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Impact of Nonsurgical Treatment of Asymptomatic Apical Periodontitis on the Oral Health-related Quality of Life: A Prospective Study

Angela Longo do Nascimento ^a , Theodoro Weissheimer ^{a*} , Maximiliano Schunke Gomes ^b ,
Jefferson Ricardo Pereira ^c , Ricardo Abreu da Rosa ^a , Marcus Vinicius Reis Só ^a

^a Department of Conservative Dentistry, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil; ^b Graduate Program in Dentistry, School of Health and Life Sciences, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil; ^c Department of Prosthodontics, School of Dentistry, University of Southern Santa Catarina, Tubarão, Santa Catarina, SC, Brazil

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*Corresponding author: Theodoro Weissheimer, Department of Conservative Dentistry, Federal University of Rio Grande do Sul- Rua Ramiro Barcelos, 2492-90035-003, Porto Alegre-Rio Grande do Sul (RS)-Brazil.

E-mail: theodoro.theo@hotmail.com

Introduction: The aim of this study was to evaluate the impact of nonsurgical root canal treatment (nRCT) and the healing of asymptomatic apical periodontitis (AAP) on the oral health-related quality of life (OHRQoL) in a Brazilian population. **Materials and Methods:** This prospective longitudinal observational study included 56 adults, in which 84 teeth with asymptomatic apical periodontitis underwent nonsurgical root canal treatment. Socio-demographic and medical data were collected; the primary outcome oral health-related quality of life was measured by the short form of the Oral Health Impact Profile (OHIP-14). Statistical analysis was carried out by Mann-Whitney U-test, and changes in the oral health-related quality of life scores post-treatment were estimated by Student t-test. **Results:** The mean age was 51.0±15.2 years, with 53.5% of females. Overall, nRCT significantly improved the OHRQoL ($P<0.001$, effect size=0.76). Gender (female) was associated with a higher OHRQoL after nRCT ($P<0.05$). OHIP-14 showed a significant reduction six months after root canal treatment compared to baseline scores. **Conclusion:** Present findings revealed that nonsurgical root canal treatment improved the oral health-related quality of life in patients with asymptomatic apical periodontitis.

Keywords: Asymptomatic Apical Periodontitis; Oral Health; Patient Outcome Assessment; Quality of Life; Root Canal Treatment

Introduction

The quality of life (QoL) is defined as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns [1]. It is composed by subjectivity, multi-dimensionality, related to physical, psychological, and social domains, and by bipolarity which is related to positive and negative dimensions [1]. In recent years, there is a growing interest in the impact of endodontic therapy on patient-centered outcomes such as QoL, based on the integration of patient perspectives and experiences with clinical data to evaluate interventions [2-5].

Endodontic needs are often related to pain and discomfort, and negatively impact on patient's QoL [6, 7]. On the other hand, recent studies suggested that oral health-related quality of life

(OHRQoL) is positively impacted after root canal treatment (RCT) [7-9]. Factors such as pain and comfort, instrumentation techniques, the experience of clinicians, and non-surgical RCT or retreatment were associated with changes in the OHRQoL [10-13]. Thus, quantifying the benefits of endodontic interventions based on integrating patient perspectives and experiences with clinical data is fundamental.

Asymptomatic apical periodontitis (AAP) is a highly prevalent oral disease in Brazil [14, 15] and worldwide [16]. On a patient-level, AAP's global prevalence varies from 7% to 86%, with a median of 52.5% [17]. AAP is an inflammatory response of the periapical tissues, resulting from the bacterial infection of the root canal system after pulp necrosis [18], with bone destruction around the root apex [19]. AAP is the most frequent inflammatory lesion related to teeth in the jaws [20] and histologically presents as granulomas or cysts [21]. The immunosuppressive mechanisms

