JMS 2022;5 (1):132-144
UDC: 616.314.163-74
DOI: 10.55302/JMS2251132k

PERIAPICAL SURGERY: THE ISSUE OF RETROGRADE OBTURATION

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Abstract

The primary objective of periapical surgery is to eradicate the etiological agents of periapical lesions, to obtain hermetic apical seal, so the parodontium is restored to a state of biologic and functional health.

Uncertain clinical and radiographic evaluation of canal obturation, coronary permeability that can't be detected during clinical investigation, are main arguments in favor of routine retro preparation and obturation.

Reported clinical study aimed to evaluate particular preoperative and intraoperative tooth related aspects as potential predictors of retrograde obturation. Patients who were referred for periapical surgery of 45 teeth with chronic periapical inflammation associated with endodontic treatment were included in this study.

Preoperative radiographs were evaluated for quality and extent of the canal obturation, as well as root and canal morphology.

During periapical surgery, using visual enhancement, the following intraoperative aspects were evaluated: resected root surfaces, root contour, canal morphology, presence of iatrogenic mistakes, canal obturation in relation to retrograde obturation. The preoperative results showed prevalence of inadequate canal obturation (91,1%) in teeth with one root and one canal structure (93,3%).

The intraoperative evaluation demonstrated prevalence of oval root surfaces (74,0%) with unobturated one canal structure (70,8%). Where obturation was present, leaking was detected (28,6%). Such findings undoubtedly pointed in favor of retro preparation.

Preoperative evaluation of canal obturation in conjunction with intraoperative examination under visual enchantment of resected root surface confirmed the need for retrograde obturation.

Therefore periapical surgery of teeth with periapical inflammatory lesions associated with canal treatment should include retrograde obturation thus primary goals are accomplished.

Keywords: periapical surgery, chronic periapical inflammation, retrograde obturation, canal obturation, radiography, root and canal morphology, resected root surface.

Introduction

Periradicular surgery is based on two goals, namely to eliminate the etiologic agents causing infection and to prevent root canal reinfection and recontamination of the periodontal tissues thereafter.

Basically, the etiologic agents involved in endodontic infections may be classified as intraradicular or extraradicular microorganisms, intraradicular or extraradicular chemical substances and extraradicular physical factors.

Surgical endodontic treatment is an option for teeth with apical periodontitis and may be indicated for teeth previously submitted to unsuccessful endodontic treatment and teeth with a strong possibility of failure by the nonsurgical approach. [1,2].

The primary objective of apicectomy is to eradicate the etiological agents of periapical pathoses and to restore the periodontium to a state of biologic and functional health. [3].

Basically, the etiologic agents involved in endodontic infections may be classified as intra radicular or extra radicular microorganisms, chemical substances and extra radicular physical factors.

The complex apical portion of the root canal system harbors microorganisms, unless it has been accessed by root canal instruments and chemically disinfected. This nidus of infection is removed by resecting the apical 3mm of the root [3].

A modern approach to root end resection involves the use of magnification to allow a smaller osteotomy.

In addition, the apex is resected with minimal or no bevel and the root end is treated with ultrasonic tips, then is sealed with modern root end filling materials other than amalgam [4,5].

Ideally, this procedure should remove irritant agents from the root canal systems and periapical tissues, as well as isolate and seal bacteria which would be unreachable by other means, so as to allow tissue regeneration or reparation. [6].

The created retro cavity and the sealing material are trying to fulfill a biological imperative: a hermetic seal of every existing and potentially dangerous agent in the root.

The retrograde filling is a major prognostic factor [1].

If we accept that apical lesions result primarily from bacterial infection in the root canal, the presence/absence of an apical barrier will therefore affect the long-term prognosis of surgical treatment. (7) The success rate can be increased by 10% to 13% if a retrograde filling is used [8-10].

Retro preparation is to be considered regardless of the age and quality of root canal obturation. [11]. Kratchman S [12] described retro preparation as a mandatory procedure in surgical endodontics.

Hirsh JM et al. and Altonen M et al. cited by Abedi HR et al [13] compared the prognosis of periapical surgery with, and, without retro obturation, and they came to the same conclusion that cases with retro obturation had higher success rate.

Several SEM analyses suggested that root resection negatively influences the gutta percha seal.

Therefore, retro preparation is to be considered always in cases of resection of root filled teeth. [14].

Uncertainty of clinical and radiographic evaluation of apical obturation, coronary permeability that can't be detected during clinical investigation, are main arguments in favor of routine retro preparation and obturation [15].

