Prevalence of Periapical Radiolucency and Root Canal Treatment: A Systematic Review of Cross-sectional Studies

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Abstract

Introduction: Cross-sectional studies describe the health status of a population and measure the prevalence of disease or treatment. Neither the prevalence of periapical radiolucency, a surrogate for disease, nor the prevalence of root canal treatment have been subjected to a systematic review, which is the highest level of clinical evidence. The purpose of this study was to conduct a systematic review and meta-analysis of the prevalence of periapical radiolucency and nonsurgical root canal treatment. **Methods:** Inclusion/exclusion criteria were used for defined searches in MEDLINE and EMBASE. Title lists were scanned and abstracts were read to determine utility. Articles meeting the inclusion/exclusion criteria were analyzed for heterogeneity. Weighted mean percentages were calculated for the prevalence of overall periapical radiolucency, root canal treatment, and apical radiolucency in both treated and untreated teeth. **Results:** Defined searching produced 11,491 titles. Thirty-three articles were included. Most patient samples represented modern populations from countries with high or very high human development indices. Meta-analysis was performed on 300,861 teeth. Of these, 5% had periapical radiolucencies, and 10% were endodontically treated. Of the 28,881 endodontically treated teeth, 36% had periapical radiolucencies; however, cross-sectional studies cannot distinguish between healing and failing cases. Of the 271,980 untreated teeth, 2% had periapical radiolucencies. The technical quality of root canal treatment was decried by most authors of the included studies. **Conclusions:** The prevalence of periapical radiolucency was very high, broadly equivalent to 1 radiolucency per patient. The prevalence of teeth with root canal treatment was very high, broadly equivalent to 2 treatments per patient. Billions of teeth are retained through root canal treatment. *(J Endod 2012;38:1170–1176)*

Key Words

Cross-sectional, endodontic, epidemiologic studies, meta-analysis, periapical diseases, population, prevalence, root canal, systematic review

The state of health, disease, or a treatment intervention in a population is best measured by a cross-sectional study. To date, neither the prevalence of periapical disease, as indicated by periapical radiolucency, nor the prevalence of root canal treatment have been subjected to a systematic review, which is often considered to represent the highest level of clinical evidence.

In contrast, longitudinal studies on the success and survival of root canal–treated teeth have received several excellent systematic reviews and meta-analyses. These have reported extremely high tooth survival rates but lower and more variable success rates (1–5). Definitions of endodontic treatment "success" include radiographic criteria, but radiographic methods and criteria vary among studies and are sources of substantial heterogeneity (2, 4, 5). Most longitudinal studies were performed in institutional settings, dental schools, or teaching hospitals rather than in typical general practice or community settings (1). Most of these studies were single-center not multicenter studies (1). Thus, longitudinal data may not be representative of routine community general dental patient care (6).

Drastically different perspectives are provided by longitudinal and cross-sectional endodontic studies (7, 8). Many cross-sectional studies have indicated that the overall prevalence of periradicular pathology in various patient populations is much higher than one might expect by studying longitudinal success or survival rates (9–18). Apical radiolucency rates over 33% have been reported often for endodontically treated teeth in cross-sectional studies (10, 11, 14–17, 19–26). This apparent disparity may result from the nature of the cross-sectional study design, which measures the cumulative condition of an entire real-world population. It has also been suggested that this discrepancy may be explained by differing technical standards, inconsistencies in radiographic interpretation, different approaches to diagnosis and treatment planning, sample bias, and other confounding effects (20). The apparent dissonance between cross-sectional studies with the relatively high prevalence of periapical radiolucency and the excellent success and survival rates reported in systematic reviews of longitudinal studies suggests that a systematic review and meta-analysis of cross-sectional studies may be revelatory.

A systematic review and meta-analysis are useful in aiding the generation of health care public policy by patient advocacy groups, providers, and third-party payers. The concept of evidence-based dentistry has gained much interest as an approach to directly link research findings to clinical treatment needs and public policy. The purpose of this study was to conduct a systematic review and meta-analysis of the prevalence of periapical radiolucency and nonsurgical root canal treatment.

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Materials and Methods

A systematic review was developed following established guidelines (27). Methodology included formulating review questions, constructing a search strategy, defining inclusion and exclusion criteria, locating studies, selecting studies, assessing study quality, extracting data, and interpretation. The review questions were as follows:

1. What is the prevalence of periapical radiolucency in adult populations?
2. What is the prevalence of conventional nonsurgical root canal treatment in adult populations?
3. What is the prevalence of periapical radiolucency in teeth that have received root canal treatment in adult populations?
4. What is the prevalence of periapical radiolucency in teeth that have not received conventional nonsurgical root canal treatment in adult populations?

