

UCLA

UCLA Electronic Theses and Dissertations

Title

Life Impact of Diseases of Pulpal Origin and its Non-Surgical Root Canal Treatment

Permalink

<https://escholarship.org/uc/item/4xv1h2vh>

Author

MANAM, RAJESWARI

Publication Date

2023

Supplemental Material

<https://escholarship.org/uc/item/4xv1h2vh#supplemental>

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Life Impact of Disease of Pulpal Origin and its Non-Surgical Root Canal Treatment

A thesis submitted in partial satisfaction of
the requirements for the degree Master of Science in Oral Biology

by

Rajeswari Manam

2023

© Copyright by
Rajeswari Manam
2023

ABSTRACT OF THE THESIS

Life Impact of Disease of Pulpal Origin and its Non-Surgical Root Canal Treatment

by

Rajeswari Manam

Master of Science in Oral Biology

University of California, Los Angeles, 2023

Professor Shane White, Chair

Objective: This systematic review aims to explore the impact of diseases of pulpal origin (DoPO) and subsequent non-surgical root canal treatment (NSRCT) on life impact and health-related quality of life (HRQoL). The focus is on understanding the multidimensional aspects of health-related quality of life (HRQoL) and satisfaction encompassing physical, psychological, and social dimensions of overall well-being.

Specific Aims:(1) To measure the impact of DoPO on OHRQoL, satisfaction, and life quality.

(2) To identify the key domains by which DoPO has life-impact.

(3) To measure the impact of NSRCT on OHRQoL, satisfaction, and life quality over time.

Methods: Inclusion criteria encompassed various study designs (comparative or non-comparative, cross-sectional, prospective or retrospective), focusing on quantitative or qualitative data related to quality of life or satisfaction related to DoPO and NSRC) between January 1, 1990, and June 6,

2022. Publications were required to be in English, indexed in refereed literature, and include data on 10 or more individuals with DoPO, needing NSRCT, or receiving NSRCT. Studies needed clear measures, sample size descriptions, treatments provided, follow-up durations. Authors were contacted for clarification or additional data if needed. An electronic search was conducted in PubMed . Complemented by manual searches through citation mining, guidance from a reference librarian, and expert advice. Full-text articles meeting inclusion criteria were analyzed for study quality using the Wong Scale–Revised. Data abstraction facilitated quantitative and qualitative synthesis, meta-analysis where possible, and L’Abbe plotting, with normalization of data to percentages.

Results: 243 titles were found through electronic searches, leading to 28 papers covering 60 populations. Most studies were recent (12 in the last 5 years, 20 in the last 10 years), from 18 countries, with acceptable to high quality ratings. Studies varied in methodologies, sample sizes (25 to 1323 individuals); comparisons made; techniques, providers, and age groups studied. OHIP scales were prevalent, but other measures such as other scales and qualitative approaches. Satisfaction was assessed in 10 studies across 18 populations using the Dugas Semantic Differential Scale (DSDS) or specific questions.

Disease of pulpal origin was generally of low-to-moderate life impact when measured by OHIP-14 and -7 instruments, but other instruments tended to indicate a higher life impact. Disease of pulpal origin overwhelmingly impacted the domains of physical pain, psychological discomfort, and psychological disability, whereas the domains of functional limitation, physical disability, and social disability were considerably less impacted. Non-surgical root canal treatment provided substantial improvement in life quality when measured by change in oral health-related instruments, such as the OHIP, when measured using the Dugas Semantic Differential Scale, by

simple satisfaction questions, and by qualitative methods. Most of the positive impact of NSRCT was discerned in days or weeks following treatment, and the impact was sustained through all time periods measured, up to 2 years. DoPO had a substantial negative impact on OHQoL. Whereas, NSRCT consistently showed a positive impact on HRQoL, notably reducing pain, psychological discomfort, and disability, with improvements often seen shortly after treatment and sustained throughout the study durations.

Discussion: It is recommended that future studies use standard instruments, present all the domain and sub-domain data, and use multiple approaches, including the qualitative exploration of patient experience. This investigation underscores the need for standardized measurement tools in assessing the impact of non-surgical root canal treatments. It emphasizes the substantial improvements observed in patients' quality of life post-treatment, thereby advocating for comprehensive assessments in future research endeavors to better understand and enhance oral health outcomes.

Conclusions: DoPO had a substantial negative impact on OHQoL, where the domains of physical pain, psychological discomfort, and psychological disability were dominant. NSRCT consistently showed a positive impact on HRQoL, notably reducing pain, psychological discomfort, and disability, where improvements were evident shortly after treatment and sustained throughout the study durations.

The thesis of Rajeswari Manam is approved.

Vinodh Bhoopathi

Insoon Chang

Carl A. Maida

Shane White, Committee Chair

University of California, Los Angeles

2023

TABLE OF CONTENTS

Introduction

Materials and Methods..... 6

Results..... 7

 Life Impact Literature 7

 Character and Quality of the Literature 8

 Heterogeneity and Potential Sources of Bias 8

 QoL instruments Used 8

 Satisfaction Measures Used 9

 Type of Life Impact of Disease of Pulpal Origin..... 9

 Severity of Life Impact of DoPO..... 10

 Factors Influencing the Life Impact of DoPO 11

 Magnitude of Life Impact of NSRCT through OHQoL Instruments..... 12

 Magnitude of Life Impact of NSRCT through the DSDS Satisfaction Instrument 12

 Magnitude of Life Impact of NSRCT through Satisfaction Questionnaires..... 13

 Type and Magnitude of Life Impact of Impact of NSRCT through Qualitative Approaches... 13

 Comparisons to Other Interventions 14

Discussion..... 14

Limitations 16

Conclusions.....	17
Recommendations:.....	18
References, Text Only.....	27
References, papers included in the evidence table.....	34

LIST OF TABLES

Table 1 Search Strategy	19
Table 2 Evidence table	20

LIST OF FIGURES

Figure 1 L'Abbe Plot of OHIP and other instruments.....	23
Figure 2 Changes in 3 Key OHIP Domains Before and After NSRCT	24
Figure 3 Satisfaction with NSRCT using DSDS	25
Figure 4 Satisfaction by survey question	26

GLOSSARY

Abbreviation	Meaning
HRQoL	Health-Related Quality of Life
DoPO	Diseases of Pulpal Origin
OHRQoL	Oral Health-Related Quality of Life
OHIP	Oral Health Impact Profile
NSRCT	Non-Surgical Root Canal Treatment
re NSRCT	Retreatment of Non-Surgical Root Canal Treatment
DSDS	Dugas Semantic Differential Scale
HDI	Human Development Index

ACKNOWLEDGEMENTS

I extend my heartfelt gratitude to Dr. Shane N. White for his unwavering support and invaluable guidance throughout my academic journey. His mentorship has been instrumental in shaping my scholarly pursuits. Dr. White's mentorship has not only enriched my academic endeavors but has also instilled in me a deeper understanding of the subject matter. His unwavering support, patience, and commitment to excellence have not gone unnoticed. His guidance, particularly during moments of uncertainty, has illuminated my path, allowing me to navigate the complexities of research and academia with confidence. His insights, encouragement, and belief in my capabilities have been pivotal in shaping my academic achievements and will continue to resonate in my future endeavors.

I am sincerely grateful to the members of my committee, Dr. Carl Maida, Dr. Vinod Bhoopathi, and Dr. Insoon Chang, and for graciously accepting their roles and for their prompt and invaluable responses whenever I sought their guidance and expertise.

I would like to thank Jason Burton, Science Collections Librarian, Louis M Darling Biomedical Library grateful for exceptional assistance in conducting thorough research & search expertise.

My deepest appreciation goes to my family for their unyielding support and unwavering love. Their constant encouragement has been the cornerstone of my strength, aiding me through every step, both in times of triumph and in moments of adversity. Their support has been invaluable, and for that, I am profoundly grateful.

Introduction

Health-related quality of life encompasses physical function, psychological well-being, social and role functioning, and health perception (Hennessy et al., 1994). This multifaceted construct can be a pivotal tool for illuminating oral health trends and assessing the needs of populations. It can encapsulate the extent to which oral issues disrupt individuals' daily lives, representing a comprehensive understanding of the impact of oral health on overall well-being (Brondani et al., 2018).

Considerable research attention has been directed towards understanding the ramifications of dental problems, particularly dental caries, on the children's quality of life. The profound influence of dental caries on children's Oral Health-related Quality of Life (OHRQoL) has been well-documented. For example, a potential correlation between untreated caries, disease of pulpal origin (DoPO), and their adverse impact on OHRQoL, has been illuminated, extending even to the quality of life of the children's guardians (Brondani et al., 2018).

However, within the realm of adult oral health, investigations focusing on the impact of DoPO are sparse. Azarpazhooh calls attention to a compelling paradox: despite the high prevalence of DoPO, individuals demonstrate a strong inclination toward retaining natural teeth (Azarpazhooh et al., 2022). This may imply a lack of knowledge of the pathogenesis of dental disease and its treatment, difficulties in decision-making, fear of NSRCT, or a lack of access to care.

Azarpazhooh's scoping review underscores the multifaceted nature of interpreting health outcomes among various stakeholders, including clinicians, patients, and researchers. (Azarpazhooh et al., 2022). The subjectivity inherent in the interpretation of health outcomes

necessitates the employment of robust measurement tools, emphasizing their pivotal role in both clinical research and practice.

Furthermore, contemporary perspectives have increasingly emphasized the significance of retaining teeth not merely for functional purposes but also for esthetic considerations, and overall quality of life (Jones et al., 2003) (Steele et al., 2004)(Gulabivala & Ng, 2019).Interest in patient-centered NSRCT outcomes has been increasing (Pak & White, 2011)(Hamedy et al., 2013)(Khan et al., 2016)(Antunes et al., 2018) (Neelakantan et al., 2020) .