Therefore, the aim of this clinical study was to evaluate particular preoperative and intraoperative tooth related aspects in teeth with periapical inflammatory lesions as potential predictors of retrograde obturation.

Material and methods

Patients older who were referred for periapical surgery of 45 teeth with periapical inflammatory lesions related to canal treatment were included in this study.

The inclusion criteria were: patients ought to be older than 18 years, and endodontic treatment had to be performed 2 years before.

The exclusion criteria were: patients younger than 18 years, recent endodontic treatment, and previous surgical treatment.

All signed a written consent to be included in this study.

The preoperative radiographs were evaluated for root and canal morphology, quality and extent of the canal obturation.

The canal obturations were qualified as acceptable or unacceptable according to the criteria used by Khabbaz et al. [16]. On the day of the surgery, local infiltrative anesthesia was administered (2% mepivacaine with epinephrine 1: 100000 - Septodont, France).

Mucoperiosteal flap was raised, osteotomy and root resection of at least 3 apical millimeters at minimum bevel were made.

Periapical lesions were enucleated.

The bone crypts were desiccated and the resected root surfaces stained with 2% methylene blue dye which was left in situ for 1 minute, then thoroughly rinsed.

The dye embedded the soft tissues (periodontal ligament, pulp remnants) and voids making them visible.

The exposed resected root surfaces were evaluated with visual aid: telescopes (Task Vision x 2.5), focused light and micromirrors (Aesculap DA 044 R, Germany) for the following anatomical landmarks**:**

- the contour of the resected root (oval, round, renal or hourglass),
- the number of canals,
- presence of an isthmus,
- presence of iatrogenic failures (root perforation, file fracture),
- presence of root fissure

Next, the canal obturation was evaluated and classified as:

- obturation is present and complete
- obturation is present and leaking
- obturation is absent.

With regard to preoperative and intraoperative specifics, retro preparations were made with Retro Berruti DC retro tip (Piezon Master 400 EMS Nyon, Switzerland), dried and filled.

Flaps were reapproximated with 4-0 silk single sutures.

The patients were to follow a standard postoperative regime.

Results

Most teeth, 40 (88,9%), were in maxilla, anterior were 26 (57,7%); 11 (24,4%) central incisors (CI), 11 (24,4%) lateral incisors (LI), and 4 (8,9%) canines (C).

Posterior teeth were 14 (32,2%), 9 (20%) second premolars (SP) and 5 (11,1%) first premolars (FP). 5 (11,1%) teeth were mandibular, incisors were 2 (4,4%), premolars 3 (6,6%), a first premolar (FP) and 2 second premolars (SP) (tabe 1)

Table 1. Distribution of teeth according to jaw and group of teethey belong (N=45)

Jaw bone	Groupe of teeth	N	%
maxilla (mx)	CI	11	24,4%
	LI	11	24,4%
	C	4	8,9%
	FP	5	11,1%
	SP	9	20 %
total		40	88,9%
mandible (md)	CI	1	2,2%
	LI	1	2,2%
	FP	1	2,2%
	SP	2	4,4%
total		5	11.1%
N	-	45	100%

The radiological evaluation of root and canal morphology revealed prevalence of teeth 42 (93,3%) with one root and one canal.

Two roots with a canal each were detected in 3 (6,6%) maxillary FP.

Most teeth 39 (86,7%) were underfilled (n=45; 100%), 2(4,4%) were overfilled, and 4 (8,9%) had acceptable canal filling and periapical lesions.

Procedural errors like root perforation and serrated file were found in 5 (11,1%). (table 2

Table.2 Distribution according to the preoperative radiological evaluation of the canal obturation (N=45).

Canal obturation		N	%		
length	- acceptable	4	8,9%		
	- underfilled	39	86,7%		
	- overfilled	2	4,4%		
total		45	100%		
density	- inadequate	6	13,3%		
	- adequate	39	86,7%		
total		45	100%		
procedural errors	- root perforation	3	6,6%		
	- separated file	2	4,4%	40	89%
	- none				
total		45	100%		

The radiological evaluation of the canal obturation in maxillary teeth revealed prevalence of underfilled maxillary teeth 34 (75,4%) (n=40%; 89%) and obturation with inadequate density 33 (73,3%). Canal obturation with acceptable length was found in 4 (8,9%) (table 3).

3 (6,6%) CI had acceptable canal obturation length (n=11;24,4%), inadequate density was detected in 2 (4,4%) CI, and underfilled were 8 (17,7%) CI. (table 3)

9 (20%) LI were underfilled, (n=11;24,4%), four had apical ⅓ empty. 2 (4,4%) LI were overfilled (table 3) and figure 1.

