

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract - The study utilized a retrospective cohort study and a randomized cohort study; - The study included 156 patients (107 women and 49 men) aged 20 to 60 years or older (mean 47 ± 5 years) with destructive forms of apical periodontitis in the acute stage, participating in therapeutic treatment; - Patients were divided into groups based on the filling materials used for permanent root canal filling; - Patients were divided into groups based on the degree of apical constriction destruction; - The study was conducted over periods ranging from 6 months to 4 years.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found - The study utilized a retrospective cohort study and a randomized cohort study
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Complications during endodontic treatment are relatively common, and treatment failure has traditionally been associated with persistent or recurrent endodontic infection. The inflammatory response in the periodontal region resembles that seen elsewhere in the body. If the irritant is removed—that is, the root canal is cleaned, shaped, and filled—healing occurs similarly to healing in any other part of the body. It is advisable to evaluate the success of endodontic treatment dynamically at regular intervals, using not only clinical but also radiographic data. It is important to note that radiographic assessment of periodontal tissue condition is convenient in descriptive medicine, but evidence-based medicine requires formalization of the obtained data and objective coverage of the dynamics of changes after treatment. Currently, the quality of endodontic treatment is recommended to be assessed based on the recommendations of the European Society of Endodontology. These recommendations are based on an assessment of treatment outcomes and the subsequent development of the periapical process according to three criteria: successful treatment, questionable treatment success, and treatment failure. These criteria are based on clinical and radiographic examination of the patient over a four-year period. The American Association of Endodontists has adopted the following term for assessing the quality of endodontic treatment: "functional tooth," which includes parameters such as an asymptomatic tooth without radiographic signs of periapical pathology and a functional tooth; and "unhealed tooth," which is a nonfunctional tooth with inflammatory symptoms and radiographic signs of periapical pathology. Based on the above, we conclude that the search for new methods for objectively assessing endodontic treatment outcomes remains relevant. The development of appropriate, accessible standards for assessing

treatment quality will allow practicing physicians to objectively evaluate their work and, therefore, improve their skills in a timely manner. Today, modern endodontics offers dentists a variety of dental treatment options. Today's clinicians must understand that endodontic treatment must have a favorable outcome. Therefore, this issue has medical and social significance.

Objectives	3	State specific objectives, including any prespecified hypotheses The objective of the study: was to evaluate the effectiveness of treating teeth with periapical pathology based on clinical and radiographic examination methods, depending on the state of apical constriction, and to justify the choice of obturation material.
Methods		
Study design	4	Present key elements of study design early in the paper -The study utilized a retrospective cohort study and a randomized cohort study; - The study included 156 patients (107 women and 49 men) aged 20 to 60 years or older (mean 47 ± 5 years) with destructive forms of apical periodontitis in the acute stage, participating in therapeutic treatment; - Patients were divided into groups based on the filling materials used for permanent root canal filling; - Patients were divided into groups based on the degree of apical constriction destruction; - The study was conducted over periods ranging from 6 months to 4 years.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Patients were examined and treated at City Budgetary Institution of the DPR "City Dental Clinic No. 1 of Donetsk" (formerly "City Dental Clinic No. 1") and the Department of Orthopedic Dentistry at the Donetsk State Medical University of the Russian Ministry of Health. The study period ranged from six months to four years. Patients were recruited from 2018 to 2021.
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up All participants had no underlying medical conditions, no chronic erosive or ulcerative diseases of the oral mucosa, or moderate to severe periodontitis that could worsen dental or general health. A retrospective study was used, including an analysis of dental records (Form No. 043u) of patients with periapical lesions in permanent teeth treated with the study filling materials. <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one

		group	
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(a)	Describe all statistical methods, including those used to control for confounding
		Statistical Methods.	
		Statistical processing of the results was performed in accordance with the study's objectives, using standard statistical methods. A personal computer and Microsoft Excel (Microsoft Corporation, Tulsa, USA) were used for data handling, and results were analyzed using the Statistica 6.0 software package (IBM® SPSS® Corporation, Chicago, USA). Statistical analysis relied on Student's t-test to compare mean values between unrelated, independent groups. The Kruskal-Wallis rank test—an analysis of variance based on ranks was used to assess quantitative differences between the sealers studied, with post hoc comparisons performed using the Mann-Whitney U test to evaluate differences between two independent samples for any quantitative variable.	
		(b) Describe any methods used to examine subgroups and interactions	
		(c) Explain how missing data were addressed	
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	

