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Single implant and crown versus fixed partial denture: A cost-benefit, patient-centred analysis

Key words *cost-benefit, cost-effectiveness, fixed partial dentures, patient perceptions, single implants*

Single implants and their crowns have high survival rates that exceed the survival rates for fixed partial dentures on teeth and most but not all publications have determined single implants are more cost-effective than 3-unit fixed partial dentures. Both initial root canal treatment and retreatment are more cost-effective than tooth extraction and rehabilitation with a single implant and crown.



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■ The literature review process

For this analysis, the scientific literature was searched using the following terms: single implants (9,261 results); single dental implants (3,483 results); cost-benefit analysis dentistry (1,172 results); single implants cost-effectiveness (74 results); dental implants cost-effectiveness (118 results); cost-effectiveness analyses dentistry (143 results); cost-benefit dental implants (104 results); dental implant versus fixed partial denture (77 results); dental implant versus bridge (16 results); dental implant versus fixed dental prosthesis (170 results); single implant versus bridge (9 results); and single implant versus fixed partial denture (19 results).

The first two searches (single implants and single dental implants) were not pursued because of the overly general nature of the resulting articles that were identified. The abstracts for all publications identified in the other searches were read to identify those that should undergo a full-text review. During this detailed review process, additional papers were identified and added to the list. All of the resulting publications received a comprehensive review to determine their relationship to the topic of single implant versus fixed partial denture.

One of the papers discussed the 'treatment options for the replacement of missing mandibular incisors' and outlined the available options along with their indica-

tions and limitations but did not contain data comparing single implants with fixed partial dentures so it was not included in the review but was included in the reference list¹. Other articles presented appropriate reasons for selecting an implant as the preferred treatment with references for most but not all of the stated reasons. Therefore, articles identified in their papers were added to the reading list as well as articles containing information and data that supported their unreferenced reasons. A total of 43 papers received full-text reviews in preparation for the literature review²⁻⁴⁴. This literature review was divided into the following topics:

1. Introduction
2. Background Information
 - a) Trends in oral rehabilitation in the United States of America
 - b) Reasons for selecting an implant as the preferred treatment
 - c) Factors affecting treatment choice: patient's perspective
 - d) Perceived need for implants amongst individuals
 - e) Sources of patient information
 - f) Patient perceptions and expectations related to oral implants
 - g) Providing implant treatment: practitioner confidence and barriers
3. Publication quality and patient perceptions about cost



- a) Assessment of publication quality
- b) Patient perceptions regarding implant treatment costs
- 4. Direct comparisons of single implants versus fixed partial dentures
 - a) Systematic reviews
 - b) Findings of the two papers specifically comparing implants and fixed partial dentures
 - c) Findings of papers published after the systematic reviews
- 5. Cost comparisons that included additional alternative types of treatment
- 6. Costs associated with specific, individual types of treatment
- 7. Survival comparisons of teeth and implants

■ Introduction

Prior to the introduction of osseointegrated implants, fixed partial dentures served as the primary means of replacing single missing teeth. But the many benefits provided by an implant compared to a fixed partial denture established the single implant as the preferred treatment alternative to a fixed partial denture (FPD) in most situations.

■ Background information

■ Dental treatment trends in the US

The placement of oral implants continues to increase as evidenced by data reported in a 2010 publication based on insurance claims filed between 1992 and 2007 in the US². A decline in the number of pontics was reported, indicating a decrease in the number of fixed partial dentures being provided to patients. In contrast, the only prosthodontic procedure that experienced increased usage during that reporting period was the placement of dental implants².

