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RESEARCH ARTICLE

PULPECTOMY BREAKTHROUGHS: UNLOCK THE POTENTIAL OF MODERN DENTISTRY WITH INNOVATIVE ADVANCEMENTS

Akil Prawin S.S, Sonal Gupta, Afsia Saly, Charu Aggarwal, Vinika Rathi and Nayana Abraham

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Abstract

In modern dentistry, it is vital for professionals to stay abreast of new techniques and advancements to provide the best possible care. This is especially true in pediatric dentistry, where the specific needs of young patients must be met.One common endodontic procedure in pediatric dentistry is the pulpectomy. This involves removing infected, inflamed, and necrotized pulp tissue, cleaning and shaping the canals, and filling them with materials that ensure the normal resorption of primary teeth without harming the underlying permanent teeth. The procedure preserves the function of primary teeth and allows for the harmonious eruption of successor teeth.This literature review aims to enhance knowledge about recent methods and materials in pulpectomy procedures, ensuring the highest standard of care for young patients.

Introduction:-

"What we know is merely a handful of sand; what we don't know is as vast as the universe" - this proverb emphasizes that we should not limit ourselves to the knowledge we've already acquired. There are countless discoveries to be made within the realms of what we think, we already know.In this modern era of constant innovation and advancement, it is crucial for dentists to continuously learn and implement new techniques in daily practice. Staying updated in the field of medicine and dentistry is essential for preserving tooth structure and providing the best possible care to patients. This is especially important in pediatric dentistry, where the goal is to meet the specific needs of young patients.

One of the most common endodontic procedures in a pediatric dental practice is the pulpectomy. This procedure involves the removal of infected, inflamed, and necrotized pulp tissue, cleaning and shaping the canals, and filling the space with materials that ensure normal resorption of primary teeth without harming the underlying permanent teeth. The pulpectomy procedure not only preserves the functions of the primary teeth but also provides an opportunity for the underlying successor teeth to erupt harmoniously.

This literature review aims to provide enhanced knowledge about the recently introduced methods and materials which are being implemented in pulpectomy procedures, ensuring the highest standard of care is offered.

The days of old pulpectomy:

In 1930, Sweet described pulpectomy for the first time, outlining the procedure of removing infected pulpal tissue and filling the emptied root canals with zinc oxide-eugenol material. Since then, various materials and methods have been suggested by different authors, which are now commonly used by dentists to treat primary teeth.

Corresponding Author:- Akil Prawin S.S

The procedure typically involves removing caries using a round bur to eliminate carious tissue, followed by preparing the access cavity with a carbide bur or taper fissure bur. Next, the root canals are shaped using the K-file system. The canals are then cleaned with saline and hypochlorite irrigation to remove any debris. Finally, the canals are refilled with materials such as Metapex to ensure the proper restoration and function of primary teeth. This stepwise procedure helps in preserving the function of primary teeth while preventing any harm to the underlying permanent teeth.

Access opening

Traditional endodontic access design has given superiorimportance to the clinician's convenience for accesspreparation above the restorative and structural needs of thetooth. Contrary to this, in conservative access, during theendodontic treatment there is maximum preservation of thehealthy coronal, cervical and radicular tooth structure toimprove the short-term and long-term success of the tooth.

According to these new access preparation designs, theelimination and prevention of the disease should beperformed without sacrificing tissue unwantedly. The aim ofconservative access preparation can be redefined from"removal of as little tooth structure as possible" to "removalof as little as necessary". It is with the technologicaladvances in the armamentarium that this newer concept ofminimally invasive endodontics evolved. Minimallyinvasive dentistry includes "a systematic respect for theoriginal tissue" and "preventing or treating disease with aslittle loss of original tissue as possible" according to Ericson[1].

The newer access preparation designs which focus on dentin preservationwith the aid of the neweradvancements in magnification and armamentarium are:

Truss access

Truss access is a constrained endodontic cavity approach that makes use of orifices to approach canal systems. The primary goal of these gain access cavity designs is to safeguard dentin by leaving a dentine truss connecting the two cavities that have been made. The truss access strategy focuses on preserving healthy dental structure while remaining minimally intrusive. This minimally invasive method eliminates the need for traditionally installed crowns subsequent endodontic therapy[2].

