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Systematic Review

A systematic review of the impact of apical patency on postoperative pain

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Abstract

Background and aims: Apical patency (AP), a technique in endodontics, involves keeping a small opening in the apical foramen during root canal instrumentation. However, there has been a debate about its effect on postoperative pain. To clarify this issue, this systematic review aimed to study the literature and determine the impact of AP on postoperative pain after endodontic procedures.

Methods: A systematic search was conducted across multiple databases, including PubMed/MEDLINE, Scopus, Web of Science, and Cochrane Library, up to November 2, 2023. Studies on the relationship between AP and postoperative pain in endodontic treatments were included in this research. Relevant articles were independently screened, and data were extracted based on our study aims.

Results: Eleven randomized controlled trial studies met the inclusion criteria. The findings indicated that among the included studies, six demonstrated no differences between the AP and non-AP (NAP) groups in terms of postoperative pain scores. In addition, four studies reported a decrease in operative pain in the AP group compared to the NAP group, and only one study showed that AP increases postoperative pain. However, conflicting evidence was observed in a subset of studies; there were no significant differences between the AP and NAP groups in terms of the postoperative pain scores.

Conclusion: Compared with NAP, AP does not intensify the postoperative pain in teeth with vital and necrotic pulp.

Keywords: Apical patency, Post-endodontic pain, Postoperative pain, Systematic review, Root canal treatment

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Introduction

Pain is the most frequently reported symptomatic complaint in medicine and one of the primary reasons for seeking medical attention (1,2). Postoperative pain is a familiar and predictable experience. Pain management, particularly with specific interventions, can decrease postoperative mortality, facilitate early recovery, and enhance patient satisfaction (3,4). Opioids, acetaminophen, and nonsteroidal anti-inflammatory drugs are mostly used for pain management. Pharmacological interventions for pain can lead to common side effects such as opioid overdose, addiction, nonsteroidal anti-inflammatory drug-related gastrointestinal bleeding, and renal dysfunction (5,6). Achieving optimal treatment outcomes and ensuring patient comfort post-operation are the main objectives in endodontics (7). Root canal procedures are intricate and require great attention to detail to salvage damaged teeth and alleviate excruciating dental pain. Apical patency (AP) is a pivotal concept in this field that has been the subject of considerable interest and debate (8, 9). It refers to the maintenance of cleanliness in the apical region of the root canal, which can potentially influence postoperative pain levels. This procedure involves using smaller instruments to ensure the canal's patency beyond its original terminus, which helps reduce the risk of debris compaction and minimize the likelihood of canal blockage. Even with the latest techniques, AP has caused postoperative pain during apical instrumentation of the tooth (10).

The correlation between AP and postoperative pain has been controversial among endodontists, so a study reported that the maintenance of AP intensified postoperative pain (11). In contrast, another study showed a different result and reported that maintaining AP in molar teeth with necrotic pulp and apical periodontitis was related to less postoperative pain after endodontic procedures (12).

Understanding the potential ramifications of AP in postoperative pain is crucial for endodontic practitioners and can help enhance patient care and refine treatment approaches. Therefore, this article focused on examining the association between AP and postoperative pain.

Materials and Methods

Search strategy

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline for 2020. A systematic search was conducted across multiple electronic databases, including PubMed/MEDLINE, Web of Science, Cochrane Library, and Scopus databases, on November 2, 2023. The search strategy utilized a combination of primary and Medical Subject Headings (MeSH) keywords such as ((“apical patency” OR “patency file” OR “root canal treatment”)

AND ("Post-operative pain" OR "Postoperative pain" OR "post-endodontic pain" OR "post endodontic pain")) were utilized to refine the search and ensure inclusivity. The search was refined until all publications in the review were identified by our search. A complementary search was also conducted on Google Scholar. To eliminate any duplicate entries, the peer-reviewed publications were imported into EndNote X8 and thoroughly examined.

Selection criteria (inclusion and exclusion criteria)

Two reviewers screened titles and abstracts based on predefined criteria. Relevant articles underwent full-text assessment. This systematic review included clinical trial studies that examine the impact of maintaining or not maintaining AP during root canal procedures on postoperative pain occurrence and severity in patients. The exclusion criteria were lack of full-text availability, non-English language studies, preclinical studies, review articles, editorials, letters, conference abstracts, and preclinical studies. The eligible publications underwent independent review. Any potential disagreements were resolved by consulting a third team member.