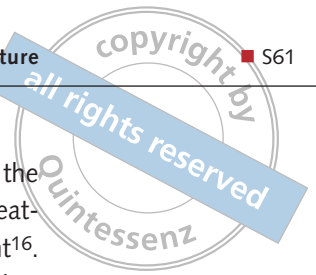
■ Reasons for selecting an implant as the preferred treatment

Several reasons for using single dental implants rather than a fixed partial denture have been discussed in the scientific literature. They include the following: 1) pres-

ervation of tooth structure on the teeth adjacent to the edentulous area^{3,4}; 2) avoiding tooth hypersensitivity that can accompany tooth preparation³; 3) avoiding the potential need for root canal treatment when teeth are prepared for fixed partial dentures³ because abutment tooth preparation was found to result in 11% of the abutment teeth requiring endodontic treatment⁵; 4) improved access for oral hygiene³; 5) enhanced gingival response compared to fixed partial dentures with subgingival finish lines (there were no references for the enhanced gingival response around implants but there are articles that show less than optimal response that occurs with fixed partial dentures⁶⁻⁹; and 6) fewer complications with single dental implants compared with fixed partial dentures^{5,10}.

In addition, survival percentages for single implants and their crowns have been very high as evidenced by a systematic literature search from The Third European Association for Osseointegration Consensus Conference in 2012¹¹. This critical review presented both 5- and 10-year survival rates for both single implants and their crowns. The estimated 5-year single implant survival was 97.7%, while the 10-year estimated survival rate was 94.9%. For the implant-supported single crowns, the 5-year survival estimate was 96.3% and the 10-year survival rate was 89.9%¹¹.

In contrast, the long-term survival of fixed partial dentures is significantly lower. A meta-analysis of seven studies by Creugers¹² calculated a high 5-year survival rate of 95% for fixed partial dentures based on 26 included studies. However, the survival rate decreased to 90% at 10 years and even further to 74% after 15 years¹². Scurria¹³ also prepared a meta-analysis based on eight studies and determined that 13% of fixed partial dentures were missing or needed replacement at 10 years and more, 31% were removed or in need of replacement at 15 years¹³. A systematic review in 2007¹⁴ provided pooled data showing that implants had a 5 year success rate of 95.1% and tooth-supported fixed partial dentures had a 94.0% survival after 5 years. However, the FPD survival rate declined to 87.0% after 10 years and dropped to 67.3% after 15 years. The authors were unable to identify direct comparative studies assessing the clinical performance of single implant-supported crowns and tooth-supported fixed partial dentures¹⁴.



■ Factors affecting treatment choice: Patient's perspective

Factors affecting the choice of treatment for replacing a single missing tooth were evaluated in a study by Al-Quran et al¹⁵. Two hundred volunteers (121 females and 79 males with an age range between 19 and 67 years, and a mean age of 43.6 ± 10.4) were asked about the factors affecting their choice of treatment. The three treatment options evaluated included a single implant and crown, a fixed partial denture and a removable partial denture. One hundred and fifty of the participants received one of the three treatments, with 50 patients in each of the three treatment options. The remaining 50 individuals received no treatment and served as controls.

Avoiding damage to the adjacent natural teeth emerged as the most frequently reported overall factor affecting treatment selection, followed closely by the duration of treatment, and then by the potential 'pain and suffering' they would experience. In reviewing each of the three treatment modalities, the time required for implant treatment was not identified as a major disadvantage by most of the participants. In this 2011 study by Al-Quran, 94% of the patients who received an implant, had a good understanding of implant therapy whereas 34% of the fixed partial denture and 72% of the removable partial denture groups had no understanding of dental implant therapy¹⁵. It is quite possible such a lack of awareness of implant surgery would likely have an effect on the treatment choice.

Brägger et al³ reported on the choice of treatment amongst 41 patients who received conventional 3-unit fixed partial dentures and 52 patients who received single crowns on implants. The final treatment choice was based on the preferences of the patient and clinician as it related to the need for preparation of the teeth with fixed partial dentures and the presence or absence of sufficient bone for the placement of an endosseous implant. The authors did not provide data regarding the selection process³.

A survey¹⁶ of 15 patients who had received single molar implants determined that the major deciding factor in treatment selection was its affordability. Such an outcome was no surprise because these patients only paid a nominal fee for their implant treatment as part of the research project. Interest-

ingly, the authors stated that the majority of the patients would have selected another form of treatment if they had to pay for their implant treatment¹⁶.

