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Review Article

Overview of instrumentation used in endodontics

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ABSTRACT

The fundamentals of root canal therapy include thorough cleaning, suitable shape, and total root canal filling. There are numerous tools at our disposal to help us achieve these goals. A complicated range of files, filling techniques, and modern materials have been designed to speed up the process, increase its dependability, and enable the clinician to properly treat challenging patients and intricate anatomies. Hand instruments include barbed broaches, reamers, and files such as K-file, K-flex file, Flexofile, and Hedstrom files. Nickel-titanium alloys have been used to replace stainless steel in the production of endodontic equipment. Compared to stainless steel tools, these lead to more straightening of canal curvature, centering, tapering, and leading to a superior preparation. In an effort to speed up preparation of canals and lessen operator fatigue, a wide variety of electric power-run tools have been created like reciprocating handpieces, rotary NiTi files and handpieces. Accurate root canal length measurement is crucial to the effectiveness of root canal therapy. Radiography and the application of an electronic apex locator are the two methods used most frequently to confirm canal length. Instruments needed for filling canals are dependent on the procedure chosen to fill the root canal. Hand or finger spreader with a pointed tip are used in lateral condensation; hand or finger pluggers with blunt, flat ends are employed in vertical condensation; thermomechanical compaction uses an engine-powered compactor, thermoplasticized injectable gutta-percha and gutta-percha carrier devices. Careful use of canal preparation, sterilization, and obturation techniques, together with the appropriate instrument selection and use, can significantly increase the likelihood that endodontic procedures will be successful.

Keywords: Endodontics, Nickel-titanium file, Root canal shaping, Root canal filling

INTRODUCTION

The fundamentals of root canal therapy include thorough cleaning, suitable shape, and total root canal filling. There are numerous tools at our disposal to help us achieve these goals. While some of the instruments are used by various dental specialties, many have undergone modifications or have been custom designed for endodontics. The ones created in the last ten years contain a complicated range of files, filling techniques, and modern materials designed to speed up the process, increase its dependability, and enable the clinician to properly treat challenging patients and intricate anatomies. The outcome of root canal therapy may be significantly impacted by changes in the form of curved channels brought on by instrumentation. Failure of the therapy may occur from undesirable root canal shape outcomes like a zip or elbow because it may be hard to establish a bacteria-tight root canal filling in such circumstances.[1] Numerous measures have been taken to reduce the likelihood of instrumentation-related undesired changes in the root canal morphology, including modifications to instrumentation techniques and the use of various root canal tools.[2-5] Recent years have seen two significant advancements in instrument technology: the introduction of flexible instruments with modified noncutting tips and the development of highly flexible instruments composed of novel alloys such nickel-titanium.[3,6] The shaping capabilities of various root canal devices have been studied by several writers using either manual instrumentation of human teeth or simulated canals in resin specimens.[3,5,7,8] Additionally, automated testing tools have been created to establish uniform experimental settings.[9]

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on November 6, 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about instrumentation used in endodontics. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Clinicians must stay current in the rapidly changing world of clinical practice. To aid in practicing the specialty more smoothly, manufacturers are always creating newer materials, inventive approaches, and revolutionary tools. Introduced to dentists with the intention to enable them in managing easy to complex situations, these products frequently promise easier, faster, and superior outcomes. Following is a description of the fundamental tools and devices primarily used in endodontic practice.

Hand instruments

In accordance with the norms of the international organization for standardization (ISO), endodontic manual instruments, such as files, reamers, and barbed broaches, are regulated in regard to dimensions, color codes, and physical properties.[10] The measurement of the working portion's diameter at the tip extreme, or d1, is its nominal dimension. The point at which the instrument's cutting part finishes, or d3, is 16 mm away from d1. The taper is also known as 0.02 taper since it is consistent at 0.02 millimeters each millimeter of cutting flute. The tip's form can change.

Barbed broaches

The evacuation of cotton wool dressings from the pulpal space and tissues from broad radicular portions are the two principal uses for barbed broaches. Fracture risk is limited if the device is utilized to involve tissue debris or cotton and is not tightly adherent to the canal walls. The steel wire used to make barbed broaches is flexible.