When 4 (8,9%) C were examined, only 1 (2,2%) had acceptable canal filling, 3 (6,6%) were underfilled, one had inadequate density, other had a separated canal file, and the third one had apical ⅓ unfilled (table 3).

As for the first premolars, 2 had ⅔ underfilled, 2 had ⅓ underfilled. One had empty canals, with root perforation in the middle (table 3).

Figure 1. Maxillary canine with underfilled root canal

Table 3. Distribution according to the preoperative radiological evaluation of the canal obturation in maxillary teeth (N=40)

Group of teeth	**Length**			**N**	**Density**		**Procedural errors**	
	acceptable	underfilled	overfilled	**%**	adequate	inadequate	perforation	separated file
CI	3 (6,6%)	8 (17,7%)	0	11(24,4 %)	1(2,2%)	10(22,2%)	0	0
LI	0	9 (20%)	2(4,4%)	11(24,4 %)	2 (4,4%)	9 (20%)	0	0
C	1 (2,2%)	3 (6,6%)	0	4 (8,9%)	1(2,2%)	2(4,4%)	0	1 (2,2%)
FP	0	5 (11,1%)	0	5 (11,1%)	0	4 (8,9%)	1 (2,2%)	0
SP	0	9 (20%)	0	9 (20%)	0	8 (17,8%)	1(2,2%)	0
N	-	-	-	40(88,8 %)	-	-	-	-

The radiological evaluation of the canal obturation in mandibular teeth revealed underfilled root canals with inadequate density, in all but 1 SP. It was overfilled with adequate density. (table 4)

Table 4. Distribution according to the preoperative radiological evaluation of the canal obturation in mandibular teeth (N=5).

Length	CI	LI	FP	SP
- acceptable - underfilled - overfilled	0 1(2,2%) 0	0 1(2,2%) 0	0 1(2,2%) 0	0 1(2,2%) 1(2,2%)
Density -adequate - inadequate	0 1(2,2%)	0 1(2,2%)	0 1(2,2%)	1(2,2%) 1(2,2%)
Procedural errors -broken instrument -root perforation	0 1(2,2%)	0 1(2,2%)	0 0	0 0
N=5 (11%)	1(2,2%)	1(2,2%)	1(2,2%)	2(4,4%)

As periapical surgeries unveiled, the apical 3-4 mm were resected, and the resected root surfaces were stained, then visually assessed for anatomical landmarks.

Most teeth in maxilla 27 (59,7%) had oval resected root surfaces (n=40; 89%): 7 CI (15,6%), (n=11; 24,4%), 8 LI (17,7%) (n=11; 24.4%) , 3 C (6,6%) (n=4; 8.8%), 4 FP (8,8%) (n=5; 11%), and 5 SP (11%) (n=9; 20%) (figure 2).

The remaining 11 (24,3%) had round shaped resected root surfaces: 4 CI (8,8%) (n=11; 24,4%), 3 LI (6,6%) (n=11; 24,4%), 1 C (2,2%) (n=4; 8,8%), and 3 SP (6,6%) (n=9; 20%) .

An hourglass contour was detected in 1 FP (2,2%) (n=5; 11%), and a reniform in 1 SP (2,2%) (n=9; 20%). (table 5).

Table 5. Distribution according to the contour of the resected root surface in maxillary teeth (N=40)

Root surface contour	**CI**	**LI**	**C**	**FP**	**SP**
oval	7(15,6%)	8(17,7%)	3(6,6%)	4(8,8%)	5 (11%)
round	4(8,8%)	3(6,7%)	1(2,2%)	0	3(6,6%)
reniform	0	0	0	0	1 (2,2%)
hourglass	0	0	0	1(2,2%)	0
N=40(88,9%)	11(24,4%)	11(24,4%)	4(8,8%)	5(11%)	9 (20%)

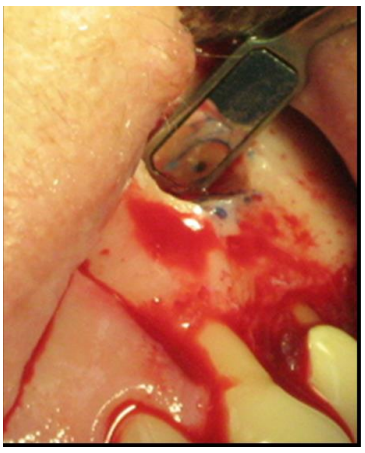

Figure 2. Oval root contour and centrally positioned canal with leaking obturation stained with methylene blue dye, viewed in micromirror, in maxillary canine.

