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Mechanized Instrumentation of Root Canals Oscillating Systems

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ABSTRACT

Cleaning and shaping are important steps in the root canal treatment. Despite the technological advances in endodontics, K and Hedströen files are still widely used. In an attempt to be more effective in preparing the root canals, faster and more cutting efficient kinematic, alloys and design alternatives utilizing mechanically oscillating or rotary files are proposed. Even with all these technological innovating alternatives, the preparation of root canals remains a challenge.

Keywords: Endodontics, K Files, Cleaning and shaping.

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INTRODUCTION

One of the most important phases of endodontic treatment is the biomechanical cleaning and shaping of the root canal.[1] Basically, this is achieved by files first creating the space for irrigants to clean and disinfect and later shaping the root canal for obturation.

Though there are several methods to accomplish the task of instrumentation, the most widely held method is conventional hand instrumentation usually performed with K-type files and/or Hedströen files. Despite the technological advances in endodontics, these instruments are still widely used.

One of the primary reasons hand instrumentation has held its popularity is due to the great tactile sensitivity the instrument transfers to the clinician allowing detailed negotiation and instrumentation through a variety of complex anatomical morphologies in root canals. Used judiciously, hand files can solve the challenges routinely faced in clinical practice.

However, in an attempt to be more effective in preparing the root canals, faster and more cutting efficient kinematic alternatives utilizing mechanically oscillating or rotary files are proposed. Despite the avant-garde appeal, the origins of the mechanized instruments are traced back to as early as the nineteenth century.

The first mechanized endodontic instrument was the Gates Glidden drill[2] introduced in 1885. This was followed in 1889 by William H Rollins' development of the first endodontic handpiece which used special steel needles and, according to the manufacturer, rotated at the low speed of 100 rpm to prevent instrument fractures. In 1892, Oltramari expanded on the design using needles with a square cross-section in the handpiece that would be passively placed to the apex then before starting the handpiece.[3]

It was not until 1928 when W&H in Bürmoos, Austria improved the existing contra-angle and launched a handpiece named Cursor. This innovation combined the rotation with vertical movements. The same company also introduced to the European market the Racer handpiece, designed only with vertical kinematics.

Later in 1964, MicroMega in Besançon, France began selling the Giromatic in Europe. This handpiece was designed to use hand files with specifically adapted handles and a reducer which provided a 90° reciprocal oscillating movement of the instruments. During the same period, Kerr Dental in Karlsruhe, Germany produced the Endolift, a handpiece also with 90° of oscillation but combined with vertical movements.

One major evolution in the development of endodontic handpieces came in 1984 with the advent of the Canal Finder System (CFS), developed by Dr Guy Levy.[4] The CFS represents the first handpiece with partially flexible kinematics. This handpiece was designed so the vertical penetration of the file is determined by the amount of resistance felt in the 90° oscillation and the file is not capable of totally advancing vertically until a full 90° oscillation is met. This design was an attempt to make the anatomy of the root canal, or at least the diameter of the root canal, the determining factor influencing the kinematics applied to the instrument.

Over the last 30 years several other endodontic handpieces have launched, some with varying degrees of similarity to the CFS. Examples of such systems include Endo-Gripper by Moyco, North America with a 90° reciprocal oscillating handpiece, the Endo-Lift M4 by Kerr United States with a 30° reciprocal oscillating design, the Intra-Endo 3-LD from Kavo, Germany and the Dynatrak from DeTrey, Germany, both 90° oscillating reciprocal products, Endoplaner from Micron, Switzerland designed with a vertical and oscillating-rotating kinematic, Channel-Leader of SET 2000, Germany, which oscillates approximately 25° with vertical kinematics, and the EndoEze system from Ultradent, USA.

Since 1992, a large number of new endodontic systems have been brought to market. The significant advancement at this time was the emergence of the nickel-titanium (NiTi) file with new designs, tapers, and a superior elasticity and flexibility that could allow continuous rotation.[3,5,6] These modifications allowed a decrease in the number of instruments for root canal preparation. Today there are over 40 different systems using NiTi files, especially rotary systems, with a variety of cutting-edge designs, cross section, helix angles, tapers, encodings and protocols for use (Fig. 1).

Given this scenario, it must be asked:

Does the fact that there are so many alternatives indicate that no one system is fully satisfactory in meeting the criteria necessary for biomechanical cleaning and shaping of the root canal?

