Long-Term Success of Implant Versus Endodontic Treatment

Authors:

Edward Perry, BHSc
*Sharmila Sachi, BSc Hons.
Shady Saleh,
Ronak Salimpoor, BSc
Arun Sharma, BSc
Chris Sims, BHSc
Victoria Skenderis, BHSc
Venus Sobhi, BSc
Benji Stern, BA

Affiliated with:

The authors are DDS candidates at the Faculty of Dentistry, University of Toronto

124 Edward Street
Toronto, Ontario, Canada
M5G 1G6

***Correspondence**

Sharmila Sachi
1680 John Street
Thornhill, Ontario
L3T-1Y9
Tel: 416-891-4336
Fax: 416-891-0456
E-mail: Sharmila_Sachi@yahoo.com

The authors have no declared financial interests.

Word count: 2489

Abstract

The aim of this evidence based report of the literature was to compare the long-term success rates of implants and endodontic treatment. Searches for journal articles were conducted in Ovid Medline, Pubmed and Cochrane database. 20 unique articles were reviewed of which 9 were deemed relevant. Based on checklists developed by Leake none of studies scored high. All studies researched were descriptive and provided the lowest level of evidence: Level III on the Canadian Task Force for Preventive Health Care Research Design Rating. None of the studies directly compared the long-term success of implants and root canal therapy. Success rates varied depending on the criteria used to define success and failure. The articles reviewed varied a considerable amount in their findings regarding the long-term success of endodontically treated teeth and overall success rates ranged between 48% and 91%. Implants obtained an overall success rate of 88.3%, however, if crown failure was not considered a failure the success rate improved to 95.3%. In conclusion, given the level of evidence present and the inconsistency with respect to defining success, more research is required with a stronger study design before long-term success rates of implants and endodontic treatment can be compared.

Endodontic or root canal treatment is a dental procedure in which the diseased or damaged pulp is removed and the pulp chamber and root canals are filled and sealed. This procedure is performed to relieve the pain of the infected pulp (pulpitis) and to prevent further complications. Dental implant involves crowning an artificial root screwed into the jaw. Stability is provided by osseointegration of the artificial root.

According to the ODA the incidence for endodontic treatment and dental implants in the US is approximately 15,838,100 and 1,505,500 respectively, however, dental implants are now becoming the standard of care in many situations[1]. More dentists and patients are opting for dental implants over endodontic treatment[1], even though a comparison of their long-term success rates, an indicator of their effectiveness, has not been investigated. When posed with a choice between endodontic treatment and implants, long-term success rate is an important factor that must be considered by both dentist and patient, especially since dental implant is an invasive procedure and involves the extraction of teeth.

The choice is further complicated since there is a wide range of success rates reported in the literature due to variation in the criteria used to define success. This review is aimed at answering the following question based on a more stringent definition of success: For long-term success, which is better an implant or endodontic treatment? The null hypothesis was that there is no difference in the long-term success rates of dental implants and endodontic treatment.

Methods

The following strategy was used to search and appraise relevant articles.

Search Strategy

Keywords such as outcome of endodontic treatment, success of endodontic treatment, successful endodontic treatment, and failure of dental implant were searched in Ovid Medline, Pubmed and Cochrane database. Searches were limited to papers written in English, with human subjects and published between 1990 and 2005. For implants and endodontic treatment this process yielded 542 and 441 unique articles (Table 1).

Determining Relevance

Since none of the articles dealt with both implants and endodontic treatment the articles were split into implant related and endodontic related research. Consequently, a separate evidence based table was constructed for each treatment option. After the search relevant articles were retained at five stages (Table 1). 1) In the first and second stage articles that were relevant based on title and abstract were retained. 2) The third stage involved retrieving articles that were available at the University of Toronto Dental Library or online through the University. 3) At the fourth stage, two groups of authors (implant and endodontic treatment) read and selected 20 articles that were relevant to the topic. Relevance was based on: a) Follow up period of at least 3 years. b) Did not define long-term success as survival c) Use of the Branemark implant system due to lack of scientific information on the long-term performances of other systems. 4) At the fifth stage each article was independently scored by two investigators, to determine the validity of the study, based on the strength of study (Canadian Task Force on the Periodic health examination) and the relevant checklists developed by Leake[14] (Tables 2 and 3). For endodontic treatment a checklist for assessing evidence of prevalence and incidence (Table 2) (highest score 12) was utilized to score primary research and a checklist for a

review article (Table 3) (highest score 9) was utilized for review articles. For dental implants a checklist to assess evidence of prevalence and incidence (Table 2) (highest score 12) was utilized. When the scores varied the investigators joined forces to establish a final score. Of the 20 articles deemed relevant, 3 studies for dental implants and 6 for endodontic treatment were selected due to a high score. Articles rejected after scoring are listed in Appendix 1.