This contemporary viewpoint contrasts with historical perceptions that relegated teeth as seemingly disposable organs of lesser importance to survival, merely due to their redundancy in numbers and distribution within the oral cavity. Nonetheless, extractions are widely performed and edentulism does not disappear, another example of the paradox described by Azarpazhooh above.

Beyond establishing treatment need by endodontic diagnosis through examination and radiography, a shift towards understanding the profound impact of DoPO on the quality of life and daily functioning of individuals is underway. This shift underscores growing interest in identifying factors associated with this impact, marking a critical juncture in assessing the burden of DoPO on life.

Locker explained a construct whereby disease causes impairment through pain and functional limitation, giving rise to physical, psychological, and social disability, that together result in handicap (Locker, 1988).To gauge the impact of treatment on quality of life, various tools and assessment methodologies have been employed. The Oral Health Impact Profile (OHIP) stands out as a widely employed and standardized measure utilized across different languages, cultures,

and countries. This tool has been instrumental in comprehensively assessing the impact of oral health interventions on the overall quality of life and well-being of individuals (Neelakantan et al., 2020).

The OHRQoL construct was expanded by Sischo and Broder to include the dimensions of oral health, function, treatment expectation, environment as well as the social/emotional aspect (Sischo & Broder, 2011). They also remind us that attention must be given to overall group differences and individual assessments to have relevance for clinical meaningful outcomes.

Disease of pulpal origin and its principal treatment, NSRCT, have a special place, not just in dentistry, but in wider culture and lore (Pak & White, 2011)(Hamedy et al., 2013) (Khan et al., 2016), indicating a profound impact on human life.

Clinical trials are an indispensable avenue for assessing QoL under real-world conditions. These trials may provide invaluable insights into treatment effectiveness from a patient-centric perspective, offering results that hold direct relevance and applicability to routine clinical practice. This real-world assessment of treatment strategies stands as a testament to their meaningfulness and impact on the lives of individuals undergoing oral health interventions (Neelakantan et al., 2020).

Systematic reviews have consistently highlighted positive outcomes across various dental treatments, shedding light on the benefits perceived by patients. From interventions involving complete maxillary denture treatments to those concerning dental implant rehabilitation and periodontal therapy, these reviews have underscored the tangible positive effects of many different dental treatments on patients' OHRQoL. Several prior systematic reviews of the effect NSRCT on

OHRQoL have been published(Antunes et al., 2018) (Neelakantan et al., 2020)(Leong & Yap, 2020).

Antunes et al used strict inclusion criteria in their systematic review that limited their appraisal to the inclusion of just two papers. They concluded that NSRCT improved OHRQoL, but they did not attempt to measure the amount or the means through which the improvement was achieved(Antunes et al., 2018).However, others have suggested that the presence of pain in of itself diminishes the overall quality of life (Neelakantan et al., 2020). Therefore, a comprehensive approach to the study of disease of pulpal origin and its treatment is warranted. Leong and Yap included six papers in their synthesis, but none for meta-analysis, and concluded that NSRCT improved OHRQoL, but noted the absence of systematic reviews and comprehensive meta-analyses in consideration of patient-centered endodontic outcomes (Leong & Yap, 2020). Neelakantan et al. included sixteen papers in their qualitative synthesis, but none for meta-analysis, and likewise concluded that NSRCT improved OHRQoL, but noted that well-designed observational studies are lacking, preventing them from conducting a quantitative synthesis(Neelakantan et al., 2020). These prior systematic reviews focused upon the impact of NSRCT on DoPO, but not on the life impact of DoPO itself. They acknowledged that many measures of OHRQoL exist but concentrated upon OHIP data.

Hence, there is little doubt that NSRCT improves patients' OHRQoL. However, OHIP and such instruments are not the only metrics for investigating OHRQoL. Patient satisfaction is also important (Dugas et al., 2002).Satisfaction may be defined as fulfillment of wishes, expectations, needs, or pleasure derived from a state or intervention. Indeed, Dugas et al described their Semantic

Differential Scale as measuring satisfaction rather than QoL. The terms QoL and satisfaction have sometimes been used synonymously. (Dugas et al., 2002).

Although much emphasis has been placed on the quantitative, aspects of QoL, several prior investigators have examined the qualitative, and others have measured satisfaction using simple questionnaires (Gatten et al., 2011)(Melgaço-Costa et al., 2016).Furthermore, life-impact and OHRQoL, like many psychosocial fields, have both qualitative and quantitative aspects; thus, mixed methods approaches are complimentary and necessary. For example, focus groups involve assembling small groups of participants to delve into discussions regarding oral health impact, allowing for interactive exploration of perceptions, experiences, and attitudes. Semi-Structured Qualitative Interviews (Gatten et al., 2011)(Maida et al., 2015)can provide a framework of questions while allowing flexibility for participants to elaborate on their experiences, perceptions, and challenges related to oral health impact.

These methods, among others, have been utilized in the assessment of the impact of oral health on individuals, aiming to capture nuanced perspectives and experiences that quantitative measures may not fully grasp. Despite being in their nascent stages with respect to understanding the impact of DoPO, these qualitative approaches offer valuable insights into the multifaceted nature of oral health's influence on individuals' lives.

Many important questions remain unanswered. Our overarching goal was to investigate the effects of disease of DoPO and subsequent NSRCT on QoL and patient satisfaction. A PICO format was used to develop specific questions.

POPULATION: Patients with DoPO, across countries and age groups.

INTERVENTION: NSRCT, across various techniques and provider types.

COMPARISON: Before and after treatment, across different time spans.

OUTCOME : OHRQoL instruments, satisfaction instruments and questionnaires, and qualitative measures, across different instruments, questions, and approaches.

The specific aims were, insofar as the extant literature allows, to:

- (1) To measure the impact of DoPO on OHRQoL, satisfaction, and life quality.
- (2) To identify the key domains by which DoPO has life-impact.
- (3) To measure the impact of NSRCT on OHRQoL, satisfaction, and life quality over time.

Materials and Methods

Inclusion criteria included comparative or non-comparative, cross-sectional, prospective, or retrospective, longitudinal quantitative or qualitative data related to quality of life or satisfaction related to DoPO and NSRCT from January 1, 1990, through June 6, 2022. Articles reviewed were published in English, in the refereed indexed literature, studied 10 or more people. The units of study were individuals in need of NSRCT or who had completed NSRCT. Clearly defined study measures, detailed descriptions of the sample size, treatments provided or not, and the time of any follow up(s) were required. PRISMA guidelines were followed. Where papers were not clear on methodology, authors were contacted to determine if the inclusion criteria were met, for clarification, or if additional unstated data were available.

Exclusion criteria consisted of studies that failed to meet above inclusion criteria. Life quality is a complex multifaceted concept, so data from studies that only reported on a single facet, e.g. pain, chewing, etc., were excluded. An Electronic search was performed in PubMed (Table 1).

Hand searching was extensively performed by two individuals with subject matter expertise, thorough citation mining of selected studies and prior systematic reviews. Guidance was provided by a reference librarian and an external subject matter expertise. Table of contents of Journal of Endodontics were hand searched. The PubMed search strategy was developed through an iterative process to best represent sentinel articles.(Table 1)

After title review and abstract selection, full-text articles were examined to verify that the inclusion criteria were met. Reasons for exclusion were identified; these included: outcomes not being specifically assessed; outcomes criteria not being well-defined or described; surgical procedures being studied, or secondary data, meta-analyses, non-original data. Included papers were reviewed and abstracted by two researchers. Study quality, methodology, design, and data analysis were assessed using the Wong Scale–Revised(Chiappelli et al., 2006) (Pak et al., 2012). An evidence table was created. Data were reviewed and verified to allow analysis through quantitative and qualitative synthesis, meta-analysis wherever possible, and L’Abbe plotting. Data were normalized from its different original scales to percentages.

Results

Life Impact Literature

Electronic searches identified 243 distinct titles. Hand searching did not identify any additional titles. From these, 68 abstracts were selected .From these abstracts, 28 papers were selected full which included 60 populations by datasets .(Table 2)

Character and Quality of the Literature

Most of the studies were recent ;12 of the papers were published within last 5 years , 20 in the last 10 years , and all but one was published after 2000 Table 2. The 28 included papers described populations in 18 countries. The included countries spanned the range of the WHO Human Development Index, but the majority of the countries represented were ranked in the mid- to-higher ranges of the HDI .The quality of all the included studies were rated as acceptable to high no studies were rejected in the basis of insufficient quality. (Table 2)

Heterogeneity and Potential Sources of Bias

Included authors used many different approaches and types of analyses to studying the life impact of disease of pulpal origin and its treatment. Most studies focused upon initial NSRCT, but secondary reNSRCT was studied in one paper (Khoo et al., 2020). One study examined patients who had been treatment planned for NSRCT, but who had not yet received treatment, describing the impact of DoPO, but not the impact of NSRCT (Wright et al., 2009). Sample sizes varied from 25 to 1323 individuals. Most studies were limited to adults, but 4 included individuals under 18 years of age. Intra-study comparisons included: before and after treatment; different NSRCT techniques; alternative treatments; types of providers and subject age.

QoL instruments Used

The OHIP-14 scale was used in 10 studies, with the OHIP-17 being used in 4 more studies. Most OHIP-based studies examined their data in terms of OHIP scores, one analyzed their data in terms of prevalence of high or low scores(Chew et al., 2019) . Some OHIP studies pooled high or low

score domains. Some OHIP data was reported in terms of a 1-5 scale, whereas others used 0-4 scales. Many authors translated or customized OHIP questions to accommodate their populations. Although many OHIP studies measured before and after treatment scores, some only included one or the other. Some OHIP-based studies reported overall OHIP summary scores; others reported data for each of the 7 individual domains within the OHIP-14 and -17 scales, and others reported data by the 14 or 17 individual questions.

