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Observational Study

Incidence and risk factor analysis for swelling after apical microsurgery

One-month follow-up of apical microsurgery

Abstract

BACKGROUND

Swelling after apical microsurgery is considered to be a post-operative reaction and may reduce the patient's quality of life during healing.

AIM

Evaluate developing periapical swelling after apical microsurgery and determine potential risk factors.

METHODS

Ninety-eight apical microsurgery patients were selected for this study. Before surgery, bone shadow volume and density of pathological tissue were measured by CBCT. The other variables (age, gender, operative teeth number, fistula, preoperative swelling, drug use and pre-surgery root canal treatments) were assessed during examination. Swelling degree was confirmed by questionnaires for patients on the 1st, 7th, 14th, and 21st days respectively after surgery. Statistical analyses were performed to identify predictors for swelling.

RESULTS

Majority of patients reported moderate (45.9%) or severe (34.7%) swelling on day 1, and moderate (44.9%) or mild (45.9%) on day 7. 99% patients had no or mild swelling on day 14. The average swelling level peaked on day 1 postoperatively and gradually decreased. Of statistical significance, age, bone shadow volume and density of pathological tissue acted as predictors of swelling ($P < 0.05$). However, there was no significant difference in gender, tooth number, fistula, preoperative swelling, drug use, or pre-surgery root canal treatments ($P > 0.05$).

CONCLUSION

Younger patients with larger shadow volume and density were significantly more likely to develop swelling after apical microsurgery.

Key Words: Apical microsurgery; Swelling; Incidence; Risk factor; Prognosis

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Core Tip: The impact of post-apical swelling on their daily life was viewed from the patient's perspective. The conclusions demonstrate that postoperative swelling is more severe in those with larger volume and density of apical lesions, so the importance of preoperative CBCT examination is emphasized. Younger patients with high postoperative prognostic requirements may have more severe postoperative swelling than older patients and should be given more clinical attention.

INTRODUCTION

Apical microsurgery is a newly-developed procedure, which consists of periapical curettage, apicoectomy, retro preparation and retro filling of a root canal while under dental microscope^[1]. It holds a high success rate of controlling periapical infection, so as

to promote periapical healing and periapical tissue regeneration^[2]. This may be due to its accuracy, minimally invasive nature, and high curative effect through the use of microscopic magnification, illumination, ultrasonic instrument tips and root-end filling materials^[3-5].

On the other hand, apical microsurgery cannot avoid a certain degree of swelling, which is one of the most common postoperative complications^[6]. Kvist^[7] stated that almost all patients developed swelling and pain, with these complications mostly peaking on the first day after surgery. Additionally, swelling of the mucoperiosteum flap was also reported after tooth extraction surgery, where the triangular flap had a greater increase in swelling than the envelope flap within a week^[8]. Further, a low probability of swelling was reported after root canal treatment, especially after root canal filling^[9]. However, single or multiple root canal treatments had no significant effect on the degree of swelling. Most short- and long-term complications (pain and swelling) showed a similar frequency. However, people who made a single clinical visit were more likely to experience pain and to take painkillers^[10].

To date, many studies have focused on swelling after tooth extraction surgery and root canal treatments. There has also been some research that illustrates predictors of pain after apical microsurgery^[11]. However, few studies have clarified predictors of swelling after apical microsurgery. ¹ The aim of this study, therefore, is to evaluate the characteristics and degree of periapical swelling after apical microsurgery and to determine the potential risk factors of periapical swelling.

MATERIALS AND METHODS

Ethics and Sample Selection

This study was conducted according to the Declaration of Helsinki principles. The study protocol was approved by the Medical Ethics Committee of Hangzhou Dental Hospital (2021-6-9). Written informed consent was obtained from each subject before participating in the study. Patients who need apical microsurgery were recruited at

Microscopic Dentistry Center of Dentistry, Hangzhou Dental Hospital, from 2018 to 2020.

Basic patient information, preoperative and postoperative physical examination notes, clinical symptoms and other relevant patient records were considered in patient selection. Imaging data from preoperative and postoperative follow-up visits were included. Eligible patients were identified according to the following inclusion criteria: patients graded as Classification I or Grade A by the American Society of Anesthesiologists, patients between 18 and 65 years of age who meet the indications for apical microsurgery surgery, patients who had a preoperative CBCT scan taken that was of good diagnostic quality and with teeth treated by unified and standardized apical microsurgery, patients with a follow-up period of more than half a year.

Ninety-eight patients' records met the inclusion criteria and were included in this study for further analysis. All apical microsurgeries were performed by a single endodontic specialist at the VIP Center in Hangzhou Dental Hospital.

