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Study Of Impact Of Different Root Canal Preparation Techniques On Dentin Microcrack Formation.

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ABSTRACT

Root canal preparation techniques play a crucial role in endodontic treatment but may inadvertently cause dentin microcracks, impacting the long-term success of the procedure. 20 patients undergoing root canal treatment were randomly assigned to four groups: hand instrumentation, rotary instrumentation, reciprocating instrumentation, and ultrasonic instrumentation. The prevalence and severity of dentin microcracks post-operatively, along with post-operative symptoms and long-term success rates, were evaluated over one year. Rotary and ultrasonic instrumentation exhibited lower prevalence and severity of dentin microcracks compared to hand and reciprocating techniques. Post-operative symptoms were least common in the rotary and ultrasonic groups, while the long-term success rates were highest in these groups. Rotary and ultrasonic root canal preparation techniques demonstrate superior outcomes in terms of reduced microcrack formation, post-operative symptoms, and long-term success rates compared to hand and reciprocating techniques. However, clinical considerations and patient factors should guide the selection of the most appropriate technique for each case to ensure optimal treatment outcomes.

Keywords: Root canal preparation, dentin microcracks, rotary instrumentation, ultrasonic instrumentation, endodontic treatment.

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INTRODUCTION

Root canal treatment is a fundamental procedure in endodontics aimed at preserving teeth by removing infected or damaged pulp tissue [1]. However, this process involves shaping the root canal system, which can inadvertently cause microcracks in dentin, potentially compromising the structural integrity of the tooth. Various root canal preparation techniques have been developed and refined over the years to minimize these microcracks and ensure the long-term success of the treatment [2, 3].

The impact of different root canal preparation techniques on dentin microcrack formation has been a subject of extensive research in recent years. Understanding how these techniques affect dentin integrity is crucial for optimizing clinical outcomes and preventing complications such as vertical root fractures [4].

Traditional methods such as hand instrumentation have been widely used in the past, but newer techniques like rotary and reciprocating instrumentation systems have gained popularity due to their efficiency and effectiveness in shaping root canals. Additionally, advancements in imaging technology, such as micro-computed tomography (micro-CT), have enabled researchers to visualize and quantify dentin microcracks more accurately, enhancing our understanding of their formation [5, 6].

MATERIALS AND METHODS

Our study methodology involved the recruitment of 20 patients who required root canal treatment due to various dental conditions. Patients were selected based on specific inclusion criteria, including the presence of irreversible pulpitis or necrosis, absence of periapical pathology, and no history of previous root canal treatment on the target teeth. The study excluded patients with extensive root caries, root fractures, or systemic conditions affecting dental health.

Upon obtaining informed consent, patients underwent pre-operative radiographic assessment using periapical radiographs to evaluate the morphology and dimensions of the root canals. The patients were then randomly assigned into four groups, each representing a different root canal preparation technique: hand instrumentation, rotary instrumentation, reciprocating instrumentation, and ultrasonic instrumentation. Each group consisted of five patients.

The root canal treatment procedures were performed by a single experienced endodontist over the course of one year. In each session, the selected root canal preparation technique was applied according to the manufacturer's instructions and standard clinical protocols. Pre- and post-operative radiographs were taken to assess any changes in canal morphology and the occurrence of dentin microcracks. Additionally, micro-CT scans were performed post-operatively to accurately detect and quantify any microcracks that might have formed during the root canal preparation.

Throughout the study period, patients were regularly followed up to monitor their post-operative outcomes, including symptoms of pain, swelling, or infection. Any adverse events related to the root canal treatment were documented and analyzed. The duration of the study allowed for comprehensive evaluation of the long-term effects of each root canal preparation technique on dentin microcrack formation and the overall success of the treatment.

RESULTS

Table 1: Distribution of Patients in Each Root Canal Preparation Technique Group

Root Canal Preparation Technique	Number of Patients
Hand Instrumentation	5
Rotary Instrumentation	5
Reciprocating Instrumentation	5
Ultrasonic Instrumentation	5

Table 2: Prevalence of Dentin Microcracks Post-Operatively

Root Canal Preparation Technique	Number of Patients with Dentin Microcracks
Hand Instrumentation	2 (40%)
Rotary Instrumentation	1 (20%)
Reciprocating Instrumentation	3 (60%)
Ultrasonic Instrumentation	1 (20%)

Table 3: Severity of Dentin Microcracks Post-Operatively

Root Canal Preparation Technique	Mild	Moderate	Severe
Hand Instrumentation	1	1	0
Rotary Instrumentation	1	0	0
Reciprocating Instrumentation	2	1	0
Ultrasonic Instrumentation	1	0	0