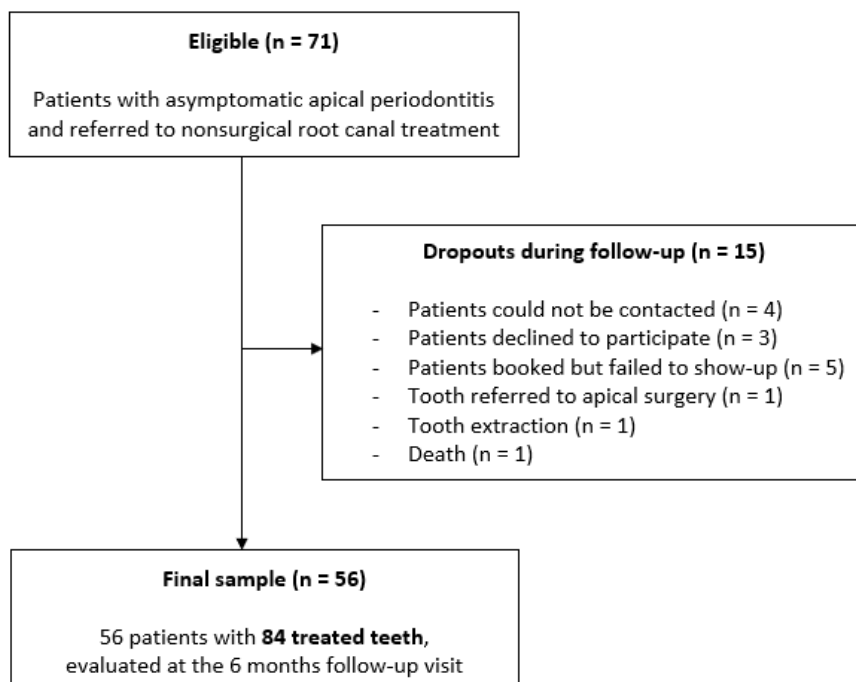


Figure 1. Flow diagram of the study sample selection

are prominent in asymptomatic AAP [22]. The principles of RCT in teeth with AAP are to control the infection in the root canal system, restoring the integrity of periradicular tissues [23]. Based on periapical healing outcomes, RCT has a success rate of 83-86% [24, 25]. Several factors may influence the RCT's outcome, such as the level of the root filling and quality of coronal restoration, but the preoperative periapical status plays a decisive role [24, 25].

The impact of endodontic diseases and its treatment on the OHRQoL is not fully explored, especially in South-American populations. Thus, considering that QoL is multidimensional and influenced by cultural and socioeconomical aspects, this study aimed to evaluate the impact of nonsurgical RCT intervention on the OHRQoL in a Brazilian sample, testing the hypothesis that RCT of AAP have a positive impact on the OHRQoL.

Materials and Methods

Study design and ethical issues

The institutional Ethics Committee approved the research protocol of this prospective longitudinal observational study (protocol number 3.198.560). Written informed consent was obtained from all participants. All data were de-identified before the analysis to protect the anonymity of participants. This study was in agreement to the STROBE Statements when applicable (URL <https://www.strobe-statement.org> 2020).

Study sample, inclusion and exclusion criteria

A convenience sample of seventy-one patients referred to a postgraduate training program between June 2017 and December 2018 were recruited to participate in the study. The inclusion criteria were as follows: adults >18 years old; individuals presenting clinical and radiographic diagnose of AAP and indication of RCT; subjects who signed the informed consent form. The diagnosis of AAP was determined based on clinical and radiographic findings, using the American Association of Endodontists Consensus Conference–recommended diagnostic terminology [26]. The following exclusion criteria were applied: pregnant women; teeth with previous RCT; patients with non-restorable teeth; patients with communication disabilities; patients lost to the follow-up visit.

Figure 1 details the flowchart of the study selection process.

Socio-demographic, medical and clinical oral variables

A structured questionnaire was applied to all participants to collect sociodemographic and health data. Sociodemographic data included age, sex and level of education. The following self-reported medical variables were collected: smoking habit (dichotomized as current versus never or former smoker), diabetes (yes or no), hypertension (yes or no), cardiovascular disease (yes or no), and rheumatoid arthritis (yes or no).

Clinical oral examinations were performed by trained postgraduate dental students. Periodontal examinations were conducted by a calibrated examiner using a periodontal probe to

diagnose periodontitis, according to pre-established criteria [27]. Periodontitis was classified as present or absent. The presence of removable dental prosthesis was classified as present or absent.

Radiographic assessment

Periapical radiographs were obtained at baseline with the digital imaging system (Vista Scan; Dürr Dental, Bietigheim-Bissingen, Germany). After exposure, the phosphor plates were immediately scanned using the software DBSWIN (Dürr Dental). The scanning resolution was 1100 dpi. One endodontist (A.L.N.) examined individually and blindly the digital images, and rated AAP lesions according to the PAI score [28]. Measurements of the lesion area were recorded at baseline using Image J 1.28 software (National Institutes of Health, Bethesda, MD, USA).