Measures of quality of life other than OHIP were employed in some studies. de Almeida et al, 2021 utilized the Parent Caregiver Perceptions Questionnaire(de Almeida et al., 2021). Wright et al, utilized a modified version of the OH 1, 6, & 12 instrument (Wright et al., 2009). Tsisis et al and Jordan et al adapted the Shugars Questionnaire into modified versions referred to as the Simple Modified Questionnaire and the Modified Health-Related Quality of Life, respectively (Tsisis et al., 2005) (Jordan et al., 2009). Gatten et al and Melgaco-Costa et al utilized qualitative methods such as focus groups or semi-structured interviews in their studies (Gatten et al., 2011) (Melgaço-Costa et al., 2016).

Satisfaction Measures Used

Satisfaction was measured in 10 studies that included 18 populations Table 2. The Dugas Semantic Differential Scale , originally with 7 domains was used in 5 studies , but some authors added additional domains, and some dropped domains. Satisfaction was also measured in a variety of different ways using specific questions for post-treatment measurements.

Type of Life Impact of Disease of Pulpal Origin

The type of DoPO life impact encountered was revealed by the prevalence of the OHIP domains with the three highest ranked scores in each population studied. Physical pain, psychological discomfort, psychological disability, physical disability, handicap, and functional limitation were reported in 30/30, 27/30, 25/30, 3/30, 3/30, and 2/30 populations respectively as being among the 3 highest scoring domains. By this analysis, physical pain, psychological discomfort, and psychological disability were an order of magnitude more impactful than the other OHIP QoL domains which are related to physical disability, function, and handicap.

Severity of Life Impact of DoPO

The severity of the DoPO life impact was informed by pre-treatment quality of life measures in several different ways.

Datapoints on the diagonal line in the L'Abbe plot represent OHRQoL measures describing populations' that are suffering from untreated DoPO (Figure 1). This data indicated that the populations' average overall OHRQoL severity was located in the mid-to-lower ranges of the scales used. This does not necessarily indicate that the severity was perceived as being low by the subjects; but simply where it was rated within the instruments used.

All the datapoints based upon OHIP scores (black and blue dots) were located in the lower half of the OHIP scales. However, one study that rated on the prevalence of certain OHIP ratings (green dot) placed untreated DoPO as having a severity above the midpoint of its range (Chew et al, 2019). OHIP data (N=2125) gave a weighted average percentile score of 20%, SD, 9.4%, with

a range from 9% to 48% for untreated DoPO OHRQoL. This data are displayed by the blue and black datapoints on the diagonal line in the L'Abbe plot (Figure 1).

Datapoints based on instruments other than the OHIP (red dots) tended to rate the OHRQoL related to untreated DoPO as being severe than the OHIP instruments.

De Almedia et al used the Parental-Caregiver Perceptions Questionnaire and regression analysis to calculate rate ratios to determine that DoPO had a negative impact on OHRQoL and that NSRCT had a positive impact on OHRQoL (de Almeida et al., 2021).

Factors Influencing the Life Impact of DoPO

As described above, pain and psychological factor domains were rated as having severity. Data for the OHIP domains of pain, psychological discomfort, and psychological disability in 6 populations (N=583) with untreated DoPO is illustrated in the “before” bars of (Figure 2). These data indicated that that the average severity of the above three domains was squarely in their midranges, thus dominating the respective overall ratings (Figure 1).

Liu et al, 2014 analyzed 10 clinical factors in patients needing NSRCT that influence OHRQoL severity; most had a negligible differential effect on QoL, but a need for multiple NSRCTs was associated with a poorer OHRQoL.(Liu et al., 2014)

Jones et al, 2003 analyzed factors predictive of receipt of NSRCT, a surrogate for improved OHRQoL by avoidance of extraction. They used regression analysis to calculate odds ratios to determine that that medical comorbidity, schizophrenia, and alcohol dependence were associated with a decreased chance of receiving NSRCT. Thus, these variables are associated with a more severe impact of DoPO on OHRQoL.(Jones et al., 2003)

Magnitude of Life Impact of NSRCT through OHRQoL Instruments

The L'Abbe plot demonstrated that NSRCT had an overwhelmingly positive impact on OHRQoL (Figure 1). OHRQoL improved markedly for 17 of the 18 populations that had received before and after QoL measurements. The single population exception used an experimental instrument which was shown to have borderline sensitivity and has not been used in a publication since. The L'Abbe plot also indicated that most of the improvement in QoL occurred quickly in the days or weeks following treatment, with less change thereafter. The QoL improvements were sustained for the reported durations of the studies, as long as a couple of years.

Data from before and after NSRCT for the three key OHIP domains illustrated in(Figure 2) indicated that NSRCT had a profoundly positive impact on DSDS patient life satisfaction, in the domains of pain, psychological discomfort, and psychological disability.

Magnitude of Life Impact of NSRCT through the DSDS Satisfaction Instrument

Five studies, Alroudhan et al; Dugas et al; Hamsha et al ; Wigsten et al ; Wigsten et al , (N=1005) that used the Dugas Semantic Differential Scale, or its derivatives, demonstrated moderate-to-high levels of satisfaction across the domains of price, treatment time, pain experienced during treatment, esthetics, chewing ability, pleasantness, and overall satisfaction (Figure 3) (Alroudhan et al., 2021) (Dugas et al., 2002) (Hamasha & Hatiwsh, 2013)(Wigsten et al., 2020) (Wigsten et al., 2021). Overall or general satisfaction, a specific technical domain within the DSDS instrument, was consistently rated highly. Differences among types of providers (DDS-students, graduate students, specialists) within studies were generally smaller than differences in domains among studies.

Magnitude of Life Impact of NSRCT through Satisfaction Questionnaires

In addition to the DSDS satisfaction instrument, 4 studies asked their own satisfaction questions (Figure 4). Torabinejad et al, , used a questionnaire to reveal very high satisfaction levels (88-99%) that were sustained for the year-long duration of their study (Torabinejad et al., 2014). Dugas et al, 2002, reported that 97% of patients were satisfied with their decision to have NSRCT(Dugas et al., 2002). Gorduysus et al, 2020, found that 95% of patients were satisfied with their NSRCT at levels from average to very good. Lobb et al, 1996, reported that 92% of patients surveyed would choose to have a NSRCT again.(Görduysus & Görduysus, 2000)(Lobb Et Al., 1996)

Type and Magnitude of Life Impact of Impact of NSRCT through Qualitative Approaches

Gatten et al, used a focus group methodology to identify key patient-driven themes relating to the perception of NSRCT: cost, pleasure with the treatment, duration opening the mouth, satisfaction with treatment, peer influence in accepting treatment, minimal treatment pain and elimination of pain, that teeth are part of overall health, and it is important to keep them(Gatten et al., 2011).

Melgaco-Costa et al, 2016 used semi-structured interviews to assess patients' perceptions of access to, and quality of, NSRCT service. They found that dentists' courtesy, attentiveness, humanity, and information were at least as important as technical competence. Patients were generally satisfied, no longer in pain, and would recommend NSRCT to others, but negative views of NSRCT also existed.(Melgaço-Costa et al., 2016)

Comparisons to Other Interventions

Two studies compared NSRCT and dental implants (Gatten et al., 2011)(Torabinejad et al., 2014).One study indicated similar levels of satisfaction between NSRCT and dental implants (Gatten et al., 2011). The other study also showed that patients perceived both treatments with high degrees of satisfaction with minimal pain and complications (Torabinejad et al., 2014). In contrast, all three studies comparing NSRCT to extraction demonstrated a significantly positive impact of NSRCT on patients' outcomes when compared to extraction (Wigsten et al., 2021) (Wigsten et al., 2020)(Chew et al., 2019).

Discussion

This study expanded knowledge of the life impact of DoPO and its primary treatment, NSRCT. Health-related Quality of Life measurement is achieved by using a broader definition of life impact, broader inclusion criteria, identification of specific data sets and subsets, identification of specific outcome domains and sub-domains, normalization of disparate scoring and ratings systems, and novel analyses.

The OHIP-14 and OHIP-17 instruments derive from a longer instrument, the OHIP-49 which was derived, as most such instruments are, from a conceptual framework, not from direct patient report. The OHIP-14 which has been well-validated has just 14 questions in 7 domains or conceptual dimensions (Campos et al., 2021). The data in this current study highlighted the importance of three key domains: physical pain, psychological discomfort, psychological disability, comprising of just seven questions. It is possible that a 3-domain, 7-question instrument, based on actual subject expression, might be easier to use, and be more discriminatory than the

current 7-domain 14-question version when evaluating DoPO and NSRCT. But comparisons to some prior studies that did not report data by question would be precluded.

Endodontic prognostic or outcomes instruments such as the Stringberg Criteria or the Orstavik Periapical Index have been appropriately criticized as being meaningful to dentists monitoring periradicular healing, but not to patients who chose, undergo, and live with the consequences of NSRCT. Likewise, most of the instruments used to measure OHRQoL are derived from conceptual frameworks, rather than being derived from patient expression. Thus, qualitative methods for evaluating patients' expression of their feelings regarding DoPO and NSRCT are critically important, but all too rare. Selective use of the OHIP domains that are demonstrated to be relevant to the patient experience, and/or adding domains directly informed by patients, have the potential to create more relevant tools.

Dentists are well-equipped and accustomed to measuring and managing patient pain; however, dentists receive minimal, if any, training in assessing and measuring psychological discomfort, and disability beyond making and considering a brief social history. Yet, DoPO and NSRCT have a profound impact on psychological dimensions.

It was found that the OHIP instruments were used in different creative ways by different investigators. Some pooled score ranges, dichotomizing or trichotomizing its 5-point scale; others reported on the prevalence of certain scores, others only reported overall summary data; and others reported differences between before and after scores, not the actual scores. Verbiage was customized or translated to suit different populations. Likewise, the Dugas Semantic Differential Scale was used in different ways by different investigators, with some domains being dropped, or

additional ones added, or verbiage edited. To enable meta-analysis, it is recommended that uniformity be used, and that all domain and sub-domain scores be published.