Results

The 3 dental implant studies scored between 6 and 8 out of the maximum 12, the 5 primary research studies for endodontic treatment scored 6 out of 12 and the 1 endodontic treatment review article scored 6 out of 9. Due to low scores, none of the studies were considered to present strong evidence and therefore 9 studies were included in the evidence based table (Table 4 and 5).

All 6 studies (Table 4) reviewed for endodontic treatment used acceptable measures during experimentation towards reaching desired outcomes. Results were achieved using standard methods and procedures and at no point were any of the studies ethically compromised.

Sample sizes in these studies ranged in the hundreds and a large amount of selection criteria were involved to ensure that subjects did have the factor being studied. As well, for the prospective studies[2,3], random methods were employed in regards to the actual selection and allocation of subjects and therefore the sampling schemes used in these studies allowed for a more representative sample. Moreover, the prospective studies were able to allocate subjects into groups based on shared characteristics. The retrospective studies[4,5,6,7], by design, were unable to achieve

this. However, one cannot conclude that all of the samples were completely representative as all the studies were carried out in dental teaching hospitals whose patient population is somewhat different socio-economically than the general population. Although this difference is not dramatic, it is clearly an item that needs consideration before any generalized application of the results could occur.

Each of the studies[2,3,4,5,6,7] reviewed had overlapping criteria for the presence of disease (equivalent to failure) including re-treatment, extraction, clinical signs and symptoms of pain, and presence of periapical radiolucency. As well, each used more than one of these criteria for diagnosis therefore the definition of the disease was very adequate and highly characterized.

All the studies[2,3,4,5,6,7] involved examination and diagnosis of failure by dental students. Furthermore, majority of endodontic treatment was conducted by dental students and not by practicing dentists. Therefore, these studies are weaker since the level of expertise of practicing dentists may have allowed for better endodontic treatment and assessment of disease criteria.

In a study the criteria used to define a successful endodontic treatment significantly influences the success rates. Certain studies used more lenient criteria to define success/failure. Heling and others[8] defined failure as an increase in the size of a periapical rarefaction while Alley and others[9] used a more lenient criterion and defined success as the presence of a tooth that was endodontically treated. Such lenient criterion usually leads to higher rates of success. Hence, for our investigation we opted to retain studies that included results from both clinical and radiographic examinations and therefore utilized a more stringent success/failure criteria. The absence of a periapical

radiolucent area was one of the criteria used to define success in several of the studies[2,3,5,6]. If the radiographic criterion used in the "Toronto Study: Phase 1"[2] study had included decreased lesions instead of the absence of lesions, the success would have increased from 81% to 92%.

The endodontic success rates ranged from 48%[5] to 91%[7]. The combined samples of the "Toronto Studies"[3] gave a success rate of 85%, based on both clinical and radiographic examinations. If only radiographic measures had been used, success would have remained at 85%[3], however, if only clinical measures had been used success would have increased to 95%[3]. This suggests that apical periodontitis is often asymptomatic and demonstrates the influence that "success" criteria has on success rates.

In order to assess the mean survival time of endodontically treated teeth, Cheung[6] and Cheung and others[5] used the Kaplan-Meier method of survival analysis in both studies and the mean survival time ranged from 91 months (plus or minus 3.5 months) to 111 months. Kojima and others[4] performed a cumulative meta-analysis using the Mantel-Haenzer technique and revealed a success rate of 82.8% (+/- 1.19%) for teeth with a vital pulp, and 78.9% (+/- 1.05%) for those with a non-vital pulp, and a cumulative odds ratio of 1.18 between the two; (95% confidence intervals, 1.06-1.32).

Of the 3 studies (Table 5) reviewed for dental implants: Andersson and others[10] (1998a), Andersson and others[11] (1998b), and Scheller and others[12] scored 6, 7, and 8 respectively. Collectively, the articles sampling scheme did not produce a representative sample. In the case of Andersson and others[10,11], inclusion was based on the following criteria: 1) Adjacent teeth intact or restored with only small restoration.2) Adjacent teeth included in functionally and aesthetically acceptable restorations. 3) A spaced dentition

(>7mm). 4) Bone volume to permit placement of implant measuring at least 10x3.75mm, of which all the threads are covered by bone.

