically treated teeth. The results of the failure of an implant and initial root canal treatment are vastly different. An implant will require extraction, with possible further bone loss. A failed root canal treatment can be re-treated nonsurgically or surgically to allow continued function. Salvaging a tooth compared with extraction of an implant and replacement with another restoration can have psychological and economic benefits for the patient (51). The collective evidence supports the fact that endodontically treated teeth are associated with less complications and procedural interventions than implant-supported crowns and that complications associated with implant failure significantly impact a patient more negatively than when endodontically treated teeth fail.

Cost Benefit

Implant treatment typically will involve separate evaluations by the surgeon and restorative dentist. Multiple casts, a variety of radiographs, and surgical stents might be required. Moiseiwitsch and Caplan (52) conducted a cost-benefit analysis of endodontic treatment versus single-tooth implants and found that a restored implant costs approximately 70%–400% more than an endodontically treated tooth restored with a crown. This analysis did not take into account any adjunctive procedures that might be needed to place an implant such as a sinus lift or bone graft. By using the mean fees charged by general practitioners as reported by the American Dental Association 2005 Survey of Dental Fees, Christensen (53) found that an implant-supported crown cost about twice that of an endodontically treated tooth restored with a crown. For implant therapy, the cost of the extraction, implant placement, implant abutment, and porcelain fused to metal crown were calculated in the cost, which averaged $2798–$3060. For endodontic treatment, the cost of the root canal procedure, post and core, and porcelain fused to metal crown averaged $1468–$1741. Possible adjunctive costs for diagnosis (a variety of radiographs, casts for models, and stents), sinus augmentation, bone grafts and membranes were not considered. Doyle et al (24) demonstrated that patients receiving implants required 5 times more postoperative interventions compared with those receiving endodontic care. The collective evidence suggests that from an economic point of view, endodontic treatment might be a more favorable treatment option compared with implant-supported crowns.

Factors Influencing Treatment Planning Considerations

Taking all the aforementioned factors into account, the role of the dentist in the treatment planning of teeth affected by caries or trauma is critical. In the past, the option of root canal treatment versus extraction was relatively easy. With the reported success of dental implants during the past few years, the treatment options are now clouded. The patient has the option of extraction, endodontic treatment, or extraction and placement of an implant-supported crown.

Di Fiore et al (54) conducted a study to determine the treatment preferences of dental faculty and dental students for retaining a tooth with endodontic treatment and crown or extraction and implant placement. The survey indicated that the majority of students and faculty preferred to keep teeth with endodontic treatment, but the selection of extraction and implant placement was progressively greater as the educational exposure to implantology became more recent. They found a generational trend among the participants toward implants especially in complex treatment situations because more students recommended implants than faculty. The authors concluded that more implant treatment will be recommended in the future and that dental students need to be provided a more comprehensive and balanced educational experience that will enable them to make the most appropriate and beneficial treatment option recommendation for their patients. Foster and Harrison (1) found that if treatment options (implants or endodontic treatment) are presented in a biased manner to favor one option over the other, the patient is more likely to choose that treatment option.

The decision to extract a tooth that might otherwise be retained through endodontic treatment is becoming more common and is an emotionally charged issue. Ruskin et al (55) recently published a professional opinion article stating the case for extraction and implant over endodontic treatment. Although many of the facts comparing implants with endodontic treatment were misrepresented, the availability of such information in a refereed journal might influence the dentist's opinion on this issue to consider implants as the first treatment option. Ruskin et al concluded that implants have greater success than endodontic therapy, are more predictable, and cost less when you consider the inevitable failure of initial root canal treatment, retreatment, and periapical surgery. Unfortunately, these conclusions might preclude some practitioners from appropriately evaluating and informing their patients. If one were to consider the review by Friedman and Mor (29) of endodontic outcomes with success as the outcome measure, defined by the absence of disease radiographically and clinical absence of signs and symptoms, the chance of having a tooth extracted after failure from initial endodontic treatment, retreatment, and apical surgery collectively would be roughly 1 in 500 cases. Although the success of implant dentistry is not questioned, the collective evidence reviewed in this article supports the use of endodontic treatment as a successful option to save and maintain a patient's natural tooth in a disease-free state. Implants are an excellent option for the replacement of a missing tooth, but it is erroneous to think that it is better to extract an otherwise restorable tooth and replace it with an implant in all cases.

Conclusion

If a tooth is deemed restorable from a restorative and periodontal aspect, endodontic therapy should be the first treatment option considered. If a tooth has a poor restorative or periodontal prognosis, extraction and implant should be considered. It is important to note that the 2 treatment alternatives have different aims; endodontic treatment is provided to treat or prevent apical periodontitis, whereas implants are used to replace missing teeth.

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