Retrospective Evaluation of Surgical Endodontic Treatment: Traditional versus Modern Technique

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Abstract

The aim of this retrospective study was to compare the outcome of surgical endodontic treatment preformed using the traditional versus modern techniques. There were 110 patients who were treated by surgical endodontic treatment between 2000 and 2002 and evaluated from their dental charts. The surgical endodontic treatment was preformed using a traditional or modern technique. The traditional technique included root-end resection with a 45 degrees bevel angle, and retrograde preparation using a carbide round bur. The modern technique included root-end resection with minimal or no bevel, and retrograde preparation using ultrasonic retro-tips with the aid of a dental operating microscope. The retrograde filling material for both techniques was intermediate restorative material. There were 71 patients with 88 treated teeth that were compatible with the inclusion criteria. Complete healing rate for the teeth treated with the modern technique (91.1%) was significantly higher than that for teeth treated using the traditional technique (44.2%) ($p < 0.0001$). In the traditional technique a significant ($p = 0.032$) negative influence of the tooth type was found. Modern surgical endodontic treatment using operative microscope and ultrasonic tips significantly improves the outcome of the therapy compared to the traditional technique. *(J Endod 2006;32:412–416)*

Key Words

Modern technique, surgical endodontic treatment outcome, traditional technique

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Surgical endodontic treatment is an option for teeth with apical periodontitis and may be indicated for teeth with failed previous endodontic treatment and teeth with a strong possibility of failure for nonsurgical approach, and where a biopsy is needed (1). The main goal is to prevent the invasion of bacteria and their by-products from the root canal into periradicular tissues. Traditional surgical endodontic treatment has been performed by root-end resection with a 45 degree bevel, retrograde preparation of the canal with bur and root-end filling (2), with a moderate success rate of approximately 60% (3, 4). Recently, a new technique was developed for surgical endodontic treatment that uses a dental operating microscope to allow a more precise procedure with minimal bevel of root resection and retrograde canal preparation and filling with the aid of an ultrasonic tip to the depth of 3 to 4 mm (5). The introduction of microsurgery to surgical endodontics attempted to minimize trauma and enhance surgical results (6). A success rate of over 90% has been reported (5, 7, 8).

The aim of the present study was to compare the traditional technique with the modern technique regarding the outcome of surgical endodontic treatment, and to evaluate the influence of various factors on the outcome.

Materials and Methods

There were 110 patients treated by surgical endodontic treatment between 2000 and 2002 that were evaluated from their dental charts. Three oral surgeons and three endodontists performed all treatments. Criteria for inclusion were good quality periapical radiographs, complete data in the dental charts (age, gender, operation technique, tooth type, information whether the previous root canal treatment was primary or retreatment, antibiotic therapy, clinical symptoms), first time surgery cases with follow-up of more than 6 months, and root end filling with intermediate restorative material (IRM). A traditional or modern technique was used.

Treatment Protocol: Traditional Technique

Treatment consisted of local anesthesia Lidocaine 2% with Epinephrine 1:100,000, a full mucoperiosteal flap, osteotomy with bur, curettage of soft tissues adjacent to the root, root-end resection of 2 to 3 mm with a 45 degree bevel, retrograde cavities prepared using bur, retrograde filling with IRM (Caulk Dentsply, Milford, DE), flap re-approximation, and sutures.

Treatment Protocol: Modern Technique

Treatment was performed with the help of dental operating microscope. Treatment consisted of local anesthesia Lidocaine 2% with epinephrine 1:50,000, a full mucoperiosteal flap, osteotomy with a high-speed bur, curettage of soft tissues adjacent to the root, root-end resection of 2 to 3 mm with minimal or no bevel using a high-speed bur, retrograde cavities prepared using ultrasonic retro-tips to a 3 mm depth, surgical hemostasis with cotton pellets with epinephrine, retrograde filling with IRM (Caulk Dentsply), flap re-approximated, and sutures.

Clinical Evaluation

The presence of pain, tenderness to percussion or palpation, presence of sinus tract, and signs of swelling were examined based on the medical records.

