Periradicular surgery of molars: a prospective clinical study with a one-year follow-up

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Abstract

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Aim The purpose of this prospective clinical study was to evaluate the outcome of periradicular surgery of molars after one year.

Methodology The material consisted of 25 molars with 39 roots demonstrating periradicular lesions of endodontic origin. Surgical treatment included root-end resection, root-end preparation with sonic microtips, and root-end filling with Super-EBA cement. At the one-year follow-up examination, healing was evaluated clinically and radiographically. Healing was assigned to three categories: (i) success (ii) improvement, and (iii) failure using well defined criteria.

Results Eighty-eight per cent of the surgically treated molars showed successful healing. In 8%, the healing was rated as improved and only 4% were failures.

Conclusions The outcome of the present study and data of recently published studies show that periradicular surgery may result in a predictable treatment outcome in molars with persistent periradicular lesions.

Keywords: molar, periradicular surgery, root-end cavity preparation, sonic microtip.

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Introduction

After microsurgical instruments became available in the early 1990s, periradicular surgery with root-end treatment was enhanced significantly, particularly the preparation of root-end cavities and the application of root-end filling materials. The goal of periradicular surgery is to create optimum conditions for healing through the regeneration of tissues, including the formation of a new attachment apparatus. In periradicular surgery with retrograde root-canal obturation, several surgical steps are essential to achieve healing: surgical exposure of the root-end, debridement of pathological tissue, root-end resection, root-end cavity preparation, root-end filling, and wound closure. Amongst these surgical steps, root-end preparation was improved following the introduction of endosonic microsurgical instruments, also termed surgical retrotips (von Arx & Walker 2000). Several experimental *in-vitro* studies performed on extracted human teeth have demonstrated that preparations made with retrotips remove less tooth structure (Abedi *et al.* 1995, Engel & Steiman 1995, Lin *et al.* 1998), and produce less smear layer along the cavity walls compared to conventional preparation using rotary burs (Gutmann *et al.* 1994, Wuchenich *et al.* 1994, Gorman *et al.* 1995). In addition, experimental studies in human cadaver teeth have shown that microsurgically prepared root-end cavities were deeper, had more parallel walls, and followed more closely the original path of the root canal than those made with burs (Wuchenich *et al.* 1994, Mehlhaff *et al.* 1997).

Root-end preparation using microinstruments has further advantages that are clinically relevant. A smaller osteotomy is required for the working end of the instruments, thereby reducing the surgical trauma (Mehlhaff *et al.* 1997). It has been demonstrated that smaller bony crypts show better healing following periradicular surgery compared to larger defects (Hirsch *et al.* 1979, Mikkonen *et al.* 1983, Grung *et al.* 1990). In addition,

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surgical access to root-ends and visibility are improved because of the small size of the retrotips, particularly in molars with restricted working space (von Arx 1999).

The objective of the present clinical study was to analyze the outcome of periradicular surgery in molars at the one-year follow-up examination.

Materials and methods

Patient selection

The specific criteria for patient selection have been reported previously (von Arx *et al.* 1998) and are summarized briefly: consecutive patients referred for periracidular surgery in molars were included in the study after obtaining informed consent. Alternative treatment options were discussed with the patients and their referring dentists. Patients presenting with acute symptoms were first treated by incision and drainage or antibiotic therapy, or a combination. Periradicular surgery was instituted only after acute symptoms had resolved. Main exclusion criteria were general medical contraindications for (oral) surgical procedures and a concomitant, advanced marginal periodontitis affecting the periradicularly diseased molar. All patients were treated by the same surgeon (T.v.A.) at the Clinic of Maxillo-Facial Surgery, Kantonsspital, Lucerne, Switzerland.

A total of 41 root-end resections with root-end filling were carried out in 26 molars of 25 patients. One patient with a mandibular first molar (both roots treated) withdrew from the follow-up study for unknown reasons. Therefore, a total of 25 molars in 24 patients (mean age 42 years, range 23–59 years) were evaluated at the one-year follow-up examination (Table 1).