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Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed The article does not present a stepwise eligibility/enrollment flow (e.g., numbers screened vs. excluded vs. analysed). It reports directly that the study involved 156 patients with 194 treated teeth (365 roots) presenting with destructive forms of apical periodontitis in the acute stage, recruited between 2018 and 2021. Root canals were filled with Foredent (82 teeth, 42.27%), Sealapex (94 teeth, 48.45%), or Trioxident (18 teeth, 9.27%). Trioxident was not used in teeth with preserved apical constriction, owing to the difficulty of inserting it into these canals, but was used in 40.74% of cases involving destroyed apical constriction. (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders The study included 156 patients aged 20 to 60 years and older with a diagnosis of destructive forms of apical periodontitis. (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i>—Summarise follow-up time (eg, average and total amount) The study was conducted over periods ranging from 6 months to 4 years.
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time Of the 82 teeth filled with Foredent, 56 teeth (68.29%) were re-examined 89 times over periods ranging from 6 months to 4 years. Seven teeth were examined in the first 6 months, 43 teeth within 1 year, 27 teeth after 2 years, 9 teeth after 3 years, and 3 teeth after 4 years. The periapical index of some teeth changed during this time. However, overall, a fairly successful endodontic treatment outcome emerged. Of the 94 teeth filled with Sealapex and gutta-percha points, 37 teeth (39.36%) were re-examined. Seven teeth were examined after 6 months, 22 teeth after 1 year, and eight teeth after 2 years. Seven teeth (18.91%) met the 7-point criteria. They were re-examined after 6 months, and in all cases, a decrease in the focus of bone tissue destruction was noted. This category included teeth from resorption groups I and II, but with foci of bone tissue destruction greater than 3 mm. The criteria of 8 points were met by 19 teeth (51.35%) examined after 1-2 years. Of these, 4 teeth (15.38%) were classified as resorption group II. The group with questionable results included 10 teeth (27.02%), whose criteria corresponded to points 4-6. All of them were examined 1-2 years after the end of treatment and belonged to resorption groups II and III, i.e., these were the teeth with the most severe pathology. We classified 1 tooth (2.7%) as unsuccessful treatment; signs of resorption of the filling material were observed in the root canal 2 years after treatment. Although no destructive lesions were observed, the periodontal ligament space in the apical region was expanded and there were no signs of cementum-like tissue formation. Of the 18 teeth treated with Trioxident, 10 were re-examined. Of these, no endodontic treatment failures were observed. A questionable outcome was observed in one case (10%), and treatment was successful in nine cases (90%). The proposed scoring system for assessing the quality of

endodontic treatment allows for statistical analysis. The assessment criteria included in the "Questionable Success" section allow the clinician to pay close attention to the tooth and attempt retreatment if there is no improvement in the "Successful Treatment" score within four years.

Case-control study—Report numbers in each exposure category, or summary measures of exposure