Anxiety related to intraoral procedures also has been identified as a major barrier to seeking implant treatment¹⁷.

■ Perceived need and acceptance of implants amongst individuals

Based on a questionnaire mailed to 3,000 randomly selected individuals in Sweden¹⁸, a 79.4% response rate was obtained, with adequate information received from 2,347 of the 2,382 subjects who returned their questionnaires. Individuals who reported they were missing teeth were asked if they wanted their missing teeth replaced with implants. Approximately 21% or 492 of the survey participants answered yes to this question. Respondents who had all their teeth were asked hypothetically what kind of treatment they would prefer if they were to lose one or two teeth and 51% opted for implants. Their subjective need for implants tended to decrease based on the state of their dentition, meaning participants with the largest number of teeth showed the highest subjective need for implants. When individuals with removable partial dentures were asked if they would rather have implants, assuming such treatment were possible, only 23% gave a positive response. For those Swedes who were edentulous in one arch, there was a 17% 'yes' response rate. However, only 8% of those who were edentulous in both jaws indicated they wanted implant-based dentures. The major reason respondents gave for not desiring implants was satisfaction with their current oral condition. Cost for treatment had some importance. The authors stated that subjective need is not equivalent to demand for treatment¹⁸.

Another study in 2002¹⁹ examined the perceived need for oral rehabilitation amongst 2,176 patients with 1,001 individuals from Sweden and 1,175 individuals from Denmark. Among the Swedes, 4.8% had oral implants (2.1% in the maxilla, 1.5% in the mandible and 1.2% in both jaws) and 2.5% of the Danes had undergone implant-based treatment (1.4% in the maxilla, 0.6% in the mandible and 0.5% in both jaws). Of those with missing teeth, 38% of the Swedes indicated they wanted an implant-based treatment whereas 54% of those



from Denmark desired implants. The authors stated this finding was surprising because patient fees in Denmark were higher than in Sweden, almost double the cost in Sweden for the placement of a single implant. In the previous study¹⁸ by these authors, cited above, 21% of the respondents indicated they would like dental implants. In this study the percentage was higher, indicating the need for implants seems to have increased over time¹⁹.

A 2003 survey in Austria²⁰ consisted of a 'representative sample' from 1,000 adults who were interviewed (sample size not specifically identified). Some of the 61% of those interviewed reported they would accept oral implants, if the need occurred. The acceptance rate was highest among males and those males below the age of 30 years old. It was of interest to note that 23% of those sampled decidedly rejected dental implants²⁰. The authors repeated the survey in 2010²¹, again with 1,000 Austrian adults, and at that time the acceptance rate for implants was 56%. Interestingly, 23% of those individuals surveyed decidedly rejected implant treatment, meaning the rejection percentage was the same as in 2003. The authors did not demonstrate an upward trend in implant acceptance. It was suggested that improved communication may lead to greater patient acceptance of implants as a treatment modality in oral rehabilitation²¹.

A study of the treatment preference of 59 subjects at a university dental hospital found that 94% of the subjects selected implant treatment rather than fixed partial dentures and removable partial dentures for the replacement of missing anterior teeth and 84% for replacement of missing posterior teeth²².

■ Sources of patient information

In a survey of 1,000 Austrian adults²³, 72% said they were familiar with implant treatment modalities, but they knew less about implants than other alternative treatments. Amongst the respondents, the preferred source of information was their clinician. However, 77% of those questioned indicated their clinicians did not use implant-based treatments. Forty-four percent thought implants should only be placed by specially trained doctors and over 60% thought clinicians or surgeons who provided treatment modalities involving implants were better qualified than those who did not

provide such treatment. When queried about the reasons for implant failure, half attributed them to allergies and incompatibilities, the other half to poor medical care. Only 29% incriminated poor oral hygiene²³.

The authors of the Swedish survey indicated that many of the 2,347 subjects in their study were not aware of the possibility of implant treatment¹⁸.