Data extraction

Two investigators performed data extraction independently using an Excel form. Extracted information recorded study characteristics, including author, publication date, the country where the study was conducted, sample size, mean age, gender, teeth status, pain assessment methods, follow-up, and outcomes related to postoperative pain.

Results

Search strategy results

The electronic search retrieved 1,312 titles/abstracts in the mentioned databases. Of the total articles retrieved, 123 were removed due to duplicate publications in terms of title review. Studies were removed for different reasons, including lack of full-text availability (commentary) (13), review articles (14-17), and irrelevance to the aim of the study (18-20). After the final screening of the studies, the flowchart of Preferred Reporting Items for Systematic Reviews and Meta-Analyses of the Search Strategy is illustrated in Figure 1. In general, 11 studies met the inclusion criteria (11,12,21-29).

Characteristics of the included studies

All included studies had randomized clinical trial designs. Six of the 11 studies included in this systematic review showed no differences between AP and non-AP (NAP) groups in terms of postoperative pain scores. Four studies reported a decrease in operative pain in the AP group compared to the NAP group, and only one study

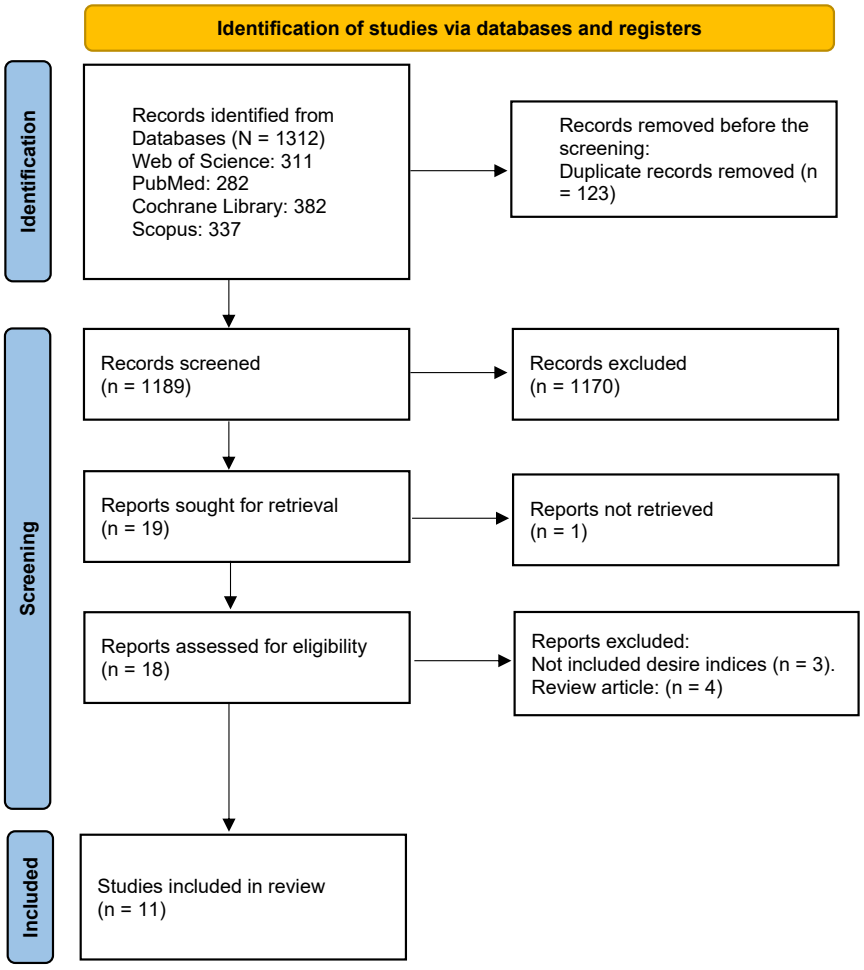

Figure 1. Flowchart for including studies in the systematic review

demonstrated that AP increases postoperative pain. Most studies were conducted in India, and most pain rating scales in the included studies were visual analogue scales (VAS). Studies published from 2009 to 2023 investigated the effect of AP on postoperative pain (Table 1).

Discussion

This systematic review investigated the literature to ascertain the impact of AP on postoperative pain following endodontic procedures. Based on most included studies, especially recent ones, there were no differences between the AP and NAP groups regarding postoperative pain scores. Thus, AP did not intensify the post-operation pain (22-28). The results of most studies agreed on the beneficial effects of AP on postoperative pain (12,21,29). The results of one study revealed that AP can increase postoperative pain compared to the NAP group (11). Research on the effects of AP on postoperative pain in endodontic procedures is ongoing and remains a topic of interest. While maintaining AP has theoretical advantages, such as improved debris removal, optimized irrigation, and reduced inflammatory responses (30,31), its conclusive impact on postoperative discomfort remains elusive. Studies generally suggest that maintaining AP has potential benefits (12,21,29), but conflicting findings and methodological limitations highlight the complexity of this relationship. In line with our study, Yaylali et al demonstrated that maintaining AP does not improve post-endodontic pain in teeth with vital or non-vital pulp compared with NAP.

