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Review Article

Comprehensive Overview of the Apicoectomy Procedure: Indications, Technique, and Postoperative Care.

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Abstract:
This review explores the theoretical and clinical aspects of the apicoectomy (root resection) process in periradicular surgery, which is crucial when standard root canal treatments fail. This procedure entails root apex amputation to resolve problems in the root area. Its goal is to eliminate enduring endodontic pathogens by employing surgical debridement, root-end resection, and canal obturation. The article consolidates extensive literature, emphasizing the procedure's significance in paediatric endodontics and updates in apical surgery. Providing a comprehensive overview, it highlights the procedure's advancements and its crucial role in managing endodontic concerns beyond traditional treatments.
KEYWORDS: Apicoectomy, Ramifications, Root Resection, Luebke-Oschenbein Flap, Guided Tissue Regeneration

INTRODUCTION

Apical surgery, like root resection or apicoectomy, is a specialized procedure addressing stubborn periapical or periradicular lesions unresponsive to standard endodontic treatments (1). It aims to salvage teeth by removing the infected or damaged tooth apex after prior root canal therapy. This surgical method targets infections, cystic areas, or granulation tissues impacting the tooth while preserving its root structure. Root resection's historical roots trace back to the late 19th century when it was identified as an alternative to tooth extraction for treating complications like 'pyorrhoea alveolaris.' Periradicular surgery addresses insistent pathogens by surgically removing infected tissues, conducting root-end resection, and applying retrograde root canal filling (2). In essence, apical surgery remains vital in managing enduring periradicular lesions that resist standard endodontic treatments, serving as a last resort to save affected teeth.

Apical surgery focuses on saving a tooth that still has issues even after regular root canal treatment. This procedure involves trimming

the root tip, creating a small cavity at the end of the root, and adequately sealing it with a filling to address any remaining problems in the root canal system **(3)**. The primary objective is to address persistent issues that conventional treatments cannot resolve, ensuring the tooth's long-term viability by addressing the root cause of the problem through surgical intervention. The surgical procedure involves the extraction of the apical delta, which refers to the complex network of root canal ramifications. This extraction aims to improve accessibility to the apex, enabling better reach for retrograde preparation. Additionally, it assists in creating a functional surface for the debridement of periapical tissue, promoting better cleaning and removal of infected or damaged tissue around the root. Furthermore, during the surgery, close observation of the resected root end is conducted to detect potential vertical fractures (4, 5).

ROOT-END OBTURATION

It is essential to reduce irritants when preparing the root-end cavity because it helps protect against harmful microorganisms and their by-products from getting into the area around the root canal. This preventive measure is essential for creating an optimal periapical tissue healing environment. By reducing the chances of microbial penetration, we enhance the prospects for the regeneration of the attachment apparatus, supporting the overall healing process.

INDICATIONS

According to the European Society of Endodontology (ESE) in 2006, updated indications for apical surgery encompass several conditions **(6)** . Radiographic evidence of apical periodontitis or associated symptoms in cases where the canal obstruction cannot be removed is not feasibly displaced or poses a significant risk of damage. When material visibly protrudes with signs of apical periodontitis or ongoing symptoms persisting for a prolonged duration, it indicates an issue. Sometimes, a new or persistent disease may develop after a root canal procedure, especially if redoing the root canal isn't a feasible solution. Root or pulp chamber floor perforation situations where treatment from within the pulp cavity is impossible. Wu et al. (2006) have proposed modified criteria for apical surgery, focusing on indications for tooth resection **(7)**.

Severe vertical bone loss has specifically impacted one root in teeth with multiple roots. The tooth has furcation involvement that goes all the way through its structure. The roots are positioned unfavourably about the nearby teeth. The condition of the tooth makes it hard to maintain hygiene nearby. Severe root exposure can occur due to dehiscence or other related issues.

CONTRAINDICATIONS

A tooth lacks an opposing tooth for functional support or lacks crucial significance as a supportive structure for a fixed prosthesis. Irreparable damage to the tooth due to insufficient periodontal support or a vertical root fracture renders restoration impossible. Patients exhibiting non-cooperation or having a medical history that poses risks for an oral surgical procedure necessitating alternative treatment approaches.

