International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 31 العدد
November 2022 نوفمبر
المجلة الدولية للعلوم والتقنية
ISTJ

Tooth Replantation as an Alternative to Tooth Extraction of Periapically Infected Teeth

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الملخص

الهدف من هذا البحث هو جمع البيانات من الأبحاث السابقة لتحديد ما إذا كانت الأربطة الداعمة للسن قادرة على التجدد على سطح الجذر في السن المعالج بقناة الجذر في وجود عدوى حول الذروة بعد الزرع. أظهر باحثون سابقون أن الأربطة الداعمة للسن يمكن أن تتجدد على سطح جذر الأسنان المخلوعة من مكانها بالعظم بسبب الحوادث وغير المصابة في ظل ظروف محددة (على سبيل المثال: الوقت و التمعدن).

(Andearsen, 1995). (Ferrazzano, 2010.)

المضادات الحيوية أو غيرها من العقاقير المضادة للميكروبات تقتل البكتيريا اللاهوائية للمساعدة في عملية الدفاع الطبيعي لمكافحة RCTأو توقف تكاثرها يمكن استخدامها في العدوى وتعزيز الشفاء. بعض الأمثلة على هذه المضادات الحيوية هي: أقراص Erythromycin ، وأقراصAmoxycillin ، كبسولات Metronidazole (Lewis MAO, 1986) (Hamanaka, 2015).

تعتمد الفرضية على حقيقة أن الجزء الأول من الشفاء في الخراج حول الذروة يعتمد على إزالة السبب والجزء الثاني من الشفاء يعتمد على جهاز المناعة وإصلاح الأنسجة باستخدام علاج واسع الانتشار للعدوى حول الجذر بحيث يمكن الاستفادة من الأسنان الطبيعية بدلاً من زراعة الأسنان الاصطناعية أنصح باستخدام المزيد من طرق الفحص مثل الخزعات النسيجية من سطح الجذر في الأسنان المصابة حول الذروة للتحقق من تجديد الأربطة الداعمة للسن بدلاً من الاعتماد على الصور الشعاعية فقط.

Abstract

The goal of this research is to collect data from previous researches to determine if the periodontal ligaments are able to regenerate on

the surface of the root in a root canal treated tooth in the presence of periapical infection after replantation. Previous researchers have shown that periodontal ligaments can regenerate on the root surface of non-infected avulsed teeth under specific conditions (e.g., time and mineralization) (Andreasen, 1995) (Ferrazzano, 2010). Antibiotics or other antimicrobial drugs kill anaerobic bacteria or arrest their multiplication can be used in RCT to assist the natural defense process to combat infection and promote healing. Some examples for these antibiotics are: Metronidazole tablets, Amoxycillin caps, and Erythromycin tablets (Lewis MAO, 1986) (Hamanaka, 2015). The hypothesis rests on the fact that the first part of healing in periapical abscess depends on removing the cause and the second part of healing depends on the immune system and tissue repair. using treatment of wide-spread periapical infection so can utilize the natural tooth instead of implanting an artificial tooth. In future researches, I advise using further investigation methods like histological biopsies from the surface of root in periapically infected teeth to verify periodontal ligament regeneration instead of depending on radiographic pictures only.
Key word:Pulp exposure, Root Canal Treatment (RCT), fistula, cellulitis, extraction, periapical, periodontal ligament.

Introduction and Background

One of the most common dental problems is pulp exposure, which can occur as a result of cavities due to poor oral hygiene and dental trauma (e.g., cracked tooth due to traumatic impact). Additionally, dental procedures such as treatment for cavities may accidentally result in exposure of the pulp (see Appendix Figure 1 for diagram of tooth anatomy). When the pulp is exposed, there is an increased risk of infection from oral bacteria. Infections of the pulp can eventually lead to periapical root infections which penetrate the roots of the tooth (Harty, 1997). Periapical abscesses are common due to untreated pulp exposure. For example, a recent study demonstrated that 47% of non-traumatic visits to the emergency room involving children in the US were due to periapical abscesses (Graham et al., 2000). A similar study on all patients admitted to the ER for periapical abscesses shows that

approximately $164 million was spent in 2006 treating these infections (Nalliah et al., 2011). When these infections are confined to the tooth root, they can be drained during a root canal treatment (RCT) and treated with antibiotics. If left untreated, these infections are dangerous and can lead to bone abscesses. Additionally, fistulas may develop from the abscess into the oral cavity, or even more widespread infection of soft tissue of the head and neck may occur (cellulitis). These infections require systemic antibiotics, and in all cases, the tooth is usually permanently extracted.

