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Bacteria and Virulence Factors in Periapical Lesions

Oral bacteria are the primary cause of the formation and persistence of periapical lesions. Addressing persistent infection after root canal treatment may require retreatment and, eventually, periapical surgery. Two virulence factors are related to inflammation and periapical bone resorption: lipopolysaccharides (LPS) and lipoteichoic acid (LTA). Residual LPS, part of the outer membrane of Gram-negative bacteria, and LTA, found on the cell wall of Gram-positive bacteria, remain in root canals with primary and secondary endodontic infections after canal instrumentation, but no study had detected either LPS or LTA in periapical tissues.

Bronzato et al from the State University of Campinas–UNICAMP, Brazil, conducted a cross-sectional study to determine the presence of 17 bacterial species present in periapical lesions associated with teeth that had undergone root canal treatment or retreatment, and how those bacteria and ensuing LPS and LTA levels are associated with clinical and radiographic outcomes. Patients requiring endodontic microsurgery for periapical lesions, with their diagnoses confirmed by cone-beam computed tomography (CBCT), were divided into primary treatment and retreatment groups. After exposing the periapical lesion, the surgeons removed it; DNA in the lesions was extracted and presence of bacteria was confirmed.

Up to 7 bacterial species were found in 32 lesions (19 from patients undergoing first root canal treatment, 13 retreatment); *Parvimonas micra*, *Porphyromonas endodontalis*, *Enterococcus faecalis* and *Fusobacterium nucleatum* were each identified in ≥20 lesions. LPS and LTA were detected in all samples but did not vary significantly between the primary treatment and retreatment groups. Levels of LPS were significantly higher in patients with tenderness to percussion, while levels of LTA were significantly higher in patients with a history of previous pain. Periapical lesions in teeth undergoing root canal retreatment had significantly higher levels of LPS when they had a post and core crown; lesions had significantly higher levels of LTA when the root had been improperly filled.

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Conclusion

Overall, levels of LTA were significantly higher than were levels of LPS, regardless of previous treatment status. This suggests that periapical lesions of teeth with secondary or persistent infections have more Gram-positive than Gram-negative bacteria. Whether bacteria in lesions are responsible for failure of root canal treatment is unknown; however, bacteria in root canals may supply more bacteria and their associated virulence factors to lesions. The results of this study reinforced the need to eliminate as much bacteria as possible during root canal treatment.

Bronzato JD, Davidian MES, de Castro M, et al. Bacteria and virulence factors in periapical lesions associated with teeth following primary and secondary root canal treatment. Int Endod J *2021;54:660-671.*

Influence of Sealer Type on Postobturation Pain

Reports of the incidence and severity of pain after root canal treatment vary widely. The highest incidence of pain appears to occur on the first and second day postoperatively, while the intensity of pain appears to peak in the first 24 hours, then taper off over the next 7 days. Multiple risk factors, including preoperative pain, sex, tooth type and size of periapical lesion, have shown a significant association with postobturation pain. However, the impact of the root canal sealer on postobturation pain, if any, remains unclear. Tan et al from the National University of Singapore conducted a randomized clinical trial to compare pain at 1, 3 and 7 days postobturation in patients treated with 2 different types of endodontic sealers.

The researchers recruited medically healthy, adult patients requiring nonsurgical root canal treatment who presented at their university's oral health center. Asymptomatic vital, nonvital and previously root-filled teeth were included in the study. After removal of caries and any previous defective restorations, the teeth were randomly assigned to receive 1 of 2 sealers carried to the full working length:

- a tricalcium silicate cement-based sealer (TotalFill BC Sealer)
- a resin-based sealer (AH Plus)

After obturation, all teeth were restored using composite resin or dental amalgam as appropriate. Patients recorded their pain in a pain diary for 7 days after obturation using a 5-point Likert scale, with 0 representing no pain and 5 severe pain. They also noted the nature of the pain and its impact (if any) on daily activities. If needed, ibuprofen was prescribed for analgesia; patients unable to take ibuprofen were prescribed acetaminophen or tramadol.