PROCEDURE

Achieving anesthesia

To achieve sustained anaesthesia beyond the surgical procedure, long-acting anaesthetic agents like bupivacaine (Marcaine) are administered. After ensuring the targeted regional anaesthesia has taken effect, the next step involves injecting a solution of lidocaine 1:50,000 with epinephrine directly into the specific flap area. This injection is carefully administered to concentrate the anaesthesia

precisely over the planned surgical site **(8).** In 1997, Kim et al. emphasized a preferred approach for buccal, palatal, or lingual infiltrations in surgical procedures. They advocated for using 2% lignocaine combined with 1:80,000 adrenaline as the recommended standard for such infiltrations **(9).** This combination has been widely acknowledged as effective. Unless medically contraindicated, incorporating a local anaesthetic with a vasoconstrictor component is crucial. This aids in haemostasis, promoting a dry operating field during the procedure.

Flap design

Choosing the right flap design is important during apical surgery because it helps us see the operation site well and makes it easier to use our tools properly. Different situations need different flap designs to work best. Some flaps we often use in this kind of surgery include the full buccal/palatal mucoperiosteal flap, the sub-marginal mucoperiosteal flap (also called the Luebke-Oschenbein flap), and the Papilla-based incision flap **(10)**. However, it is noteworthy that the semilunar flap has fallen out of favour in endodontic surgery due to its limitations—such as the unpredictable nature of accommodating periapical lesions and the substantial scarring associated with this technique.

Position of the apex for osteotomy

In some cases, the outer cortical bone around a tooth might seem thin, or a damaged area could have affected the outer wall, making locating the root tip more straightforward. But when these conditions are not met, checking the tooth's length and position before starting any procedure to remove bone is essential. If the cortical bone is thin, a gentle removal can be done using a curette. However, in areas with a lot of bone, a slow-speed small hand tool with a round trip might be needed to remove it carefully.

Osteotomy

Maintaining an osteotomy size that is minimally sufficient for the surgical requirements is essential, typically around 4–5 mm with micro instruments. Accessing the apical area should involve a slow handpiece with a round bur and water irrigation to avoid surgical emphysema. Smaller osteotomy windows promote faster healing; lesions smaller than 5 mm heal in about 6.4 months, while those in the 6–10 mm range take about 7.25 months. More extensive lesions (over 10 mm) may need up to 11 months for complete healing. Removal of soft tissue via curettage from the periradicular region is standard, with extracted periapical tissue given for histopathological analysis.

Apical resection

During root-end resection, the main goal is to remove around 3 mm of tissue at the apex to create space for placing filling material and eliminate the apical delta. This process significantly increases the chances of getting rid of smaller canal branches around the root tip. The recommended method for this resection involves using a fissure bur at a 90-degree angle or a bevel that does not exceed 10 degrees, according to the suggestions made by Thesis et al. **(11)**. Having good access during surgery is crucial for accurately placing the filling material. So, while it is essential to keep the bevel minimal, aiming for a bevel as close to 90 degrees as possible helps ensure better access for this purpose.

Root-end preparation

Creating a root-end cavity is a crucial step in retrograde cavity formation, where the goal is to shape and clean the root tip to establish a cavity with either retentive walls or parallel along the tooth's length. This cavity is meant to hold biocompatible filling materials

securely. To achieve this, the process focuses on addressing fins and anatomical isthmuses and ensuring centralization for sufficient wall thickness. Traditionally, small round or inverted cone burs used in angled micro-handpieces were the norm, but they had limitations in controlling both the direction and depth of the cavity. Ultrasonic-driven microtips revolutionized this technique, offering improved directionality and simplicity. Ultrasonic tips are standard, minimizing bone removal, following canal axes, and aiding isthmus debridement. However, lingual wall perforation risks persist. Precise cavity depth (3mm) and parallel walls are critical for material retention. Low-power ultrasonic use minimizes root damage, necessitating sterile saline/water for cooling. Haemostasis (pressure, vasoconstrictor, gauze) maintains a dry, visible surgical site, which is crucial for successful root-end preparations.

Retrograde filling

During root-end surgery, it's super important to carefully check the cavity to make sure it's totally clean and free from any leftover filling materials. Keeping the root-end prep separate from fluids like blood is a must-do. To do this, a special agent that helps stop bleeding is put in the bone hole, and the root-end cavity is dried out well. When picking the material to fill the root end, it's crucial to pack it tightly using a small tool to ensure it fills the space without leaving any extra stuff on the cut root surface.