Materials and Methods Used

The specific goal of this paper is to determine if the periodontal ligaments, which hold the tooth to the bone, are able to regenerate on the surface of the root in a root canal treated tooth in the presence of periapical infection after replantation. Previous researchers have shown that periodontal ligaments can regenerate on the root surface of non-infected avulsed teeth under specific conditions (e.g., time and mineralization) (Andreasen, 1995) (Ferrazzano, 2010). This procedure is being investigated as an alternative to permanent tooth extraction. The using of the natural tooth in replantation has many benefits. It reduces treatment costs because no artificial crown is required. Post-implantation symptoms such as swelling, fever, and postoperative pain are avoided. Finally, this treatment plan saves time because temporary crowns are not required.

Root Canal Treatment is defined as the treatment of necrotic or damaged pulp in the tooth to allow the tooth to maintain its function in the dental arch (Harty, 1997). This practice of treating the pulp to preserve the tooth is a modern development in dentistry. Here, I provide a brief review of the history of pulpal treatment to establish a context for the RCT procedure.

Both the Egyptians and the Chinese left records describing caries and alveolar abscesses (Harty, 1997). The Chinese reported that dental abscesses were caused by a white worm. The ‘worm theory’ was current until 18th century, when the doubts were raised (Guerini V, 1909). However, those doubts were not expressed forcibly because senior figures still believed in the worm theory (Curson I, 1965). Chinese used arsenic-containing material to kill those

worms, but that was self-limiting because they realized that the arsenic drug cause extensive tissue destruction if it leaked into the soft tissues.

Pulpal treatment in Greek and Roman times was aimed at destroying the pulp contents through cauterization by a hot needle or boiling oil. At the end of first century, it was realized that the best way to eliminate the pain of an abscessed tooth was by draining the abscess through drilling of the pulp (Harty, 1997). Endodontic knowledge remained static until 16th century when pulpal anatomy was described. Before the latter part of 19th century, RCT aimed at providing retention for dowel crown (which is a metal pin used to build crown on) and bridgework became popular in many dental schools (Cruse WP, Bellizzi R, 1980). Root canal therapy became popular for this reason and also because the discovery of cocaine led to painless extirpation of the pulp.

Shortly after the discovery of x-rays by Roentgen in 1895, the first radiograph of the teeth was taken (Grossman L, 1976). This discovery had a large impact on root canal treatment. Around the same time, dental manufacturers started to produce instruments to help in the removal of pulp tissue. There was still no concept of filling the root canal since the main reason of pulp extirpation is provide retention for a crown post.

By 1910, RCT was quite popular, but dentists still could not extract the tooth. They left the roots in place to use for retaining the crown post. The dentists knew that there is a relationship between the abscess beside the root and the pulpless tooth, but a treatment was not known (Harty, 1997).

In 1911, William Hunter built bridgework in several patients with diseases of unknown etiology and found that abscesses disappeared with extraction of the teeth related to those abscesses (Cruse WP, Bellizzi R, 1980). At about this time, the field of bacteriology became established and the findings of bacteriologists added an understanding of the causes of pulpitis and abscesses (Harty, 1997).

In recent years, dentists have found that maintenance of the function of the tooth in the arch depends mainly on the integrity of the periodontal ligament and not on the vitality of the pulp (Marshall J, 1928). Another important advance was the formulation of the

"Hollow tube" theory (Rickert U, 1931), which was later tested in research using sterile polyethylene tubes implanted in rats (Torneck CD, 1966, 1967). When a sterile tube that is closed at one end is implanted into healthy tissue, the surrounding tissue was relatively free of inflammation and displayed normal healing capacity. When such a tube was filled with muscle tissue contaminated with microorganisms, it experienced localized inflammation at the opening of the tube. Thus, if the tube contains microorganisms then the healing potential is less favorable than when the lumen of the tube is sterile (WU MK, Wesselink PK,1989).