Figure 3. Hourglass root contour with two canals and leaking obturation stained with methylene blue dye in maxillary first premolar with fused roots.

One canal at the level of root resection was detected in the majority of maxillary teeth 33 (73,3%) (n=40; 89%).

The remaining 7 (15,4%) had two canals.

Two canals connected with isthmus were visible in two SP. Concerning the existence of obturation at the level of root resection, 4 (8,8%) maxillary teeth had obturation that was complete. 18 (39,4%) had no obturation, instead the canal was filled with necrotic debris; 11 (24,2%) had a leaking obturation (figure 3).

The remaining teeth 7 (15,4%) with two canals didn't have obturation, the canals were filled with necrotic remnants. (table 6)

Table 6. Distribution according to the visual evaluation of canal morphology and obturation of the resected root surface in maxillary teeth(N=40)

Canal morphology	**CI**	**LI**	**C**	**FP**	**SP**
one canal without obturation	5(11%)	6(13,3%)	2(4,4%)	1(2,2%)	4(8,8%)
one canal with complete obturation	2(4,4%)	1(2,2%)	1(2,2%)	0	0
one canal with, leaking obturation	4(8,8%)	4(8,8%)	1(2,2%)	1(2,2%)	1(2,2%)
two canals without obturation	0	0	0	3(6,6%)	1(2,2%)
two canals with complete opturation	0	0	0	0	0
two canals with leaking obturation	0	0	0	0	1(2,2%)
two canals with isthmus	0	0	0	0	2(4,4%)
three canals	0	0	0	0	0
fissure	0	0	0	0	0
N=40 (88,9%)	11 (24,4%)	11 (24,4%)	4 (8,8%)	5 (11%)	9 (20%)

During periapical surgery, after root resection, resected root surfaces with oval contour were detected in the mandibular teeth 5 (11%). (table 7).

Table.7 Distribution according to intraoperative visual evaluation of the root contour in mandibular teeth (N=5)

Root contour	**CI**	**LI**	**C**	**FP**	**SP**
oval	1(2,2%)	1(2,2%)	0	1(2,2%)	2(4,4%)
round	0	0	0	0	0
reniform	0	0	0	0	0
N=5 (11%)	1(2,2%)	1(2,2%)	0	1(2,2%)	2(4,4%)

One canal on the resected root surface was detected in all mandibular teeth.

Concerning the assessment of canal obturation at the level of resection, one canal with complete obturation was visible in 2(4,4%) samples, leaking obturation was found in 2 (4,4%), one canal with leaking obturation was found in two (4,4%), and one canal without obturation was found in one (2,2%) sample. (table 8).

Table 8. Distribution according to intraoperative visual evaluation of the canal morphology and obturation in mandibular teeth (N=5)

Canal morphology	**CI**	**LI**	**C**	**FP**	**SP**
one canal without obturation	0	0	0	1(2,2%)	0
one canal with complete obturation	1(2,2%)	0	0	0	1(2,2%)
one canal with, leaking obturation	0	1(2,2%)	0	0	1(2,2%)
fissure	0	0	0	0	0
N =5 (11%)	1(2,2%)	1(2,2%)	0	1(2,2%)	2(4,4%)

Discussion

Taking into consideration the primary goal of periapical surgery besides elimination of periapical infection, is to obtain hermetic apical seal, this clinical study focused on determined preoperative and intraoperative tooth related aspects as potential predictors of retrograde obturation.

Most teeth that were operated belonged to the anterior maxilla (88,8%), while few were in the mandible (11,2%).

Maxillary central and lateral incisors were 57,7%, premolars were 31,1%. These results were in conjunction with other reports of the majority of patients having apical resection procedures for incisors,

and rates of canine and premolar teeth were low and similar. Also, more apical resection procedures were performed in the maxilla (81%), and at a lower rate in the mandible (19%). [17].

Similar were the results showing that periapical surgery was performed mostly on the middle incisor teeth at the maxilla (73.3%). [18].

Maxillary incisors are the most affected teeth with periapical inflammation associated with endodontic treatment. Concerning the quality of the endodontic treatment, the preliminary radiographic evaluation revealed prevalence of unacceptable canal obturation in teeth with one root and one canal structure, 91,1% and 93,3% respectively.