Questions about buyer or user satisfaction are commonly used by commercial vendors or service providers. These questions are no less important when evaluating health interventions. Questions regarding patients' satisfaction with their decisions to have NSRCT, and whether they would choose to have NSRCT again, received extremely high ratings that would be the envy of any car manufacturer or commercial service provider.

It is probably unwise to make detailed comparisons or conclusions upon the DSDS satisfaction findings illustrated in (Figure 3). However, it appears that care by specialists may be associated with more satisfaction than that provided by dental students.

All of the data presented in this systematic review must be considered in the context, norms, and expectations inherent to its original study population and the investigators. For example, satisfaction with price or cost, as measured in the DSDS should be considered in the context of the payer(s), patient or third party, or shared (Figure 3). Likewise, the limitations of the extant literature must be appreciated (Antunes et al., 2018)(Leong & Yap, 2020)(Neelakantan et al., 2020). Nonetheless, clear and substantive patterns and trends are evident among all the types of data presented herein.

Limitations

This systematic review is de-facto limited to the adequacy of methodological approaches present in the extant literature. The absence of controlled trials or standardized interventions in some studies limits the ability to draw direct causative inference between NSRCT and improvements in

QoL. Studies conducted in different languages or in the context of cultures and expectations might have nuances that affect the interpretation of QoL or satisfaction outcomes. In this study, a conscious decision was made to use broad inclusion criteria. This resulted in several fold more studies and populations, with increased diversity in approaches, methodologies, and populations, being included than in any previous systematic review. Thus, our sample sizes were much bigger than previous attempts, and for the first time, simple meta-analyses were possible, and the findings broadly generalizable. However, the cost to our approach was decreased precision.

Conclusions

- (1) Disease of pulpal origin was generally of low-to-moderate life-impact when measured by OHIP-14 and -7 instruments, but other instruments tended to indicate a higher life-impact.
- (2) Disease of pulpal origin overwhelmingly impacted the domains of physical pain, psychological discomfort, and psychological disability, whereas the domains of functional limitation, physical disability, social disability were considerably less impacted.
- (3) Non-surgical root canal treatment provided substantial improvement in life quality when measured by change in oral health-related instruments, such as the OHIP, when measured using the Dugas Semantic Differential Scale, by simple satisfaction questions, and by qualitative methods.
- (4) Most of the positive impact of NSRCT was discerned in days or weeks following treatment, and the impact was sustained through all time periods measured, up to 2 years.

Recommendations

- (1) Future studies will need to use standard instruments, or at least components of standard instruments.
- (2) Future studies will also need to present all the domain and sub-domain data, and use multiple approaches, including the qualitative exploration of patient experience.
- (3) To enable meta-analysis, uniformity will need to be used, so that all domain and sub-domain scores of whatever instruments used can be published.
- (4) Future studies will need to employ multiple approaches, including the qualitative exploration of patient experience.
- (5) Future studies can explore and compare diverse populations, e.g. rural and urban, wealthy, and fiscally disadvantaged, etc.

Table 1 Search Strategy

"Quality of Life"[Mesh] OR "Patient Satisfaction"[Mesh] OR OHRQoL OR OQOL OR Oral-Health-Related-Quality-of-Life OR "Oral Health Impact Profile" OR OHIP OR QOL OR SF-36 OR SF-12 OR SF-9 OR EUROQOL OR EQ-5d OR WHOQOL OR AQOL OR Health-Related-Quality-of-Life
AND
"Endodontics"[Mesh] OR "Root Canal Therap*" OR "Root Canal Treatment*" OR "Endodontic Treatment*" OR "Endodontic Therap*" OR "Endodontic retreatment*" OR "endodontic care" OR "Root Canal retreatment*" OR "Dental Pulp Diseases"[Mesh] OR "Periapical Abscess"[Mesh] OR "Tooth, Nonvital"[Mesh]
NOT
Surgery OR Surgeries

Table 2 Evidence table

Author(s)	Year	Country	Focus of Study	Cross-Sectional	Longitudinal	Other Characteristics	Quality Rating (0-27)	Sample Description	Sample Size, N	Comparisons made	Interventions	Subgroup	QoL Measure	QoL Type	QoL Instruments used	QoL Baseline	QoL AlterTx	Overall Domain Score	OHP Scores	OHP Domains	Most Impacted OHP BASELINE Domains	Satisfactoriness on Measure (6)	Satisfactoriness on Instrument	Satisfactoriness on Treatment			
Alroufhan et al	2021	Saudi Arabia	NSRCT	No	Yes	Prospective	23	NSRCT Patients	18-60	250	Yes	NSRCT by DDS- DSDS	96	Yes score	OHP-17	Yes	2W	Yes	Yes	PP, PHD, H	Yes (6)	Yes (6)	No	2W			
Chew et al	2019	Australia	NSRCT	No	Yes	Prospective	23	Electoral Roll	30-61	285	Yes	NSRCT by specialist Had NSRCT Dign/Taste NSRCT Had extraction Had denture	81 263 45 203	Yes score Yes Yes Yes	OHP-17 SROHS, GTS	Yes	1Y	No	No	PP, FL, H NA NA	No	No	NA	NA			
Dagher et al	2019	Beirut	NSRCT	No	Yes	RCT	20	NSRCT Patients	19-73	56	Yes	PIPS Irrigation Comprehensive care	31 60 12	Yes score Yes score Yes score	VAS	No	1D, 2D, 3D, 7D	No	No	NA	No	No	No	No			
De Almeida et al	2021	Brazil	NSRCT	No	Yes	Prospective	25	ASD Patients	16-14	115	No	Comprehensive care	60	Yes score	P-DQ	Yes	3 M	No	No	NA	No	NA	No	No	No		
Diniz-de-Figueiredo et al	2020	Brazil	NSRCT	No	Yes	RCT	25	NSRCT Patients	>18	120	Yes	Manual Reciprocal subject's teeth Single visit multiple visit	17 16 16 16	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	6, 12M within 1 Y Immediately During &	Yes No Yes Yes	6, 12M PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes (7)	Yes No Yes	No No No	No No No	No No No			
Dugas et al	2021	Canada	NSRCT	Yes	Yes	Cross sectional Controlled clinical	25	NSRCT Patients	15-60	31	Yes	NSRCT Irrigation Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-17 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	>1Y >1Y Immediately 2 W	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	No No No No	No No No No			
Ezzat et al	2021	Saudi Arabia	NSRCT	Yes	Yes	Retrospective	19	NSRCT Patients	>18Y	48	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	>1Y Immediately 2 W	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No No No	Yes No No No		
Gattien et al	2011	USA	NSRCT	Yes	No	Retrospective	19	NSRCT Patients	>18Y	48	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	>1Y Immediately 2 W	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No No No	Yes No No No		
Gözüyus et al	2020	Turkey	NSRCT	No	No	Prospective	19	NSRCT Patients	>11	200	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	Immediately 2 W	No Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No No No	No No No No		
Hamesta et al	2023	Jordan	NSRCT	No	Yes	Prospective	25	NSRCT Patients	18-60	308	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	Immediately 2 W	No Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No Yes Yes	Yes No No No	No No No No		
He et al	2017	USA	NSRCT	No	Yes	Cohort	24	NSRCT Patients	18-80	63	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	6, 12, 24M	Yes No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No		
Jordan et al	2009	Gambia	NSRCT	No	Yes	Pilot	25	NSRCT Patients	16-45	25	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	6, 12 M	No No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No		
Khoo et al	2020	Singapore	NSRCT	Yes	No	Retrospective	25	NSRCT & Surgery	>21	150	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	6-24M	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No		
Lobb et al	1996	USA	NSRCT	Yes	No	Cohort	24	NSRCT Patients	>18	165	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	1, 2 Y	No Yes Yes Yes	NA PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	Yes No No No	NA Yes No No	Yes No No No	Yes No No No	No No No No	No No No No	No No No No	
Liu, P et al	2012	China	NSRCT	Yes	No	Case control	23	NSRCT Patients	>18	200	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	No Yes Yes Yes	1 yr	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No	NA Yes No No	Yes No No No	Yes No No No	No No No No	No No No No	No No No No	
Liu, P et al	2013	China	Endobomic	No	Yes	Retrospective	20	NSRCT Required, Single NSRCT Required, moders NSRCT Required, not Re-NSRCT Required Initial NSRCT Required NSRCT Required, PAI <3 NSRCT Required, PAI >3 NSRCT Required, abcess NSRCT Required, no	>18 >18 >18 >18 >18 >18 >18	412 412 261 261 351 271 35 340	No No No No No No No	None None None None None None None	64 64 261 261 351 271 35 340	Yes Yes Yes Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes Yes Yes Yes	No No No No No No No	No No No No No No No	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No No No No	Yes No No No No No No	Yes No No No No No No	Yes No No No No No No	No No No No No No No	No No No No No No No	No No No No No No No	
Liu, P et al	2014	China	NSRCT	Yes	Yes	Cross sectional	25	NSRCT Patients	>18	279	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	1, 6M	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	
Mandras et al	2020	Italy	NSRCT	No	Yes	RCT	23	NSRCT Patients	>18	54	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14 OHP-14 OHP-14 OHP-14	Yes Yes Yes Yes	7D	No Yes Yes Yes	NA NA NA NA	No No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	
Mégaro-Costa et al	2016	Brazil	NSRCT	Yes	No	Qualitative	21	NSRCT Patients	18-75	10	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	No Yes Yes Yes	SAQ	No	Immediately	No Yes Yes Yes	NA NA NA NA	No Yes Yes Yes	NA NA NA NA	No Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes
Montero et al	2015	Spain	Pulpal	No	Yes	Prospective	26	NSRCT Patients	>18	250	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14	No	No	Yes Yes Yes Yes	PP, PSD, PHD PP, PSD, PHD PP, PSD, PHD PP, PSD, PHD	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes	
Pasquini, D et al	2016	Italy	NSRCT	No	Yes	RCT	24	NSRCT Patients	>18	47	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	POCOL, VAS	Yes	7D	No No No No	NA NA NA NA	No No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	
Torabnejad et al	2014	USA	NSRCT	No	Yes	Prospective	24	NSRCT patients	>18	48	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	No Yes Yes Yes	Interview, OA	Yes	7D, 3M, 6M, 12M	No No No No	NA NA NA NA	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No
Tessis, Igore et al	2005	Israel	Surg Endo	No	Yes	Prospective	23	NSRCT Patients	>18	66	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OA	Yes	7D, 3M, 6M, 12M	No No No No	NA NA NA NA	No No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	
Vena et al	2014	USA	NSRCT	Yes	No	Cross sectional	21	NSRCT Patients	>14	1333	No	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14	No	3-5Y	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	
Wigsten et al	2000	Sweden	NSRCT	No	Yes	Cohort-Control	21	NSRCT or Extraction	>18	85	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14, EQVAS, EQ	No	2D, 1 M	Yes Yes Yes Yes	NA NA NA NA	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	
Wigsten et al	2021	Sweden	NSRCT, percepti	No	Yes	Cohort	22	NSRCT	>18	248	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	No Yes Yes Yes	VAS, O48 items	No	1-3Y	No No No No	NA NA NA NA	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	Yes No No No	
Wright et al	2009	USA	Instrument	No	Yes	Self assessed	26	NSRCT Patients	>18	63	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	new O48, OHTOOL	Yes	3M	No No No No	NA NA NA NA	No No No No	NA NA NA NA	No No No No	No No No No	No No No No	No No No No	No No No No	
Zafinklatte-Petrusiani et al	2021	Norway	NSRCT, NSRCT	No	Yes	NA	25	NSRCT Patients	18-64	150	Yes	NSRCT Ulig(2) Graduate(4) specialists(3)	24 24 200 201	Yes Yes Yes Yes	OHP-14	Yes	No	Yes Yes Yes Yes	PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy PP, PSD, PSDy	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	No No No No	