Cross-sectional study—Report numbers of outcome events or summary measures

Main results	16	(a)	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
			Treatment failure rates were reported for each sealer by apical-constriction group (Table 6). In the group with preserved apical constriction, the 2-year failure rate with Foredent was 4.4 times that with Sealapex. In the partially destroyed group, this ratio reached 7.9 times for Sealapex and 5.5 times for Trioxident, while in teeth with destroyed apical constriction, Foredent's failure rate reached 80%—5.3 times higher than Sealapex and 8.9 times higher than Trioxident. Statistical testing (Kruskal-Wallis) showed the preserved-constriction group differed significantly between materials ($p = 0.000029$); in the partially destroyed group, Trioxident vs. Sealapex showed no significant difference ($p = 0.642$, and $p = 0.678$ at an increased threshold); in the destroyed-constriction group, Sealapex vs. Trioxident also showed no significant difference ($p = 0.3684$). Across all three groups, Mann-Whitney analysis yielded a highly significant p value (0.0007), confirming the advantage of Trioxident and Sealapex with gutta-percha pins over Foredent.
		(b)	Report category boundaries when continuous variables were categorized
			The analysis of the long-term clinical results of endodontic treatment was assessed after 6 months, 1 year, 2, 3, and 4 years. To evaluate the dynamics of radiographic parameters after treatment in patients with destructive forms of chronic apical periodontitis, PAI values were assessed and changes in the area of destructive lesion (mm^2) were calculated. Since pronounced root resorption with destruction of the apical constriction develops over a long period of time, the lesion size could reach 1.5-2 cm, an average of 9.0 ± 2.3 mm. Correlation between the lesion size and the degree of resorption in teeth with preserved and partially destroyed constriction was not found. The average lesion size was 6.5 ± 2.5 mm. Thus, the lesion size was assigned a weight of 100%, and its change relative to the initial size was tracked over a period of up to one year. The PAI value was estimated as the mean for each group.
		(c)	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion

Key results	18	Summarise key results with reference to study objectives
		An evaluation of the treatment efficacy of teeth with periapical pathology using three root canal sealers with varying degrees of apical constriction destruction revealed that in the case of apical constriction destruction, the failure rate of endodontic treatment after using Foredent reaches 80%, which is 5.3 times worse than the rates of Sealapex

and 8.9 times worse than Trioxident. Conclusions. The best treatment outcomes were achieved in the group with preserved apical constriction using Sealapex and gutta-percha pins (11.5% more effective than Foredent ($p < 0.005$)). In the group with partially destroyed constriction, both Sealapex and Trioxident demonstrated similar success rates. Over a period of up to 4 years, success rates reached 93% and 89%, respectively. However, Foredent's efficacy was only 35% ($p < 0.05$), due to disrupted canal obturation. In teeth with a compromised apical constriction, the best results were achieved with Trioxident (91% at one year and at four years ($p < 0.05$)). Positive results in this group of teeth were achieved with Sealapex (88% to 80%), and with Foredent (47.14% to 8%), respectively.

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Not addressed in the article. The authors do not include a discussion of study limitations, potential sources of bias, or their direction/magnitude.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence For teeth with preserved and partially destroyed apical constrictions, Sealapex with gutta-percha pins or its equivalent is recommended. For teeth with severely destroyed constrictions, root canal filling with Trioxident using the standard technique is recommended. This method ensures high-quality obturation in a moist environment, creating a monoblock that firmly adheres to the root canal wall. Based on previous studies, we do not recommend using Trioxident for filling teeth with preserved apical constrictions due to the high risk of seal failure in the absence of moisture in the root canal and the difficulty of its placement in this case. Trioxident equivalents with similar physicochemical properties can be used for filling apical constrictions in this group of teeth. Currently, there is no single tool for assessing the results of endodontic treatment that meets all requirements. Assessing the quality of treatment of teeth with periapical pathology is particularly challenging. To this end, we proposed the "Periapical Index for Assessing the Quality of Endodontic Treatment of Destructive Periodontitis." This system for assessing the quality of endodontic treatment allows for statistical analysis. The proposed periapical index for assessing the quality of endodontic treatment is readily available and does not require material costs, expensive equipment, or specially trained personnel.
Generalisability	21	Discuss the generalisability (external validity) of the study results Trioxidant or its analogs are the material of choice for root canal fillings with destroyed apical stenosis. The developed criteria for assessing the quality of root canal fillings in destructive forms of periodontitis will help the dentist not only accurately evaluate the work performed and make timely decisions to correct any deficiencies, but also predict the final treatment outcome.

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based The study did not receive any external funding and was conducted using only institutional resources.
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.