Prognostic Factors for Clinical Outcomes in Endodontic Microsurgery: A Retrospective Study

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Abstract

Introduction: This retrospective study examined the potential prognostic factors on the outcome after endodontic microsurgery and compared the predictors of isolated endodontic lesion with those of both isolated endodontic lesions and endodontic-periodontal lesions. **Methods:** The data were collected from patients with a history of endodontic microsurgery performed between August 2004 and December 2008 and at least 1 year before being evaluated. Surgical procedures were performed by the endodontic faculty and residents. After surgery, an operation record form was made with the preoperative, intraoperative, and postoperative factors from the clinical and radiographic measures. For statistical analysis of the predisposing factors, the dependent variable was the dichotomous outcome (ie, success vs failure). **Results:** Of 907 cases, 491 were retained at follow-up. At the 0.05 level of significance, age, sex (female), tooth position (anterior), root-filling length (adequate), lesion type (endodontic lesion), root-end filling material (mineral trioxide aggregate and Super EBA; Harry J. Bosworth, Skokie, IL), and restoration at follow-up appeared to have a positive effect on the outcome. On the other hand, with an isolated endodontic lesion, the tooth position (anterior), root-filling length (adequate), and restoration at follow-up were significant factors at the 95% confidence level. **Conclusions:** Under the control of the significant variables in logistic regression, the potential prognostic factors on the outcome were sex, tooth position, lesion type, and root-end filling material. On the other hand, the tooth position was a pure predictor of an endodontic lesion affecting the clinical outcome. *(J Endod 2011;37:927–933)*

Key Words

Clinical study, endodontic microsurgery, isolated endodontic lesion, prognostic factor

Endodontic treatment is a procedure for preventing or curing apical periodontitis caused by an infection of the root canal systems of affected teeth (1). However, epidemiologic studies have reported that 33% to 60% of root-filled teeth in the population present with apical periodontitis (2). When possible, nonsurgical retreatment is considered the treatment of choice. Endodontic surgery is often a last resort in the treatment of apical periodontitis in cases that are related to a periapical cyst, a complex canal anatomy, extraradicular infections, or inadequate healing after nonsurgical retreatment (3).

The outcome of endodontic surgery and its predictors have been reported with success rates varying considerably from 37% to 91% (4). Most predictable prognostic factors in many studies include the age of the patient, existing root-filling length, preoperative lesion size, and apical and coronal seal (4–6). This inconsistency may be caused by the differences in the technical quality of periapical surgery as well as case selection, sample size, the observation period, and methodology.

With recent surgical techniques including endoscopy, sonic-driven microtips, and biocompatible materials, such as Super EBA and mineral trioxide aggregate (MTA), von Arx et al (7) examined the effect of various prognostic factors on the outcome. The only individual predictor to have a significant effect on the outcome was pain at the initial examination. Several predictors, such as lesion size, retro filling materials, and postoperative healing course, almost reached statistical significance (7).

After microsurgical principles, which include the use of a dental operating microscope, microinstruments, ultrasonic tips, and more biologically acceptable root-end filling materials, were introduced (8), the success rate of endodontic surgery was reported to be approximately 90% (9, 10). The relative risk ratio showed that the probability of success for endodontic microsurgery was 1.58 times that of traditional root-end surgery (11), which means that endodontic microsurgery has a considerably higher and predictable clinical outcome. Because the surgical technique has become more precise and predictable than traditional endodontic surgery, the predictors affecting the clinical outcome of endodontic microsurgery might have changed.

Moreover, because of the low success rate in cases of a periodontally involved lesions (10), several studies excluded endodontic-periodontal lesions in their case selection (12–14). When periodontally involved lesions were excluded, the pure predictors of an endodontic lesion affecting the clinical outcome might be determined.

This retrospective study examined the potential prognostic factors on the outcome of endodontic microsurgery and compared the predictors of an isolated endodontic lesion with those of both an isolated endodontic lesion and endodontic-periodontal lesion.

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Materials and Methods

Case Selection

The clinical database of the Department of Conservative Dentistry at the Dental College, Yonsei University, Seoul, Korea, was searched for patients with a history of endodontic microsurgery performed between August 2004 and December 2008 and at least 1 year before being evaluated.