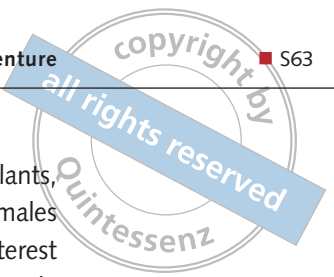
A stress-provoking intraoral procedure such as implant surgery can impair the ability of patients to process relevant information. In support of this effect, a study¹⁷ involving 98 healthy subjects showed that the ability of patients to correctly understand information provided to them when they are under the stress of an anticipated treatment is limited. While patients felt they properly comprehended the supplied information, their perception was unreliable¹⁷.

■ Patient perceptions and expectations related to oral implants

Interviews were conducted with 15 participants who had been part of a controlled clinical trial of immediately placed molar implants¹⁶. Patients were asked their opinion about the preoperative, intraoperative and postoperative phases of their treatment. The participants indicated they expected a long life span from their implants, yet it was apparent they only had minimal knowledge regarding the need for postoperative maintenance, a finding that was described by the authors as alarming¹⁶.

■ Providing implant treatment: Confidence of the clinician and barriers

In a 2010 questionnaire sent to 500 general dental practitioners in Wales, 217 responses were received²⁴. The survey was focused on determining the confidence level, barriers and attitudes of clinicians toward the replacement of missing teeth. Approximately 81% of the respondents indicated they were not confident enough to provide dental implants to their patients. Almost all of the respondents admitted they had poor or no university training relative to providing implant treatment. In addition, many of the clinician's highlighted the significance of financial barriers to their treatment planning imposed by the National Health Service (NHS)²⁴.



■ Publication quality

The quality of peer-reviewed 'economic evaluation' publications in dentistry was examined in a 2015 systematic review²⁵. Published papers were compared as to how they rated against the Drummond Checklist (a guideline used extensively amongst health economists to ensure studies reach an acceptable standard). This checklist is recommended by the Cochrane Handbook for Systematic Reviews of Interventions. The conclusion of the review was that methodological limitations were often present in the reviewed publications. These limitations included absence of sensitivity analysis (an approach for handling variable uncertainties in economic analyses, such as examining the best and worst case scenarios and allowing one item to vary while all others are held constant), absence of discounting (a method for eliminating the effects of inflation) and insufficient information being provided on how costs and outcomes were measured and valued. In fact, 21% of the eligible studies did not discount costs and 11% provided insufficient information regarding costs and outcomes discounting. In addition, the authors reported that more than half of the published articles did not perform a sensitivity analysis²⁵.

In an earlier systematic literature review²⁶ related to economic outcomes in prosthodontics, the authors stated that measures of cost-benefit (comparing the cost of different options against anticipated benefits including physiologic and psychosocial impact), cost-effectiveness (comparing the cost with the benefit based on strong evidence of the treatment effectiveness, often used to calculate the 'cost-saved' by a particular treatment), and cost-utility (comparing cost with value as evidenced by quality of life and length of life) are the gold standards for evaluation but the feasibility of such analyses is an issue. To ensure these measures were included in publications, the authors recommended collaboration with health economists to help guide such future research²⁶.

■ Patient perceptions regarding treatment cost

In questioning a representative sample of 1000 adults in Austria, Tepper et al²⁰ determined that cost was an important factor when choosing amongst treatment

options for tooth replacement. Interest in implants, should there be a need, was highest amongst males and interviewees below the age of 30. The interest in implant therapy increased with increased family income. However, all of those questioned considered implant treatment to be very expensive²⁰.

In the previously cited study¹⁶ on 15 patients, implants were selected as the treatment option because the patients "took part in the clinical trial mainly because it offered oral implant therapy at a reduced cost". If they had to pay the regular cost for the implant treatment, the majority would have selected another treatment option¹⁶. This response indicates the participants considered implant treatment to be too costly.