The concept that apical sealing was important led to a search for filling and sealing materials which are stable, non-irritant and provide a good seal at the apical foramen of the root. With more recent realization of the importance of coronal seal leakage is presented in (Saunders WP, Saunders E, 1990).

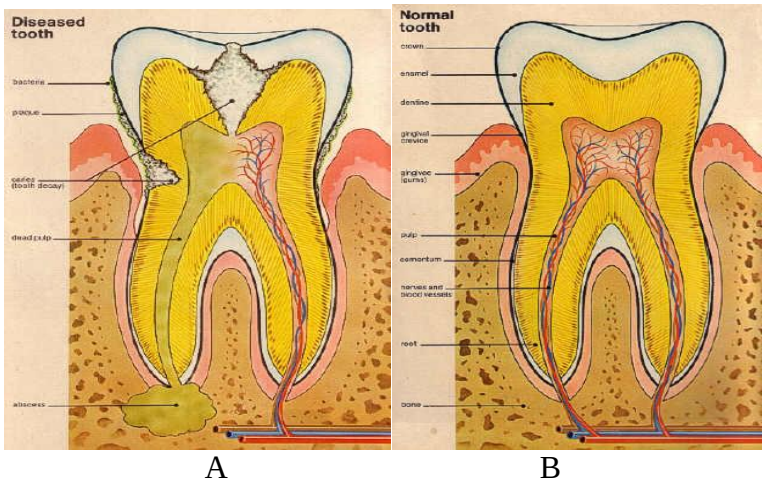
The Chinese believed that dental abscesses were caused by small worms, and this finding held until the 18th century (Harty, 1997). At the end of 19th century, Miller (1894) stated that bacteria was responsible for root canal infection, and noted that there are different microorganisms in open pulp chambers. In 1930, microbial techniques were used to re-establish the basis of root canal treatment; however, the techniques in that time were only used for aerobic bacteria, and this led to confusion in clinical results (Seltzer S et al., 1964).

The development of anaerobic culturing in the root canal allowed many microorganisms to grow (Moller A, 1966). This rapidly led to the demonstration that the majority of microorganisms in the root canal are anaerobes (Kantz W, Henery CA, 1974) .

Sundqvist (1976) found that there is a close relationship between the presence of anaerobic bacteria and periapical radiolucency in traumatized teeth. With this rapid increase in knowledge, anaerobic bacteria in the root canal continue to be classified. The bacteria that were the main causes of root canal infection were classified in Bacteroides (Haapasalo M, 1989), and then reclassified to Prevotella and Porphyromonas (Sunqvist G, 1994). In the recent years, classification of bacteria depends on biochemical tests, and bacteria which in the past could not be cultured, are now found in

abundance (Harty's, 1997). Most root canal infection is caused by mixture of bacteria (Fabricius L and et al., 1982), and they are usually found in pulpless teeth; however, the inflammatory cells around the periapical area limit the spread of these bacteria to nearby tissue (Pitt Ford T, 1982). This fighting leads to the formation of periapical abscesses.

The presence of bacteria, their products, or damaged tissue in the root canal can cause periapical inflammation at the apical foramen and accessory canal opening, and fractures. Periradicular inflammation prevents wide spread infection to the bone tissue. The inflammatory region contains numerous inflammatory cells, such as macrophages, lymphocytes, polymorphonuclear leucocytes, and plasma cells (Harty, 1997). The interaction between these cells and antigenic substance will lead to the production of large numbers of inflammatory mediators. The inflammatory mediators include neuropeptide, lysosomes, and metabolites of arachidonic acid (Torabinejad M, 1994). Further, prostaglandins and leukotrienes play important roles in periapical abscess formation (Torabinejad M, et al., 1992). As long as antigens emerge from the foramen, the inflammatory response will continue. Effective elimination of microorganism will allow healing to occur. See (Fig1).