Surgical technique

The technique of periradicular surgery utilized in the present study was identical to the technique described in recent publications (von Arx *et al.* 1998, von Arx & Kurt 1999). Therefore, only a brief summary is given. All surgeries were performed under local anaesthesia with patients completely draped. Intrasulcular and divergent release incisions were made with subsequent reflection of a full mucoperiosteal flap on the buccal aspect. Osteotomies with a diameter of approximately 5 mm were made to locate the affected root-ends. A 3-mm root-end resection was carried out almost perpendicular to the long axis of the root by means of a fissure bur in a slow-speed handpiece with copious irrigation using sterile saline. All pathological tissue was thoroughly debrided. Subsequently, a 2–3 mm deep root-end cavity was prepared employing diamond-coated retrotips (KaVo SONICretro, KaVo GmbH, Biberach, Germany) driven by a sonic handpiece (KaVo SONICflex, KaVo GmbH, Biberach, Germany). Root-end filling was accomplished with Super-EBA cement (Stailine®, Staident International, Staines, UK). Wound margins were reapproximated with multiple interrupted sutures which were removed 10 days postoperatively. Patients were given non-steroidal analgesics and a 0.1% chlorhexidine-digluconate mouthwash. Antibiotics were not prescribed routinely.

Evaluation

Postoperatively, clinical and radiographic examinations were performed after six and 12 months. Standardized periradicular radiographs were taken using individualized beaming aids (von Arx *et al.* 1998). At the one-year follow-up, healing was determined by clinical and radiographic assessment. All radiographs were evaluated by the same person, whereas the clinical examination was completed by two observers. The latter were calibrated to the evaluative criteria to reach a high observer reliability.

The percentage of osseous regeneration (R) was calculated with the formula $R = 100 - (S^{recall} \times 100/S^{postop})$ with S representing the size of the periradicular radiolucency. This size (S) was approximated with the formula $S = \pi \times A/2 \times B/2$ (A = length and B = height of the radiographic appearance of the lesion, von Arx & Kurt 1999).

The following clinical symptoms were noted preoperatively and at the one-year follow-up: pain reported by the

Table 1 Summary of treated molars (n = 25) and roots (n = 39)

Tooth	*n* teeth	*n* mesial roots	*n* distal roots	*n* palatal roots
First maxillary molar	9	9	5	1
Second maxillary molar	–	–	–	–
First mandibular molar	13	13	7	–
Second mandibular molar	3	3	1	–
Total	25	25	13	1

patient, tenderness to apical palpation on the buccal or lingual aspect of the tooth, tenderness to horizontal or vertical percussion (crown tapping), and presence of a swelling, sinus tract or abscess.

The criteria for healing classification were modified according to Zetterqvist *et al.* (1991) and Jesslén *et al.* (1995), and were as follows:

Success: the radiograph demonstrated complete healing of the former radiolucency, and no clinical signs or symptoms were present.

Improvement: incomplete radiographic healing of at least 50% and absence of any clinical signs or symptoms.

Failure: less than 50% radiographic healing or presence of clinical signs or symptoms.

Results

Postoperative course

The initial healing assessed at the time of suture removal was uneventful for all teeth. After 6 months, one patient with periradicular surgery of both buccal roots of a maxillary first molar presented with a fistula over the buccal aspect of the distal root. Revision was performed but this was unsuccessful.

Clinical symptoms at the one-year examination

All but one molar were without symptoms at the one-year recall examination. The exception was the case mentioned above presenting with a recurring sinus tract and moderate pain. Eventually, the distal root of that maxillary molar was removed by root resection. Intraoperatively, the mesial root of the same tooth showed complete periradicular regeneration with hard, bony-like tissue. This molar was classified as a failure since the outcome was evaluated per tooth and not per root.

Radiographic assessment at the one-year examination

Periradicular radiographs demonstrated complete healing of the previous periradicular lesions in 22 molars. Two molars presented with a healing of 80% and 71%, respectively, of the postoperative radiolucency. The molar with the clinical complication, as mentioned above, showed a radiographic healing of 55%.

Healing success rates

According to the success criteria established above, 88% of all recalled molars were deemed successful at the one-year follow-up, 8% showed improvement, and only 4% presented as failures.

Discussion

The present prospective clinical study analyzed the outcome of periradicular surgery with root-end filling of molars. Only a small number of studies have published data on periradicular surgery in molars (Table 2). Three studies (Testori *et al.* 1999, Rubinstein & Kim 1999, Zuolo *et al.* 2000), as well as the present study, have reported the use of microsurgical instruments for root-end preparation. These retrotips have several advantages such as improved surgical access, particularly in posterior teeth with limited working space, a more parallel cavity preparation with respect to the root-canal system, and the possibility of removing isthmus tissue which is often the cause of persistent periapical lesions. Except for one study (Testori *et al.* 1999), the reported success rates of these studies, including the present one, are high approaching or exceeding 90%.