(Alroudhan et al., 2021; Chew et al., 2019; Dagher et al., 2019; de Almeida et al., 2021; Diniz-de-Figueredo et al., 2020; Dugas et al., 2002; Ezzat et al., 2021; Gatten et al., 2011; Görduysus & Görduysus, 2000; Hamasha & Hatwsh, 2013; He et al., 2017; Jordan et al., 2009; Khoo et al., 2020; Liu et al., 2012, 2014b, 2014a; LOBB et al., 1996; Mandras et al., 2020; Melgaço-Costa et al., 2016; Montero et al., 2015; Pasqualini et al., 2016; Torabinejad et al., 2014; Tsesis et al., 2005; Vena et al., 2014; Wigsten et al., 2020, 2021; Wright et al., 2009; Zilinskaite-Petrauskiene & Haug, 2021)

Key to abbreviations in Evidence Table:

OHIP	Oral health index profile
QA	Questionnaire
VAS	Visual analogue scale
DSDS	Dugas Semantic Differential Scale
B	Baseline
H	Hours
D	Days
M	Months
Y	Years
Tx	Treatment
SSIQ	Semi-structured interview questions
RCT	Randomized Controlled Trial
NSRCT	Non-surgical root canal treatment
NSRCTRe	Re-Non-surgical root canal treatment
DSDS	Dugas Schematic Differential Scale
R	Radiograph

SRDHS	Self rated dental health score
SAQ	Self-assessment questionnaire
GTSC	Global transition statement of change
P-CPQ	Parental caregiver perceptions questionnaire
POQOL	Post operative quality of life
PP	Physical pain
PsDt	Psychological discomfort
PhD	Physical disability
Pssy	Psychological disability
H	Handicap
EPPQ	Endodontic Patient Profile Questionnaire

Figure 1. L'Abbe plot of OHIP and other OHRQoL instruments, showing change from before to after NSRCT, with follow up times. All data was normalized to a percentage scale. The data points on the diagonal line indicate initial baseline data before NSRCT. Post-NSRCT data point that showed improvement in OHRQoL fell below the diagonal line.

L'Abbe Plot of OHRQoL Data

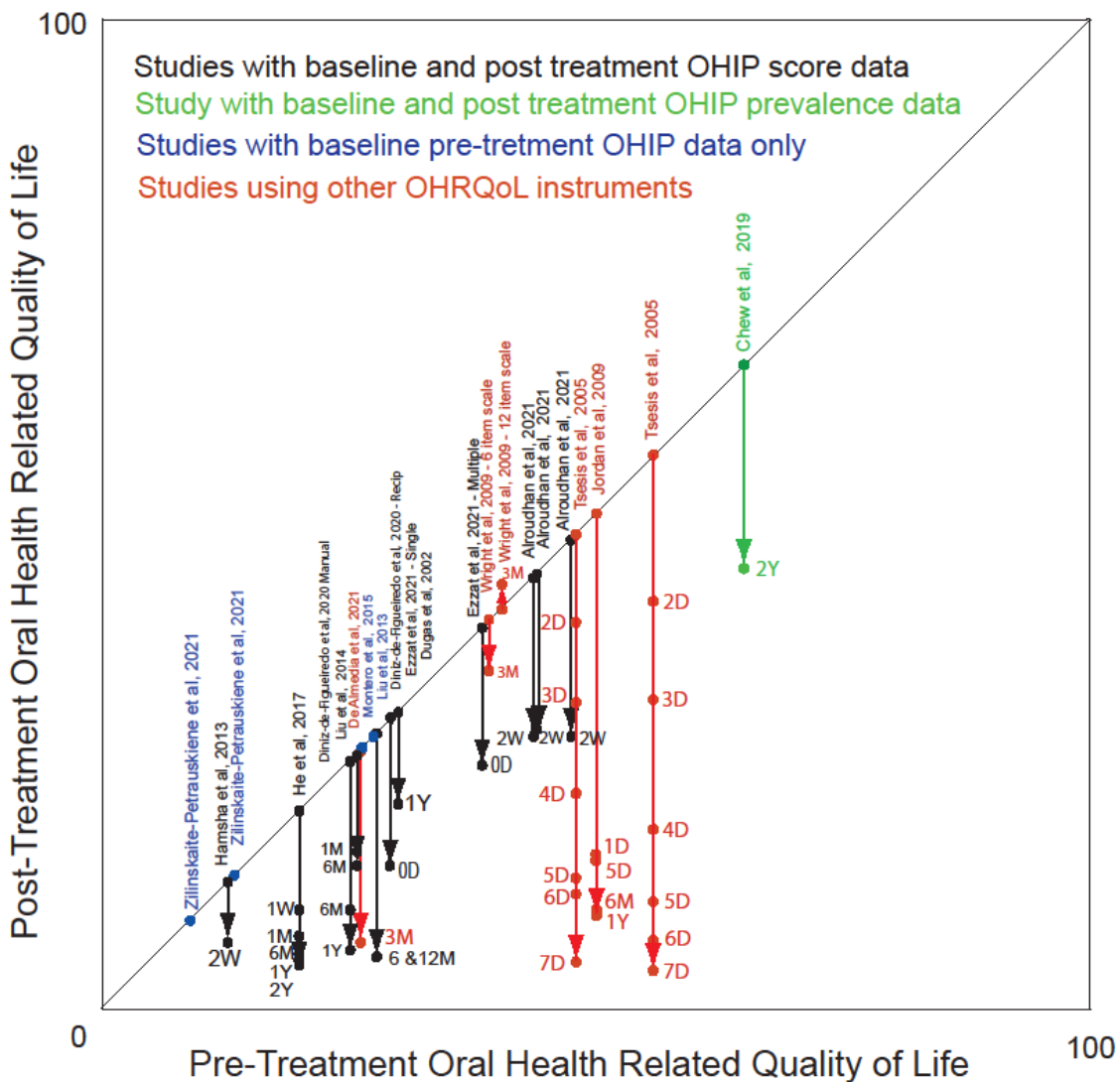


Figure 1 L'Abbe Plot of OHIP and other instruments

Figure 2. Changes in 3 key OHIP domains before and after NSRCT for 6 populations from Diniz-de-Figueiredo et al, year; Alroudhan et al, year; and Liu et al, 2014, weighted averages and standard deviations, N = 583. All data was normalized to a percentage scale. The “before” data is indicative of the impact of disease of pulpal origin on life satisfaction on a key domain. The difference between the “before” and “after” data is indicative of the impact of NSRCT on life impact.