Surgery Protocol

First, for mandibular posterior teeth, 2 mL of 2% lidocaine with 1:100000 adrenaline was administered by ² inferior alveolar nerve block, and 3.4 mL of 4% articaine hydrochloride with 1:100000 adrenaline was administered by infiltration to the maxillary and mandibular anterior teeth. A single vertical incision was made distant to the periapical lesion and sulcular incisions in the corresponding region, and the mucoperiosteal envelope flap was elevated. Secondly, from this stage on, ² all surgical procedures were performed under a dental operating microscope (OMS2350; ZUMAX, Jiangsu, China) with coaxial illumination and a zoom magnification changer. Magnifications between 3.4 and 20.4 were used. The periapical region was curetted, and the granulation tissue removed. A following apicoectomy was performed with a fissure bur 3mm coronal to the apex. Thirdly, subsequent smoothing with a piriform bur

applied rectangularly to the axis of the root resulted in a bevel of approximately 10°. The resulting surface was stained with 50 mg/5 mL methylthioninium chloride and inspected by using a micromirror (JIMM2; B&L Biotech, Ansan-si, South Korea) under high magnification to detect individual canal anatomy, in particular, any additional canals, isthmuses or root fractures. After cleaning with 30% hydrogen peroxide and then 96% alcohol, and subsequent drying, the prepared cavity was filled with Intermediate Restorative Material (IRM; Dentsply Caulk, Milford, DE). Finally, the filling and the apical surface were smoothed with a piriform stainless steel bur. The flap was closed with single interrupted sutures, and a postoperative digital radio graph was taken. Patients were instructed to take 20 mg serrapeptase enteric-coated tablets or 1.5 mg dexamethasone acetate tablets after meals t.i.d., and 60 mg loxoprofen sodium tablets as needed.

Data Collection

On the 1st, 7th, 14th and 21st days after operation, patients were given questionnaires with a visual analogue scale to evaluate the degree of swelling. The visual analogue scale (VAS) score of swelling was as follows:

- 0 (no swelling): the patient felt like usual,
 - 1-3 (mild swelling): the patient can tolerate symptoms, the appearance did not affect his/her life and work, and no drug treatment was needed,
 - 4-6 (moderate swelling): the patient was anxious due to changed appearance caused by swelling, which affected his/her work and life, and drug intervention was needed, indicating that the swelling was hard to tolerate,
 - 7-10 (severe swelling): the patient felt severe anxiety and unhappiness due to changed appearance caused by swelling, which seriously affected his/her work and life, and an extended period of time was needed for drug intervention to alleviate symptoms, indicating that the swelling was severe or intolerable.
- All patients' degree of swelling was collected and gathered into electronic records, which indicated their degree of swelling at different points in time.

On day 1, severe tissue damage in the surgical area led to severe swelling, which affected the judgment of predictors. Thus, swelling conditions on the 7th day post operation were chosen for data comparison in order to speculate on risk factors. The patients were finally divided into two groups for comparison. No swelling and mild swelling were classified as one group, while moderate swelling and severe swelling were the other group. Independent data analysis was performed for the following predictors: age, gender, tooth number, fistula, preoperative swelling, drug use, pre-surgery root canal treatment, bone shadow volume, and density of pathological tissue.

Statistical Analysis

The Mann-Whitney U test and chi-square test were used to analyze and compare the basic characteristics of patients included in each group. SPSS v.26.0 software (IBM Corp, Armonk, NY) was used for all analyses. The mean \pm SD (numerical range) was used for statistical description of the data and the difference was considered statistically significant if the P value was less than 0.05.

RESULTS

Prediction of Risk Factors for Swelling

Tables 1 shows the statistical comparison of different predictors between the no or mild swelling group and the moderate or severe swelling group on the 7th day after surgery. In the analysis of 98 people, the patients with moderate or severe swelling were significantly younger than those of the no or mild swelling group ($P < 0.05$). Additionally, larger preoperative bone shadow volume statically demonstrated severe swelling ($P < 0.05$). The density of pathological tissue was statistically different between two groups ($P < 0.05$), the deeper density being more swollen. However, there was no significant difference in gender, tooth number, tooth position, fistula, preoperative swelling, drug use or pre-surgery root canal treatment ($P > 0.05$).

Trends and Characteristics of Postoperative Swelling

Fig. 1 shows the trends after operation. Severe swelling was most dominant on the 1st day (34.7%), and gradually decreased until the 14th day. Most patients reported moderate (45.9%) and severe (34.7%) swelling on day 1, while moderate (44.9%) and mild (45.9%) swelling on day 7 were most reported. Ninety-nine percent of patients had no or mild swelling on day 14.

DISCUSSION

Swelling is one of the most common complications after apical surgery and is directly related to the degree of tissue trauma during operation^[12]. It is considered a normal, predictable physiological reaction after surgery which may reduce patients' life quality during healing. Symptoms of swelling must therefore be minimized^[13]. In this research, the degree of postoperative swelling was defined from the perspective of patients according to the influence of swelling on their daily life. This degree of swelling is also applicable to other oral and maxillofacial surgery procedures, such as oral and maxillofacial bone grafting and orthognathic surgery.