Reamers

Reamers are made by using stainless-steel blanks that are twisted into a spiral-shaped tool with sharpened cutting surfaces. They are utilized in a half-rotation twisting and pulling motion that removes dentinal particles from the radicular segments while shaving the walls. Although they are nominally triangular, the lesser sizes can sometimes be produced from square blanks.

Files

Root canal files come in a variety of designs and are often made of stainless steel. The majority of the time, files are used in the root canal in a filing or rasping motion with little to no rotation of the tool. The characteristics of various files are connected to their design elements.[11-13] K-file, K-flex file, Flexofile, and Hedstrom files are the four most popular kinds of files on the market.

K-flex file

To continue improving on the basic K-file architecture, the K-flex file was created. Its cross-section is rhomboidal. Due to this, the instrument has a pattern of cutting flutes with alternating sharp (<60°) cutting edges and obtuse non-cutting edges when the blank is twisted to create it.

Flexofile

The K-file is utilized to develop this file; however, it is made from a stainless-steel alloy of greater flexibility. The alloy used to make files has an impact on their cutting effectiveness and fracture resistanc.[14,15] The Flexofile was said to deliver good instrumentation outcomes; these have non-cutting (Batt) tips and a triangle-shaped cross-sectional surface, making the cutting flutes cleaner and providing more space for removing particles.[16]

Hedstrom file

A steel blank with a round cross-section is milled to create the elevated cutting edges of the Hedstrom file. A series of intersecting cones seem to be created by the tapering effect. It works best when applied in a pulling motion.[17] It is also utilized in engaging and removing gutta-percha, silver points, and retained tools.

Nickel-titanium instruments

Newer designing and technological advancements with respect to endodontic instrumentation have been made. Nickel-titanium (NiTi) alloys have been used to replace stainless steel in the production of endodontic equipment.[18] The shape memory effect, superelasticity (low modulus of elasticity), superior biocompatibility, and great corrosion resistance are just a few of the intriguing characteristics of NiTi alloys.

NiTi instruments are more flexible in bending and more resistant to torsional fracture than stainless steel. NiTi tools are challenging to precurve and possess non-cutting tips. In contrast to stainless steel tools, their cutting ability is less aggressive and is reliant on the cross-sectional shape.[19-21] Compared to stainless steel tools, these lead to more straightening of canal curvature centering, tapering, and leading to a superior preparation.[22-24] In addition, they possess distinct wear properties when compared to tools made of stainless steel.[25]

Power-run instrumentation

In an effort to speed up preparation of canals and lessen operator fatigue, a wide variety of electric power-run tools have been created.

Reciprocating handpieces

These handpieces enable the tool to mechanically cut the dentinal surface. The Giromatic, a motorized handpiece that converts the driveshaft's continuous rotation into an alternate 45 degree turn motion, is a classic example. The M4 Safety handpiece is another example. This handpiece incorporates a push button-style chuck mechanism to accept root canal instruments with plastic handles. The handpiece gives the associated root canal instrument an oscillating movement similar to that of a timepiece.

Rotary NiTi instruments

Endodontists, at large, have begun to switch to numerous novel rotary systems, many of which combine rotary and manual NiTi files, since the introduction of NiTi manufactured tools. Manufacturers have included numerous more recent and distinctive design elements such as variable taper, flute design, rake angle, helical flute angle, variable core diameter, non-cutting tip, and surface treatment.[26,27]

Rotary NiTi handpiece and motor

Typically, rotary NiTi instruments are operated at low speeds and low torque (150–350 rpm). So, in order to use the apparatus, a speed-lowering handpiece that is powered by an air or electric motor is required. Electric-motor-powered handpieces offer the benefit of being smooth, non-vibrating, and superior at holding the chosen pace. On the market, there are also motorized pieces without cords that use rechargeable batteries. Some of these handpieces are offered with a smaller head size to improve accessibility. To make it easier to reach posterior teeth, several rotary files have been produced as well with shorter handles of lower lengths.

Devices to determine working length

Without knowing the vertical dimension of the root canal, it is impossible to accomplish the goals of endodontic treatment; as a result, accurate root canal length measurement is crucial to the effectiveness of root canal therapy. Radiography and the application of an electronic apex locator are the two methods used most frequently to confirm canal length.

