Review Article

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Biomechanical Preparation of Primary Teeth: A Comprehensive Review.

Abstract:
A major objective of modern dentistry for children is to maintain the integrity of the primary dentition until normal exfoliation, for the purpose of promoting function, esthetics and phonetics. Endodontic treatment in primary teeth can be challenging and time consuming, especially during canal preparations, which is considered one of the most important steps in root canal therapy. In recent years, new materials, equipments and instruments have evolved to a great extend and simplified the endodontic treatment procedures for the clinicians. Hence, we aim to provide review on some of the important aspects of the biomechanical preparation of the teeth.

Key words: Biomechanical Preparation, Root canal therapy, Endodontic treatment, Primary teeth.

Introduction:

The root canal preparation is one of the major components of root canal treatment and is directly related to subsequent disinfection and filling.[1,2] The goal of root canal preparation is to form a continuously tapered shape with the smallest diameter at the apical foramen and the largest at the orifice to allow effective irrigation and filling, using techniques and instruments which have the greatest precision and the shortest working time.[3,4] Several types of endodontic instruments have been recommended but only a few seem to be capable of achieving these primary objectives of root canal preparation consistently.[5,6,7]

Many dentists consider removal of pulp (& not infected dentin) is only objective of this step. They consider dentin removal unnecessary. This is one of the biggest misconceptions in field of Endodontics.[8] Advancement is being achieved in the field of endodontics for primary teeth from the use of hand Headstrom files and Kerr-files to the current rotary systems being used.[9,10] Since biomechanical preparation with hand instrumentation has been time-consuming, focus has shifted to rotary instruments for biomechanical preparation with the aim of decreased treatment time.[11] The contents of the root canal system are removed during the biomechanical preparation. However, primary teeth have zones inaccessible to debridement, such as accessory canals, ramifications, and dentinal tubules. Therefore, it is imperative to use auxiliary solutions that promote disinfection of these areas, mainly because infected primary teeth can harbor micro-organisms inside the dentinal tubules, in the same way permanent teeth do.[12,13] Irrigation is presently the best method for lubrication, destruction of microbes, the removal of tissue remnants, and dentin debris during instrumentation. The simple act of irrigation allows the flushes away loose, necrotic, contaminated materials before that they are inadvertently pushed deeper into the canal and apical tissues, compromising the periapical tissue and permanent bud.[14]

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The introduction of nickel titanium (NiTi) rotary instrumentation has made endodontics in permanent teeth easier and faster than manual instrumentation resulting in consistent and predictable root canal shaping.[15] Similar principles of canal debridement and dentin shaping using NiTi instruments can be applied to primary teeth. Rotary instruments were introduced to pediatric endodontics by Barr et al. in 2000.[16] Manual stainless steel files provide excellent tactile control and sharp, long-lasting cutting surfaces. However, due to the inherent limited flexibility of stainless steel, manual preparation of curved canals is difficult. In the bygone decade, several rotary NiTi endodontic file systems have been launched to improve the shaping procedure. However, all these systems recommended the use of a series of files to accomplish the final shape. Recently, the concept of single-file systems has been introduced and is currently being debated for its applicability in contemporary endodontics.[17]

Root Canal Anatomy and Morphological Changes in the Primary Teeth:

Before beginning root canal therapy, the clinician should understand the morphologic changes that continually occur within primary teeth and be familiar with the basic differences between primary and permanent root canal anatomy. The root canals of anterior primary teeth are relatively simple, have few irregularities, and are easily treated Endodontically. Conversely, the root canal systems found in posterior primary teeth frequently contain many ramifications and deltas between canals making thorough debridement quite difficult.[18,19] Generally, there is only one canal present in each root of the primary molars when the formation of the roots has been completed. The primary tooth root will begin to resorb as soon as the root length is completed. This resorption causes the position of the apical foramen to change continually. Simultaneously, secondary dentin is deposited within the root canal system.[19,20] This deposition produces variations and alterations in the number and size of the root canals, as well as many small connecting branches or fins between the facial and lingual aspects of the canals. Continued deposition of dentin within the root will divide it into separate canals. In addition, accessory canals, lateral canals, and apical ramifications of the pulp may be found in 10-20% of primary molars.[19,21]

Methods of Biomechanical Preparation:

Biomechanical preparation of root canal system mainly consists of 3 elements namely,

1) Mechanical removal of pulp tissue & infected dentin
2) Irrigation of root canal &
3) Intra-canal medicaments.[8]

Mechanical removal of pulp tissue & infected dentin:

