Frequency of Persistent Tooth Pain after Root Canal Therapy: A Systematic Review and Meta-Analysis

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Abstract

Introduction: Little is known about the frequency of persistent pain after endodontic procedures even though pain is a core patient-oriented outcome. We estimated the frequency of persistent pain, regardless of etiology, after endondontic treatment. **Methods:** Persistent tooth pain was defined as pain present ≥6 months after endodontic treatment. Endodontic procedures included in the review were pulpectomy, nonsurgical root canal treatment, surgical root canal treatment, and retreatment. Four databases were searched electronically complemented by hand searching. Two independent reviewers determined eligibility, abstracted data, and assessed study quality. A summary estimate of persistent all-cause tooth pain frequency was established by using a random-effects meta-analysis. Using subgroup analyses, we explored the influence of treatment approach (surgical/nonsurgical), longitudinal study design (prospective/retrospective), follow-up rate, follow-up duration, initial treatment versus retreatment, and quality of reporting (Strengthening the Reporting of Observational Studies in Epidemiology rankings) on the pain frequency estimate. **Results:** Of 770 articles retrieved and reviewed, 26 met inclusion criteria. A total of 5,777 teeth were enrolled, and 2,996 had follow-up information regarding pain status. We identified 168 teeth with pain and derived a frequency of 5.3% (95% confidence interval, 3.5%-7.2%, $p < 0.001$) for persistent all-cause tooth pain. High and statistically significant heterogeneity among studies (I^2 = 80%) was present. In subgroup analysis, prospective studies had a higher pain frequency (7.6%) than retrospectives studies did (0.9%). Quality of study reporting was identified as the most influential reason for study heterogeneity. **Conclusions:** The frequency of all-cause persistent tooth pain after endodontic procedures was estimated to be 5.3%, with higher report quality studies suggesting >7%. *(J Endod 2010;36:224–230)*

Key Words

Frequency, meta-analysis, outcome, pain, root canal therapy, systematic review

Tooth pain causes suffering and reduced functioning and is a major component of oral health and quality of life (1–3). Pain is often the motivation for an individual seeking dental care (4–6) although for some patients the fear and anxiety associated with dental pain prevents them from requesting needed care (7, 8). Acute postsurgical pain is known to cause functional changes in the nervous system (9), and research suggests that improved perioperative pain control can result in reduced chronic pain (10). Our overarching research goal is to better understand intraoral pain associated with dental procedures, with the long-term objective of being able to implement preemptive interventions to decrease postprocedural pain.

Customarily, research assessing the outcomes of root canal therapies has focused not on pain, but rather on the presence of radiographic signs, specifically periapical rarefaction (11–13). When this metric is used to define the success/failure of endodontic procedures, reports suggest an overall favorable outcome rate ranging from 68% to 91% after at least 1 year (14–17). The problem with using periapical rarefaction as the primary measure of outcome status, either alone or as part of a composite index, is that it fails to address the issues of primary concern to patients – whether it hurts and whether the patient can function (18–21). By definition, periapical rarefaction is a surrogate outcome measure, because the patient cannot perceive it (22). The use of surrogate outcomes can be misleading, at times resulting in unneeded treatment (23).

Following the principles of epidemiology and patient-centered care (24), better primary outcome measures for the success of endodontic treatment are a) retention of the tooth, b) absence of pain, c) adequate oral functioning, d) patient satisfaction, and e) adequate overall quality of life (21, 25). Tooth survival has been the focus of some studies of endodontic treatment (18, 26). Although the survival of teeth could be related to the absence of pain symptoms, tooth survival alone is not a definitive indication that patients are asymptomatic after treatment. The importance of evaluating the outcome of pain is all the more evident by the knowledge that pain is a prominent reason for tooth loss (27) and for continued care seeking (4, 5), is a major component of oral functioning (28), and is associated with long-term negative perceptions of dental care (29).

Pain at ≥6 months after root canal therapy (ie, persistent pain) is known to occur and has many possible explanations, including an untreated or incompletely obturated canal, failed coronal seal, tooth fracture, pain associated with an adjacent tooth, referred pain from a nonodontogenic structure, or deafferentation pain. Thus, such

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pain might best be characterized as all-cause pain. Whatever the underlying etiology, it is important for dentists to keep in mind that the subjective feeling of pain is the contributing negative factor for their patients.

Although persistent pain is an important outcome in dentistry, its frequency, severity, and extent of interference with daily life has not been well characterized in dental care populations. Adequate treatments for some of these pains are emerging, and early identification and treatment may improve prognosis (30), but the first step is to determine how widespread the problem is. To our knowledge, no individual study has systematically reviewed the endodontic literature to assess the frequency of persistent pain as a primary outcome. To fill this important knowledge gap, we conducted this systematic review of published endodontic treatment studies and performed a meta-analysis of their data to estimate the frequency of all-cause tooth pain at 6 months or greater in patients who underwent root canal therapy on permanent teeth. We also explored, through subgroup analyses, the influence of treatment approach, study design, follow-up rate, follow-up duration, initial treatment versus retreatment, and quality of reporting (Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] rankings) on the pain frequency estimate.