Change in Key OHIP Domains Before and After NSRCT

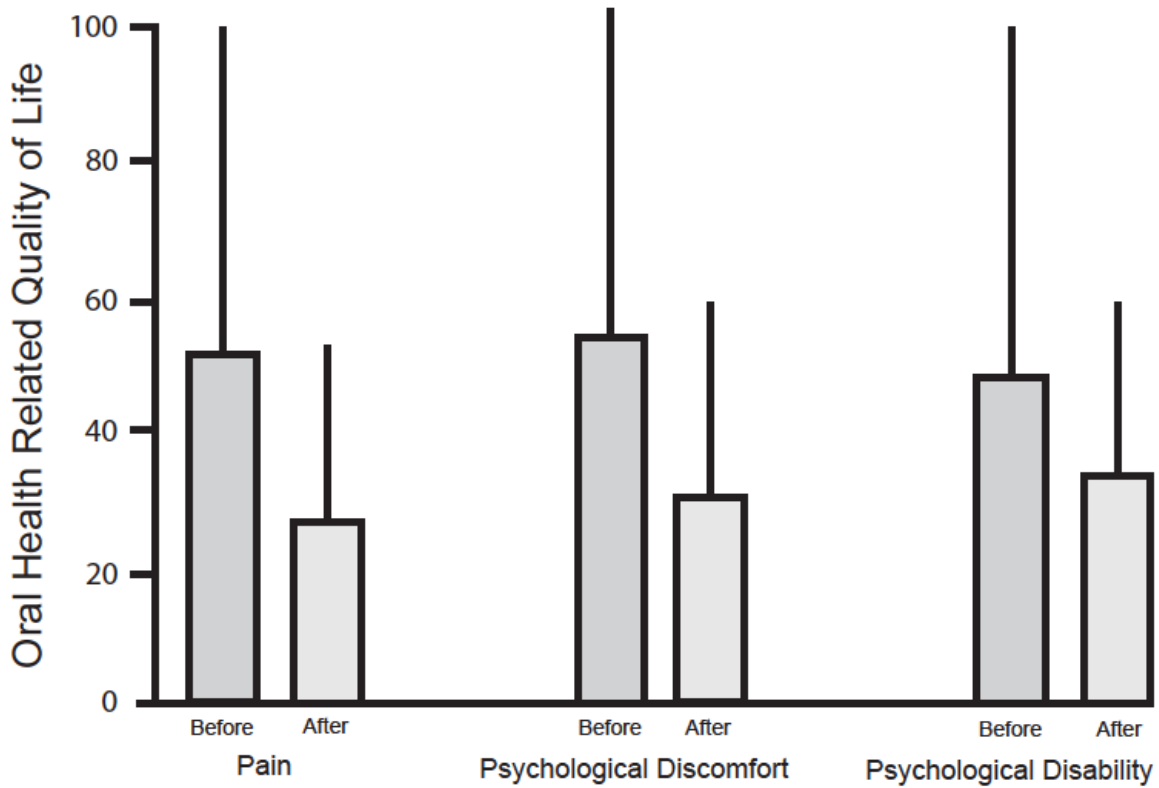


Figure 2 Changes in 3 Key OHIP Domains Before and After NSRCT

Figure 3. Satisfaction with NSRCT as measured using the Dugas Semantic Differential Scale.

All data was normalized to a percentage scale. Investigators have modified the scale by adding to or dropping from the original 7 domains. Two studies did sub-analyses by provider type, U = undergraduate dental student, G = graduate student, and S = specialist

NSRCT Satisfaction, Dugas Semantic Differential Scale

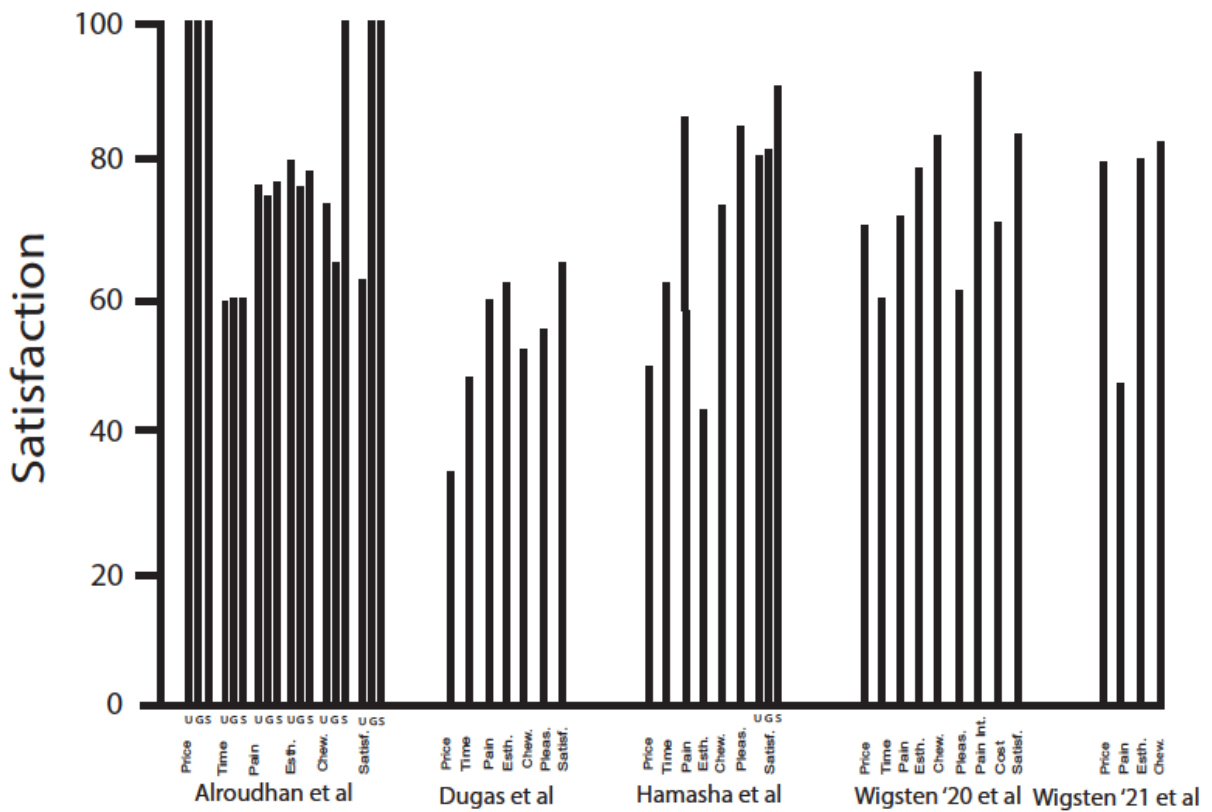


Figure 3 Satisfaction with NSRCT using DSDDS

Figure 4. Satisfaction by the survey questions asked. All data was normalized to a percentage scale.

NSRCT Satisfaction by Question Asked

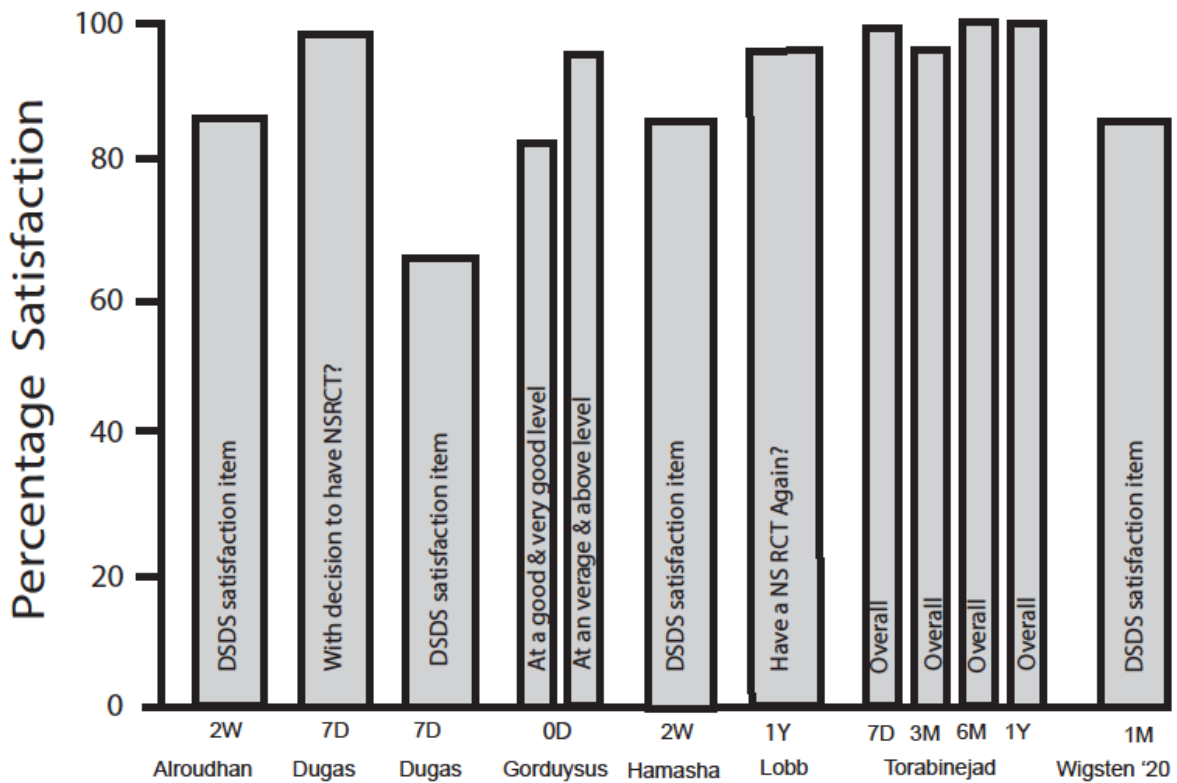


Figure 4 Satisfaction by survey question

References, Text Only

- Alroudhan, I. E., Ravi, J., Magar, S. S., Alam, M. K., Alsharari, K. N., & Alsharari, F. M. (2021). Oral health-related quality of life and satisfaction after root canal treatment according to operator expertise: A longitudinal prospective study. In *Saudi Endodontic Journal* (Vol. 11, Issue 3, pp. 388–392). Wolters Kluwer Medknow Publications.
https://doi.org/10.4103/sej.sej_291_20
- Antunes, L. S., Souza, C. R., Salles, A. G., Gomes, C. C., & Antunes, L. A. (2018). Does Conventional Endodontic Treatment Impact Oral Health-related Quality of Life? A Systematic Review. *European Endodontic Journal*, 3(1), 2–8.
<https://doi.org/10.5152/eej.2017.17008>
- Azarpazhooh, A., Sgro, A., Cardoso, E., Elbarbary, M., Laghapour Lighvan, N., Badewy, R., Malkhassian, G., Jafarzadeh, H., Bakhtiar, H., Khazaei, S., Oren, A., Gerbig, M., He, H., Kishen, A., & Shah, P. S. (2022). A Scoping Review of 4 Decades of Outcomes in Nonsurgical Root Canal Treatment, Nonsurgical Retreatment, and Apexification Studies- Part 2: Outcome Measures. *Journal of Endodontics*, 48(1), 29–39.
<https://doi.org/10.1016/j.joen.2021.09.019>
- Brondani, B., Emmanuelli, B., Alves, L. S., Soares, C. J., & Ardenghi, T. M. (2018). The effect of dental treatment on oral health-related quality of life in adolescents. *Clinical Oral Investigations*, 22(6), 2291–2297. <https://doi.org/10.1007/s00784-017-2328-3>
- Campos, L. A., Peltomäki, T., Marôco, J., & Campos, J. A. D. B. (2021). Use of Oral Health Impact Profile-14 (OHIP-14) in Different Contexts. What Is Being Measured? *International*

Chew, T., Brennan, D., & Rossi-Fedele, G. (2019). Comparative Longitudinal Study on the Impact Root Canal Treatment and Other Dental Services Have on Oral Health–related Quality of Life Using Self-reported Health Measures (Oral Health Impact Profile-14 and Global Health Measures). *Journal of Endodontics*, 45(8), 985-993.e1.