Several studies indicate that NiTi instruments provide a centered root canal preparation when used with a rotary system. However, clinical experience and literature indicate that these instruments were prone to fracture.[7-10] In an attempt to minimize recurrent fractures of NiTi files while taking advantage of the excellent flexible characteristics, dental manufacturers have since, developed oscillatory systems using NiTi files. In 2008 Yared[11] first reported in literature the use of a NiTi ProTaper file with a previously designed oscillating nonreciprocal, i.e. approximately 120° to one direction and 30° in reverse, electric motor developed by ATR an Italian manufacturer. It was the impact of this research which verified the effectiveness of combining nonreciprocal oscillating kinematics with NiTi files.

Motivated by this new modality, which used pre-existing instruments as well as an engine also already in production, in 2010 Dentsply brought to market the Wave-one system by the subsidiary Maillefer, Switzerland and Reciproc System by subsidiary VDW, Germany. During the same period, Ultradent launched a North American system called Tilos, which also incorporates NiTi files but with an oscillatory reciprocating 30° movement handpiece. These systems are safer and designed to use as few as one or two instruments in some cases, depending on the anatomy. Due

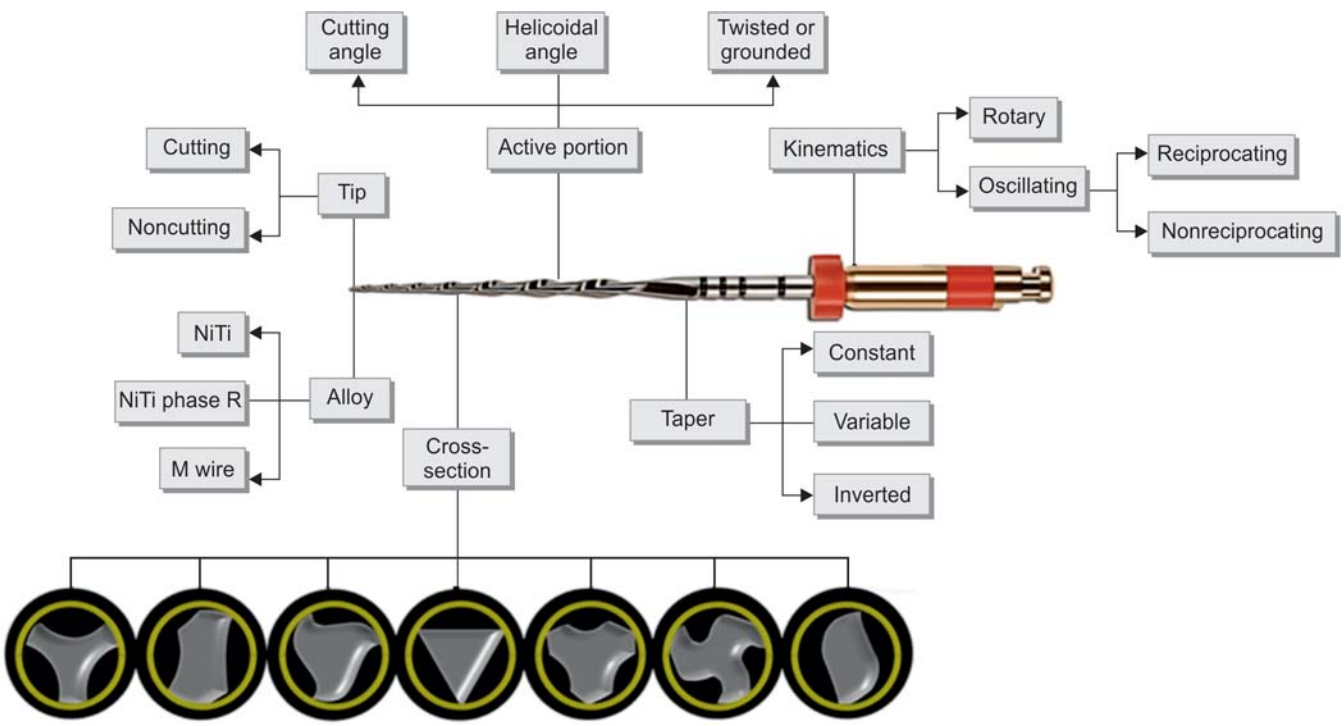


Fig. 1: Variations in the mechanized instruments used today

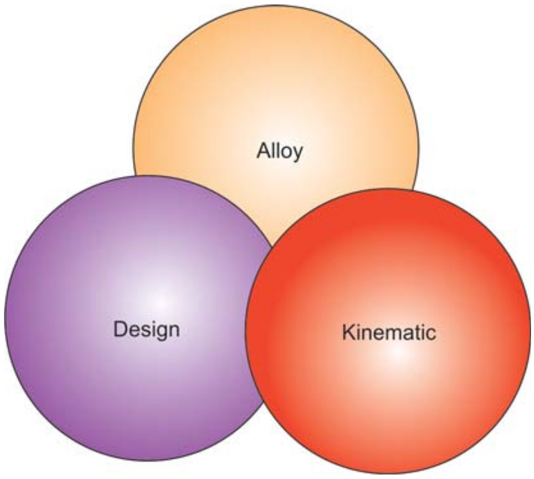


Fig. 2: Elements that must be balanced to provide an effective and safe preparation

to the short time they have been on the market, few studied have been published but because of clinical experience with this type of instrumentation a few observations can be made.