The RCT intervention

Postgraduate dental students performed all RCT under the supervision of an endodontics clinical professor. The RCT followed the institutional protocols, and were accomplished through two or more visits using calcium hydroxide as root canal dressing between visits. The canals were prepared with hand files using crown-down pressureless technique, and/or rotary or reciprocating instruments. The irrigant used during RCT was 2.5% sodium hypochlorite, and root canal filling was completed with gutta-percha and endodontic sealer (AH-Plus; Dentsply Sirona, York, PA, USA). Access cavities were filled using light-cured glass-ionomer cement, and patients were referred for restoration.

Follow-up

At the follow-up visit, after 6 months, clinical examination was performed, and the presence of sinus tract, pain, swelling, tenderness to percussion or gingival palpation, and quality of coronal restorations were recorded.

The quality of restorations was scored as: (i) visual or tactile exposure of root filling that can be probed clinically, (ii) marginal discrepancy under probing or visible radiographically without exposure of root filling, and (iii) satisfactory coronal restoration with good retention and marginal fit [25].

Additionally, periapical radiographs were obtained with parallel technique using a digital imaging system (Vista Scan, Dürr Dental, Bietigheim-Bissingen, Germany). The phosphor plates post exposure were immediately scanned with proprietary software (DBSWIN, Dürr Dental, Bietigheim/Bissingen, Germany), with a scanning resolution of 1100 dpi.

Two endodontists individually and blindly examined the images and rated them according to the PAI score [28]. Measurements of the periapical lesion area were obtained by using Image J 1.28 software (National Institutes of Health, Bethesda, MD, USA). In case of disagreement, a third investigator was consulted and a final agreement was reached. The lesion area and volume at

the first visit were compared with those at recall. The outcome was presented in 4 categories: absence, reduction or enlargement of the radiolucency, or uncertainty. Reduction or enlargement of the radiolucency was determined only when changes in the radiolucency size was of 20% or more.

The apical status was classified into three categories:

1. Healed: the absence of any clinical signs or symptoms and normal periapical tissue with an intact periodontal ligament space and lamina dura or a slightly widened periodontal ligament around extruded material
2. Healing: the absence of any clinical signs or symptoms and periapical radiolucency still present but reduced in size
3. Nonhealing: the presence of signs or symptoms and/or the emergence of new periapical radiolucency or unchanged or enlarged periapical radiolucency

The outcome variable: OHRQoL measures

The short version of the OHIP instrument (OHIP-14) [29], validated for Brazil [30], was used. One examiner interviewed the participants, reading the OHIP-14 questionnaire at baseline and 6-months after RCT. Responses were marked on a Likert scale ranging from 0 (never) to 4 (very often). A lower OHRQoL score indicates a better QoL. The main outcome OHRQoL was calculated as the difference between the baseline and the 6-month follow-up measurements.

Data analysis

A combination of statistical methods was used for this analysis. The Kolmogorov-Smirnov test revealed a non-normal distribution of the data for all variables assessed ($P < 0.05$). The changes in the OHRQoL scores were obtained by subtracting post-treatment scores from baseline scores. Positive scores indicated improvement and negative scores indicated deterioration following RCT. Association between clinical health status, gender, smoking, and changes at 6-months in OHRQoL were evaluated with Mann-Whitney U-test. Changes in OHRQoL scores post-treatment were analyzed by Student's *t* test. The magnitude of the statistical mean difference was determined by a nonparametric method of effect size (ES) calculation.

The patient was considered the statistical unit, and the significance level was set at 5%. A statistical package was used for all analyses (SPSS 20.0, IBM SPSS Statistics for Windows; IBM Corp., Armonk, NY, USA).

Results

Sociodemographic and dental characteristics of the sample are summarized in Table 1. After exclusions, a total of 56 patients and 84 teeth comprised the final analysis. Most participants were

female (53.6%), and the age ranged from 18 to 84 years. There were 50 molars and 34 non-molars, and 72.6% of all teeth presented the score PAI \geq 3 at baseline. The level of education was high, and 57.0% of the individuals presented complete high school or college levels.

The association between sociodemographic and medical variables and changes in the OHIP-14 score are expressed in Table 2. In general, individuals with systemic conditions (diabetes, hypertension, cardiovascular disease, rheumatoid arthritis) had non-significant lower crude mean differences in the OHIP-14 scores compared to healthy participants after RCT. Gender was the only variable associated with modifications in the OHIP-14 score ($P=0.008$), with females presenting a higher mean difference (8.20 ± 7.37) compared to males (3.19 ± 6.34).