The main aim of retrograde filling is to choose a material that will not cause problems and can seal things up tight, stopping any bad stuff or mouth germs from getting out of the root canal and messing with the tissues around it. Different materials have been used for this over time, from temporary ones like Super-EBA, IRM, and Cavit to more permanent ones like gold, amalgam, resin composite, glass ionomer cement, and compomer. Amalgam used to be popular, but now guidelines from the Royal College of Surgeons of England advise against using it for root-end fillings **(12)**. Mineral trioxide aggregate (MTA) is the best choice because it is the ideal root-end filling material.

MTA, made of hydrophilic particles consisting of tricalcium silicate, aluminate, oxide, and silicate, along with bismuth oxide for radio-opacity, has shown better success rates and improved sealing and compatibility than amalgam. Research suggests that MTA might not just repair but potentially stimulate tissue regeneration. Its ability to kill bacteria, due to releasing hydroxyl ions and creating a high pH environment, contributes to its positive outcomes. Notably, MTA solidifies in about three to four hours when mixed with water in a 3:1 ratio in the presence of moisture. Another promising material, Biodentine, has a tricalcium silicate core, easier handling, and similar biocompatibility to MTA. However, more extended studies are needed to establish its qualities. One downside of Biodentine is its lower radio-opacity, which makes it harder to assess post-operative healing using X-rays. After retrograde filling, taking a post-operative X-ray to check the apical restoration before closing the wound is crucial. This X-ray acts as a baseline to monitor future healing processes.

Wound closure

A thorough surgical area check and cleaning is crucial before closing a wound with sutures. After lifting the flap, it is essential to bring the edges together using individual stitches carefully. For precise alignment, finer sutures like 5-0, 6-0, or 7-0 are preferred. Gently pressing with gauze helps the tissue and bone make proper contact. Sutures come in two types: resorbable and non-resorbable. Resorbable ones can irritate until they dissolve or are removed. That is why, for gum wounds, non-resorbable

materials are better since they cause less inflammation. Once these sutures are removed, any irritation usually fades, especially if removed within a few days. Removing them early helps prevent the formation of a track along the suture line. Usually, sutures are taken out within 3–5 days after surgery. It's important to note that there's no proven benefit in giving antibiotics right after surgery for better healing **(13)**.

Surgery outcome/ healing

Apicoectomy outcomes depend on various factors that researchers have thoroughly investigated. They have investigated elements such as patient characteristics (like age and gender), the tooth's location, the quality and timing of root canal treatment, the presence of retrograde root fillings, overall gum health, the extent of damage around the tooth's tip, the expertise of the surgeon, and more. Success evaluation usually occurs about a year after the surgery. However, more minor issues around the tip of the tooth might heal in just a few months. When we talk about healing, we refer to clinical checks (like examining for pain, swelling, sinus tracts, and signs of inflammation) and the use of X-rays. X-rays help categorize healing into complete, incomplete (indicating scar tissue), uncertain (showing some improvement but not completely healed), or unsatisfactory (no change or worsened condition). These categories are like studies that compare X-ray results with what is seen in the extracted tooth under a microscope after the surgery.

Follow-up appointments are crucial for suture removal and early healing assessment, with subsequent regular visits to monitor healing through clinical and radiological criteria. While guided tissue regeneration (GTR) techniques are proposed to aid post-surgical healing, they are sparingly employed in paediatric endodontic procedures. Notably, innovative approaches combining materials like MTA, bovine bone grafts, and cortical collagen membranes promise to save teeth with uncertain prognoses and facilitate osseous healing. Enhanced techniques in root-end cavity preparation, meticulous soft tissue handling, and strategic flap design collectively contribute to surgical success rates. Magnification, optimal lighting, and advanced filling materials promote favourable outcomes in apicoectomies by aiding bony healing and reducing the likelihood of surgical failures.

CONCLUSION

In summary, apicoectomy is an efficient surgical recourse for cases where conventional root canal treatment fails to yield results. Additionally, it holds significant importance within paediatric endodontics, especially in managing traumatic injuries concerning both young permanent and adult teeth. This comprehensive review offers a holistic understanding of the apicoectomy procedure, encompassing its historical evolution and contemporary advancements.

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