The study was completed by 160 patients with 183 treated teeth. The median pain score among the 33 patients who reported pain on day 1 was 1 (very mild pain); no patient reported a pain score >3. By day 3, the number of patients reporting any pain dropped to 16, again with a median score of 1 and no patients reporting a score >3. On day 7, only 9 patients reported any pain. Just 1 patient needed to use an analgesic; 3 patients reported that the pain affected their daily activities (Table 1). Four prognostic factors were found to have a significant relationship with postobturation pain:

- moderate to severe preoperative pain
- a complaint of provoked pain
- pulp status
- the use of sonic activation during treatment

However, the number of patients who experienced pain was too small for a multivariate analysis of these factors to be conducted. AH Plus sealer was associated with more cases of extrusion,

Table 1. *Postobturation pain scores by sealer.*

	AH Plus (*n* = 83 patients)			TotalFill BC (*n* = 80 patients)		
Pain score	**Day 1**	**Day 3**	**Day 7**	**Day 1**	**Day 3**	**Day 7**
No pain	67 (80.7%)	75 (90.4%)	80 (96.4%)	62 (77.5%)	72 (90.0%)	74 (92.5%)
Very mild pain	10 (12.0%)	5 (6.0%)	2 (2.4%)	12 (15.0%)	6 (7.5%)	2 (2.5%)
Mild pain	4 (4.8%)	2 (2.4%)	1 (1.2%)	1 (1.3%)	0 (0.0%)	3 (3.8%)
Moderate pain	2 (2.4%)	1 (1.2%)	0 (0.0%)	5 (6.3%)	2 (2.5%)	1 (1.3%)

No patients reported severe pain at any time point.

but this did not affect patients' perception of postobturation pain.

Conclusion

The results of this study showed that patients experienced mild or no pain regardless of which type of sealer was used. A contributing factor to this result could be the high technical standard maintained by the endodontists treating the patients.

Tan HSG, Lim KC, Lui JN, et al. Postobturation pain associated with tricalcium silicate and resin-based sealer techniques: a randomized clinical trial. J Endod *2021;47: 169-177.*

Predictors Associated with Endodontic Surgical Outcomes

The emergence over the past 2 decades of advances in endodontic surgery under the heading of endodontic microsurgery has resulted in greater success in patient treatment. While many studies have looked at the impact of endodontic microsurgery on patient outcomes based on such variables as patients' age, tooth type and lesion size, little work has been done to evaluate such factors as sequence of treatment, retropreparation depth and the use of guided tissue regeneration (GTR) in conjunction with endodontic microsurgery. The widespread adoption of cone-beam computed tomography (CBCT) for diagnosis and treatment planning of endodontic surgery also allows for more accurate evaluation of treatment outcomes than was possible using periapical radiographs.

Table 2. *Favorable outcomes following GTR as measured by different modalities.*

	n	GTR	No GTR
Periapical radiographs			
Complete healing (score 6)	68	47	21
Incomplete healing (score 4 or 5)	5	2	3
Cone-beam computed tomography			
Complete healing (score 6)	44	39	5
Incomplete healing (score 4 or 5)	27	11	16

Azim et al from the University at Buffalo, New York, undertook a study seeking to answer the following questions:

- What impact does using CBCT rather than periapical radiographs have on perceived outcomes of endodontic microsurgery?
- What prognostic factors affect the success rate of endodontic microsurgery?
- What effect does GTR have on apical bone remodeling?

The researchers retrospectively identified adult patients with signs of apical periodontitis upon clinical and radiographic examination who underwent endodontic surgery at their university's clinic over a 3-year period. All treated teeth had adequate coronal restoration and showed no periodontal disease or any confirmed signs of vertical root fracture.

Before surgery, periapical radiographs and CBCT scans of the affected teeth were taken. Endodontic microsurgery followed a standard protocol, including a full-thickness flap reflection, osteotomy to expose the root apices, removal of the periradicular pathoses, root-end resection and canal irrigation from the root end. A freeze-dried allograft and a resorbable collagen membrane were used in cases where a bone graft and a barrier were recommended. At the end of the surgical procedure, a fresh set of periapical radiographs was taken. Follow-ups, which included a clinical examination, periapical radiographs and CBCT scans, occurred between 1 and 3 years after surgery. As shown on the radiographs, healing was scored on a standard 6-point scale, then divided into 4 categories:

- complete healing (score of 6)
- incomplete healing (scores of 4 or 5)
- uncertain healing (score of 3)
- unsatisfactory healing (scores of 2, 1 or 0)

CBCT scans were scored 0, 1 or 2 for each of the periradicular area, the resection plane and the cortical plane, thus also creating a final score of 0 to 6.