Furthermore, Scheller and others[12] did not describe the criteria for patient selection, and hence a negative value was assigned on the checklist. All three articles did not provide evidence of the lack of systematic difference in prevalence, environmental, behavioural or health care access factors between the experimental group and the population. Also in the Andersson and others[11] study sex distribution was not similar. These factors have to be considered before any generalized application of the results could occur. Furthermore, the accuracy of the data tested in all 3 studies is questionable, since measurements were not checked by a second examiner.

Six categories for measuring failure were identified (Table 5) and included in this review. Soft tissue complications included persisting pain, excessive swelling or hyperplasia (requiring surgical therapy) or fistula formation. A single case of fistula formation was recorded. A hard tissue complication, defined as unsuccessful osseointegration, occurred in a single patient. The rate of soft/hard tissue complications is 1.2%. Peri-implanitis, an inflammatory reaction with loss of supporting bone did not occur in any of the test subjects. Bone loss was recorded in all three studies as either a mean value[10,11] or in the case of Scheller and others[12] numerical ranges were defined up to a maximum of 2 mm. This proved to be a sticking point as it was not possible to determine the cases in which bone loss was 2.5 mm or greater. The failure of the implant component in the aforementioned studies was associated with the loosening of the abutment screw and in a single case due to a gap between the implant and abutment[10]. Andersson and others[10] reported that the replacement of the abutment screw and manual

re-tightening corrected the problem. In the Scheller study[12], the loosening of the abutment screw occurred on 4 occasions and in all but one case re-tightening was able to solve the problem. The overall rate of implant component failure is 3.5%. Implant fracture did not occur in any of the studies. Finally, crown failure occurred in all the studies. Andersson and others[10,11] (1998a and 1998b) and Scheller and others[12] reported there were 3, 1, and 8 crown fractures respectively. The overall rate of crown failure is 7.0%.

The overall rate of implant failure, based on the aforementioned categories, was 11.7% and hence an overall success rate of 88.3%. If we do not include crown failure as a factor in implant failure (which was the case in all of the studies) the success rate was 95.3%.

Discussion

The articles reviewed varied a considerable amount in their findings regarding the long-term success of endodontically treated teeth. Overall success rates ranged between 48%[5] and 91%[7]. Much of the variation between the success rates found in the studies can be attributed to the different success criteria that the studies employed. Studies[5,6] that had the strictest criteria regarding success of endodontic treatment had the lowest overall success rates, 48%[5] and 56%[6] respectively. Both studies by Cheung[5,6] considered any periapical lesion, re-treatment and extraction as a failure while Cheung[6] in 2002 included any clinical symptoms as a failure. The other studies had relatively less stringent criteria and consequently had higher success rates. One must carefully examine how success is defined by these studies to determine if the corresponding success rates are of clinical importance to patients. For example, in most of the studies, teeth that were considered to

be a failure from a radiographic perspective (e.g. persistence of a periapical lesion) were usually not associated with any adverse clinical symptoms for the patient (e.g. pain, mobility, tenderness, etc.). When these "failed" teeth were included in the success column, the resulting success rates increased dramatically. Cheung and Chan[5] reported an increase from 48% to 67.5%, Cheung[6] reported an increase from 56% to 79% and Friedman and others[2] increased from 81% to 97%. Friedman and others[2] state, "this dimension of outcome is noteworthy; it can provide the patient with an additional perspective when weighing initial endodontic treatment against alternative treatment modalities."

Another aspect of these studies that must be considered is their applicability to the general population. All the studies (except Cheung[6] and Cheung and Chan[5]) used data garnered from patients of dental faculties or hospitals. It is unclear how similar these subjects are to the general population in terms of factors that may influence the outcome of root canal therapy. None of the studies could ensure this generalizability because none of them drew their participants randomly from the general population. Also, just as the overall success rates varied between the studies, the influence of different pre-treatment and treatment variables were also different. Among these were variables such as preoperative periapical status, preoperative pulp vitality, tooth type, quality and extension of instrumentation, type of coronal restoration used and type of inter-appointment medicament. While some studies found that some of these factors did have a statistically significant impact on the success of the root canal treatment, others found that the same variables had no significance.

When the success rate for implants were considered, an overall success rate of 88.3% was obtained. Furthermore, if they did not consider crown failure as failure of the implant, the success rate improved to 95.3%. Unlike endodontic success rates, implant studies did not show such a huge variation in success rates. This may be due to the fact that the studies used relatively similar success/failure criteria.