Radiographic Evaluation

Pre- and postoperative radiographs were scanned to the computer. Brightness and contrast were automatically adjusted for all images using Adobe Photoshop 7.0 software (Adobe, San Jose, CA) and evaluated by two observers, who were calibrated before the assessment. Each observer evaluated radiographs independently, and the results compared. Any disagreement resulted in joint evaluation until agreement was achieved.

Teeth were evaluated radiographically for the quality of coronal restoration, presence of caries, and presence of post. The quality of root canal filling was evaluated as adequate when there was radiographically dense filling with its end located between 0 and 2 mm from the apex, or less than 1 mm over extended from the apex (9). Immediately postoperatively and on follow-up, the minor and major diameters of the lesion were measured to determine its size. A mean value of the minor and major diameters >5 mm was considered a large lesion, and equal or <5 mm, a small lesion (5, 7, 10).

Healing Criteria

Success criteria were used according to Rud and Andreasen (11) and Molven (12):

Category 1: Complete Healing

- Reformation of periodontal space of normal width and lamina dura to be followed around the apex
- Slight increase in width of apical periodontal space, but less than twice the width of noninvolved root parts
- A tiny defect in the lamina dura (maximum 1 mm^2) adjacent to the root filling
- Complete bone repair; bone bordering the apical area does not have the same density as surrounding noninvolved bone
- Complete bone repair; no apical periodontal space can be seen

Category 2: Incomplete Healing (scar tissue)

Rarefaction has decreased in size or remained stationary and is characterized by one or more of the following findings:

1. Bone structures are recognized within the rarefaction; the periphery of the rarefaction is irregular and may be demarked by a compact bone border; the rarefaction is located asymmetrically around the apex; the connection of the rarefaction with the periodontal space is angular.
2. Isolated scar tissue in the bone with findings specified in 1.

Category 3: Uncertain Healing

Rarefaction has decreased in size, and with one or more of the following characteristics:

- Radiolucency larger than twice the width of the periodontal space; bordered by lamina dura-like bone structures; a circular or semicircular periphery; located symmetrically around the apex, as a funnel-shaped extension of the periodontal space; or bony structures discernible within the bony cavity.

Category 4: Failure

Rarefaction has enlarged or is unchanged

In the current study incomplete healing (scar tissue) and complete healing cases were combined into one group and classified as complete healing. A case was considered as failure, regardless the radiographic evaluation, when a clinical symptom was present.

Statistical Analysis

The influence of follow-up period and patient's age was statistically analyzed using the Student *t*-test. The influence of the treatment technique (traditional or modern), gender of the patients, tooth type, nature of orthograde root canal therapy (primary versus re-treatment), quality of coronal restoration or presence of caries, presence of post, quality of root canal filling, preoperative diagnosis, lesion size, and use of antibiotic therapy, were analyzed by Person χ^2 test. Statistical value was set on $p > 0.05$.

Results

The medical records of 71 patients with 88 treated teeth were compatible with the inclusion criteria. From the records, the traditional technique was used in 36 patients (43 teeth) and the modern technique in 35 patients (45 teeth).

Equal distribution was found between the surgical techniques (modern versus traditional) of the follow-up period, gender of patients, quality of coronal restoration or presence of caries, presence of post, nature of orthograde root canal therapy (primary versus re-treatment), quality of orthograde root canal filling, size of periapical lesion, preoperative diagnosis, and use of antibiotic therapy (Table 1). Average age of patients treated with the modern technique was significantly ($p = 0.013$) higher compared to those treated with the traditional technique (43.7 versus 35.5, respectively).

No statistically significant difference was found regarding distribution of the tooth type between the surgical techniques (Table 2).

Differences in the healing outcome were highly significant ($p < 0.0001$). Complete healing was found in 41 teeth (91.1%) treated with the modern technique compared to only 19 teeth (44.2%) treated with the traditional technique. Uncertain healing was found in five teeth (11.6%) treated with the traditional technique compared to only two teeth (4.4%) treated with the modern technique. Failure was found in 19 teeth (44.2%) treated with the traditional technique compared to only two teeth (4.4%) treated with the modern technique (Fig. 1).