Radiographic method

This technique for determining canal length involves inserting an instrument into the canal before taking a traditional or digital radiograph. The instrument's length, indicated by a rubber or silicone stop, is noted. Adjustments are done in accordance with whether the required depth, as revealed radiographically, has been reached. This method requires positioning and maintaining the digital sensor or X-ray film in place while estimating the working length. Instead of using the patient's finger, this is accomplished with the use of a surgical hemostat when using an X-ray film. As an alternative, specially created digital sensor holders and X-ray film are available.

Electronic apex locators

The dental mucosa and root canals have differing electrical conductivities, which can be used to estimate the length of a root canal.[28,29] Electronic apex locators (EALs) now measure voltage gradients and calculate the ratio of impedances instead of measuring electrical resistance with direct, alternating, or high frequency currents.[30] It has been discussed how electronic root canal length measurement devices function fundamentally.[31]

Measuring devices

The tools used to measure file lengths range from simple metal rulers found in hardware stores to gauges and measuring blocks that are specifically made for the purpose. Most manufacturers already include silicone stops as markings on their hand instruments. It is also possible to measure using the ruler included into combination devices like a file-bending tool and a silicone stop dispenser.

Instruments for filling root canals

The instruments needed are dependent on the procedure chosen to fill the root canal.

Lateral condensation

In this method, the root canal is filled with sealer and a master gutta-percha point that fits perfectly. Condensing the gutta-percha to provide room for the insertion of accessory gutta-percha points requires the employment of a hand or finger spreader with a pointed tip. Up till the canal is completely filled, the gutta-percha is gradually added. Spreaders come in a range of lengths and widths, and while most are made of stainless steel, there are also variations made of NiTi.

Vertical condensation

In this method, vertical pressure is applied to condense the gutta-percha and sealer using hand or finger pluggers with blunt, flat ends. To determine plugger depth, hand pluggers of various sizes are typically marked with reference lines. The traditional Schilder method involves adding small amounts of gutta-percha, heating it with heat carriers to soften it, and then condensing it with the help of a variety of different-sized pluggers. This process is continued until the canal is completely filled. There are double-ended instruments that have a plugger on one end and a heat carrier on the other. For warm gutta-percha filling methods, electrically heated carriers with spreaders or pluggers have been developed.

Thermomechanical compaction

This method involves rotating an engine-powered compactor, such as the Gutta-Condensor, coupled with a fitted gutta-percha point or numerous fitted points, in a forward direction. In addition to being compacted against the canal walls by the centrifugal forces produced, the heat produced by the friction plasticizes the gutta-percha. The amount of heat produced increases with rotational speed.[32] The compactor is pushed out of the canal as the amount of gutta-percha in the canal increases. When contrasted to lateral condensation, the outcome can be a root canal filling that is well-condensed and more homogeneous.[33]

Thermoplasticized injectable gutta-percha

As a result of condensing vertically, the idea of inserting gutta-percha after softening into the canal was first suggested few decades earlier.[34] A high temperature mechanism using setup which can warm the gutta-percha in the heating vault to over 200°C is one example.

Similar thermoplasticized injectable gutta-percha delivering systems have been produced by other companies, including a cord-free model and a dual-function model that combines a heated spreader of the System B variety with a motorized warm gutta-percha extruding element.

Gutta-percha carrier devices

An example of a gutta-percha carrier device is the Thermafil system (Dentsply Maillefer). The process of molding heated gutta-percha into a root canal file, which was subsequently used to fill the root canal, gave rise to this commercial product.[35] The plastic core of the Thermafil obturators has a 0.04 taper and a V-shaped cross-section. It is covered with outstanding flow-property gutta-percha in the alpha phase. The obturators are available in ISO sizes 20–140 and are color-coded.

CONCLUSION

In the dental pulp chamber and root canal systems, endodontic tools are used. In order to choose the right tool and utilize it correctly, one must be familiar with the arsenal of endodontic instrumentation. The careful use of canal preparation, sterilization, and obturation techniques, together with the appropriate instrument selection and use, can significantly increase the likelihood that endodontic procedures will be successful. The purpose of preparation is to get the canal ready for obturation with a good seal and the right sealant.

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