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Nickle titaniumts in endodontics: A Review

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Abstract

Preparation of root canal system is one of the most important procedures in endodontic treatment. There has been a constant quest for quicker, safer and more efficient method for cleaning and shaping of root canals.[1] The two primary goals of root canal instruments are, to provide a biologic environment conductive to healing and to develop a canal shape receptive to sealing.[2, 3] Historically most instrument used to shape the canal were designed to be used by hand.

Keywords: Nickel titanium, endodontic instruments

Introduction

Although initially most instruments used in general dentistry were also used for endodontic therapy, later on some hand instrument are designed specially for endodontic procedure. In addition many different types of instruments have been designed for procedures inside the pulp space. This include manually operated instrument for root canal preparation, engine driven and energized instrument for canal preparation.[4] Initially root canal hand instruments were manufactured from carbon steel, however, due to carbon steel these instruments had shown significant corrosion. Subsequently, the use of stainless steel greatly improved the quality of instruments. [5, 6]

More recently, the introduction of Ni-Ti alloy for the manufacturing of endodontic instrument has resulted in significant changes in the field of Endodontics. The advent of nickel-titanium alloy allowed the development of new endodontic instruments and techniques. [7]

Recent changes in both metallurgy and endodontic concepts have led to the introduction of a range of new instruments which do not confirm to these specifications. These instruments have been widely adopted, and appear to give consistently better results in root canal treatment. However, the conventional 2% taper instruments are essential for the initial exploration of most root canals, for difficult procedures such as bypassing separated instruments, and for the apical preparation of some difficult canals.

Use of automated Ni-Ti instruments was a logical development to improve the efficiency of the treatment. Separation of instruments while preparing root canals is something that has plagued all dental practitioners. Therefore, an evaluation of effect of speed and torque on the rotary Ni-Ti instruments is of value to the clinician.

Historical Background of Standardization of Endodontic Instruments

Historically, very little was done to improve the quality or standardization of instruments until the 1950s, when two research groups started reporting on the sizing, strength, and materials that can be used for hand instruments. Before the establishment of standardization, endodontic instruments were numbered from 1 to 12 and there was no system for determining the instrument taper.

The necessity for development of worldwide standards for endodontic instruments had arisen when it was realized that a considerable amount of variation existed between root canal instruments of different manufactures.

By 1962, a working committee on standardization had been formed including manufacturers, the American Association of Endodontists (AAE), and the American Dental Association (ADA). This group evolved into the present-day International Standards Organization (ISO). At that time proposals for standardizing instruments were produced and covered the following:

1. The diameter, taper of instrument and filling point.
2. The graduated increase in size from one instrument to the next.
3. An instrument-numbering system based on the diameter of the instrument. [12, 13]

It was not until 1976, however, that the first approved specification for root canal instruments was published (ADA Specification NO. 28), 18 years after Ingle and Levine first proposed standardization in 1958. After the introduction of standardized instruments, changes were introduced supporting the universal use of stainless rather than carbon steel; other significant changes were the addition of smaller and larger sizes as well as color coding and the re-emergence of power-driven instruments.

Use of Ni-Ti in Endodontics

In the early 1960s, nickel–titanium was developed by W. F. Buehler, a metallurgist investigating nonmagnetic, salt resisting, waterproof alloys for the space program at the Naval Ordnance Laboratory in Silver Springs, Maryland, USA.[8] The thermodynamic properties of this intermetallic alloy were found to be capable of producing a shape memory effect when specific, controlled heat treatment was undertaken.

The alloy was named Nitinol, an acronym for the elements from which the material was composed; ni for nickel, ti for titanium and nol from the Naval Ordnance Laboratory. Nitinol had been found to have unique properties of shape memory and super-elasticity. The super-elastic behavior of Nitinol wires means that on unloading they return to their original shape before deformation (Lee et al. 1988).[9]

As suggested in the separate studies conducted by Andresen and Morrow in 1978, [2] Andresen et al. in 1985 [11], Schäfer in 1997, [12] the Ni-Ti alloy has found to be greater strength and a lower modulus of elasticity compared with stainless steel, which may be an advantage in the use of Ni-Ti instruments. Ni-Ti alloy are overall softer than Stainless Steel, are not heat treatable, have a low modulus of elasticity (about one fourth to one fifth that of stainless steel) but a greater strength are taught and more resilient, and show shape memory super elasticity. [3, 2]

Super elastic nickel-titanium alloy instruments are often recommended to the practitioner to negotiate curved canals without the deleterious effect. (Al Omari et al.1992)[5] Unfortunately these more flexible alloy exhibit different mechanical properties compared with stainless steel.[6] Now made universally of nickel titanium and stainless steel rather than carbon steel, K-type instruments are produced using one of two techniques.

Air –driven high speed hand piece were first developed in the late 1950s, the innovators many benefits. Many dentists acquired such high speed hand piece by the early 1960. Rotary Ni-Ti instruments are now well accepted and considered exceptional in their ability to shape root canals. [11]

Need for flexible files

From the start of the 20th century until the 1970, the molar teeth with sharply curved canals were rarely treated. In fact Grossman wrote in his textbooks as late as 1967 that teeth with canal curvatures of 45 degree and greater could not be treated successfully without surgery.[13] However, traditional hand instruments often failed in achieving these objectives, especially when used in severely curved canals (Briseno and Sonnabend 1991).[3] Although this was not known at that time, the main reason of failure was that most endodontic files used then were rather inflexible.

Table 1: Comparative Evolution of Hand Instrumentation and The Solutions Provided By Rotary Instrumentation.

Problems-Hand Instrumentation	Solutions-Rotary Instrumentation
Gaining access to the apical third of the canal	Enhanced crown-down technique enables a direct and unimpeded pathway to the apical third of the canal without instrument binding in the coronal third.
Shaping of the apical to middle third of the canal	Crown-down technique along with variable tapered instruments enhances the canal shaping in this region.
Difficulty visualizing working length with small instruments on radiographs	Enhanced opening in the coronal and middle third of the canal allows better initial penetration with large instruments for working length.
Apically pushing debris	Instruments enhance the coronal removal of debris
Deviations from the central axis of the canal	Better centering ability is offered with some limitations-deviations with larger instruments.
Apical deviations such as zipping	Deviations are minimal to nonexistent with small rotary instruments and if instruments are excessively used to the working length.
Breakage (separation) of instruments in small and curved canals	Breakage will occur if a pathway or glide path has not been created with small hand instruments. Breakage will also occur with excessive pressure and at higher speeds and if larger, tapered instruments are used, which significantly bind along the canals walls. Breakage will also occur while passing the instruments through sharp curves, S-shaped canals or through canals that have rapid, abrupt deviations or ledges.
Shapes too narrow for some obturation techniques	Consistent shapes are possible with variably tapered instruments.

Conclusion

This article is aimed to providing a comprehensive review of review of rotary endodontics with emphasis on the behavioral properties of Ni-Ti and it mode of application.

Although not universally used, rotary instruments have gained considerable interest and most often is used in combination with hand instruments.

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