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The torsional resistance of NiTi reciprocating endodontic instruments: A literature review

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Abstract

Purpose: This literature review examines the torsional resistance of NiTi reciprocating endodontic instruments, analyzing factors such as design, heat treatment, and brand comparison. Torsional resistance is a key property, as instrument separation due to excessive torque can lead to clinical failure.

Methods: Studies were gathered from PubMed and Scopus using terms like "torsional resistance" and "NiTi reciprocating instruments." Recent literature was prioritized, focusing on laboratory tests that simulated clinical conditions and comparing different brands of NiTi instruments with various heat treatments.

Introduction

Nickel-titanium (NiTi) instruments have revolutionized endodontics, particularly with the development of reciprocating systems that reduce the risk of instrument separation and simplify canal shaping.[1] These systems alternate rotational movements, allowing for more effective shaping with fewer instruments. Despite these advancements, torsional fractures remain a significant challenge in endodontic practice.[2,3] Torsional fracture occurs when the applied torque surpasses the instrument's resistance, leading to separation. This type of failure is particularly problematic during root canal therapy, as the retrieval of a broken instrument can be complex and compromise treatment outcomes.[3] Therefore, the resistance to torsional stress is a critical parameter for evaluating the performance of endodontic instruments.

Materials and methods

This review considered peer-reviewed articles published in the last 10 years. A comprehensive search was performed using databases such as PubMed and Scopus, applying keywords including "torsional resistance," "NiTi instruments," and "reciprocating systems." Articles that assessed the influence of design, diameter, taper, and heat treatment on the performance of NiTi instruments were selected.[4] Special attention was given to studies utilizing mechanical fatigue tests under conditions that mimic clinical practice.[5] Instrumentation systems were compared, with a focus on reciprocating NiTi instruments like Reciproc Blue and WaveOne Gold, which are widely used in clinical settings. Heat treatment techniques, such as M-Wire and Blue Wire, were also evaluated to understand their impact on torsional resistance.[6]

Results

The findings from various studies indicate that instruments treated with advanced heat technologies, such as M-Wire and Blue Wire, exhibit superior torsional resistance compared to non-treated NiTi instruments. The system Reciproc Blue demonstrated higher torsional resistance than WaveOne Gold, which was attributed to its enhanced heat treatment process.[7] However, regardless of the system, repeated usage reduces torsional resistance, increasing the risk of fracture.[8] Studies also revealed that instruments with a greater taper or diameter generally have higher torsional resistance.[3] However, this increase in resistance often comes at the cost of flexibility, which is essential for navigating complex root canal anatomies.

Discussion

The introduction of heat-treated NiTi alloys has markedly improved the performance of endodontic instruments by increasing their torsional resistance. These treatments alter the crystalline structure of the alloy, making it more resistant to mechanical stresses encountered during root canal shaping.[9] The specific heat treatment process varies among manufacturers, which explains the differences in performance between instrument systems.[10] Despite these improvements, torsional resistance is not uniform across all instruments, and the choice of instrument must balance between flexibility and strength. Instruments with larger diameters and tapers may provide better resistance but are less adaptable to complex curvatures, where flexibility is crucial to avoid transportation or perforation of the canal.[11]

Conclusion

Torsional resistance is a key factor in the durability and effectiveness of NiTi reciprocating instruments. Heat treatment processes such as M-Wire and Blue Wire have enhanced the resistance of these instruments, but careful attention must be paid to the number of uses. Repeated clinical use decreases resistance, making single-use or limited use advisable to avoid fractures.

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None.

Conflicts of interest

None.

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