Methods

Eligibility Criteria

Eligible for inclusion in this review were endodontic procedure articles that were published in any language up to June 5, 2009, and that reported on postoperative tooth pain at a minimum of a 6-month follow-up. The endodontic procedure could be initial treatment or retreatment and surgical or nonsurgical but not pulpotomy, partial pulpectomy, or pulp capping. The unit of observation was a human permanent tooth *in vivo*; primary teeth were excluded. The study outcome was the presence of all-cause pain; we did not differentiate among or exclude on the basis of pain etiologies. The outcome of all-cause tooth pain was considered positive if reported by either the patient or the practitioner. Pain could be spontaneous or provoked by biting, palpation, or percussion.

Inclusion of a study was dependent on having data to calculate the frequency of occurrence of postoperative pain; thus, if the count was not reported for the baseline population from which the follow-up sample was drawn, the article was excluded. This criterion resulted in the inclusion of cohort studies and clinical trials and the exclusion of case series, cross-sectional, and case-control studies. Articles reporting randomized controlled trials were included as a special type of prospective cohort study; however, the pain outcomes associated with individual treatment arms were combined given that our study outcome variable was all-cause pain. Unpublished research and studies that were reported only in abstract form were not considered for inclusion.

Information Sources and Search Strategy

We conducted an initial search in MEDLINE via the PubMed interface covering the period from 1949 to June 5, 2009, using the following search terms: pain OR quality of life OR hypersensitivit*) AND (root canal* OR endodont*) AND (cohort stud* OR prognos* OR treatment failure OR morbidity OR survival analysis OR disease susceptibility OR disease progression OR disease free survival OR time factor* OR recurrence OR clinical course OR inception cohort OR predict* OR outcome OR course OR postoperative OR longitudinal stud* OR treatment outcome OR follow-up stud* OR followup stud* OR prospective) NOT Review (publication type). This search was then adapted for use and run in the Cochrane Library, TRIP database, and Google Scholar. We assumed a priori that most data on the frequency of pain would come from studies that were not necessarily designed to assess pain as their primary outcome. Therefore, we also hand searched the references of prominent articles, literature reviews, and textbook chapters (source list available upon request). Our intent was to be broad in scope to ensure the inclusion of as much relevant existing data as reasonably possible.

Selection Process and Reliability Testing

Identified articles were screened by two of the authors (DRN and EJM) who were trained beforehand to apply the eligibility criteria. Training began with 10 randomly selected abstracts. This was followed by a calibration exercise in which the abstracts of 40 randomly selected articles were independently reviewed by the two raters and the results compared. Interrater agreement was found to be "substantial" (kappa = 0.79) according to published guidelines (31). Training and reliability testing was overseen by another author (MTJ).

If the information in the abstract and title was insufficient to determine eligibility, the article's full text was retrieved and reviewed. If the article was written in a language other than English, a person fluent in that language read the entire article in the presence of the raters who then assessed its eligibility. The raters met to compare their screening results for all articles, and disagreements were discussed until a consensus was reached. If the disagreement could not be resolved, arbitration was sought from two other dentists (MTJ on methodology and ASL on scientific content) whose decision was deemed final.

Data Abstraction and Study Variables

For all articles that met eligibility criteria, the full text was acquired electronically. Data abstraction forms were used by two independent reviewers (DRN and EJM) to obtain the following information: type of endodontic procedures, study design, stage of treatment (initial vs retreatment), use of nontraditional endodontic procedures (ie, N2 paste and external laser ablation of the root tip), number of teeth enrolled, number of teeth followed to 6 months or greater, number of teeth associated with pain, duration of follow-up, number of multiple observations per patient, and STROBE criteria (Table 1). Any differences in the abstraction reports were resolved in the same manner as outlined earlier for the article selection process.

Two articles (32, 33) did not clearly state that only one tooth was treated in each of the enrolled patients. We made the assumption that each tooth came from a separate participant. This is a reasonable assumption given the implied wording of the reports and the low overall frequency (1.2%) of multiple treatments in patients from the final set of articles.

Assessment of Study Quality by Reporting

We used the STROBE criteria (34) to assess the quality of study reporting. A total of 22 criteria pertaining to the title, abstract, introduction, methods, results, or discussion were assessed as either met or not met. Each item was given equal weight (a single point if met). Thus, the possible range of quality summary scores was 0 to 22. We divided studies into lower and higher reporting quality by using a median split of the quality summary scores.

Statistical Methods

We used the random-effects method for meta-regression (35) to determine a summary estimate for frequency of all-cause pain at $\geq$6 months after endodontic treatment. In a sensitivity analysis, we examined whether the deletion of a single study would substantially change the meta-analysis summary estimates. To explore factors influencing the estimates, we performed subgroup meta-analyses for each category of the following variables: i) surgical versus nonsurgical treatment,