A B

Figure1. A intact pulp. B infected pulp with periapical abscess. From the web site: www.dentalexcellence.co.nz/.../root-canals.htm

The dentist who intends to restore a broken-down or decayed tooth needs to determine first whether the pulp of the tooth is dead or alive. There is no routine test that can directly indicate whether the pulp tissue is living. In the past, electric currents or temperature changes were applied to the tooth surface and the face of the patient was observed. However, these methods do not produce reliable results in teeth with damaged pulps, because inflammation of the pulp is usually localized, the response to thermal or electrical testing may primarily come from remaining living tissues. Thus, the response is not indicative of dead tissue. Additionally, when the pulp does not respond to testing, it cannot always be assumed to be dead, for pulp may have formed large amount of dentine in response to irritation and retreated sufficiently enough that it does not respond to the stimulus (Harty, 1997). The correlation between histological findings and the results of pulp tests are satisfactory at a crude level, but poor when exacerbation, which is the removal of the pulp tissue, or nature of the pain are correlated (Dummer P, et al., 1980).

In recent dentistry, the dentist depends on two methods to investigate the vitality of the pulp tissue. First, the clinical technique is to knock a hard instrument (percussion) on the occlusal surface of the tooth and watch the facial response to the patient. In the case of damaged pulp, periapical changes on the tooth will result in pain at the nerve ending when vertical pressure is applied. The second technique uses X-ray. The damage to the pulp of tooth leads to a periapical tissue response. The inflammatory products will result in bone resorption at the periapical area, which appear radiolucent in x-ray film. For more clarity, see (Fig2).

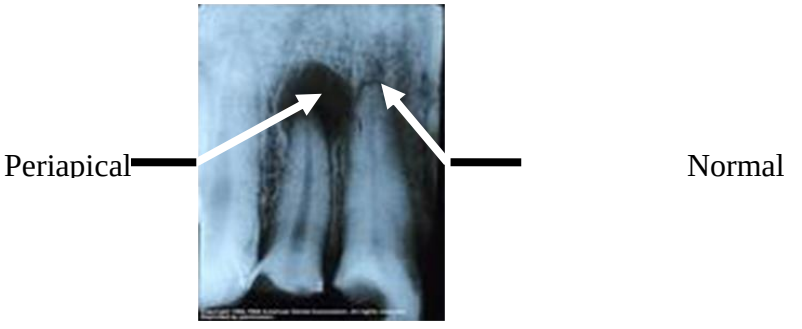
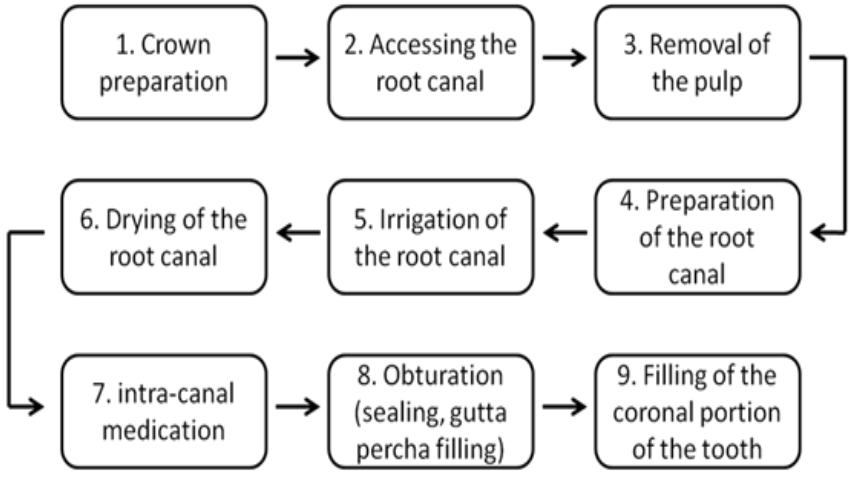


Figure. 2 Periapical infection appears as radiolucency in x-ray film. This picture is taken from web site: kermanonline.blogsky.com

STEPS OF ROOT CANAL TREATMENT:



Overview of the steps involved in root canal treatment.

The first step in root canal filling is taking an x-ray of the tooth to identify the anatomical structure of the root (root curvature), the number of roots, and the length of cleaning, shaping, and filling required to repair the tooth. The crown must then be prepared. It is essential that all caries and defective restorations are removed to place a sound coronal restoration later such as amalgam or

composite material. The tooth should be restored in such a way that contamination and coronal leakage cannot take place during treatment or between visits. Preparation of the crown is completed by using a high speed hand piece and round and inverted cone burs. A permanent type of restorative material such as amalgam, resin composite, and glass ionomer are suitable in this situation. Local anesthesia is essential when vital tissue is present in the tooth. It is also recommended in all cases in order to minimize stress in the patient and the doctor. The root canal is accessed by removal of dentine tissue with a high speed hand piece until the pulp chamber is reached. This cavity should be wide enough to access the entire root canals of the tooth. The removal of necrotic pulp tissue from non-vital teeth is carried out during preparation of root canal system using cleaning and shaping instruments. See (Fig.3).