In comparing the survey results obtained in 2003²⁰ with those obtained 7 years later²¹, the authors found that significantly more interviewees complained about treatment costs, which were rated as the major disadvantage of oral rehabilitation by means of implants. In both the high-income and the low-income groups, implant treatment was reported to be too expensive. However, those who had first-hand experience with dental implants tended to have less of a negative opinion about costs to benefits²¹.

There have been studies comparing the amount of money individuals would be willing to pay for dental implants with what they thought the actual cost of such treatment would be. In one study²⁰, individuals were asked to estimate the cost of a single implant without a crown, 18% responded with 750 Euros, 26% said 1000 Euros, 20% said 1500 Euros, 11% said 2000 Euros, 16% said more than 2000 Euros and 9% were undecided. Amongst those who provided the lowest estimate of 750 Euros, 75% considered this amount to be too expensive. Even in the group who had already received implants, 79% believed that oral implants were too expensive. Most of the respondents attributed the cost to the clinician (62%) while 21% felt it was the dental laboratory technician and another 15% indicated it was due to the implant manufacturers and government taxes²⁰.

A study of 59 individuals in Hong Kong determined participants were willing to pay 10,000 Hong Kong dollars for a single tooth replacement using an implant (1 USD = 7.8 HKD)²².



■ Comparisons between single implants and fixed partial dentures

■ Systematic reviews

A 2012 systematic review²⁷ compared a single tooth implant and crown with a conventional fixed partial denture placed on teeth, based on economic considerations. Twenty-six publications were full-text reviewed. The authors determined initial costs for both treatments were similar but varied depending on geographic location. Additionally, they stated failure rates were comparable between the two treatment modalities and the long-term economic comparisons were similar. Paradoxically, in their discussion section, the authors stated the following: "The main finding of the present review is that in most of the included reports, the outcome of the implant crown was regarded as economically superior compared to the FDP"²⁷.

Another systematic review²⁸, published in 2013, examined the cost-effectiveness of dentures on implants and determined the single implant was a more cost-effective treatment compared with a 3-unit fixed partial denture. This conclusion was based on 14 studies looking at long-term costs and cost-effectiveness²⁸. However, only 2 of the 14 included studies were specifically focused on comparing the cost-effectiveness of single implants versus fixed partial dentures.

■ Direct comparisons of implants versus fixed partial dentures

In one of the two papers³, which made a direct comparison between single tooth implants and fixed partial dentures (FPDs), 37 patients received 41 conventional fixed partial dentures and 53 patients received 59 single crowns on implants. Based on the Swiss system, the mean total treatment cost was $3,939 \pm 766.4$ Swiss francs for the fixed partial dentures and $3,218 \pm 512$ Swiss francs for the implant treatment. Laboratory costs were higher for the FPD group ($1,527.8 \pm 209$ Swiss francs) than for the implant group (579.6 ± 106.9 Swiss francs). The time span from the start of treatment to completion was 3.23 ± 2.64 months for the FPD group and 5.94 ± 3.29 months for the implant group. However, the total treatment time in hours was similar

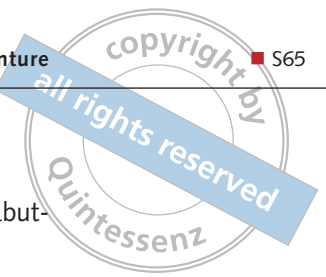
(4.8 ± 0.9 h for the implant group and 5.1 ± 1.3 h for the FPD group). The authors concluded that implant treatment had a more favourable cost-effectiveness ratio than a fixed partial denture, especially in situations where there was sufficient bone and the adjacent teeth were intact or minimally restored³.

The second paper²⁹, published in 2009, compared a single implant and crown with a fixed partial denture based on a model that used a 'simulation decision framework', which covered a 20-year period. Costs were determined based on a survey of 47 clinicians with the following results: 1) The fee of a fixed partial denture ranged from 1850 to 4200 Euros; 2) The cost of an implant and crown ranged from 1990 to 3950 Euros. The authors concluded that an implant appears to be the dominant 'first-line strategy' based on its lower overall costs and higher success rate. They also indicated the data in their study showed the implant strategy was acceptable in all the high-income areas of Europe, within the limitations of their model²⁹.