Evidence Based Recommendations

The literature on long-term success rates of both implants and root canal therapy would be strengthened by studies that used a design that provided a higher level of evidence. Neither group used randomized or non-randomized controlled studies. While most of the implant research was prospective, the root canal therapy group was dominated by retrospective descriptive studies. All studies researched were descriptive and therefore provided the lowest level of evidence: Level III on the Canadian Task Force for Preventive Health Care Research Design Rating. The following recommendations would overcome some of the weaknesses present in previous studies:

- Conduct primary research to collect evidence from controlled trials without randomizations (Level II 1 on the Canadian Task Force for Preventive Health Care Research Design Rating)
- In the root canal therapy research, using a standard set of success / failure criteria would greatly improve comparability between the studies. A set of criteria has been proposed by the European Society of Endodontists, and while many of the studies mention it, few actually implemented the criteria in their study.

- Finally, the literature would obviously benefit from studies that directly compare the long-term success of implants and root canal therapy. Currently, there is a lack of such studies.

In conclusion based on success rates it appears that implants demonstrate a consistently (due to less variation in reported success rates) higher long-term success rate. However, given the level of evidence present and the inconsistency with respect to defining success, more research is required with a stronger study design before long-term success rates of implants and endodontic treatment can be compared.

Acknowledgements

The authors would like to thank Amir Azarpazhooh, Dr. Mayhall, and Dr. Leake for their guidance and feedback.

References

1. Bader HI. Treatment Planning for Implants versus root canal therapy: a contemporary dilemma. *Implant Dentistry* 2002;11(3):217-23.

2. Friedman S, Abitbol S, Lawrence HP. Treatment outcome in endodontics: the Toronto Study. Phase 1: initial treatment. *Journal of Endodontics* 2003;29(12):787-93

3. Farzaneh M, Abitbol S, Lawrence HP, Friedman S. Toronto Study. Treatment outcome in endodontics-the Toronto Study. Phase II: initial treatment. *Journal of Endodontic* .2004;30(5):302-9.

4. Kojima K, Inamoto K, Nagamatsu K, Hara A, Nakata K, Morita I, Nakagaki H, Nakamura H. Success rate of endodontic treatment of teeth with vital and non-vital pulps. A meta-analysis. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 2004;97(1):95-9.

5. Cheung GS, Chan TK. Long-term survival of primary root canal treatment carried out in a dental teaching hospital. *International Endodontic Journal 200*3;36(2):117-28.

6. Cheung GS. Survival of first-time non-surgical root canal treatment performed in a dental teaching hospital. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 2002;93(5):596-604.

7. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. *Journal of Endodontics* 1990;16(10):498-504.

8. Heling I, Bialla-Shenkman S, Turetzky A, Horwitz J, Sela J. The outcome of teeth with periapical periodontitis treated with non-surgical endodontic treatment: a computerized morphometric study. *Quintessence International* 2001;32(5):397-400.

9. Alley BS, Kitchens GG, Alley LW, Eleazer PD. A comparison of survival of teeth following endodontic treatment performed by general dentists or by specialists. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 2004;98(1):115-8.

10. Andersson B, Odman P, Lindvall A, Branemark P. Cemented single crowns on osseointegrated implants after 5 years: results from a prospective study on CeraOne. *Int J Prosthodont* 1998a;11(3):212-8

11. Andersson B, Odman P, Lindvall A, Branemark P. Five year prospective study of prosthodontic and surgical single-tooth implant treatment n general practices and at a specialist clinic. *Int J Prosthodont* 1998b;11(4):351-5

12. Scheller H, Klineberg I, Stevenson-Moore P, Alonso JMN, Corria RM, Toreskog S, Smith CR. *Int J Oral Maxillofac Implants* 1998;13:212-8

13. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. *J Clin Periodontol* 2002;29(3):197-212.

14. Leake JL, Department of Biological and Diagnostic Sciences, Faculty of Dentistry, University of Toronto. Unpublished document. Course notes 300Y 2005. The checklist was adapted from Fletcher SW, Wagner EH. Clinical epidemiology. The essentials. 3rd ed. Baltimore: Williams and Wilkins, 1996; and Sackett DL, Richardson WS, Rosenberg W, Haynes RB. Evidence based medicine: how to practice and teach. EBM. 2nd ed. New York: Churchill Livingstone, 1997.