The mean changes in the different dimensions of the OHIP-14 score after RCT are expressed in Table 3. Data revealed a significant reduction in the OHIP-14 summary scores between baseline and the follow-up period ($P<0.05$). The scores of all domains, except social disability, decreased following RCT ($P<0.05$).

Table 1. Descriptive sociodemographic, oral, and endodontic status at baseline

| Completed (n = 56) | |
|----------------------------------|--------------|
| Sociodemographic characteristics | |
| Age, mean (SD) | 51.38 (15.2) |
| Sex, % (n) | |
| Male | 46.45 (26) |
| Female | 53.63 (30) |
| Education level, % (n) | |
| Primary school incomplete | 25 (14) |
| Primary school complete | 8.9 (5) |
| High school incomplete | 8.9 (5) |
| High school complete | 39.2 (22) |
| Incomplete college | 10.7 (6) |
| Complete college | 7.1 (4) |
| Periodontal Status, % (n) | |
| Periodontitis | 35.7 (20) |
| No periodontitis | 64.2 (36) |
| Prosthetic status, % (n) | |
| No removable denture | 66 (37) |
| Possesses removable denture | 33.9 (19) |
| Endodontic characteristics | |
| Multiple teeth, % (n) | |
| Single tooth | 60.7 (34) |
| Multiple teeth | 39.2 (22) |
| Type of tooth, % (n) | |
| Molar | 59.5 (50) |
| Anterior or premolar | 46.4 (34) |
| Number of teeth, mean (SD) | 22.5 (6.9) |
| PAI score, % (n) | |
| <3 | 27.3 (23) |
| \geq 3 | 72.6 (61) |

Over the 6-months period, the effect size values ranged from 0.23 (social disability) to 0.82 (physical pain). The overall effect size over the 6-months follow up was 0.76.

Discussion

The results of this study revealed that RCT significantly improved the OHRQoL in patients with AAP. Interestingly, periapical healing assessed by a reduction in the PAI scores occurred 6-months

Table 2. Association between clinical health status, sex, smoking and changes after 6-months of follow-up in QoL (OHIP-14) (n=56)

| | Δ OHIP Mean (SD) | Δ OHIP Median (SE) | P-value |
|-------------------------------|-------------------------|---------------------------|---------|
| Smoker (n=13) | 6.08 (7.31) | 5 (2.03) | 0.808 |
| No smoker (n=43) | 5.81 (7.38) | 5 (1.13) | |
| Male (n=26) | 3.19 (6.34) | 1 (1.24) | 0.008* |
| Female (n=30) | 8.20 (7.37) | 6.5 (1.35) | |
| Diabetic (n=9) | 3.44 (5.88) | 3 (1.96) | 0.353 |
| Non-diabetic (n=47) | 6.34 (7.5) | 5 (1.09) | |
| Presence of cardiopathy (n=6) | 2.00 (4.9) | 2 (2) | 0.177 |
| Absence of cardiopathy (n=50) | 6.34 (7.43) | 5 (1.05) | |
| Presence of HTN (n=19) | 3.84 (6.84) | 3 (1.57) | 0.131 |
| Absence of HTN (n=37) | 6.92 (7.39) | 5 (1.22) | |
| Presence of RA (n=3) | 13 (11.36) | 18 (6.56) | 0.258 |
| Absence of RA (n=53) | 5.47 (6.95) | 5 (0.95) | |

*Denotes statistically significant difference ($P<0.05$); OHIP-14: short form of the Oral Health Impact Profile; Δ OHIP: (OHIP2-OHIP1); QoL: quality of life; SD: standard deviation; RA: Rheumatoid arthritis; HTN: Hypertension

Table 3. Changes in QoL Scores (OHIP-14) after endodontic treatment (n=56)

| OHIP-14 score (mean) | | | | |
|--------------------------|--------------|-------------------|----------|-------------|
| | Baseline | 6-month follow-up | P-value | Effect size |
| OHIP-14 score | 13.65 (9.12) | 8.5 (8.14) | < 0.001* | 0.76 |
| Functional limitation | 0.91 (1.7) | 0.43 (0.93) | =0.049* | 0.27 |
| Physical pain | 3.14 (2.16) | 1.64 (1.77) | <0.001* | 0.82 |
| Psychological discomfort | 3.73 (2.86) | 2.63 (2.39) | =0.003* | 0.41 |
| Physical disability | 1.68 (2.16) | 0.77 (1.53) | =0.002* | 0.43 |
| Psychological disability | 2.7 (2.52) | 1.84 (2.1) | =0.003* | 0.42 |
| Social disability | 1.25 (1.71) | 0.79 (1.56) | =0.088 | 0.23 |
| Handicap | 0.96 (1.49) | 0.41 (0.95) | =0.007* | 0.37 |

*Denotes statistically significant differences ($P<0.05$)

after RCT in most cases, but it was not associated with changes in the OHRQoL. Thus, present findings suggest that the benefits of endodontic therapy measured through patient-centered outcomes may occur before the conventional radiographic confirmation of the healing of AAP.