■ Findings of papers published after the two systematic reviews

The long-term cost-effectiveness of an implant and a 3-unit fixed partial denture was compared in 26 patients³⁰, 15 of whom had selected an implant and 11 who chose a fixed partial denture. The cost-effectiveness of the treatments was analysed over 3, 5, and 10 years. The implant and single crown had a higher probability of being cost-effective compared with the fixed partial denture over both the 3-year and 10-year time horizons. The 'quality adjusted tooth years' (QATYs) were slightly higher for the implant treatment and there were fewer complications. Implant treatment led to a cost saving of 584 Swiss francs primarily due to the higher initial costs of the fixed partial denture³⁰.

A 2014 study³¹ from Korea examined the cost-effectiveness of a single dental implant and a 3-unit tooth-supported fixed partial denture from a societal perspective. The mean cost in US dollars for an intraoral implant was 1,616 in a clinic and 2,708 in a hospital whereas the fixed partial denture cost was 1,308 in a clinic and 1,805 in a hospital. Using a decision tree model to estimate cost-effectiveness over a 10-year period, the implant treatment cost 261 to 342



US dollars more than the fixed partial denture while having an average survival rate that was 10.4% higher than the fixed partial denture. It was determined that the implant would become the dominant intervention if the cost of an implant were reduced to 80% of the current cost (in U.S. dollars in 2010). In other words, a dental implant would be more effective from a societal perspective, if the cost were 20% lower³¹.

■ Cost comparisons that included additional alternative types of treatment for replacement of missing single teeth

The long-term cost-effectiveness of five treatment alternatives (single implant and crown, resin bonded fixed partial denture, conventional complete coverage fixed partial denture, cantilevered fixed partial denture and autotransplantation of a tooth) for replacing a maxillary lateral incisor was investigated³². The costs were based on the national fee schedule in Switzerland, provided by the Swiss Dental Association. The following rankings of cost-effectiveness were presented, from most cost-effective to least cost-effective: 1) autotransplantation; 2) cantilever fixed partial denture; 3) resin bonded fixed partial denture; 4) single implant and crown; and 5) conventional complete coverage fixed partial denture. Therefore, the most cost-effective treatment was autotransplantation and the least cost-effective treatment was the conventional complete coverage fixed partial denture³².

One 2009 paper³³ on clinical decision-making included a table containing the cost of various treatment options based on the cost as a factor of 'X'. The information related to the cost of 'X' was obtained through a survey of 100 dentists from various metropolitan areas throughout the US. Six of the 11 cost factors that were most closely related to the topic of this review are presented below:

1. Three-unit fixed partial denture cost factor was 4.0X (meaning 4 times the value of X)
2. Three-unit FPD with crown lengthening surgery = 5.1X
3. Three-unit FPD with one root canal treatment = 4.9-5.3X
4. Three-unit FPD with two root canal treatments = 6.2X

5. Implant, stock abutment and crown = 4.3X
6. Implant with sinus augmentation, stock abutment and crowns = 6.8X

The cost of maintaining single implants and their crowns was compared with the cost of maintaining teeth through periodontal care in 43 patients who had 847 teeth at the initial examination and received 119 implants³⁴. It was determined that the mean cost of maintaining the implants was 10.2 Euros per year and the cost of maintaining the teeth was 2.1 Euros per year, about five times lower. The higher cost of maintaining the implants was due to the high prevalence of peri-implantitis. Indeed, the prevalence of peri-implantitis was 53.5% at the patient level and 31.1% at the implant level while the prevalence of periodontitis was 53.4% at the patient level and 7.6% at the tooth level³⁴.