Age, gender, preoperative diagnosis, antibiotic therapy, follow-up period, nature of orthograde root canal therapy (primary versus re-treatment), quality of coronal restoration or presence of caries, presence of post, quality of orthograde root canal filling, and size of periapical lesion, had no significant influence on the outcome ($p > 0.05$). In the traditional technique, a statistically significant influence of the tooth type was found on the healing outcome: failure in seven mandibular posterior teeth treated with the traditional technique ($p = 0.032$). No significant ($p > 0.05$) influence of the tooth type was found for the modern technique.

Discussion

The present retrospective study examined the outcome of two surgical endodontic treatment techniques performed by six operators. One of the disadvantages of a retrospective study is the difficulty of standardization of the procedures. However, the oral surgeons who did traditional technique and the endodontists who did the modern technique had similar philosophy and experience that minimized the differences between the groups.

The common retrograde filling material used in the traditional technique is dental amalgam (13–16), and in the modern technique, IRM, Super-EBA, and MTA (17). Dorn et al. (16) in retrospective study found that success rates for IRM (91%) and Super-EBA (95%) were significantly higher than for amalgam (75%). A high percentage of long-term failures of teeth with surgically placed amalgam fillings were also found by Frank et al. (18). To eliminate the possible influence of root end filling material on the outcome of treatment, in the present

TABLE 1. Variables distribution between the surgical techniques

Variable	Variable Category	Traditional Technique	Modern Technique	Statistical significance
Follow-up period (mo)	Minimal	6	6	$p > 0.05$
	Maximal	48	48	
	Average	11.36	11	
Age (yr)	Minimal	13	16	$p = 0.013$
	Maximal	60	77	
	Average	35.5	43.7	
Gender	Men (%)	20 (46.5%)	19 (42.2%)	$p > 0.05$
	Women (%)	23 (53.5%)	26 (57.8%)	
	Total (%)	43 (100%)	45 (100%)	
Quality of coronal restoration/ presence of caries	Good (%)	31 (72.1%)	33 (73.3%)	$p > 0.05$
	Not Good (%)	11 (25.6%)	11 (24.4%)	
	Unknown (%)	1 (2.3%)	1 (2.2%)	
	Total (%)	43 (100%)	45 (100%)	
Post presence	Present (%)	28 (65.1%)	29 (65.9%)	$p > 0.05$
	Missing (%)	15 (34.9%)	15 (34.1%)	
	Total (%)	43 (100%)	44 (100%)	
Nature of orthograde root canal therapy (primary vs re-treatment)	Primary (%)	18 (41.9%)	16 (36.4%)	$p > 0.05$
	Retreatment (%)	7 (16.3%)	10 (22.7%)	
	Unknown (%)	18 (41.9%)	18 (40.9%)	
	Total (%)	43 (100%)	44 (100%)	
Quality of orthograde root canal filling	Good (%)	30 (71.4%)	26 (61.9%)	$p > 0.05$
	Not Good (%)	12 (28.6%)	16 (38.1%)	
	Total (%)	42 (100%)	42 (100%)	
Size of periapical lesion	Large (%)	22 (51.2%)	18 (40.9%)	$p > 0.05$
	Small (%)	21 (48.8%)	26 (59.1%)	
	Total (%)	43 (100%)	44 (100%)	
Preoperative diagnosis	Chronic apical periodontitis (%)	32 (74.4%)	28 (62.2%)	$p > 0.05$
	Acute apical periodontitis (%)	7 (16.3%)	10 (22.2%)	
	Chronic abscess (%)	4 (9.3%)	7 (15.6%)	
	Total (%)	43 (100%)	45 (100%)	
Antibiotic therapy	Used (%)	17 (39.5%)	11 (24.4%)	$p > 0.05$
	Not used (%)	26 (60.5%)	34 (75.6%)	
	Total (%)	43 (100%)	45 (100%)	

study only cases that used IRM as a retrograde filling material were selected, because it is most preferable (14–16, 18).