Ninja endodontic access cavity (Orifice-Directed Dentin Conservation Access)

To obtain an outline for "ninja" access, during access preparation, an oblique projection is created in an occlusal plane over the central recess of the underlying orifices. Endodontic access parallel to the enamel cut at 90º or beyond the occlusal plane makes it easier to find root canal orifices from various visual angles[2].

Caries leveraged access

Clark and Khademi demonstrated,nil or minimal value tooth or restorative structures i.e.,removing only the affected carious part, existing rerstorations and the weekend tooth structure. Thus, this concept of caries leveraged access design preserves the dentin structure during the access cavity preparations.

Cala Lilly enamel preparation

As the name suggests the shape of the cavity preparation entirely resembles the cala lilly flower. Where the occlusal portion of both enamel and dentine is preserved along with the proper access to the underlying root canal orifices. Thereby it increases the overall retention and resistance of the tooth structure after root canal treatment[3].

Guided endodontic access preparation

The "Guided Endodontics" method involves 3D printed templates for establishing minimally invasive access for root canals. Intraoral scanning is performed initially, followed by the CBCT procedure scanning. The virtual drills path is subsequently generated on the desktop screen using data from intraoral image analysis and CBCT, and a virtual sleeve is created to guide the bur[4].

Templates are created based on this, and their fit is validated. Marks are then placed through the pattern's sleeves to denote the area of the access cavity. Access is subsequently made in this location using a specialized bur to acquire passage to the underlying root canal.

Dynamic Guided access

Dynamic guidance, formerly utilized for implants, was recently presented as a substitute to machined drill guides. Dr. Maupin saw dynamic guidance as a solution to the issues encountered while using static drill leads in guided dental treatment. It employs a ceiling-mounted three-dimensional camera technology (X-NAV System), which aids in determining the position between the handpiece and the patient's jaw during the clinical process. This allows the operator to assess the orientation of the bur throughout access preparations[4].

Despite technological advances that enabled dentin sparing treatments in modern accessibility cavity designs, data for increased fracture resistance is scarce and contentious.

Rotary Instruments for Pediatric Dentistry:

1. **Nickel-Titanium (NiTi) Rotary Files:**NiTi rotary files have revolutionized pediatric endodontics with their superior flexibility and strength, allowing for more precise and efficient cleaning of root canals. Their adaptability is particularly beneficial when dealing with the complex and often unpredictable anatomy of primary teeth. By maintaining their shape and resisting fractures, NiTi files ensure that the entire canal system is thoroughly cleaned and shaped, reducing the risk of missed canals and improving the overall success rate of endodontic treatments in children[5].
2. **Exclusive Pediatric Rotary Systems:** Innovations in endodontic technology have led to the development of rotary systems specifically designed for primary teeth, such as the Kedo file system and K3 Rotary system. These systems incorporate variable taper designs and enhanced flexibility, making them well-suited to the unique challenges presented by the smaller and more delicate root canals of primary teeth. By using these specialized systems, pediatric dentists can achieve more accurate and efficient canal preparation, ensuring that the delicate structures of primary teeth are preserved and protected[5].
3. **Improved Techniques:**Pediatric endodontics has seen the adaptation of various advanced techniques, including the crown-down and step-back methods. These techniques have been modified to cater to the specific needs of primary teeth, helping to achieve better cleaning and shaping of the root canals while minimizing the risk of instrument fracture. The crown-down method involves initially enlarging the coronal portion of the canal and gradually working towards the apex, while the step-back method involves sequentially enlarging the canal from the apex upwards. Both techniques contribute to a more predictable and successful endodontic outcome by ensuring thorough debridement and shaping of the canals[5].
4. **Enhanced Safety:** Modern rotary instruments are designed with advanced safety features to mitigate the risk of iatrogenic errors, such as ledging, zipping, and canal transportation. These safety features help to preserve the original canal anatomy and reduce the likelihood of procedural mishaps. By minimizing these risks, dental professionals can achieve more predictable and successful outcomes in pediatric endodontic treatments, ensuring the long-term health and functionality of primary teeth.
5. **Integration with Technology:** The incorporation of advanced imaging techniques, such as CBCT (Cone Beam Computed Tomography), has significantly improved the visualization of root canal anatomy. CBCT provides detailed three-dimensional images of the tooth structure, allowing for more accurate assessment and planning of endodontic procedures. With better visualization, dental professionals can navigate the complex root canal systems of primary teeth more effectively, ensuring that all canals are properly identified, cleaned, and filled. This integration of technology enhances the precision and efficacy of pediatric endodontic treatments[5].