Inclusion and Exclusion Criteria

Inclusion criteria required cross-sectional data on the prevalence of both periapical radiolucency and conventional nonsurgical root canal treatment in general patient populations. Inclusion criteria for paper review were articles published in English from January 1968 to December 2011, studies including adult subjects, studies involving permanent teeth, and studies with 20 or more subjects. Exclusion criteria consisted of literature that failed to meet these inclusion criteria, studies using treatment modalities not currently being used, studies that only sampled patients known to have or presenting for root canal treatment, and studies without radiographic measurement of periapical radiolucency or root canal treatment prevalence.

Search Methodology

Electronic searches were performed in MEDLINE and EMBASE databases. The search strategy for both MEDLINE and EMBASE was described in Figure 1 (1). The results from the designed search strategy were supplemented by manual searches, citation mining, and expert recommendation. Manual searching involved reviewing the table of contents of every issue of the most recent 2 years of the following journal titles: *American Journal of Dentistry*, *International Endodontic Journal*, *Journal of Dentistry*, *Journal of Endodontics*, *Journal of Oral Rehabilitation*, *Oral Surgery Oral Medicine Oral Pathology and Oral Radiology and Endodontics*, and *Quintessence International*. The citation mining and expert recommendation processes incorporated relevant materials that did not appear in database searches, such as book chapters or review articles. Experts were consulted to recommend additional articles or books for review. Two investigators screened the titles and abstracts of all articles identified in the electronic and manual searches. Articles that did not meet the inclusion criteria were excluded. All remaining articles were full-text reviewed in the second stage of the process.

Study Quality Rating

The quality of study methodology, design, and data analysis was assessed using the Wong Scale–Revised (28). Studies were assessed by reviewer responses to 9 questions; a score of 1 (inappropriate), 2 (mediocre), or 3 (appropriate) was assigned to each question. Out of a comprehensive total score of 9 to 27, a score under 19 indicated that the methodology, design, and analysis of the study failed to support the reliability of the authors' conclusions, necessitating exclusion from the meta-analysis.

Data Analysis

An iterative process was used to determine what data could be combined and analyzed. For each article that met validity criteria and an acceptable quality rating, data were extracted and compiled into a table of evidence, and descriptive statistics, weighted means, and associated standard deviations calculated.

Results

Description of the Existing Literature

Initial electronic and manual searches identified 11,491 titles. After title screening, 612 abstracts were reviewed, and full texts for 232 articles were obtained. After full-text review and citation mining, 33 articles pertaining to the prevalence of periapical radiolucency and root canal treatment were identified as determined by inclusion and exclusion criteria (9, 10, 12, 14, 16, 19–25, 29–49). Of the 33 included articles, 29 were initially identified by electronic search, 3 by manual search, and 1 by citation mining. A systematic review yielded an extremely low return rate (ie, 0.3%) for the titles initially identified by defined searching. The 33 included studies reported 38 distinct datasets (Table 1).

Major sources of heterogeneity included differing outcome measures, differences in study geographic location, differences in operator type, and variations in patient selection or sample size. Interpretation criteria varied, as did radiographic methods that generally included full-mouth X-ray series, but sometimes only included panoramic films.

The overall mean study quality rating of the 33 included studies was 23 (standard deviation = 2) on the 27-point Wong Scale–Revised. All studies had quality ratings of 19 or above, so none were excluded for reasons of quality. The studies included in the meta-analysis were mostly published in the 1990s and 2000s, with 2 exceptions (19, 29). The mean year of publication was 2000. The common unit of reporting in the included literature was the tooth. Pertinently, 30 of the 33 the studies described in this article were performed in countries with very high human development indices, 2 were performed in countries with high indices, and 1 was performed in a country with a medium index. The findings of this study can be broadly generalized to modern populations in countries with higher development indices.

The prevalence of teeth with periapical radiolucency was very high, approximately 5% of all teeth, with a range from as low as 0.5% to as high as 13.9%, and a standard deviation of 6% (Table 1). The prevalence of teeth with nonsurgical endodontic treatment was approximately 10%, with a range from as low as 1% to as high as 22% and a standard deviation of 6%. Substantially more teeth had endodontic treatment than radiolucency. Nonetheless, for the teeth that had endodontic treatment, approximately 36% (standard deviation = 10%) also had periapical radiolucency. The prevalence of periapical radiolucency on teeth that had not received root canal treatment was consequential (ie, 2%, standard deviation = 4%).

Of the 33 studies that included data on root canal treatment, 24 also contained numeric data on technical treatment quality (9, 10, 12, 14, 16, 19–24, 29–33, 39, 42–45, 47–49). These data indicated that, based on radiographic findings alone, the majority of included root canal treatments were of poor or unacceptable technical quality. Up to 78% of root canal treatments were reported as being inadequate, whereas lower percentages, up to a maximum of 56%, of root canal treatments were reported as being acceptable (24, 43) Differences in criteria and reporting precluded general meta-analysis of root canal treatment quality.

Discussion

The prevalence of periradicular radiolucency reached epidemic proportions (ie, 5% of all teeth). The prevalence of periapical