The different results presented in studies assessing the outcome of surgical endodontic treatment (5, 7–8, 14, 15) might be a result of the lack of standardization in the inclusion criteria and assessment criteria. In the present study, radiographic criteria according to Rud et al. (11) were used to assess healing after endodontic surgery. The observers were calibrated using the illustrations from Molven et al. (12). Two observers separately evaluated the radiographic findings. In cases of disagreement, radiographs were evaluated jointly until an agreement was reached (8, 13).

The radiographic healing categories, incomplete healing (scar tissue) and complete healing were combined into complete healing. This is consistent with Molven et al. (19) who noted that patients who exhibit scar tissue, 1 yr postoperatively, can be considered successful. During a prolonged observation period, patients whose healing was incomplete after 1 yr, often completely healed or remained in the scar tissue group. It was recommended to that these two groups be combined (5, 7, 13).

Coronal restoration may be a significant factor in the outcome of endodontic surgery (3, 8, 14, 20, 21). Rahbaran et al. (14) used strict criteria to assess coronal restorations and found that a tooth with a good coronal restoration had a better probability of having complete peria-

TABLE 2. Distribution of the tooth type between surgical techniques

Tooth Type	Technique	
	Modern (%)	Traditional (%)
Mandibular molars	7 (15.6)	5 (11.6)
Mandibular premolars	1 (2.2)	2 (4.7)
Mandibular anterior	0 (0)	0 (0)
Maxillary molars	10 (22.2)	5 (11.6)
Maxillary premolars	10 (22.2)	5 (11.6)
Maxillary anterior	17 (37.8)	26 (60.5)
Total	45 (100)	43 (100)

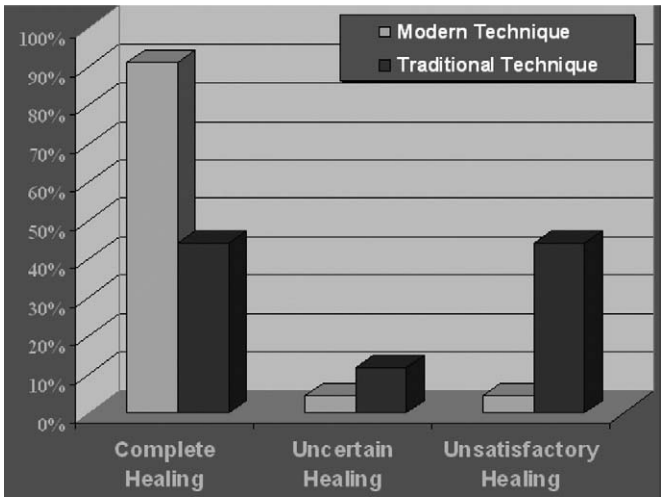

Figure 1. Comparison between treatment ($p < 0.0001$).

pical healing. Rapp et al. (20) found significantly better healing in teeth that were permanently restored after surgery. However, Mikonen (21) found that the success rate in teeth fitted with prosthetic crowns was significantly lower than in teeth without crowns, which could be a result of traumatic occlusion that causes pressure on the periodontal tissues and prevents healing. In the present study, no significant influence was found of the quality of coronal restoration and presence of caries on the treatment outcome.

A negative influence of post presence on the treatment outcome has been found, because of preparation of the post space in the absence of a rubber dam, which could result in disturbance of the root filling and contamination of the canal, or posts may predispose teeth to cracks and fractures (14, 22). In the present study, there was no significant influence of the post presence on the treatment outcome.

Zuolo et al. (8) evaluated patients' 1 yr postsurgery and doubtful cases were followed every 12 months for 4 yr. No significant relation was found between the observation period and the treatment results. Rubinstein et al. (5, 7) found that average time for lesions to heal was 7.2 months (5). At a long-term follow up of cases considered healed at the short-term observation 5 to 7 yr after, 91.5% of the roots evaluated remained healed (7). It may indicate that a 6-month follow-up can predict the treatment outcome, although long-term follow up is still recommended. In the present study the average follow-up period was 11 months in the modern technique, and 11.3 months in the traditional technique.