Of the 85 teeth (68 patients) at follow-up, 6 teeth showed clinical signs of failure, 1 due to a missed canal during surgery and 5 with vertical root fracture. After 2 teeth in 2 patients were eliminated from analysis for reasons unrelated to their endodontic surgery, the periapical radiographs showed a success rate of 88% vs a success rate of 86% based on CBCT scans. The only prognostic factor that had a significant impact on outcomes was error during surgery. While the use of GTR did not correlate to the

type of healing seen on periapical radiographs, there was a significant correlation seen on CBCT scans (Table 2).

Conclusion

In the end, little difference in success rate was found between evaluation by periapical radiograph and evaluation by CBCT scans, nor did any potential prognostic factors (other than operator error) demonstrate any significant impact on outcome. However, periapical radiographs appear to be significantly less accurate than CBCT scans for evaluating healing in restorations employing GTR.

Azim AA, Albanyan H, Azim KA, Piasecki L. The Buffalo study: outcome and associated predictors in endodontic microsurgery–a cohort study. Int Endod J *2020;54:301-318.*

Adverse Pulp Reactions After Traumatic Dental Injury

After a traumatic dental injury, various adverse pulp reactions—pulp necrosis with infection, pulp canal obliteration, root resorption—may occur from damage to or interference with neurovascular supply. Studies have shown that mild traumatic dental injuries (such as enamel infractions and enamel fractures) rarely lead to adverse pulp reactions, while moderate and severe traumatic dental injuries (such as complicated crown fractures, lateral luxation, extrusive luxation, intrusion and avulsion) are more likely to lead to adverse pulp reactions and loss of alveolar bone.

Early intervention, such as pulp capping or pulpotomy, leads to a good prognosis after trauma in teeth with exposed pulp. Revascularization of the pulp may be possible even if the apical vascular supply of the pulp is severely disturbed, with final outcome related primarily to the size of the apical foramen and the prevention of pulp space infection. Similarly, the diameter of the apical foramen is an important predictor of pulp necrosis in moderate and severe luxation injuries and avulsed teeth. Pulp canal obliteration is found more frequently in immature teeth than in mature teeth. Ironically, mild traumatic dental injuries are more likely to develop pulp canal obliteration because of increased probability of pulp survival.

Bratteberg et al from the University of Bergen, Norway, conducted a retrospective longitudinal study of adolescents to determine the prevalence and risk factors of various pulp sequelae after traumatic dental injury. Traumatic dental injuries were classified as mild, moderate or severe, according to clinical significance. Criteria for sequelae were as follows:

- **pulp necrosis:** lack of pulp sensibility, tenderness to percussion, color change of the crown (gray/blue), periapical radiolucency
- **pulp canal obliteration:** yellow discoloration of the crown, radiographic signs of reduction in the size of the pulp chamber
- **root resorption:** metallic percussion sound, lack of mobility, infraocclusion, radiographically visible loss of hard tissue, presence of apical periodontitis, pink discoloration of the crown

Of the 2055 ≥16-year-olds participating in the study, 338 had suffered traumatic dental injuries affecting 637 teeth. Pulp necrosis was seen in 43 teeth, significantly more often in teeth that had suffered dental hard tissue injuries than in teeth with luxation injuries. Although a higher proportion of immature teeth developed pulp necrosis than mature teeth developed pulp necrosis, the difference did not reach statistical significance. Pulp canal obliteration was seen in 16 teeth, all of which had suffered luxation injuries. All 13 teeth with radiographic signs of root resorption had pulp necrosis.

Conclusion

Overall, pulp necrosis, pulp canal obliteration and root resorption following traumatic dental injury in this group of adolescents were relatively infrequent. The authors suggested that the low occurrence of pulp necrosis in this study might be related to the availability of free dental care provided by the Norwegian Public Dental Health Service to all children until their eighteenth birthdays.

Bratteberg M, Thelen DS, Klock KS, Bårdsen A. Traumatic dental injuries and pulp sequelae in an adolescent population. Dent Traumatol *2021;37:294-301.*

In the next issue:

- Treatment outcomes of immature teeth with a crown fracture
- Outcomes of periapical surgery of molars
- Osteosarcoma of the anterior maxilla: a case report

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