Mechanical removal of infected pulp & dentin helps irrigating solutions to reach & disinfect root canal system in deeper aspects. Vice versa, copious irrigation removes debris & gives clean & clear path for insertion & working of root canal instruments in root canals.8 Each canal orifice of the roots should be located and a properly sized barbed broach selected. Primary molar roots are usually curved to allow for the development of the succedaneous tooth. During instrumentation, these curves increase the chance of perforation of the apical portion of the root or the coronal one-third of the canal into the furcation. The instruments should be slightly bent to adjust to the curvature of the canals, thus preventing perforations on the outer and inner portions of the root. The broach is used gently to remove as much organic material as possible from each canal. Endodontic files are selected and adjusted to stop 1 or 2-mm short of the radiographic apex of each canal, as determined by a radiograph. This is an arbitrary length but is intended to minimize the chance of apical over-instrumentation that may cause periapical damage.[22] During chemomechanical preparation, stainless steel hand files, usually not larger than size 30, should be used carefully to prevent the occasion of broken segments. The removal of organic debris is the main purpose for filing. The canal should be periodically irrigated to aid in removing debris.

A sodium hypochlorite and/or a chlorhexidine solution should be used to ensure optimal decontamination of the canal(s). However, because of the possibility that sodium

hypochlorite solution could be forced into the periapical tissues, it should be used very carefully and with the minimum irrigation pressure. Sterile saline rinses should follow each chemical irrigant. The canal is dried with appropriately sized paper points.

Other methods of canal preparation use nickel-titanium (Ni-Ti) instrumentation, laser therapy, and ultrasonic instrumentation. Advantages of these techniques may include better cleaning and shaping of the canal, promoting a more uniform paste fill. Disadvantages include equipment cost and the learning curve necessary to become proficient with the techniques. Many dentists prefer to use root canal instruments placed in a special rotary handpiece and nickel titanium files for root canal debridement. Root canal instrumentation may be facilitated with the judicious use of this mechanical technique, especially in canals that are difficult to negotiate with hand instruments. Cautious manipulation is important, however, to prevent breaking the file or overinstrumentation of the canal and apical tissues.23

Irrigation of root canal:

In root canal treatment, cleaning is the removal of all contents of root canal system before and during shaping. Irrigation is presently the best method for lubrication, destruction of microbes, the removal of tissue remnants, and dentin debris during instrumentation. The simple act of irrigation allows the flushes away loose, necrotic, contaminated materials before that they are inadvertently pushed deeper into the canal and apical tissues, compromising the periapical tissue and permanent bud. In this context, the use of cleansers in the irrigation process is essential.[24]

Intra-canal medicaments:

In Endodontic therapy of primary teeth, due to the tortuous and complex character of root canals and the change in their morphology with root resorbtion, 'biomechanical preparation' is restricted only to debridement of the root canals.[25] When this root canal environment is left unfilled, it allows for microbial recolonization in the pulp space, making it a shelter for microorganisms, their byproducts and degradation products of both the, microorganisms and pulpal tissue. Thus, for most favourable success, it becomes essential to place intracanal medicaments within the pulp chamber or canals, which exert their antimicrobial effect by direct contact with the organisms or by way of vapour action of the volatile components that reaches all the irregularities within the canals.

Out of all the intracanal medicament, formocresol, 2% gluteraldehyde and iodine-potassium iodide are reported to have excellent antimicrobial activity and vapour-forming effect with minimal toxicity and tissue irritation based on observations made in vitro studies.[26-28]

Newer file systems in Pediatric endodontics:

There are various file systems which are recently developed and are specially designed for pediatric patients.

Kedo file system:

Kedo files system are the world's first files designed for root canal preparation in primary teeth. Kedo files are available in Hand type (Kedo - SH) and rotary type (Kedo - S, Kedo - SG).

Kedo-S pediatric rotary file system :

The Kedo-S file system consists of three Ni-Ti rotary files. The total length of the files is 16 mm. The working length of the files is 12 mm.

The files are named as D1, E1, U1, respectively. All the files have a variable taper corresponding to the use in primary teeth.

D1 file: Has a tip diameter of 0.25 mm with a variable taper. It can be used in primary molars with narrow canals (mesial canals in mandibular molars and disto buccal canal in maxillary molars).

E1 file: Has a tip diameter of 0.30 mm and can be used in wider molar canals (distal canal in mandibular molars and palatal canal in maxillary molars).

U1: Has a tip diameter of 0.40 mm and used in primary incisor teeth.