This study demonstrated the negative impact of AAP on patients' QoL. Previous evidence indicated that AAP might lead to a systemic response, including increased nitric oxide metabolites (NOx) production and oxidation of proteins [31]. Patients with AAP presented lower QoL, partly explained by the activation of oxidative and nitrosative pathways, mainly nitric oxide metabolites enhancing neuroprogressive processes, caused by the lipopolysaccharides present in the root canal system [31]. Significant changes in the OHIP-14 scores were observed, demonstrating the beneficial impact of RCT in the QoL. RCT has been associated with high satisfaction and improvement in OHRQoL [32], especially when compared to tooth extraction with no replacement [7, 8, 11].

A total mean OHIP-14 score of 13.6 ± 9.1 was observed at baseline in this study. These values are comparable to those reported on different populations of endodontic patients [7, 8, 11]. After RCT, the mean total OHIP-14 score was 8.5 ± 8.14 , equivalent to the mean scores of maintenance patients and a population of young adults [7, 33]. These findings confirm that RCT significantly decreased the mean OHIP-14 scores, comparable to groups of low oral health impact.

Some methodological strengths of this study must be mentioned. The dropout rate was low (21.2%) and comparable to other patient-centered endodontic studies [8, 9]. There are several forms to evaluate OHRQoL. In the present study, OHIP-14, a condensed version of the OHIP, was used [29, 30]. The specific domains are (i) functional limitation; (ii) physical pain; (iii) psychological discomfort; (iv) physical disability; (v) psychological disability; (vi) social disability; and (vii) handicap. OHIP-14 is a specific instrument to recognize the impacts of oral conditions on QoL [34]. It is also a suitable tool to discriminate endodontic conditions due to its ability to identify with or without disease [8].

The present results revealed that the OHRQoL domains more affected by AAP were psychological discomfort, physical pain, and psychological disability. Although pain is not a characteristic of AAP, the high scores of the physical pain domain could be associated with previous pain experience. The study sample is from a waiting list of a dental school, and some patients may have experienced acute endodontic diseases and received dental emergency treatment before. Importantly, all OHIP-14 domains, except social disability, demonstrated significant improvements after RCT intervention.

The most suitable method to interpret changes in the OHRQoL is to evaluate of minimal important difference (MID) [35]. The

MID represents the smallest worthwhile improvements under the patient's perspectives, and not only on statistical significance. The distribution-based method is an approach to determine the MID. The effect size is one strategy to examine the distribution of the results. In the present study, the overall effect size for treatment was 0.76. This value is standardized as "medium". Present results agree with a previous study with a follow up of six months after RCT [8].

Changes in OHIP-14 scores were significantly associated with gender in this study, and the benefits of the endodontic therapy were higher among females than men. Previous investigations showed the influence of sex and a tendency of worse OHRQoL associated with women [34, 36]. QoL is multidimensional and influenced by cultural and socioeconomical aspects. Thus, it is possible to infer those differences related to sex may be in part related to the characteristics of the present South-American sample, where RCT seems to be more beneficial to the QoL of women than men. These findings highlight the importance to explore the relation between endodontic disease and treatment and the OHRQoL in different populations worldwide.

Additionally, some methodological limitations of the present study must be clarified. This study used a convenience sample from a postgraduate dental school, with a limited number of participants. Thus, the external validity of the present findings must be interpreted with caution. Furthermore, the sample size did not allow performing a multivariate regression, especially related to the possible influence of medical covariables in the OHRQoL outcome.

On the other hand, the present study confirmed the feasibility of employing the OHIP-14 instrument in a dental school setting [37]. Moreover, the fact that postgraduate students provided the treatment did not seem to have influenced the results. Previous studies demonstrated that treatments provided by specialists, graduate students, or undergraduate students improved the OHRQoL scores, but patients related higher satisfaction levels when treated by specialists [6, 10].

Conclusion

Present findings revealed that nonsurgical RCT improved the OHRQoL in patients with AAP in a Brazilian sample. We hope to see further trials in quality of life and endodontic treatment in Brazil.

Conflict of Interest: 'None declared'.

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