Treatment Protocol in Yonsei

With the exception of the incisions, flap elevation, and suturing, all surgical procedures were performed using an operating microscope (OPMI PICO; Carl Zeiss, Göttingen, Germany). All clinical procedures were the same as those reported in a previous study (10) and were performed by the endodontic faculty and residents.

Briefly, the flap was reflected after deep anesthesia, and the osteotomy was performed. After removing the soft-tissue debris, an additional 2 to 3 mm of root tip with a 0° to 10° bevel angle was sectioned with a 170 tapered fissure bur under copious water irrigation. The resected root surfaces were then stained with methylene blue and inspected with micromirrors (ObturaSpartan, Fenton, MO) under 20 × to 26 × magnification to examine the cleanness of the root-end preparation and to search for other anatomic details overlooked. The root-end preparation extending to 3 mm into the canal space along the long axis of the root was made using KIS ultrasonic tips (ObturaSpartan) driven by a Piezoelectric ultrasonic unit (Spartan MTS, ObturaSpartan). The root-end filling material used was an Intermediate Restorative Material (Caulk Dentsply, Milford, DE), Super EBA (Harry J. Bosworth, Skokie, IL), or ProRoot MTA (Dentsply, Tulsa, OK), which was selected according to the operators. The wound site was closed and sutured with 5 × 0 monofilament sutures, and a postoperative radiograph was taken to check for correct placement and an absence of excess material in the surgical site. A postoperative mouthwash (0.2% chlorhexidine gluconate, Hexamedin; Bukwang Phar Co, Ansan, Korea) was commonly prescribed, and the sutures were removed 4 to 7 days later. After surgery, an operation record form was made with the preoperative and intraoperative factors from the patient records and periapical radiographs. The operation record form was updated with the postoperative events whenever the patients were recalled periodically to assess the clinical and radiographic signs of healing.

Evaluation Factors

The evaluation factors were divided into preoperative, intraoperative, and postoperative factors. The preoperative factors included the patient's age and sex, tooth position, preoperative signs and/or symptoms, type of periapical radiolucency, root-filling state (ie, material, density, and length), whether root canal treatment was the initial treatment or retreatment, a history of apical surgery, the presence or absence of post and restoration, and lesion type. Intraoperative factors included root-end filling material and operator. The postoperative factors included the presence or absence of a permanent restoration at follow-up. The preoperative signs and/or symptoms were defined as preoperative pain or swelling, and the type of periapical radiolucency was divided into three subgroups: none (intact lamina dura), demarcated (well-defined boundary), and diffuse (vague boundary). The adequate root-filling length was defined as a filling within 2 mm from the apex, and the criteria of the adequate density was a filling without voids with uniform radiopacity. The lesion type was divided into isolated endodontic lesions (class A, B, and C) and endodontic-periodontal combined lesion (class D, E, and F), as classified by Kim and Kratchman (15). A large proportion of the data was collected mainly from the operation record form, and any missed record was referred to the patient records and periapical radiographs. If there was no postoperative record, the patients were contacted by telephone to attend a follow-up evaluation. Because all data in the operation record form were recorded by several operators, the factors evaluated from the radiographs were re-evaluated and corrected by two examiners. These included the type of periapical radiolucency, root-filling density, and root-filling length.

Clinical and Radiographic Evaluation

The patients were usually followed up at 3, 6, and 12 months and every year thereafter. On every recall visit, a routine examination was performed, and periapical radiographs were taken. The clinical data including the signs and/or symptoms or loss of function, tenderness to percussion or palpation, subjective discomfort, mobility, sinus tract formation or periodontal pocket formation, postoperative complications, and presence or absence of a restoration at follow-up were included in the operation record form.

The evaluation was performed at least 1 year after surgery. The postoperative radiographs were evaluated independently by two examiners using the same criteria used by Molven et al (16, 17). The two examiners standardized the evaluation criteria before case analyses. Therefore, their results were based on the same evaluation methods and conditions. Cohen kappa statistical analysis was performed to measure the interexaminer variability. Any disagreement regarding the clinical outcome was resolved by a discussion until agreement between the two examiners was reached. The radiographic healing classification was as follows: (1) complete healing, (2) incomplete healing, (3) uncertain healing, and (4) unsatisfactory healing.

