

“RECENT ADVANCEMENT IN ROOT CANAL TREATMENT”

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ABSTRACT

A root canal is the naturally occurring space within a tooth that consists of the pulp chamber, the main canal(s) and the more intricate anatomical branches that may connect it to each other or to the surface of the root. This article throws light on the recent advancement in root canal treatment using various therapies like endodontic, non surgical and surgical therapies. Root canal treatment not only corrects the damaged tooth but also restores the esthetics, phonetics and function of the tooth. Proper treatment should be done to avoid any complications and to make tooth appear more natural. Patents are the richest source of the latest technological information. A review of some patents on root canal treatment of tooth diseases is provided that summarizes the recent technical advancements taken place in this area.

KEY WORDS: Root canal, Endodontic therapy, Surgical and non- surgical treatment.

1. INTRODUCTION

A tooth mainly consists of a hard material called dentine. Enamel is the surface layer that protects the visible part of the tooth (crown). The part of the tooth that sits beneath the gum line is called the root. The root is the ‘prong’ that helps anchor the tooth into the jaw. Front teeth have only one root, while molars may have upto several branches. There may be several root canals in one root. The hollow centre of a tooth is called the pulp chamber which contains the blood vessels, nerves and pulp. The pulp is a sensitive tissue which provides oxygen, nutrients, feeling, etc to the tooth. The main function of the pulp is to regulate the growth and development of the tooth during childhood. The pulp extends from the roof of the pulp chamber down into the bottom of each root canal. Nutrition

for the tooth comes from the tissues surrounding the root after the tooth is fully formed. A tooth can function without its pulp after full growth has occurred of the tooth¹.

Tooth caries are known as tooth decay or a cavity, is a disease in which bacterial processes change carbohydrate like sugar in food left on teeth to acid that dematerializes hard tooth structure (enamel, dentin and cementum). If demineralization exceeds saliva and other demineralization like from fluoride, these tissues progressively break down, producing dental caries (cavities, holes in the teeth). Thus, study of dental caries is known as Cariology².

Space within the root of a tooth is known as a root canal. It is the part of a naturally occurring space within a tooth that consists of the pulp chamber (within the coronal part of the tooth), the main

canal(s), and more intricate anatomical branches that may connect the root canals to each other or to the surface of the root. The smaller branches are known as accessory canals and are most frequently found near the root end (apex) but can be encountered anywhere along the root length. There may be one or two main canals within each root. This space is filled with a highly vascularized, loose connective tissue known as the dental pulp³.

Endodontics is the branch of dentistry that deals with diseases of the tooth's pulp. Removing the pulp is called endodontic treatment, but it is often referred to as root canal treatment or root canal therapy. Root canal treatment requires one or more visits which depend on the situation of the tooth. An uncomplicated root canal treatment requires only one visit. Teeth having more roots requires more time for its treatment. Once the root canal treatment is finished, a crown or filling is placed on the tooth. A crown is given if the tooth is discolored or if it is used for chewing. The crown prevents the tooth from breaking in the future⁴.

2. SIGNS AND SYMPTOMS

In case of an infection of the pulp, pain is not felt at first but if it is not treated, the infection will cause pain and swelling and may also lead to formation of an abscess⁵.

A tooth may need a root canal if:

- It hurts when you bite down on it, touch it or push on it
- It is discolored (whether it hurts or not)
- Tooth is broken
- Unprovoked or spontaneous pain
- Sensitivity to hot and cold drinks and foods
- Loosening of the tooth
- Swelling of the gum near the affected tooth

- Oozing of pus surrounding the affected tooth
- Facial swelling.

3. FACTORS AFFECTING TOOTH CARIES

The tooth caries can occur within days of a tooth erupting into the mouth if the diet is rich in carbohydrates. Proximal caries take an average of four years to pass through enamel in permanent teeth. In very severe cases, where oral hygiene is very poor and where the diet is very rich in carbohydrates, caries may cause cavities within months of tooth eruption. To prevent caries, proper oral hygiene should be maintained and dietary modification can also be done. Fluoride treatments can slow the process of caries⁶.

4. BACTERIA RESPONSIBLE FOR TOOTH CARIES

Two groups of bacteria are responsible for initiating caries namely *Streptococcus mutans* and *Lactobacillus*. If the diseased tooth is not treated, it can lead to pain, tooth loss, infection and in severe cases, death⁷.

5. ADVANCED ROOT CANAL INSTRUMENTS/MATERIALS USED IN CLINICS^{8, 9, 10, 11}

5.1 Root ZX II apex locator & dentaport handpiece

It is used to determine the length of the root canal electronically and for rotary preparation of root canals.