<https://doi.org/10.1016/j.joen.2019.05.002>

Chiappelli, F., Navarro, A. M., Moradi, D. R., Manfrini, E., & Prolo, P. (2006). Evidence-Based Research in Complementary and Alternative Medicine III: Treatment of Patients with Alzheimer’s Disease. *Evidence-Based Complementary and Alternative Medicine : ECAM*, 3(4), 411–424. <https://doi.org/10.1093/ecam/nel072>

Dagher, J., El Feghali, R., Parker, S., Benedicenti, S., & Zogheib, C. (2019). Postoperative Quality of Life Following Conventional Endodontic Intracanal Irrigation Compared with Laser-Activated Irrigation: A Randomized Clinical Study. *Photobiomodulation, Photomedicine, and Laser Surgery*, 37(4), 248–253.

<https://doi.org/10.1089/photob.2018.4558>

de Almeida, J. S., Fernandes, R. F., Andrade, Á. C. B., Almeida, B. da C., Amorim, A. N. da S., Lustosa, J. H. da C. M., Mendes, R. F., & Prado Júnior, R. R. (2021). Impact of dental treatment on the oral health-related quality of life of children and adolescents with Autism Spectrum Disorder. *Special Care in Dentistry*, 41(6), 658–669.

related quality of life: a randomized controlled pragmatic clinical trial. *International Endodontic Journal*, 53(10), 1327–1338. <https://doi.org/10.1111/iej.13356>

- Dugas, N. N., Lawrence, H. P., Teplitsky, P., & Friedman, S. (2002). Quality of life and satisfaction outcomes of endodontic treatment. *Journal of Endodontics*, 28(12), 819–827. <https://doi.org/10.1097/00004770-200212000-00007>
- Gatten, D. L., Riedy, C. A., Hong, S. K., Johnson, J. D., & Cohenca, N. (2011). Quality of life of endodontically treated versus implant treated patients: a University-based qualitative research study. *Journal of Endodontics*, 37(7), 903–909. <https://doi.org/10.1016/j.joen.2011.03.026>
- Görduysus, M. Ö., & Görduysus, M. (2000). Endodontic patient profile of Hacettepe University, Faculty of Dentistry in Ankara, Turkey. *International Dental Journal*, 50(5), 274–278. <https://doi.org/10.1111/j.1875-595X.2000.tb00565.x>
- Gulabivala, K., & Ng, Y.-L. (2019). Value of root-filled teeth in maintaining a functional dentition for life. *British Dental Journal*, 226(10), 769–784. <https://doi.org/10.1038/s41415-019-0313-8>
- Hamasha, A. A., & Hatiwsh, A. (2013). Quality of life and satisfaction of patients after nonsurgical primary root canal treatment provided by undergraduate students, graduate students and endodontic specialists. *International Endodontic Journal*, 46(12), 1131–1139. <https://doi.org/10.1111/iej.12106>
- Hamedy, R., Shakiba, B., Fayazi, S., Pak, J. G., & White, S. N. (2013). Patient-centered endodontic outcomes: a narrative review. *Iranian Endodontic Journal*, 8(4), 197–204.
- Hennessy, C. H., Moriarty, D. G., Zack, M. M., Scherr, P. A., & Brackbill, R. (1994). Measuring health-related quality of life for public health surveillance. *Public Health Reports (Washington, D.C. : 1974)*, 109(5), 665–672.

- Jones, J. A., Boehmer, U., Berlowitz, D. R., Christiansen, C. L., Pitman, A., & Kressin, N. R. (2003). Tooth retention as an indicator of quality dental care: development of a risk adjustment model. *Medical Care*, *41*(8), 937–949. <https://doi.org/10.1097/00005650-200308000-00007>
- Jordan, R. A., Markovic, L., Holzner, A. L., Richter, B., & Gaengler, P. (2009). Development of a Basic Root canal Treatment (BRT) for primary oral health care-evaluation after one year. *International Dental Journal*, *59*, 141–147. https://doi.org/10.1922/IDJ_2082
Jordan07
- Khan, S., Hamedy, R., Lei, Y., Ogawa, R. S., & White, S. N. (2016). Anxiety Related to Nonsurgical Root Canal Treatment: A Systematic Review. *Journal of Endodontics*, *42*(12), 1726–1736. <https://doi.org/10.1016/j.joen.2016.08.007>
- Khoo, S.-T., Ode, W., Lopez, V., Yu, V. S. H., Lai, C., & Lui, J.-N. (2020). Factors Influencing Quality of Life after Surgical and Nonsurgical Interventions of Persistent Endodontic Disease. *Journal of Endodontics*, *46*(12), 1832–1840.
<https://doi.org/10.1016/j.joen.2020.08.020>
- Leong, D. J. X., & Yap, A. U.-J. (2020). Quality of life of patients with endodontically treated teeth: A systematic review. *Australian Endodontic Journal : The Journal of the Australian Society of Endodontology Inc*, *46*(1), 130–139. <https://doi.org/10.1111/aej.12372>
- Liu, P., McGrath, C., & Cheung, G. (2014a). What are the key endodontic factors associated with oral health–related quality of life? *International Endodontic Journal*, *47*(3), 238–245. <https://doi.org/10.1111/iej.12139>

- Lobb, W. K., Zakariassen, K. L., & Mcgrath, P. J. (1996). Endodontic Treatment Outcomes: Do Patients Perceive Problems? *The Journal of the American Dental Association*, *127*(5), 597–600. <https://doi.org/10.14219/jada.archive.1996.0271>
- Locker, D. (1988). Measuring oral health: a conceptual framework. *Community Dental Health*, *5*(1), 3–18.
- Maida, C. A., Marcus, M., Hays, R. D., Coulter, I. D., Ramos-Gomez, F., Lee, S. Y., McClory, P. S., Van, L. V., Wang, Y., Shen, J., Cai, L., Spolsky, V. W., Crall, J. J., & Liu, H. (2015). Child and adolescent perceptions of oral health over the life course. *Quality of Life Research*, *24*(11), 2739–2751. <https://doi.org/10.1007/s11136-015-1015-6>
- Mandras, N., Pasqualini, D., Roana, J., Tullio, V., Banche, G., Gianello, E., Bonino, F., Cuffini, A. M., Berutti, E., & Alovise, M. (2020). Influence of Photon-Induced Photoacoustic Streaming (PIPS) on Root Canal Disinfection and Post-Operative Pain: A Randomized Clinical Trial. *Journal of Clinical Medicine*, *9*(12), 3915. <https://doi.org/10.3390/jcm9123915>
- Melgaço-Costa, J. L. B., Martins, R. C., Ferreira, E. F., & Sobrinho, A. P. R. (2016). Patients' Perceptions of Endodontic Treatment as Part of Public Health Services: A Qualitative Study. *International Journal of Environmental Research and Public Health*, *13*(5). <https://doi.org/10.3390/ijerph13050450>
- Neelakantan, P., Liu, P., Dummer, P. M. H., & McGrath, C. (2020). Oral health-related quality of life (OHRQoL) before and after endodontic treatment: a systematic review. *Clinical Oral Investigations*, *24*(1), 25–36. <https://doi.org/10.1007/s00784-019-03076-8>

- Pak, J. G., Fayazi, S., & White, S. N. (2012). Prevalence of periapical radiolucency and root canal treatment: a systematic review of cross-sectional studies. *Journal of Endodontics*, *38*(9), 1170–1176. <https://doi.org/10.1016/j.joen.2012.05.023>
- Pak, J. G., & White, S. N. (2011). Pain prevalence and severity before, during, and after root canal treatment: a systematic review. *Journal of Endodontics*, *37*(4), 429–438. <https://doi.org/10.1016/j.joen.2010.12.016>
- Sischo, L., & Broder, H. L. (2011). Oral health-related quality of life: what, why, how, and future implications. *Journal of Dental Research*, *90*(11), 1264–1270. <https://doi.org/10.1177/0022034511399918>
- Steele, J. G., Sanders, A. E., Slade, G. D., Allen, P. F., Lahti, S., Nuttall, N., & Spencer, A. J. (2004). How do age and tooth loss affect oral health impacts and quality of life? A study comparing two national samples. *Community Dentistry and Oral Epidemiology*, *32*(2), 107–114. <https://doi.org/10.1111/j.0301-5661.2004.00131.x>
- Torabinejad, M., Salha, W., Lozada, J. L., Hung, Y.-L., & Garbacea, A. (2014). Degree of Patient Pain, Complications, and Satisfaction after Root Canal Treatment or a Single Implant: A Preliminary Prospective Investigation. *Journal of Endodontics*, *40*(12), 1940–1945. <https://doi.org/10.1016/j.joen.2014.08.022>
- Tsesis, I., Shoshani, Y., Givol, N., Yahalom, R., Fuss, Z., & Taicher, S. (2005). Comparison of quality of life after surgical endodontic treatment using two techniques: A prospective study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*, *99*(3),

Wigsten, E., Al Hajj, A., Jonasson, P., & Kvist, T. (2021). Patient satisfaction with root canal treatment and outcomes in the Swedish public dental health service: A prospective cohort study. *International Endodontic Journal*, 54(9), 1462–1472.