Furthermore, it does not cause flare-ups or increase analgesic use (16). Abdulrab et al, in another systematic review and meta-analysis study, found that maintaining AP during routine endodontic treatment does not increase post-endodontic pain and may even improve it. However, it is essential to exercise caution when drawing this conclusion due to the limitations mentioned earlier. The heterogeneity statistics are also based on a few publications, which could lead to imprecise results (15). Several factors can justify the difference in the results of the studies. Postoperative pain is multifaceted and influenced by patient-specific factors, including gender, patient age, current opioid use, current smoking, skin incision length, anxiety, other psychological disorders, individual pain experiences (individual pain perception varies due to pain thresholds and psychological factors), diverse treatment protocols, and surgeon experience (32-35). Based on a systematic review, the foraminal enlargement, utilization of hand instruments, engine-driven instruments, reciprocating files, and conventional syringe irrigation technique during root canal treatment may elevate the risk of post-endodontic pain score (14).

Moreover, variations in populations and methodologies, different sample sizes, and follow-up periods among the included studies contribute to the heterogeneous findings. Thus, attributing postoperative pain solely to the presence or absence of AP becomes a complicated and challenging study. To ensure optimal patient comfort post-operation, clinicians may tailor their treatment approaches based on the individual patient's characteristics and the case's complexity (36). Finding a balance between effectively cleaning and shaping the root canal system while avoiding undue trauma or compromising periapical tissues could be critical to achieving this goal (37,38). The success of root canal treatment outcomes (including reducing inflammation and pain) largely depends on the interaction between the patient's infection and host factors before the treatment (38-40).

Additionally, the main factors are the effectiveness of the root canal treatment procedure in creating a favorable microbial environment, reductions in periapical inflammation during the treatment, and the ability of the tooth and its restoration to resist infection after the treatment (38). Inflammation, infection, and neural tissue damage are involved in the pathophysiology of postoperative pain (41,42). Some other technical factors are associated with post-endodontic pain. Ensuring a clear pathway for irrigation solutions is essential to minimizing the risk of debris compaction within the canal system. This can help reduce debris accumulation and contribute to less inflammation and subsequent postoperative pain (43,44).

Additionally, to effectively deliver and circulate irrigants throughout the entire length of the root canal system, it is crucial to maintain AP. This thorough irrigation may improve antimicrobial action, thereby reducing the bacterial load and lowering the risk of postoperative infections or inflammatory reactions that could trigger pain (45). In addition, using smaller instruments and endodontic files to maintain AP helps lessen the chances of creating dentinal microcracks and minimizes invasion in the apical region. This, in turn, could mitigate postoperative discomfort associated with dentinal hypersensitivity or inflammatory responses (11,46).

Therefore, following the principles that can minimize these cases before, during, and after root canal surgery is one of the most important and safest methods to minimize postoperative pain. While awaiting conclusive evidence, taking a personalized approach may be beneficial.

Root canal treatment is a common dental procedure that involves removing infected or damaged pulp from the tooth's root canal system. Proponents of this treatment believe that it can help achieve cleaner and more successful root canal treatments, which can have a positive impact on dental health. They argue that this treatment can help prevent tooth loss and alleviate pain caused by infection (47).

However, skeptics have expressed concern about the potential risks associated with over-instrumentation. Over-instrumentation can lead to damage to the tooth, which can cause further pain and discomfort. Additionally, it can cause the tooth to become more susceptible to infection and can even result in tooth loss in severe cases.