5.2 Dental operating surgical microscope

It can provide magnifications from 5X to 25X. High magnification aids in diagnosis and also enhances the cleaning of root

canals with improved visibility inside the root canals. It has also got a camera attached to it.

5.3 Dental dam

It is used for isolation of the tooth being operated upon. Dental Dam is a rubber sheet which is placed over the mouth in such a way that the tooth being worked on is above it and the rest of the teeth are below. It used to avoid the salivary contamination of the root canals and also prevents pus/infected tooth fragments and strong medicines from going down the throat.

5.4 Thermaflo obturation system

It is a simple, fast and effective carrier based heated gutta percha endodontic obturation system.

5.5 E & Q plus obturation system

It gives the clinician the option to choose from either vertical compaction of warm gutta percha, heat softened gutta percha injection or a combination of both techniques in filling the canals.

5.6 Rotary files from pro-taper, M2, K3, varitaper and light-speed

Pro-Taper file has a variable changing taper over the length of its cutting blades. It's shaping files have small-sized tips which follows the path of the canal previously secured with hand files. It cut dentin by their larger, stronger and more active blades. M2 instruments are flexible and are more efficient as have an S-shaped cross-section and deep cutting blades. It provides maximum space for removal of dentinal debris and helps in making minimum radial canal wall contact for a safe and fast preparation. K3 files active cutting action is provided by a positive rake angle while blade support and increased peripheral strength to resist

rotary stresses is provided by its wide radial land. Instrument is kept centred in the canal by third radial land and it also minimizes over engagement. Friction on the canal wall is reduced by radial land relief. The LSX spade blade cuts only where cut is needed. It cleans all walls of the apical third without removing root structure coronally or in the mid-root which may lead to tooth weakening.

5.7 Pro-Ultra ultrasonic inserts

It is mainly used for removal of coronal and root restorative material, locating and opening of calcified root canals, elimination of root obturation material, pulp stone removal and removal of broken instruments.

5.8 Hand files from pro-taper, senseus, C+, NitiFlex

Pro-Taper root canal files are made from Nickel -Titanium for greater flexibility to reach into curved root canals and shape them according to the latest crown-down technique of root canal treatment. Along with these files, Pro-Taper paper points and gutta percha points are also used which are designed to match the shape of canals prepared with Pro-Taper finishing files providing optimal coronal and apical fit and seal of root canal filling. Senseus files have large and soft grip silicone handles for more efficiency. C+ Files - These have a variable taper design to reduce flexion with greater buckling resistance and these also have easier access to the root canal tip during initial canal catheterization. They are considered the ideal choice in highly calcified canals and for re-treatment procedures.

5.9 Glyde root canal conditioner & lubricant

It contains EDTA and Carbamide Peroxide in form of gel. By its action of

lubricant, it reduces risk of instrument separation within canal. It also removes the smear layer from canal walls and helps in proper cleaning and sealing. It helps in removing debris from within the canals by its bubbling action in contact with root canal irrigant like hypochlorite.

5.10 AH 26 root canal sealer (silver free)

AH 26 is a radiopaque root canal filling material and is available with silver or silver free composition. It can be used alone or in combination with Gutta Percha points for the permanent filling of root canals. It does not shrink during setting and contains no irritants. It has excellent tissue compatibility and helps in a tightly sealing of root canal obturation.

5.11 Pulp testers

These are used to determine the response of the dental pulp to electrical stimuli.

5.12 Sodium hypochlorite root canal irrigant

This is used as disinfectant in endodontic treatment and it works by dissolving the necrotic pulpal tissue within the root canal preparing it for a sealed filling.

5.13 2% Chlorhexidine root canal irrigant

It increases the success rate of the root canal treatment when used. It has a higher level of root canal disinfection when compared with conventional techniques.

5.14 Calcium hydroxide + Iodoform paste

This is used for disinfection of root canals and also in immature roots.

5.15 Fiber posts

These have flexibility similar to that of natural tooth. These are used to restore

badly broken down teeth which may otherwise have to be extracted.

6. ROOT CANAL TREATMENT

6.1 Endodontic therapy

Endodontic therapy is a sequence of treatment for the pulp of a tooth which results in the elimination of infection and protection of the decontaminated tooth from future microbial invasion. This set of procedures is also known as root canal treatment. Root canals and their associated pulp chamber are the physical hollows within a tooth that are naturally inhabited by. Endodontic therapy involves the removal of nerve tissue, blood vessels and other cellular entities and the proper cleaning, shaping, and decontamination of the canals with tiny files, irrigating solutions, gutta percha, cement, etc. After endodontic surgery the tooth will be dead. Root end surgery is done if an infection spreads at apex. Root canal treatment is needed for two main reasons - The first is infection which may be due to any untreated cavity. The decay erodes the enamel and dentin of the tooth until it reaches a root canal allowing the bacteria to infect the pulp. In this case, antibiotics are not useful as they can't get to infections inside the teeth. The inflammation caused by the infection reduces the blood supply to the tooth which doesn't allow the tooth to heal. The second reason for a root canal is damage like tooth fracture or trauma to the pulp that can't be fixed. Common dental procedures like preparing a tooth for a crown, etc can also damage the pulp. An inflamed pulp can heal by itself but not an infected pulp. If the pulp remains inflamed, it can be painful and may lead to infection which can affect the bone around the tooth leading to formation of an abscess. Root canal treatment is done