***Table 1*: Number of articles retained at each stage**

			Number of articles selected	
		Inclusion/Exclusion Criteria	Implants	Endodontic treatment
	Search Strategy	Abstracts found (limits=papers written in English, with human subjects and published after 1990)	542	441
Determining Relevance	Stage 1	Relevant to the topic based on title	100	46
	Stage 2	Relevant to the topic based on abstract	10	24
	Stage 3	Availability at University of Toronto dental library or online through University of Toronto	10	15
	Stage 4	First read	10	10
	Stage 5	Articles meeting scoring cut off	**3**	**6**

***Table 2*: Checklist to assess evidence of prevalence and incidence[14]**

1) Was the study ethical?
2) Was the study internally valid?

Sampling Questions

a) Was the sampling frame complete, or for longitudinal studies, were all members of the cohort entered at the beginning?
b) Did the sampling scheme allow a representative sample?

Participation Questions

a) Was the response rate 80% or higher, or for longitudinal studies, was loss to follow-up low –less than 20%?
b) Was completion rate on individual items of the assessment instrument high?

Measurement Questions

a) Did the survey use valid measures of disease (case definition) and risks?
b) Were the data gathered using the best-accepted techniques? (e.g., trained telephone interviewers or examiners, mail questionnaire)
c) Were the data tested for accuracy and reliability?

3) Do the findings relate to your patient/population?
a) Are the age/sex distributions similar?
b) Is there evidence of no systematic differences in prevalence or trends in disease between this group and your patients?
c) Is there evidence of no systematic differences in important environmental, behavioural or health care access factors between this group and your patients?

***Table 3*: Checklist for a review article[14]**

1)	Was the question stated clearly and relevant?
2)	Were the methods stated clearly?
3)	Was the search for studies comprehensive (Medline, etc., selection from bibliographies, contact with investigators)?
4)	Were the inclusion/exclusion criteria for studies clearly stated and relevant (population, intervention, outcomes, study designs)?
5)	Was the validity of the primary studies assessed (e.g. independent reviewers, scoring of articles)?
6)	Was the assessment of the primary studies reproducible and free from bias?
7)	Were results of primary studies combined appropriately using summary tables meta-analysis (patients are similar in the combined studies)?
8)	Was the homogeneity of the primary studies analysed?
9)	Were the conclusions consistent with results and strength of the primary studies?

Appendix 1: **List of articles excluded after scoring**

Alley BS, Kitchens GG, Alley LW, Eleazer PD. A comparison of survival of teeth following endodontic treatment performed by general dentists or by specialists. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 2004;98(1):115-8.
Chugal NM, Clive JM, Spangberg LS. Endodontic infection: some biologic and treatment factors associated with outcome. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 2003;96(1):81-90.
Dammaschke T, Steven D, Kaup M, Ott KH. Long-term survival of root-canal-treated teeth: a retrospective study over 10 years. *Journal of Endodontics* 2003;29(10):638-43.
Fardal O, Johannessen AC, Olsen I. Severe, rapidly progressing peri-implantitis. *Journal of Clinical Periodontology* 1999;26:313-7
Heling I, Bialla-Shenkman S, Turetzky A, Horwitz J, Sela J. The outcome of teeth with periapical periodontitis treated with non-surgical endodontic treatment: a computerized morphometric study. *Quintessence International* 2001;32(5):397-400.
Jemt T, Linden B, Lekholm U. Failures and complications in 127 consecutively in-stalled fixed partial prostheses supported by Branemark implants. A study from prosthetic treatment up to the first annual checkup. *International Journal of Oral and Maxillofacial Implants* 1992;7: 40-4
Karoussis IK, Salvi GE, Heitz-Mayfield LJA, Bragger U, Hammerle CHF, Lang NP. Long term implant prognosis in patients with and without a history of chronic periodontitis: a 10 year prospective cohort study of the ITI Dental Implant System. *Clin. Oral Impl. Res*. 2003;14:329-39
Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin. Oral Impl.* Res. 2005;16:26-35
Mombelli A, Lang NP. Clinical parameters for the evaluation of dental implants. *Periodontology* 1994;4:81-6
Rahman A, Rashid S, Noon R, Samuel ZS, Lu B, Borgnakke WS, Williams RC. Prospective evaluation of the systemic inflammatory maker C-reactive protein in patients with end stage periodontitis getting teeth replaced with dental implants: a pilot investigation. *Clin. Oral Impl*. Res. 2005;16:128-31
Yerit KC, Posch M, Hainich S, Turhani D, Klug C, Wanschitz F, Wanger A, Watzinger F, Ewers R. Long term implant survival in the grafted maxilla: results of a 12 year retrospective study. *Clin. Oral Impl. Res.* 2004;15:693-99