Assessment of Outcome

Healing was judged clinically and radiographically. The criteria for a successful outcome included the absence of clinical signs and/or symptoms and radiographic evidence of complete or incomplete healing. The criteria for failure included any clinical signs and/or symptoms or radiographic evidence of uncertain or unsatisfactory healing.

Analyses of Data

For statistical analysis of the predisposing factors, the dependent variable was the dichotomous outcome, success versus failure. A univariate description with the percentage frequencies was generated to characterize the study material. Significant associations between the outcome and all the variables were examined by bivariate analyses (χ^2 or Fisher exact tests) to identify the potential outcome predisposing factors. Multivariate analysis of the predisposing factors using the logistic regression model was performed. All statistical analysis was two-tailed, performed with SPSS v18.0 software (IBM Corp, Somers, NY), and interpreted at the 5% level.

Results

Of the 907 cases with a history of endodontic microsurgery performed between August 2004 and December 2008, 491 were retained at follow-up. Table 1 lists the distribution of cases according to the variables/category and bivariate analysis. The Cohen kappa value for the preoperative type of periapical radiolucency, density, and length of pre-existing root filling as well as postoperative radiographs ranged from 0.83 to 0.94 (Table 2).

Of the preoperative factors examined, significant differences were observed for age ($P = .002$), sex ($P = .014$), tooth position ($P < .001$), root-filling length ($P = .020$), and lesion type ($P = .008$). Of the intraoperative factors, the root-end filling material ($P = .045$) was found to be significant. An evaluation of the restoration at follow-up revealed