to save the tooth by removing the infected or damaged pulp, treating any infection, and filling the empty root canals with a material called gutta percha. If root canal treatment is not done, an infected tooth may have to be extracted. In case of missing tooth, neighboring teeth can drift out of line and also can be overstressed from chewing^{12, 13, 14}.

6.2 Non-Surgical Root Canal Treatment (NSRCT)

It is done to save an endodontically failing tooth. It may need to remove the patient's existing artificial crown if access through the crown is not possible. The access into the root canal space is given by access opening through the biting surface of the tooth. A non-surgical retreatment procedure oftentimes requires:

- Locating and treating previously missed canals.
- Removing old filling materials from the root canal space.
- Removing posts and broken instruments.
- Enhancing existing root canal treatment.
- Negotiating blocked canals and bypassing canal ledges.
- Repairing mechanical and pathological perforations in the root.

Once this has been done, the root canal system is re-cleaned, re-shaped, disinfected, and sealed. A protective restoration is then placed on the tooth and it is restored to a healthy and function state¹⁵.

6.3 Surgical Root Canal Treatment (SRCT)

It is a procedure in which it is necessary to elevate a small flap of tissue adjacent to the involved tooth to gain access to and treat root canal disease. These treatments are usually minor performed under local anaesthesia. Once the pathological area is

exposed, curettage is done to remove the diseased tissue from around the root followed by an apicoectomy for removing the diseased portion of the root. The remaining portion of the root is sealed by small fillings. This treatment results in a good long-term prognosis for the tooth¹⁶.

6.4 Measuring and Cleaning the Root Canal

Measuring is done to know how long the canals are to make sure the entire canal is cleaned. It helps in knowing how much filling material is to be put in the cleaned canals. It is done by using X-rays or an electric device known as an apex locator. After measuring, diseased pulp from all canals is cleaned by using special tools. Then the canal is cleaned with antiseptic to treat and prevent infection. After cleaning the canals, the roots are filled and a temporary filling is placed over the tooth and the top of the tooth is then covered with a permanent filling or crown¹⁷.

7. COMPLICATIONS^{18, 19, 20}

Even of care, some complication may occur. Here are some possibilities:

- The oxygen in the air can trigger some bacteria to start growing. This may lead to swelling and pain.
- Sometimes during a root canal procedure, bacteria may push through a small hole at the bottom of the root from which blood vessels enter the tooth and may affect the surrounding tissues making them inflamed and infected.
- A root canal treatment can puncture the side of the tooth if a canal is curved or hard to find making a small hole in the side of the tooth. If saliva can get into the hole, it will have to be

filled. If the hole is far enough under the gum that saliva can't reach it, the hole may close on its own.

- If any canal remains unclean, the tooth can stay infected. This may happen if a canal isn't measured correctly and any infected or inflamed pulp is left near the bottom.
- The tip of a file may break off inside the tooth which has to be removed if canal isn't fully cleaned.
- Any bacterial infection can cause a severe infection or an endodontic abscess when it spreads into the surrounding bone.
- The infection may spread around the ends of the infected root canal and cause bone loss in the jaw.
- The tooth may have to be removed if interferes with the person's ability to bite and chew.
- An undetected crack may be present in the root of a tooth.
- A tooth may get recontaminated if defective or inadequate dental restoration is done that has allowed bacteria to get past itself into the inner aspects of the tooth
- A breakdown of the inner sealing material over time may also occur allowing bacteria to recontaminate the inner aspects of the tooth.

8. SUCCESS AND PROGNOSIS

Fractures in a tooth which is endodontically treated increase when cuspal protection is not provided by a crown and root canal treatments may fail. They may fail if the tooth is not cleaned and filled properly in all canals or any infection remains in the canal that may cause a continued infection or "flare up" of the tooth. It may also fail if any canal is missed while performing the root canal. The hole may be filled with a material

derived from natural cement called MTA. Recent studies indicate that substances commonly used to clean the interior of the tooth provide a low chance of succeeding in completely sterilizing a tooth internally though a properly restored tooth following root canal therapy has a long-term success rates near 97%. Endodontically treated teeth are more prone to extraction mainly due to non-restorable carious destruction and endodontic-related reasons like endodontic failure, vertical root fracture (VRF), or due to procedural error. A root canal treatment is highly successful as the procedure has more than a 95% success rate. A tooth fixed with a root canal can last a lifetime. Esthetics is good as the crown or a filling resembles the natural tooth and onlookers cannot identify whether or not any root canal treatment was performed^{21, 22}.