It is interesting to note that all studies mentioned above, including the present one, have used modified zinc-oxide-eugenol (ZOE) cements as root-end filling material, either Super-EBA (ethoxy benzoic acid; Harry J. Bosworth, Skokie, IL, USA) or IRM (intermediate restorative material; Caulk Dentsply, Milford, DE, USA). It has been shown clinically and experimentally that ZOE cements are superior to amalgam, composite and glass-ionomer cements (Bondra *et al.* 1989, Dorn & Gartner 1990, O'Connor *et al.* 1995, Trope *et al.* 1996). Since periradicular surgery is limited in terms of removing all potential irritants from the root-canal system, it is essential that the root-end filling produces an hermetic seal to prevent egress of bacteria and toxins from this reservoir into the periradicular tissues.

To date, the highest success rate (97%) of periradicular surgery of molars has been reported by Rubinstein & Kim (1999). A total of 94 teeth, including 31 molars, were followed for 1 year and 2 months. The authors attributed the healing success primarily to the microsurgical technique employed throughout the study, particularly the use of the surgical operating microscope. The visualization of isthmus tissue or accessory canals, and their subsequent preparation with microinstruments might be a key factor for the enhanced success rates of periradicular surgery of molars. It is of particular interest that Rubinstein & Kim (1999) reported isthmuses in 81% of molars with the highest incidence (90%) present in the mesial root of mandibular first molars. Isthmus tissue connecting two canals in the apical portion of molar