Underfilled were 86,7% and overfilled were 4,4% of examined teeth. Acceptable canal filling was detected in low 8,9%. Root perforation and separated file were procedural errors found in 11,1% of the cases. Underfilled root canals harbor different bacteria that sustain the periapical inflammation.

Even if the root canal filling is radiographically classified as adequate, the occurrence of apical gap between the obturation and the canal walls and the need for root-end cavity preparation and retrograde restoration should always be assessed after apicoectomy [19].

The purpose of periapical surgery is the removal of all necrotic tissues from and around the apical region (the root, soft tissues and bone) and obturation of all portals of exit, orthogradely and/or retrogradely. Persisting intracanal infection will be a source of failure after surgery if the method and materials used did not provide an effective seal.

This may be aggravated if an apicoectomy leaves open a large number of tubules and canal ramifications, through which microorganisms may penetrate and cause periapical inflammation [20]. Root-end resection will remove the anatomical complexities that may harbor intra radicular infection: apical ramifications, accessory canals, or severe apical curvatures; iatrogenic mishaps that prevented access to the entire root canal system throughout non-surgical retreatment, including perforations, ledges, transportations, or foreign body materials; apical root fractures or cracks; or apical resorptions that prevented an adequate seal during the conventional procedure [21].

A 3mm root resection reveals a respected root surface susceptible to visual and instrumental exploration. Use of methylene blue and other suitable dyes is used to stain the resected root surface [22]. First roots outline is identified, then canal morphology and the quality of exposed canal obturation.

This procedure not only outlined the circumference of the periodontal ligament ensuring complete root resection, but it also aided in identifying canal morphology, missed canals, isthmuses and iatrogenic errors. The anatomy of the resected root varies greatly. It's shape can be oval, ovoid, reniform and various other irregular forms [23,24].

Most single root teeth had oval resected root surfaces (70,8%), and the remaining had round (24,3%). The oval or ovoid shapes are frequently found in single roots while the more complex shapes, e.g. reniform, are found in fused premolar or molar roots. [25].

Such were the findings in this study. More complex root contours were detected in a fused maxillary FP and SP.

The resected surface contour is an important anatomical factor that influences the retro-cavity shape and extension. Its dentinal walls should be at least 2mm thick so leaking is prevented. This prerequisite is especially challenging in narrow roots. Considering the canal morphology, one canal at the resection level was found in the majority of maxillary teeth (73,3%), and the remaining had two canals (15,4%); un instrumented isthmus was found in few premolars.

Taking into account that the endodontic treatments were associated with periapical inflammation, it didn't come as a surprise that obturation was not detected in 54,8% maxillary and 2,2% mandibular teeth at the resection level. Instead, necrotic remnants were present.

In cases of visible obturation (28,6%), leaking was discovered. The determined preoperative and intraoperative findings were undoubtedly in favor of retrograde obturation.

Ultrasonic retro preparations were executed so the retrograde cavity was established. Root-end preparation should be parallel to the long axis of the root, 3 mm deep, and centered within the root in order to preserve adequate wall thickness and retain a biocompatible filling material [26-28].

In 14.4 % the obturation was complete, with exposed gutta percha and canal filling. It was possible to leave it as it is.

But instead, retro preparations were executed. Given that the goal of peri radicular surgery is to eliminate root canal infection and prevent recontamination, apical gap of the filling material after root-end resection is an important factor that should be taken into account [14].

To reduce the infection, it is not sufficient just to make a retrograde preparation. As stated previously, the underlying reason for apical surgery is almost invariably because of persistent infection and residual necrotic tissue left in the root canal space [29–31]. Therefore, treatment must be directed at reducing or eradicating these contaminants from within the retro preparation. The use of either 17% EDTA, 10% citric acid, 35% phosphoric acid, or MTAD,followed by irrigating with 2% CHX [32–34], will decrease bacterial load and increase the predictability of success.

In cases of failed endodontic treatment, periapical surgery should address the issue of apical canal obturation. Absence, or incorrect placement of a root-end filling is the most common cause of failure of an initial surgical procedure [35].

Conclusion

Taking into account the preoperative and intraoperative findings from this study, it is reasonable to expect inadequate canal obturation in teeth with canal treatment associated with chronic periapical inflammation.

Preoperative evaluation of canal obturation in conjunction with intraoperative examination under visual enchantment of resected root surface confirmed the need for retrograde obturation.

Where canal obturation is absent or leaky, even if it seems regular, it is advisable to execute retrograde preparation so the primary goal of periapical surgery is fulfilled: removal of periapical infection, and hermetic obturation of the root canal.

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