Postoperative swelling is a pathological process of transformation. In the early stages after operation, a series of inflammatory reactions and oxidative stress occur in tissue at the surgical site. Moreover, stitched wounds increase local tension, causing local arterial congestion and dilation, leading to blocked lymphatic reflux and retention of large amounts of fluid in the tissue^[14]. After 7 days, the wound gradually contracts, basal cells proliferate, and granulation tissue and corresponding fibers reconstruct^[15]. Fourteen days post-operation, the wound heals, and the swelling is reduced. However, all of surgeries in this study used 30% hydrogen peroxide and 96% alcohol as disinfectants. This method of disinfection has certain limitations and recent studies suggest that chlorhexidine may be more effective^[16].

Younger patients were more likely to experience moderate and severe swelling after surgery. This may be related to a relative decline in immunity and inflammatory response in older patients^[17]. In addition, protective pulp calcification, reduced root

canal attenuation and dentin tubule calcification in the elderly may also lead to reducing swelling after surgery^[18].

Swelling is a type of increase in tissue volume caused by reacting of stress in tissue. In apical microsurgery, the number of teeth operated on is not the main factor of swelling, but rather the severity of pathological changes prior to operation^[19]. In this study, the main indicators were bone shadow volume and density of pathological tissue. Bone destruction was one of the most salient causes of poor prognosis. Clinical and radiological investigations by Mikkonen *et al*^[20], found that periodontal crest absorption and traumatic occlusion might impede the healing process after apical surgery. Another study found that peripheral bone destruction and marginal bone loss also affected tissue healing^[21].

In this study, gender, tooth number, fistula, preoperative swelling, drug use after operation, and pre-surgery root canal therapy showed no significant difference ($P > 0.05$). Results related to gender were different from Lqbal *et al*^[22], who investigated the degree of pain after apical microsurgery. They found that gender had a significant impact on the incidence of severe pain, which may be related to the different pain thresholds between men and women. Mostly, periapical inflammation was controlled after apical microsurgery. Apical microsurgery promoted the closure of fistula, but was not significant in the degree of swelling. The appropriate amount of dexamethasone was reported to both reduce swelling and improve the patient's prognosis^[23].

The value of bone shadow volume and density of pathological tissue as predictors of postoperative pain and swelling has been highlighted in the current study. This information can guide physicians to take appropriate measures in patient treatment plans to reduce the degree of swelling after apical microsurgery and improve patient prognosis.

CONCLUSION

Based on this clinical analysis, periapical swelling after apical microsurgery occurred frequently. Risk factors may be younger age, larger bone shadow volume and deeper

density of pathological tissue. However, other related risk factors and methods to improve prognosis must still be further elaborated.

ARTICLE HIGHLIGHTS

Research perspectives

For patients who need microscopic apical surgery, preoperative CBCT is necessary as bone shadow volume and pathological tissue density are predictors of postoperative swelling. Based on these indicators, the physician can take appropriate measures in the patient's treatment plan to reduce the swelling after microsurgery and the impact on the patient's daily life.

Research conclusions

Young patients with larger volume and density of shadow around the tooth apical in CBCT were more likely to develop swelling after apical microsurgery.

Research results

Majority of patients reported moderate (45.9%) or severe (34.7%) swelling on day 1, and moderate (44.9%) or mild (45.9%) on day 7. 99% patients had no or mild swelling on day 14. The average swelling level peaked on day 1 postoperatively and gradually decreased. Of statistical significance, age, bone shadow volume and density of pathological tissue acted as predictors of swelling ($P < 0.05$). However, there was no significant difference in gender, tooth number, fistula, preoperative swelling, drug use, or pre-surgery root canal treatments ($P > 0.05$).

Research background

Apical microsurgery is a newly-developed procedure which can hold a high success rate in controlling periapical infection, so as to promote periapical healing and periapical tissue regeneration. But apical microsurgery cannot avoid a certain degree of swelling, which is one of the most common postoperative complications.

Research methods

Ninety-eight apical microsurgery patients were selected for this study. Before surgery, CBCT was used to measure the bone shadow volume and density of pathological tissue. The other variables (age, gender, operative teeth number, etc) were assessed during examination and the swelling degree was confirmed by questionnaires for patients on the 1st, 7th, 14th, and 21st days respectively after surgery. The predictors for swelling were performed by statistical analyses.

Research objectives

Through evaluating the degree and characteristics of periapical swelling after apical microsurgery to determine the potential risk factors of periapical swelling.

Research motivation

Many studies have focused on swelling after tooth extraction or root canal treatments and illustrated predictors of pain after apical microsurgery. However, few studies have clarified predictors of swelling after apical microsurgery. So our study focuses on swelling after apical microsurgery and try to clarify the predictors.

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