Limitations of the study

Table 1. General Characteristics of the Included Studies in This Systematic Review

Lead author	Date	Country	Sample size (AP/NAP)	Mean Age	Gender (Male %)	Teeth status	Pain assessment methods	Follow-up	Outcomes
Arias (21)	2009	Spain	115/121	NR	NR	Vital and necrotic	Ordinal scale	NR	There was less postoperative pain when AP was maintained in non-vital teeth.
Sharaan (22)	2012	Egypt	40/40	14–60 years	NR	Vital and necrotic	Modified VAS (0–9)	6, 12, 18, 24, and 48 hours	AP did not elevate the post-operation pain significantly (no significant differences between the two groups).
Arora (23)	2016	India	32/33	AP: 23.6 NAP: 26.9	AP: 52.78 NAP: 47.23	Necrotic	Pain scale (0–10)	Daily for seven days	The AP group had a lower incidence of postoperative pain compared to the NAP group, but the difference was not significant.
Garg (24)	2017	India	40/40	NR	NR	Vital and necrotic	VAS score (0–10)	1st, 2nd, and 7th days	AP did not elevate the post-operation pain significantly (no significant differences between the two groups).
Yaylali (12)	2018	Turkey	160/160	AP: 31.5 NAP: 31.0	AP: 46 NAP: 43	Necrotic pulp and apical periodontitis	VAS score (0–100)	12, 24, and 48 hours, as well as 3, 4, 5, 6, and 7 days	Pain scores were significantly lower in the AP group than in the NAP group.
Arslan (25)	2019	Turkey	20/22	Patients aged 18–65 years	AP: 35 NAP:45.45	Necrotic pulp and apical periodontitis	VAS score (0–10)	1, 3, 5, and 7 days, 1 week, and 3, 6, 9, and 12 months	There were no significant differences between the AP and NAP groups in terms of postoperative pain scores.
Shubham (11)	2021	Nepal	80/80	NR	NR	Vital and necrotic	NRS-11 (0–10)	1, 2, and 7 days	Maintenance of AP increased postoperative pain.
Vikmani (26)	2021	India	30/30	NR	NR	first molars with vital pulps	VAS score (0–10)	4, 8,12, 24, 48 hours, as well as 3 and 7 days	There were no significant differences in postoperative pain scores between the AP and NAP groups.
Yousaf (27)	2021	Pakistan	120/120	AP: 42.5 NAP: 50	AP: 45.83 NAP: 40	Necrotic pulp	VAS score (0–10)	24, 48, and 7 days	There were no significant differences in postoperative pain scores between the AP and NAP groups.
Bhagwat (28)	2022	India	30/30	33%: 18–30, 20%: 31–40, 18%: 41–50 29%: 50–60 age groups	45	Vital pulps	VAS score (0–10)	4, 8, 12, and 24 hours, as well as 2, 3, and 7 days	There were no significant differences in postoperative pain scores between the AP and NAP groups.
Negm (29)	2023	Egypt	16/38	AP: 39 NAP: 41.3	AP: 50 NAP: 56.2	Molars with irreversible pulpal pathology and healthy periodontium	VAS score (0–100)	6, 12, 24, and 48 hours	Maintaining AP during a single session is attributed to decreased postoperative pain.

Note. AP: Apical patency; NAP: Non-apical patency; NR: Not reported; VAS: Visual analogue scale; NRS: Numerical rating scale.

Some clinical trial studies in this study needed a more robust methodology, which can confuse the study results. Studies examining the effects of AP often used different protocols and instrumentation techniques, making it challenging to establish a standardized approach. Variations in the definition of AP, the instruments utilized in the population, and pain assessment tools may affect the results. Most studies were conducted at a single center with small sample sizes. This could limit the generalizability of the findings to diverse clinical settings and broader populations.

Conclusion

The currently available evidence on the relationship between AP and postoperative pain indicates that AP does not intensify postoperative pain in teeth with vital and necrotic pulp compared to NAP patients. Most studies demonstrated that AP does not significantly impact postoperative pain, while fewer studies suggested a potential reduction in pain scores. Further well-designed randomized controlled trials with larger sample sizes, diverse patient populations, and standardized methodologies are required to conclusively establish the influence of AP on postoperative pain in endodontic procedures. To obtain a more accurate evaluation of the impact of AP on postoperative pain, it is necessary to address the current methodological limitations. Such an assessment would significantly affect clinical practices and endodontic treatment protocols. Therefore, it is crucial to continue research efforts using rigorous methodologies to determine the precise impact of AP on postoperative pain. This would allow clinicians to refine endodontic practices and improve patient outcomes.

Authors' Contribution

Conceptualization: Samira Rezvani.
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Project administration: Samira Rezvani.
Resources: Samira Rezvani.
Writing–original draft: Samira Rezvani, Amir Kouchakzadeh, and Mohammad Amin Eghtesad.
Writing–review & editing: Samira Rezvani, Amir Kouchakzadeh, and Mohammad Amin Eghtesad.

Competing Interests

The authors declare that there is no conflict of interests.

Ethical Approval

Not applicable.

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