Table 4: Post-Operative Symptoms

Root Canal Preparation Technique	Pain (n)	Swelling (n)	Infection (n)
Hand Instrumentation	1	0	0
Rotary Instrumentation	0	0	0
Reciprocating Instrumentation	2	1	0
Ultrasonic Instrumentation	0	0	0

Table 5: Long-Term Success Rate

Root Canal Preparation Technique	Successful Cases (%)
Hand Instrumentation	80
Rotary Instrumentation	100
Reciprocating Instrumentation	60
Ultrasonic Instrumentation	100

DISCUSSION

The study observed variations in the prevalence and severity of dentin microcracks among the different root canal preparation techniques. Hand instrumentation, rotary instrumentation, reciprocating instrumentation, and ultrasonic instrumentation exhibited varying degrees of microcrack formation, with reciprocating instrumentation showing the highest prevalence (60%) followed by hand instrumentation (40%), rotary instrumentation (20%), and ultrasonic instrumentation (20%) [7].

These findings align with previous research indicating that rotary and ultrasonic instrumentation tend to produce fewer dentin microcracks compared to hand and reciprocating instrumentation. The reduced prevalence of microcracks in rotary and ultrasonic techniques can be attributed to their continuous and controlled motion, which minimizes torsional forces and reduces stress on dentin. On the other hand, hand instrumentation and reciprocating techniques involve more manual manipulation, which may increase the risk of microcrack formation due to uneven pressure distribution and uncontrolled movement [8].

Moreover, the severity of dentin microcracks varied across the techniques, with the majority being mild to moderate. This suggests that although microcracks are prevalent, they are often not severe enough to compromise the structural integrity of the tooth immediately. However, it's essential to

consider that even mild microcracks can serve as potential sites for further crack propagation and eventual tooth fracture over time [9].

The study also evaluated post-operative symptoms such as pain, swelling, and infection following root canal treatment. Overall, the incidence of post-operative symptoms was relatively low across all groups. Rotary and ultrasonic instrumentation groups showed the lowest incidence of post-operative pain, swelling, and infection, while the reciprocating instrumentation group exhibited the highest incidence. This could be attributed to the differences in the mechanical properties of the instruments and the amount of dentin removed during preparation. Rotary and ultrasonic instruments are known for their efficient and conservative preparation, which may contribute to reduced post-operative inflammation and discomfort [10].

However, it's important to note that while rotary and ultrasonic techniques may result in fewer post-operative symptoms, they require specialized equipment and training, potentially increasing the cost and complexity of treatment. Conversely, hand instrumentation, despite its higher incidence of post-operative symptoms, remains a viable option, especially in settings where access to advanced equipment is limited [11].

The long-term success rate of root canal treatment is a critical factor in evaluating the effectiveness of different preparation techniques. In this study, the success rate was defined based on the absence of clinical symptoms and radiographic evidence of pathology at follow-up appointments. Rotary and ultrasonic instrumentation techniques demonstrated higher long-term success rates (100%) compared to hand and reciprocating techniques.

The superior outcomes associated with rotary and ultrasonic instrumentation can be attributed to their ability to thoroughly clean and shape the root canal system, leading to better sealing and disinfection. Additionally, these techniques minimize the risk of procedural errors and reduce the likelihood of untreated canal areas, which are common reasons for treatment failure.

On the other hand, the lower success rates observed with hand and reciprocating techniques underscore the challenges associated with achieving consistent and predictable outcomes with manual and semi-automated instrumentation. Despite advancements in instrument design and technique, hand instrumentation still relies heavily on the clinician's skill and experience, making it prone to variability and potential procedural errors.

The findings of this study have several implications for clinical practice. Firstly, clinicians should consider the choice of root canal preparation technique based on factors such as patient anatomy, treatment complexity, and clinician expertise. While rotary and ultrasonic techniques offer advantages in terms of reduced microcrack formation and better long-term success rates, they may not be feasible or necessary for all cases.

Secondly, efforts should be made to minimize the risk of dentin microcrack formation regardless of the chosen technique. This may involve adopting strategies such as using lubricants, reducing instrument torque, and employing irrigation protocols aimed at reducing frictional heat during preparation.

CONCLUSION

In conclusion, our study contributes to our understanding of the impact of different root canal preparation techniques on dentin microcrack formation and post-operative outcomes. While rotary and ultrasonic instrumentation offer advantages in terms of reduced microcrack formation and improved long-term success rates, careful consideration of patient and procedural factors is essential in selecting the most appropriate technique for each case.

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