The taper of the instruments are designed according to the diameter of primary teeth with narrow and wide root canals. Kedo-S paediatric rotary file system must be used in a low speed constant- torque handpiece.

The ideal rotation speed is 150 - 300 rpm. The kedo-S paediatric rotary files have a gradual taper aiding in easy coronal enlargement and straight line access. This gradual taper also help in efficient canal preparation and avoids over instrumentation of the inner wall of root surface. It is necessary to use copious amount of irrigating solution to remove any loose pulp tissue and to ensure canal walls are clean before obturation.

In 2018, Jeevanandan and Govindaraju conducted a study to compare and evaluate the instrumentation time and quality of obturation between paediatric rotary file (Kedo-S) and manual instrumentation techniques in primary molars in children of age 4 - 7 years with pulp necrosis. Sixty primary mandibular molars were randomly divided into two groups: 30 were instrumented with paediatric rotary files Kedo-S (experimental group) and 30 with hand K-files (control group). They concluded that clinical use of paediatric rotary files Kedo-S was effective during root canal preparation of primary teeth with reduction in instrumentation time and better quality of obturation.

Kedo SG Blue (controlled memory files):

Kedo SG Blue file system consists of three Ni-Ti rotary files. The total length of the files is 16 mm. The working length of the files is 12 mm. The files are named as D1, E1, U1, respectively. All the files are heat treated and have controlled memory and have a variably variable taper corresponding to the use in primary teeth. It has super flexibility and 75% greater resistance to cyclic fatigue. The ideal rotational speed is 250 - 300 RPM. The torque required is [2.2 - 2.4] Ncm.

PRO AF baby gold file advanced pediatric rotary endodontic file system

Pro AF Baby Gold file (Dentobizz) consist of 5 files made up of NiTi CM wire- Flexible with Constant taper of 4%, 6%.

Features:

- Specially designed and registered short 17 mm file.
- More safety with comfort to both dentist and patient.
- Unique short orifice enlarger to prevent cervical ledging.
- Advance NiTi M wire with heat treatment for better canal centricity.
- High Flexibility with minimal chances of separation.
- A versatile rotary file system suitable for conservative preparation of all canals.
- Improved shaping of canals with sequential combination of files from orifice enlarger, 4% and 6% taper files.
- Less number of files per canal, most canals required only 2 files for preparation.

Indications:

- Specially for Pediatric rotary endodontic treatment.
- Adult rotary endodontic in conditions of Restricted opening of mouth and Third molar root canals.

Instructions for use:

- The files should be instrumented at 2N 300 rpm.
- The file should be used with 18% EDTA gel in brushing motion.
- Prepare canal manually upto 20/02.
- Place orifice enlarge upto 4 mm in calcified canals or narrow orifice (optional)

Rotary endodontic instrumentation technique for primary teeth The most commonly used rotary instrumentation technique, suggested by Barr et al. in 2000 is widely accepted technique. The pulpectomy procedure begins with a standard access and removal of coronal tissue. A NiTi rotary instrument (ProFile; Denstply, Tulsa Dental) is chosen that approximates the canal size. It is inserted into the canal while rotating and is taken to working length as determined on the

pretreatment radiograph. The rotating file is withdrawn and cleaned of pulp tissue and dentinal debris. The canal is cleansed and shaped with sequentially larger files until the last file binds. The preparation is now complete.

To minimize the risk of fracture in clinical practice, the following guidelines are recommended:

- Always create a glide path and patency with small (at least #10) hand files.
- Ensure straight line access and good finger rests.
- Use a crown-down shaping technique depending on the instrument system.
- Use stiffer, larger, and stronger files (such as orifice shapers) to create coronal
- shape before using the narrower, more fragile instruments in the apical regions.
- Use a light touch only, ensuring to never push hard on the instrument.
- Use a touch-retract (i.e. pecking) action, with increments as large as allowed by
- the particular canal anatomy and instrument design characteristics.
- Do not hurry instrumentation and avoid rapid jerking movements; beware of clicking.
- Replace files sooner after use in very narrow and very curved canals.
- Examine files regularly during use, preferably with magnification.
- Keep the instrument moving in a chamber flooded with sodium hypochlorite.
- Avoid keeping the file in one spot, particularly in curved canals, and with larger and greater taper instruments.
- Practice is essential when learning new techniques and new instruments.[29]

Conclusion:

Predictable success of endodontic treatment requires accurate diagnosis, proper cleaning and shaping and hermetically obturation of the root canal. Special care should be taken while performing the biomechanical preparation of the tooth for best prognosis.

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