In the present study, the mean age of patients treated using the traditional technique was: 35.5 yr, and for the modern technique: 43.7 yeas. Although, theoretically, it could be that younger population treated by traditional technique might influence the outcome, this seems unlikely. For both techniques no significant influence was found of the patient age upon the treatment outcome was found, which is consistent with previous studies (8, 14, 15, 23).

There were two different anesthetic regimens and two different approaches to hemostasis. Hemostasis during endodontic surgical procedures is essential. If continuous bleeding obscures the view, the benefit of microsurgery is neglected (17). More blood contamination may cause more leakage of retrograde filling material. In the modern technique local anesthesia with epinephrine 1:50,000 and cotton pellets with epinephrine were used to improve hemostasis. Concern has been expressed about fibers from cotton pellets that may impair root-end seal or serve as foreign bodies in the surgical site (24). Vy et al. (24) successfully used resorbable CollaCote collagen sponges saturated with racemic epinephrine with no evidence of cardiovascular changes.

In the present study, we found no significant influence of the size of the periapical lesion, on the treatment outcome. Our results correlate with the findings of Danin et al. (10) and Rahbaran et al. (14). Rubinstein et al. (5) found that small lesion healed within 6.4 months, while large lesions healed within 11 months. In a prospective study Wang et al. (25) demonstrated significantly lower healed rate among teeth with a small preoperative radiolucency and teeth with adequate length of preoperative root filling. The overall healed rate in their study was 74%, which is lower than we found in the present study for the modern technique. This may be attributed to the fact that in Wang et al. (25) all surgical procedures were performed by graduate students using various retrograde filling materials or no retrograde filling at all, loupes were used for magnification instead of operating microscope and re-surgery cases were included.

Different treatment protocols include the use of antibiotics as an integrated part of the surgical treatment (8, 26). In one study (14), antibiotics were prescribed to several patients treated with the modern technique and most of the patients treated with the traditional technique. No significant influence of the postoperative medication on the treatment outcome was found, which is in agreement with the present study. Antibiotics do not cure an apical infection in the long term. Therefore, it should be used only when needed. This attitude should diminish the number of penicillin-resistant bacteria and patients hypersensitive to penicillin (27).

Conflicting results have been reported for treatment outcome for various tooth groups (5, 8, 14, 15, 23). Scar tissue was most frequently found in the maxillary lateral incisor region, whereas the maxillary canine and first premolar regions had a lower prevalence (23). Testori et al. (15) found that the success rate was higher in maxillary than mandibular teeth (77.9% versus 66.1%, respectively), and that this difference could be because of the greater difficulty involved in performing surgery in the mandible. As well, there should be an exaggerated bevel of the root apex to improve the visibility of the apex of the mandibular molars. In contrast, with the modern technique, a high rate of success was found in the posterior teeth (5, 8). This finding was supported in the present study when teeth were treated with the modern technique. There was a statistically significant influence of the tooth type on the treatment outcome with the traditional technique: failure in seven posterior mandibular teeth.

Root-end resection and ultrasonic preparation may create dentinal cracks, which could compromise a long-term prognosis of teeth treated by endodontic surgery. Wright et al. (28) in an in vitro study found that transillumination along with magnification was the most accurate way of diagnosing root-end dentinal cracks. Unaided visions without magnification seems inadequate to evaluate root ends properly (28).

Mead et al. (29) investigated levels of evidence of clinical articles pertaining to success and failure of endodontic surgery. Although they found that the majority of studies were case series, the authors concluded that endodontic surgery is effective in saving natural teeth (29).

We conclude that within the limitations of this retrospective study, it appears that surgical endodontic treatment with the modern technique highly improves the treatment outcome compared to the traditional technique.

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