Figure. 3 Frame 2 using headpiece to remove coronal portion of the pulp and frame 3 using the reamer to remove root pulp. This picture token from web site: dentalexcellence.co.nz

Removal of agents which cause periapical infection, such as necrotic pulp debris and microorganisms, will promote healing. The removal of soft tissue of the pulp takes place by using reamer instrument. The shaping of the root canal can be done by using special file such as K-file or K- flex, which is instrument that remove dentine chips from root canal wall and make it wider and smoother.

During root canal irrigation, pulp debris and dentine slurry are flushed from the root canal and to lubricate endodontic instruments to facilitate their cutting action. Sodium hypochlorite with its

antiseptic and tissue dissolving properties is considered the irrigant of choice (Harty, 1997). The root canal is then dried to absorb irrigating solution and provide good retention for sealing and filling materials. This step could be done by using paper point

After drying the root canal, the medication is applied to root canal. "Endodontic success is related to the absence of signs and symptoms of apical periodontitis" (Strindberg L, 1956). Root canal treatment can therefore be considered the prevention or cure of this disease (Ørstavik D, 1988). The most common medication used in root canal treatment is ((Tetracycline)), which shows affinity to hard tissues and may be retained on the tooth structure (Bjorvatn K, 1986). It is used locally in periodontitis with good clinical results (Genco R, 1991). However, its antimicrobial spectrum is quite narrow, and it may be ineffective against several oral and endodontic pathogens (Harty, 1997).The root canal system should be filled after cleaning and shaping. The objectives of obturation , which means fill out of the root canal with material, are to prevent microorganisms, left in the canal after preparation, from proliferating and escaping into periradicular tissue through the apical foramen, to seal the pulp chamber and canal system to prevent leakage of microorganisms and toxic material to periradicular area, and to prevent percolation of periradicular exudates to the pulp chamber through apical foramen (Harty, 1997). A root canal sealer (cement) is used in combination with root canal filling materials. At the first it was thought that sealer material plays a secondary role in the root canal obturation simply by cementing the core filling material to canal; however, it is now appreciated that the sealer plays a primary role in sealing the canal by obliterating the irregularities between the canal wall and the core material. The sealer material should cement the core material to the canal and act as a bactericide that is non-irritating to periapical tissue, insoluble in tissue fluid, non-staining to dentine, and which has good working time (Grossman L et al., 1988). The common sealers used today are Zinc Oxide-eugenol, Calcium hydroxide, Resin, and Glass ionomer sealer.

Canal obturation with gutta-percha

The object of canal oburation is to fill the root canal system completely to prevent leakage from the apical or coronal area. However, it must be emphasized that a sealer material should be used to lute (adhere) the gutta-percha to the wall of the root canal and fill minor irregularities in the canal wall which cannot be filled with gutta-percha. (Harty, 1997) Gutta-percha has been used for the past hundred years as filling material to root canal (Bowman G,1876) and is the most widely used and accepted material for this purpose. Gutta-percha is a form of rubber obtained from a number of tropical trees. It is a transpolyisoprene which, in its pure form, is hard, brittle, and less elastic than natural rubber. It is mixed with variety of other materials to produce a blend which can be used to easily fill root canal. Gutta-percha has many advantages: it is inert; dimensionally stable, non-allergic, non- staining to dentin, softened by heat, radioopaque, and can be removed from the root canal when necessary. However, as any material, it has some disadvantages: it does not adhere to dentine, can be stretched, and lacks of rigidity (Harty, 1997). There are many companies that make gutta-percha; in my research I will use Gutta-percha and absorbent paper point made from Schwed Company just because I am familiar with it from my clinical work.