<https://doi.org/10.1111/iej.13548>

Wigsten, E., Kvist, T., Jonasson, P., Bjørndal, L., Dawson, V. S., Fransson, H., Frisk, F., Markvart, M., Pigg, M., Wolf, E., & Davidson, T. (2020). Comparing Quality of Life of Patients Undergoing Root Canal Treatment or Tooth Extraction. *Journal of Endodontics*, 46(1), 19-28.e1. <https://doi.org/10.1016/j.joen.2019.10.012>

Wright, W. G., Jones, J. A., Spiro III, A., Rich, S. E., & Kressin, N. R. (2009). Use of Patient Self-Report Oral Health Outcome Measures in Assessment of Dental Treatment Outcomes.

Journal of Public Health Dentistry, 69(2), 95–103. [https://doi.org/10.1111/j.1752-](https://doi.org/10.1111/j.1752-7325.2008.00106.x)

[7325.2008.00106.x](https://doi.org/10.1111/j.1752-7325.2008.00106.x)

References, Papers Included in the Evidence Table

- Alroudhan, I. E., Ravi, J., Magar, S. S., Alam, M. K., Alsharari, K. N., & Alsharari, F. M. (2021). Oral health-related quality of life and satisfaction after root canal treatment according to operator expertise: A longitudinal prospective study. In *Saudi Endodontic Journal* (Vol. 11, Issue 3, pp. 388–392). Wolters Kluwer Medknow Publications.
https://doi.org/10.4103/sej.sej_291_20
- Chew, T., Brennan, D., & Rossi-Fedele, G. (2019). Comparative Longitudinal Study on the Impact Root Canal Treatment and Other Dental Services Have on Oral Health–related Quality of Life Using Self-reported Health Measures (Oral Health Impact Profile-14 and Global Health Measures). *Journal of Endodontics*, *45*(8), 985-993.e1.
<https://doi.org/10.1016/j.joen.2019.05.002>
- de Almeida, J. S., Fernandes, R. F., Andrade, Á. C. B., Almeida, B. da C., Amorim, A. N. da S., Lustosa, J. H. da C. M., Mendes, R. F., & Prado Júnior, R. R. (2021). Impact of dental treatment on the oral health-related quality of life of children and adolescents with Autism Spectrum Disorder. *Special Care in Dentistry*, *41*(6), 658–669.
<https://doi.org/10.1111/scd.12618>
- Diniz-de-Figueiredo, F. E., Lima, L. F., Oliveira, L. S., Bernardino, I. M., Paiva, S. M., & Faria-e-Silva, A. L. (2020). The impact of two root canal treatment protocols on the oral health-related quality of life: a randomized controlled pragmatic clinical trial. *International Endodontic Journal*, *53*(10), 1327–1338. <https://doi.org/10.1111/iej.13356>

- Dugas, N. N., Lawrence, H. P., Teplitsky, P., & Friedman, S. (2002). Quality of life and satisfaction outcomes of endodontic treatment. *Journal of Endodontics*, 28(12), 819–827.
<https://doi.org/10.1097/00004770-200212000-00007>
- Ezzat, A., Nagro, A., Fawzy, A., & Bukhari, O. (2021). The effect of root canal treatment on oral health-related quality of life: Clinical trial. *Saudi Endodontic Journal*, 11(3), 334.
https://doi.org/10.4103/sej.sej_148_20
- Gatten, D. L., Riedy, C. A., Hong, S. K., Johnson, J. D., & Cohenca, N. (2011). Quality of life of endodontically treated versus implant treated patients: a University-based qualitative research study. *Journal of Endodontics*, 37(7), 903–909.
<https://doi.org/10.1016/j.joen.2011.03.026>
- Görduysus, M. Ö., & Görduysus, M. (2000). Endodontic patient profile of Hacettepe University, Faculty of Dentistry in Ankara, Turkey. *International Dental Journal*, 50(5), 274–278.
<https://doi.org/10.1111/j.1875-595X.2000.tb00565.x>
- Hamasha, A. A., & Hatiwsh, A. (2013). Quality of life and satisfaction of patients after nonsurgical primary root canal treatment provided by undergraduate students, graduate students and endodontic specialists. *International Endodontic Journal*, 46(12), 1131–1139.
<https://doi.org/10.1111/iej.12106>
- Jones, J. A., Boehmer, U., Berlowitz, D. R., Christiansen, C. L., Pitman, A., & Kressin, N. R. (2003). Tooth retention as an indicator of quality dental care: development of a risk adjustment model. *Medical Care*, 41(8), 937–949. <https://doi.org/10.1097/00005650-200308000-00007>
- Jordan, R. A., Markovic, L., Holzner, A. L., Richter, B., & Gaengler, P. (2009).

- Development of a Basic Root canal Treatment (BRT) for primary oral health care-evaluation after one year. *International Dental Journal*, 59, 141–147.
https://doi.org/10.1922/IDJ_2082Jordan07
- Khoo, S.-T., Ode, W., Lopez, V., Yu, V. S. H., Lai, C., & Lui, J.-N. (2020). Factors Influencing Quality of Life after Surgical and Nonsurgical Interventions of Persistent Endodontic Disease. *Journal of Endodontics*, 46(12), 1832–1840.
<https://doi.org/10.1016/j.joen.2020.08.020>
- Liu, P., McGrath, C., & Cheung, G. (2012). Quality of life and psychological well-being among endodontic patients: a case-control study. *Australian Dental Journal*, 57(4), 493–497.
<https://doi.org/10.1111/j.1834-7819.2012.01722.x>
- Liu, P., McGrath, C., & Cheung, G. (2014a). What are the key endodontic factors associated with oral health–related quality of life? *International Endodontic Journal*, 47(3), 238–245.
<https://doi.org/10.1111/iej.12139>
- Liu, P., McGrath, C., & Cheung, G. S. P. (2014b). Improvement in Oral Health–related Quality of Life after Endodontic Treatment: A Prospective Longitudinal Study. *Journal of Endodontics*, 40(6), 805–810. <https://doi.org/10.1016/j.joen.2014.02.008>
- Lobb, W. K., Zakariasen, K. L., & Mcgrath, P. J. (1996). Endodontic Treatment Outcomes: Do Patients Perceive Problems? *The Journal of the American Dental Association*, 127(5), 597–600. <https://doi.org/10.14219/jada.archive.1996.0271>
- Melgaço-Costa, J. L. B., Martins, R. C., Ferreira, E. F., & Sobrinho, A. P. R. (2016). Patients’ Perceptions of Endodontic Treatment as Part of Public Health Services: A Qualitative

Study. *International Journal of Environmental Research and Public Health*, 13(5).

<https://doi.org/10.3390/ijerph13050450>

Montero, J., Lorenzo, B., Barrios, R., Albaladejo, A., Mirón Canelo, J. A., & López-Valverde, A. (2015). Patient-centered Outcomes of Root Canal Treatment: A Cohort Follow-up Study.

Journal of Endodontics, 41(9), 1456–1461. <https://doi.org/10.1016/j.joen.2015.06.003>

Torabinejad, M., Salha, W., Lozada, J. L., Hung, Y.-L., & Garbacea, A. (2014). Degree of Patient Pain, Complications, and Satisfaction after Root Canal Treatment or a Single Implant:

Tsesis, I., Shoshani, Y., Givol, N., Yahalom, R., Fuss, Z., & Taicher, S. (2005). Comparison of quality of life after surgical endodontic treatment using two techniques:

A prospective study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*, 99(3), 367–371. <https://doi.org/10.1016/j.tripleo.2004.06.082>

Vena, D. A., Collie, D., Wu, H., Gibbs, J. L., Broder, H. L., Curro, F. A., Thompson, V. P., & Craig, R. G. (2014). Prevalence of Persistent Pain 3 to 5 Years Post Primary Root Canal Therapy and Its Impact on Oral Health–Related Quality of Life: PEARL Network Findings.

Journal of Endodontics, 40(12), 1917–1921. <https://doi.org/10.1016/j.joen.2014.07.026>

Wigsten, E., Al Hajj, A., Jonasson, P., & Kvist, T. (2021). Patient satisfaction with root canal treatment and outcomes in the Swedish public dental health service: A prospective cohort study. *International Endodontic Journal*, 54(9), 1462–1472.

<https://doi.org/10.1111/iej.13548>

Wigsten, E., Kvist, T., Jonasson, P., Bjørndal, L., Dawson, V. S., Fransson, H., Frisk, F.,

Markvart, M., Pigg, M., Wolf, E., & Davidson, T. (2020). Comparing Quality of Life of

Patients Undergoing Root Canal Treatment or Tooth Extraction. *Journal of Endodontics*, 46(1), 19-28.e1. <https://doi.org/10.1016/j.joen.2019.10.012>

Wright, W. G., Jones, J. A., Spiro III, A., Rich, S. E., & Kressin, N. R. (2009). Use of Patient Self-Report Oral Health Outcome Measures in Assessment of Dental Treatment Outcomes. *Journal of Public Health Dentistry*, 69(2), 95–103. <https://doi.org/10.1111/j.1752-7325.2008.00106.x>

Zilinskaite-Petrauskiene, I., & Haug, S. R. (2021). A Comparison of Endodontic Treatment Factors, Operator Difficulties, and Perceived Oral Health–related Quality of Life between Elderly and Young Patients. *Journal of Endodontics*, 47(12), 1844–1853. <https://doi.org/10.1016/j.joen.2021.08.017>