A 2015 publication determined the most cost-effective management for oral conditions that could lead to partial or complete edentulism³⁵. The available evidence indicated that root canal treatments were the most cost-effective treatment for central incisors with irreversible pulpitis and coronal lesions. When initial root canal treatments failed, retreatments were still the most cost-effective. When root canal retreatments failed, extractions and replacement with implant-supported crowns were more cost-effective than fixed partial dentures or removable partial dentures³⁵.

The cost-effectiveness of molar endodontic retreatment was compared with fixed partial dentures and single-tooth implants. When there was a failed endodontically treated first molar, endodontic microsurgery was the most cost-effective treatment followed by nonsurgical retreatment and crown, then extraction and a fixed partial denture, and finally extraction and a single tooth implant with a crown³⁶.

Based on costs specific to the state funded health-care system in the UK, an evaluation was made of the cost-effectiveness of conventional approaches to root canal treatment versus replacement with an implant³⁷. The authors concluded that root canal treatment is highly cost-effective as the first treatment option. Retreatment is also cost-effective but if retreatment were to fail, the additional cost of apical surgery could not be justified. The authors stated that implant treatment is limited to a third line intervention when re-treatment fails³⁷.



A 2008 article³⁸ reviewed the available literature regarding single implants and restored natural teeth, to recommend management strategies that influence treatment planning decisions. The authors determined that “endodontic treatment of teeth represents a feasible, practical, and economical way to preserve function” and they also stated that “implants serve as a good alternative in selected indications in which prognosis is poor”³⁸.

A paper by White et al³⁹ compared endodontic and implant treatments for the purpose of helping clinicians make treatment decisions. The authors indicated there is a need for long-term, large, clearly defined studies, with simple and clear outcome measures (such as survival in combination with defined treatment protocols that compare the clinical performance of endodontic and implant treatments)³⁹.

■ Costs associated with specific, individual types of treatment

A cost analysis based on 24 patients with ectodermal dysplasia and severe hypodontia was used to develop a model that would accurately identify the dental costs from birth through to early adulthood⁴⁰. The analysis produced a cost range from 2,038 to 3,298 US dollars for those who only received prosthodontic treatment whereas the cost ranged from 12,038 to 41,146 US dollars for patients treated with a combination of prosthodontic, orthodontic and implant treatment⁴⁰.

The cumulative costs associated with prosthodontic treatment and maintenance of 45 young adult patients with birth defects was determined (22 patient with hypodontia/oligodontia, 22 with hypodontia/oligodontia and 5 with amelogenesis/dentinogenesis imperfecta)⁴¹. The initial treatment costs per replaced tooth unit were higher for implant treatments than tooth-supported treatments, but there were no significant differences in the long-term treatment costs over an 8-year time period. However, the treatments involved replacement of multiple teeth and were not related to the replacement of single missing teeth. The median costs per person associated with amelogenesis/dentinogenesis were by far the highest⁴¹.

In 2014, an estimation of the long-term complication costs associated with single implants in periodontally healthy patients was calculated after a time period

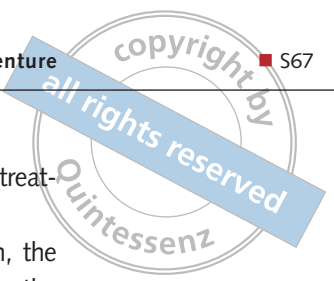
of 16 to 22 years old⁴². Fifty patients with 59 surviving implants were recalled for a clinical examination and complications data retrieved from their patient records. After a mean follow-up of 18.5 years, the cost of complications amounted to an average of 23% of the initial treatment cost ranging from 0 to 110%. There were no costs associated with 39% of the implants whereas 22% had expenses that exceeded 50% of the initial treatment fees. Eight percent of the patients experienced costs that were 75% of the initial treatment costs⁴². A 5-year prospective randomised clinical trial⁴³ assessed the need for surgical aftercare and prosthodontic aftercare in 93 patients with implant crowns in the anterior maxilla where bone grafting had also been performed. Surgical aftercare was required in 9% of the patients and was related to peri-implant tissue problems. The average time required for surgical aftercare was 6 min per patient whereas the prosthodontic aftercare was 54 min per patient⁴³. While there was no cost analysis provided, the time required in providing aftercare did have a financial implication.