The advancements in rotary instrumentation, specialized pediatric systems, improved techniques, enhanced safety features, and integration with cutting-edge imaging technology have collectively transformed pediatric endodontics. These innovations ensure that primary teeth are treated with the utmost care and precision, preserving their function and preventing any potential harm to the underlying permanent teeth.

Advanced Irrigation Techniques and smear layer removal in Pediatric Dentistry:

Recent advancements in irrigation systems specifically for pulpectomy procedures in pediatric dentistry have enhanced the effectiveness and safety of the treatment. Here are some notable developments:

1. **Ultrasonic Activation**: Ultrasonic irrigation uses high-frequency sound waves to agitate the irrigant within the root canal. This enhances the cleaning efficiency by better removing debris and bacteria, especially in hard-to-reach areas.
2. **Laser-Activated Irrigation**: Laser systems, such as Er:YAG and Nd:YAG lasers, activate the irrigant within the canal. The energy from the laser creates cavitation and acoustic streaming, which improves the penetration and effectiveness of the irrigant[6].

3. **Negative Pressure Irrigation:** Systems like the EndoVac use negative pressure to deliver and remove irrigants from the root canal[6]. This technique minimizes the risk of irrigant extrusion beyond the apex, which is particularly important in primary teeth to avoid damage to developing permanent teeth.
4. **Heated Irrigants:** Heating sodium hypochlorite (NaOCl) before its application has been shown to enhance its antimicrobial properties and tissue-dissolving capabilities, leading to more effective disinfection.
5. **Combination Irrigation Protocols**: Using a combination of irrigants, such as sodium hypochlorite (NaOCl) followed by EDTA, improves the removal of both organic tissue and the smear layer, ensuring a cleaner canal system[6].
6. **Apical Negative Pressure (ANP) Systems:** These systems use a negative pressure approach to deliver irrigants directly to the apical third of the canal, ensuring thorough cleaning while reducing the risk of extrusion[6].
7. **Side-Vented Needles**: The use of side-vented needles for irrigation has improved the distribution of irrigants within the root canal system. These needles help in better removal of the smear layer, especially in the apical third[6].

Obturating Materials for primary teeth– Let's get updated:

1. **Bioceramic Materials**: These materials have gained popularity due to their excellent sealing properties, biocompatibility, and ability to promote healing. They are being increasingly used as an alternative to traditional materials like zinc oxide-eugenol and iodoform-based pastes.
2. **Resorbable Materials**: Newer resorbable materials are designed to be absorbed by the body over time, which is particularly important in primary teeth to avoid interference with the eruption of permanent teeth. Examples include **calcium silicate-based materials** and **bioactive glass**.
3. **Antibacterial Additives**: Some obturating materials now include antibacterial additives to enhance their effectiveness in preventing reinfection. These additives help maintain a sterile environment within the root canal system[7].
4. **Metronidazole-Containing Materials**: Some recent studies have explored the use of metronidazole in combination with other materials, such as calcium hydroxide and zinc oxide, to enhance the antimicrobial efficacy of the obturating material.
5. **Natural Extracts**: Research is ongoing into the use of natural extracts, such as **ginger extract**, as potential obturating materials due to their antimicrobial properties and biocompatibility[7].

Conclusion:-

Continuous updates are crucial not only in hardware and software but even more so in the field of medicine and dentistry. This review has highlighted the recent advancements in pulpectomy procedures, focusing on access opening, shaping and irrigation systems, as well as obturation materials. There's a saying: "Learn and relearn." By embracing the latest advancements, we can enhance our clinical practice and provide better care to patients.

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