9. ROOT CANAL PREVENTION

The need of root canal treatment can be reduced by good oral hygiene practices like brushing twice a day, flossing at least once a day, scheduling regular dental visits, etc. Wearing a mouth guard reduces the trauma resulting from a sports-related injury²³.

10. RISKS

There is a possibility that the root canal treatment will not be successful the first time. Before treating the second root canal treatment in the same tooth, the problem of first failure should be known by using x-ray to detect any infection or inflammation and whether or not the old filling material is removed and the canals are thoroughly cleaned out. If an x-ray indicates that retreatment cannot correct the problem, endodontic surgery may be performed by a procedure known as

apicoectomy in which the root end of the tooth is accessed in the bone and a small amount is shaved away. The area is cleaned of diseased tissue and a filling is placed to reseal the canal²⁴.

11. ALTERNATIVES TO A ROOT CANAL

Saving the natural teeth is the very best option and the root canal procedure is the treatment of choice. The tooth extraction is the only alternative to a root canal procedure and replacing it with a bridge, implant or removable partial denture to restore chewing function and prevent adjacent teeth from shifting. These alternatives are more expensive than a root canal procedure but require more treatment time and additional procedures to adjacent teeth and supporting tissues²⁵.

12. SOME PATENTS ON TREATMENT OF ROOT CANALS

Patents provide latest technical information to us. A review of some patents that relate the use of root canal treatment in the treatment of bacterial diseases is presented here. This review provides an insight on the recent technological advances that have taken place in the area of root canal treatment.

12.1 Apparatus and methods for root canal treatments

Apparatus and methods for root canal treatments is reported. In some cases, an aiming element may be used to position a high-velocity liquid jet near a desired location in the tooth. Some root canal cleaning techniques include one or more applications of the liquid jet followed by application of a disinfectant such as sodium hypochlorite aqueous solution.²⁶

12.2 Dental and medical instruments comprising titanium

An endodontic instrument used in root canal therapy on a tooth is reported. It includes an elongate shank having a cutting edge extending from a distal end of the shank along an axial length of the shank. The shank comprises a titanium alloy, and is prepared by heat-treatment at a temperature above 25° C in an atmosphere consisting essentially of a gas unreactive with the shank. The instruments solve the problems encountered when cleaning and enlarging a curved root canal.²⁷

12.3 Root canal filler and dental tissue regeneration method

A novel dental tissue regeneration method for regenerating the tissues after pulpectomy of the infected root canal is reported. After pulpectomy and cleaning of an infected root canal, root canal filler having an extra cellular matrix containing the cells enriched for dental pulp stem cells, is inserted into the apical side of the root canal of a target tooth. The cells including dental pulp stem cells include one of the following: dental pulp SP cells, CD31-negative and CD146-negative cells, CD24-positive cells, CD105-positive cells, and CD150-positive cells. For instance, dental pulp SP cells are CD31– and CD146– negative.²⁸

12.4 . Filling material pin for a root canal of a tooth

A filling material pin is reported. It is made from a flexible material and is used for filling a root canal of a tooth. The material is memory material, which expands upon heating to the tooth or body temperature in the form of a volume change. The exterior of the filling material

pin is profiled at least across the length thereof that is effective in the use position such that regions having both larger and smaller cross-sections alternate in the axial direction, which can be achieved in a particularly useful and simple manner by a helical, threaded, or worm shape of the profiling, which simultaneously pushes an added cement or filling material more effectively and deeper into the canal upon rotating the filling material pin inserted into the root canal, thus allowing air contained therein to escape.²⁹

12.5 . Device for dental treatment

A device and system for use in a root canal treatment is reported. The device has a probe member and a handpiece for holding the elongate probe member. The probe member has an elongate distal portion capable of being accommodated in a root canal.³⁰

13. CONCLUSION

Root canal treatment not only corrects the damaged tooth but also restores the esthetics, phonetics and function of the tooth. Proper treatment should be done to avoid any complications and to make tooth appear more natural. Every treatment should be done according to the particular patient's condition and work should be done in such a way that most portion of natural tooth is protected from damage. Hope this review will be helpful in providing some useful information related to root canal treatment to dental students.

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