■ Survival comparisons of teeth and implants

A systematic review⁴⁴ conducted in 2007 compared the outcomes of the following three courses of treatment: 1) root canal treatment with single implants; 2) fixed partial dentures attached to teeth; and 3) extraction without replacement. The authors concluded that success criteria differ greatly among the various courses of treatment, preventing direct comparisons of success rates. However, survival comparisons were able to be made, making it possible to determine that root canal treatment and single implants had similar survival rates in the studies that were evaluated. In addition, both root canal treatment and single implants produce superior long-term survival compared to fixed partial dentures. Limited data suggested that tooth extraction without replacement resulted in inferior psychosocial outcomes compared to the other treatment choices⁴⁴.

■ Discussion

Two systematic reviews that compared single oral implants with fixed partial dentures provided differing



conclusions regarding a long-term economic comparison. One review²⁷ determined the economic comparisons were similar whereas the other review²⁸ indicated the single implant was more cost-effective. In both of the included studies^{3, 29} that made direct comparisons between implants and fixed partial dentures, the single implant treatment modality was judged to be more cost-effective. There were two papers published after the above-mentioned systematic reviews. One of the publications³⁰ indicated the 'quality adjusted tooth years' were higher for the implant treatment and resulted in cost savings due to the higher cost of a fixed partial denture. In contrast, the other study³¹ calculated a higher cost of implant treatment and suggested a 20% implant fee reduction if the dominant intervention was used. Based on this limited scientific evidence, oral implant treatment was determined to be more cost-effective in some geographic areas but not in other areas. Therefore, more scientific evidence is needed to form the basis for a definitive statement regarding which treatment modality is the most cost-effective. However, it is apparent from patient cost perceptions that oral implant therapy is judged to be expensive^{20,21}.

In comparing the long-term cost-effectiveness of multiple treatments for the replacement of missing single teeth, treatments other than the single implant were determined to be the most cost-effective. These treatments included autotransplantation, a cantilever fixed partial denture and a resin bonded fixed partial denture³². The cost of maintaining teeth through periodontal care was calculated to be five times lower than the cost of maintaining implants³⁴. Root canal treatment was determined to be the most cost-effective first treatment for teeth requiring such an intervention^{35, 37}. Root canal retreatments were found to be more cost-effective than extraction and replacement with a single implant³⁵⁻³⁷. When root canal retreatments fail, extraction and implant placement was found to be more cost-effective than a fixed partial denture in two studies^{35,37}, but not in another analysis³⁶. A systematic review that compared root canal treatment with single implant fixed partial dentures attached to teeth, found that root canal and single implant treatments had similar survival rates that were superior to the survival rate of fixed partial dentures. Based on these studies, the preservation of natural teeth is the preferred treatment modality while oral implants provide an excellent solu-

tion should tooth retention through root canal treatment or retreatment not be successful.

For patients with congenitally missing teeth, the cost of treatment can be high, particularly when the oral rehabilitation includes orthodontic, prosthodontic and oral implant treatment modalities.

■ Conclusions

1. The use of single implants has increased while the use of fixed partial dentures has decreased. Reasons for this change have been related to the higher long-term survival of dental implants and factors such as tooth structure preservation.
2. There is limited perceived need for implants in many patients but the acceptance of implant therapy is greater in those patients who have a greater number of teeth.
3. Patients consider implant treatment to be expensive.
4. More scientific evidence is needed to formulate a definitive statement regarding the comparative cost-effectiveness of single oral implants and fixed partial dentures that replace one tooth. However, given the available publications, single implants appear to be more cost-effective than fixed partial dentures.
5. Retaining teeth through periodontal care and both initial root canal treatment and root canal retreatment was determined to be more cost effective than tooth extraction and rehabilitation with a single implant.
6. Oral rehabilitation for patients with congenitally missing teeth can be quite expensive when it involves multiple oral disciplines.

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