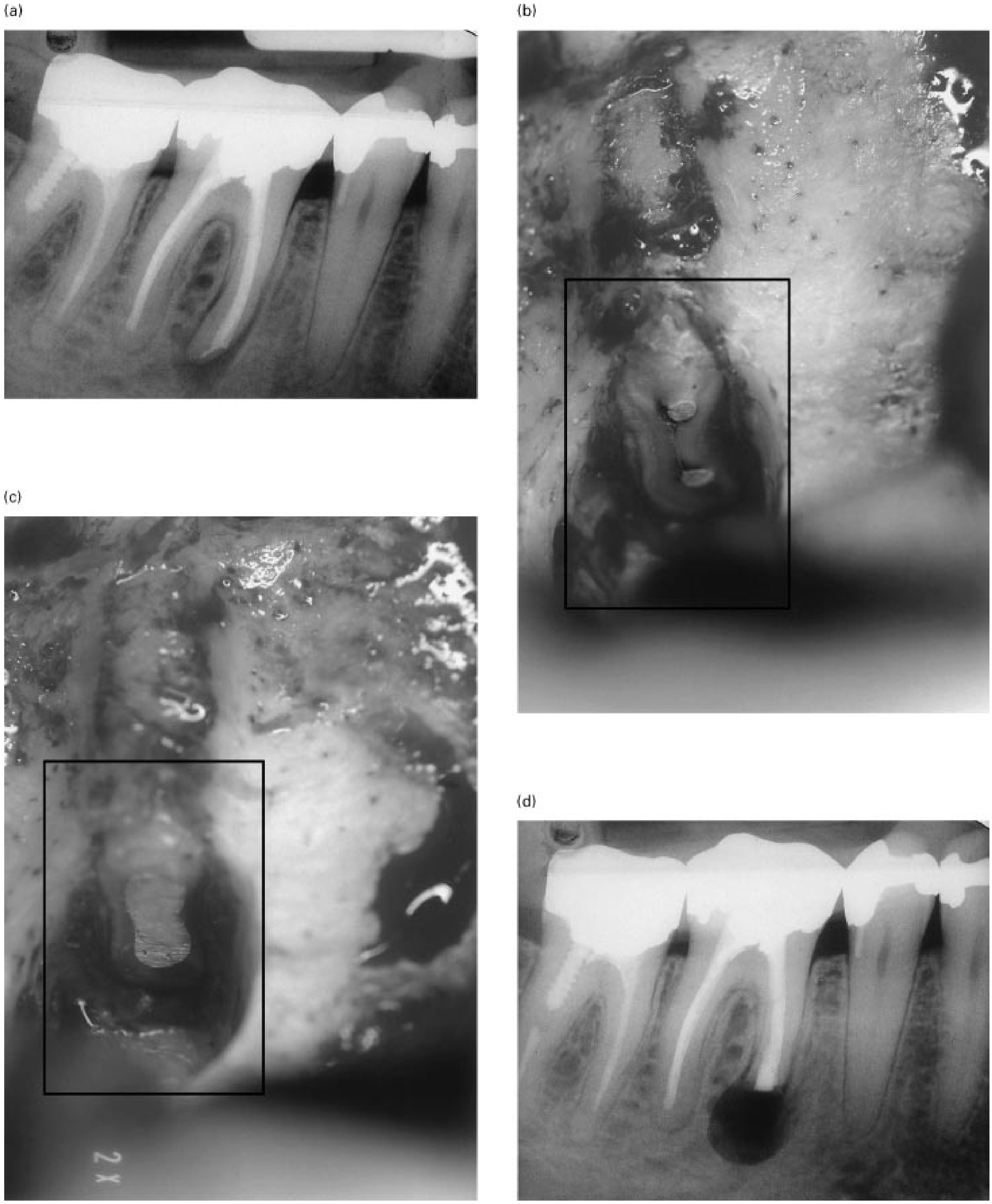

Figure 1 (a) Right mandibular first molar with a persistent periradicular lesion of the mesial root. (b) Intraoperative view following osteotomy and root-end resection. The obturated buccal and lingual root-canals are connected by a fine line of isthmus tissue. (c) Intraoperative view following root-end preparation and root-end filling using Super-EBA cement. (d) Immediate postoperative radiograph depicting the osteotomy defect and the resected mesial root with root-end obturation. (e) The one-year radiograph demonstrates complete healing of the previous radiolucency with formation of a normal PDL space around the apex.

(e)

Figure 1 *continued*

roots appears to be the Achilles' heel of conventional root canal treatment (Hsu & Kim 1997). In the present study, well-obturated canals but non-obturated isthmuses were found regularly (Fig. 1).

Another important factor influencing healing might be the bevel of the apical resection. The root-end preparation technique using rotary instruments in a microhandpiece either required an excessive osteotomy or a steep-angled bevel for surgical access to the root-end. It has been shown that leakage correlates with the resection bevel and with the depth of the root-end filling (Vertucci & Beatty 1986, Tidmarsh & Arrowsmith 1989, Gilheany *et al.* 1994). The use of microsurgical retrotips for root-end preparation allows for a resection plane more perpendicular to the long axis of the root. Thereby, the number of exposed dentine tubules is reduced and the risk of periradicular leakage is lowered.

Conclusions

Periradicular surgery of molars resulted in a high percentage of healing at the one-year follow-up examination. However, the results should be interpreted with caution because of the limited number of cases and follow-up period.

Table 2 Success rates of periradicular surgery of molars

Authors	Study design and follow-up period	# molars (max/mand)	# roots (max/mand)	Success rate (%) (max/mand %)
Altonen & Mattila (1976)	Retrospective	46	93	71
	1–6 years	(20/26)	(47/46)	
Persson (1982)	Retrospective	26	43	73
	1 year	(18/8)	(31/12)	(78/63)
[b]Ioannides & Borstlap (1983)	Retrospective	–	45	84
	–		(22/23)	(–/–)
[a]Friedman *et al.* (1991)	Retrospective	–	40	40
	6 months to 8 years		(12/28)	(50/36)
Lasaridis *et al.* (1991)	–	24	–	79
		(0/24)		(–/–)
[a]Rud *et al.* (1991)	Prospective	203[c]	–	79
	6 months to 1 year	(89/114)		(79/80)
		203[d]	–	62
		(89/114)		(63/61)
[a]Cheung & Lam (1993)	Retrospective	13	–	46
	2 years	(3/10)		(33/50)
[a]Testori *et al.* (1999)	Retrospective	?	152	76
	Mean 4.6 years		(62/90)	(69/87)
[a]Rubinstein & Kim (1999)	Prospective	31	–	97
	1 year 2 months	(N/A)		(–/–)
[a]Zuolo *et al.* (2000)	Prospective	39	–	85
	1 year (some up to 4 years)	(20/19)		(85/84)
von Arx *et al.* (present study)	Prospective	25	39	88
	1 year	(9/16)	(15/24)	(78/94)

[a]Studies included all types of teeth, but with available data on molars.
[b]Study included large number of cases with orthograde filling; only cases with retrograde filling selected for this table.
[c]Retrograde composite fillings.
[d]Retrograde amalgam fillings.

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