The instruments for preparing root canals must have a balanced triad formed by alloy, design and kinematics (Fig. 2).

Wave-one system and reciproc system rely on kinematic safety and have added as a novelty, M Wire NiTi files. These files are heat treated and are reported to provide better resistance to flexural fatigue.[12] The kinematics is of these systems are oscillatory so the combination including this new variable must be analyzed and reviewed particularly with regard to safety and efficacy.

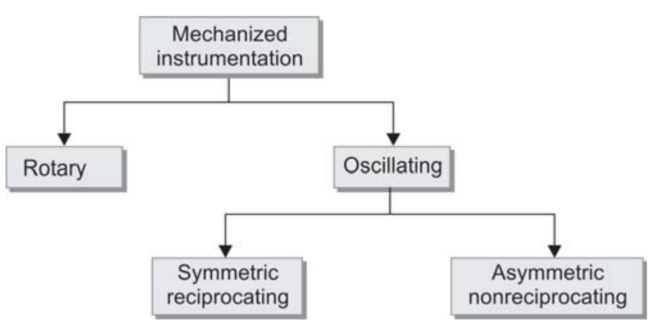
The movement which is now used is outlined in Flow Chart 1.

Most systems using NiTi files are rotary systems and use speeds ranging from 280 to 500 rpm.

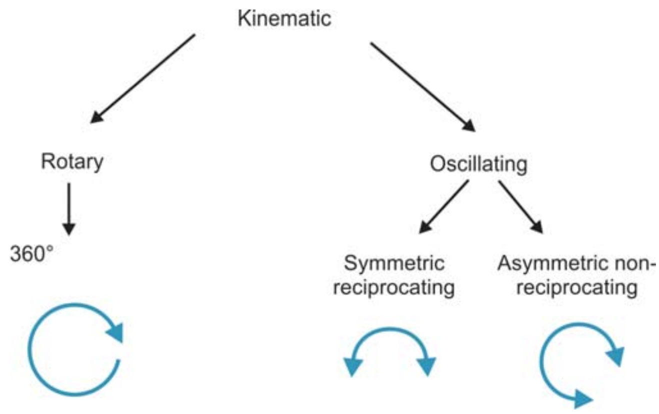
Oscillatory systems are divided into symmetrical (mutual) and asymmetric (not reciprocal). In reciprocal symmetrical oscillating system, the instrument oscillates both directions the same number of degrees, such as with Ultradent's Tilos system.

In the nonreciprocal asymmetric systems, instruments oscillate in one direction about 30° and in reverse about 120° (Flow Chart 2).

Flow Chart 1: Mechanized movements



Flow Chart 2: Mechanization and kinematics



Even with all these technological innovations, the preparation of curved root canals remains a challenge. The properties of highly flexible NiTi alloy along with changes in the design of the instruments have solved some of these problems of a continuous rotation. But it is precisely the continuous rotation or rotational kinematics in curved portions of the root canal that cause the flexural fatigue and consequently fracture.

The new proposals of oscillatory instrumentation systems with newly designed files improve the safety and seem to control flexural fatigue effectively while keeping the same degree of cutting effectiveness.[13-16]

Just as the concept of the balanced forces of Roane introduced a change in the design of the tip of the instruments and the importance of oscillatory hand motion in the preparation of curved canals, it is expected that these new systems will change endodontics. With their evolved designs, new alloys and mechanical oscillatory motion these systems will give a new approach and higher level of success to endodontics, with safer and more effective files in the preparation of root canals.

Some questions still remain and only time and research will answer. Questions such as:

- Do such systems improve cleaning ability compared to rotary systems or hand instrumentation?
- What happens to the compacted debris in flat or oval root canals?
- Is it possible to use different angles of oscillation according to the anatomy of the root canal?
- Will it be necessary that the instruments are disposable?
- How will learning protocols and instrumentation be incorporated?

The belief that one instrument using one type of movement can act in all canals in the same way, without the evaluation and consideration of its anatomical characteristics such as curvature, amplitude and taper, is not the safest and most effective way to perform endodontics.

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