At the first, it is necessary to determine the length of the cleaned and shaped area minus 2mm to avoid overfilling. Overfilling of the root canal will lead to an inflammatory response at the periapical area, which is a sign of failure of the root canal treatment. Under-filling of the root canal provides room for microorganisms to proliferate in, which is another sign of root canal failure. Next, points of gutta-percha are put in the root canal. Then a lateral spreader is used to condense gutta-percha to the wall of canal (lateral condensation). For clarity see (Fig4). Finally, the extra coronal portion of gutta-percha is cut. This can be completed by using a heated probe to melt the gutta-percha points.

Figure 4. Lateral spreader instrument used in lateral condensation of gutta-percha. Taken from the web site: www.rootcanaldrs.com/images/unh.ht8.jpg

The last step of the root canal treatment is to fill the coronal portion of the tooth using amalgam or a composite material (obturation) to avoid coronal leakage from a treated root canal. Antibiotics or other antimicrobial drugs kill anaerobic bacteria or arrest their multiplication can be used in RCT to assist the natural defense process to combat infection and promote healing. Some examples for these antibiotics are: Metronidazole tablets, Amoxycillin caps, and Erythromycin tablets (Lewis MAO, 1986). Analgesics may be used in RCT to treat existing pain or to reduce post-operative pain (Jackson DL, et al., 1989). Aspirin and paracetamol remain the most effective analgesics for relief of mild to moderate pain; however, Aspirin has some contraindication for blood disease patients, in which it may increase susceptibility to bleeding and for children under 14 yrs old because it may cause Reye's syndrome. Other non-steroid anti-inflammatory medicine (NSAIDs), such as Ibuprofen, may be used in cases with more severe pain. (Harty, 1997).

Discussion

According to data that have been collected from previous researches, it is possible to replant a periapically infected and root canal treated tooth. This hypothesis rests on the fact that the first part of healing in periapical abscess depends on removing the cause

and the second part of healing depends on the immune system and tissue repair. using treatment of wide-spread periapical infection so can utilize the natural tooth instead of implanting an artificial tooth. To address the first part of healing, infection (microorganisms) should be removed from the area through root canal treatment. Apicictomy to the root will eliminate apical room of the root, so there will be no space for microorganisms to proliferate.Smooth curettage to the socket of the tooth will avoid injury to the periodontal ligament. If necessary, the periapical abscess will be drained by pulling the pus through a syringe. To address the second part of healing, the general immune system should be strong by giving a course of antibiotics such as Metronidazole which has wide-spectrum effect on anaerobic bacteria, which are the main cause of periapical abscesses. (Hamanaka, 2015).

Results

The general project goal is to demonstrate the viability of replantation of the natural tooth. The recent research of Andreasen and others (1995) determined that the following four factors had the strongest positive effect on upon healing in the periodontal ligament (PDL) following replantation of the original tooth: 1) stage of the root development, 2) length of the dry extra-alveolar storage period, 3) immediate replant, and 4) length of wet period (saliva or saline). This research is based on cases involved 400 individual teeth. Non physiological storage, such as homemade saline and sterilized solutions (chloramines and alcohol) always led to root resorption. Storage in tap water for more than 20 minutes usually led to root resorption.The common denominator for all these factors related to PDL healing appears to be survival of the PDL cells along the root surface (Andreasen JO et al, 1995).

Combined clinical, radiographic, and mobility findings revealed that periodontal healing after replantation could be divided into the following groups (Andreasen JO, 1975):

Normal periodontal healing–If the mobility of the replanted tooth is equal to that of the natural tooth in the arch, and there is no radiological sign of root resorption (Andreasen JO, 1981).

External resorption--(root surface resorption) was divided into the following group:
Surface resorption--if there is a cavity on root surface bordered by PDL space and lamina dura.
Inflammatory resorption--if there is any radiographic sign of external root resorption or cavities it is affecting both root surface and the bone.
Permanent replacement resorption (Ankylosis)--If there is lowered mobility and loss of the PDL space radiologically.
Transient replacement resorption--if there is lowered mobility and normal PDL.
Gingival healing and loss of marginal attachment--Evaluated clinically by probing the gingival sulcus at the follow-up visits. Values greater than 3 mm were considered pathological. Periodontal status was considered normal if the distance between the cement-enamel junction and alveolar crest was not more than 2mm. A greater distance was registered as pathological state.

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