TABLE 1. Distribution of Cases per Variables/Category and Bivariate Analysis

Variables/category	Endo + endo-perio				Endo			
	Success *n* (%)	Failure *n* (%)	Chi-square value	*P* value	Success *n* (%)	Failure *n* (%)	Chi-square value	*P* value
Age	—	—	18.900	.002	—	—	10.349	.066
<20	2 (66.7)	1 (33.3)	—	—	2 (66.7)	1 (33.3)	—	—
21–30	90 (90.9)	9 (9.1)	—	—	82 (90.1)	9 (9.9)	—	—
31–40	123 (87.9)	17 (12.1)	—	—	110 (87.3)	16 (12.7)	—	—
41–50	66 (81.5)	15 (18.5)	—	—	64 (85.3)	11 (14.7)	—	—
51–60	66 (83.5)	13 (16.5)	—	—	59 (85.5)	10 (14.5)	—	—
>60	62 (69.7)	27 (30.3)	—	—	57 (74.0)	20 (26.0)	—	—
Sex	—	—	6.068	.014	—	—	2.111	.146
Male	150 (78.1)	42 (21.9)	—	—	138 (81.7)	31 (18.3)	—	—
Female	259 (86.6)	40 (13.4)	—	—	236 (86.8)	36 (13.2)	—	—
Tooth position	—	—	16.648	.000	—	—	16.685	.000
Anterior	240 (89.6)	28 (10.4)	—	—	228 (90.8)	23(9.2)	—	—
Premolar	91 (75.2)	30 (24.8)	—	—	81 (75.7)	26(24.3)	—	—
Molar	78 (76.5)	24 (23.5)	—	—	65 (78.3)	18 (21.7)	—	—
Mx vs Mn	—	—	0.000	.990	—	—	0.090	.764
Mx	299 (83.3)	60 (16.7)	—	—	280 (85.1)	49 (14.9)	—	—
Mn	110 (83.3)	22 (16.7)	—	—	94 (83.9)	18 (16.1)	—	—
Rt vs Lt	—	—	0.118	.731	—	—	0.226	.634
Rt	213 (83.9)	41 (16.1)	—	—	196 (85.6)	33 (14.4)	—	—
Lt	196 (82.7)	41 (17.3)	—	—	178 (84.0)	34 (16.0)	—	—
Preoperative sign and symptom	—	—	0.056	.814	—	—	0.011	.917
No	33 (84.6)	6 (15.4)	—	—	32 (84.2)	6 (15.8)	—	—
Yes	370 (83.1)	75 (16.9)	—	—	336 (84.8)	60 (15.2)	—	—
Type of periapical radiolucency	—	—	1.405	.495	—	—	0.999	.607
None	29 (85.3)	5 (14.7)	—	—	26 (86.7)	4 (13.3)	—	—
Demarcated	90 (79.6)	23 (20.4)	—	—	85 (81.7)	19 (18.3)	—	—
Diffuse	289 (84.3)	54 (15.7)	—	—	262 (85.6)	44 (14.4)	—	—
Root-filling material	—	—	2.892	.235	—	—	4.176	.124
Empty	21 (80.8)	5 (19.2)	—	—	19 (79.2)	5 (20.8)	—	—
Gutta-percha	371 (84.3)	69 (15.7)	—	—	341 (85.9)	56 (14.1)	—	—
Other	11 (68.8)	5 (31.3)	—	—	11 (68.8)	5 (31.3)	—	—
Root-filling density	—	—	2.343	.126	—	—	3.260	.071
Adequate	185 (81.1)	43 (18.9)	—	—	163 (81.9)	36 (18.1)	—	—
Inadequate	203 (86.4)	32 (13.6)	—	—	194 (88.2)	26 (11.8)	—	—
Root-filling length	—	—	5.382	.020	—	—	5.826	.016
Adequate	171 (79.5)	44 (20.5)	—	—	154 (80.6)	37 (19.4)	—	—
Inadequate	217 (87.5)	31 (12.5)	—	—	203 (89.0)	25 (11.0)	—	—
Previous treatment	—	—	0.984	.321			0.468	.494
Initial	288 (86.2)	46 (13.8)	—	—	267 (87.5)	38 (12.5)	—	—
Retreatment	68 (81.9)	15 (18.1)	—	—	60 (84.5)	11 (15.5)	—	—
Previous apical surgery	—	—	0.867	.352	—	—	0.179	.672
No	358 (84.0)	68 (16.0)	—	—	329 (85.2)	57 (14.8)	—	—
Yes	50 (79.4)	13 (20.6)	—	—	44 (83.0)	9 (17.0)	—	—
Restoration	—	—	0.598	.439	—	—	0.114	.736
Permanent	340 (82.7)	71 (17.3)	—	—	312 (84.6)	57 (15.4)	—	—
Temporary	69 (86.3)	11 (13.8)	—	—	62 (86.1)	10 (13.9)	—	—
Post	—	—	0.422	.516	—	—	0.120	.729
Absent	264 (82.5)	56 (17.5)	—	—	243 (84.4)	45 (15.6)	—	—
Present	145 (84.8)	26 (15.2)	—	—	131 (85.6)	22 (14.4)	—	—

(*Continued*)

TABLE 1. *(Continued)*

Variables/category	Endo + endo-perio: Success n (%)	Endo + endo-perio: Failure n (%)	Endo + endo-perio: Chi-square value	Endo + endo-perio: P value	Endo: Success n (%)	Endo: Failure n (%)	Endo: Chi-square value	Endo: P value
Lesion type	—	—	7.078	.008	—	—	—	—
Endo	374 (84.8)	67 (15.2)	—	—	—	—	—	—
Endo-perio	35 (70.0)	15 (30.0)	—	—	—	—	—	—
Root-end filling material	—	—	6.191	.045	—	—	3.090	.213
MTA	214 (85.6)	36 (14.4)	—	—	186 (86.9)	28 (13.1)	—	—
Super EBA	100 (85.5)	17 (14.5)	—	—	95 (85.6)	16 (14.4)	—	—
IRM	83 (75.5)	27 (24.5)	—	—	81 (79.4)	21 (20.6)	—	—
Operator	—	—	0.676	.411	—	—	0.519	.471
Faculty	357 (83.8)	69 (16.2)	—	—	324 (85.3)	56 (14.7)	—	—
Resident	51 (79.7)	13 (20.3)	—	—	49 (81.7)	11 (18.3)	—	—
Restoration at follow-up	—	—	9.576	.012	—	—	11.206	.008
Permanent	406 (85.3)	70 (14.7)	—	—	371 (86.9)	56 (13.1)	—	—
Temporary	3 (42.9)	4 (57.1)	—	—	3 (42.9)	4 (57.1)	—	—

Endo, isolated endodontic lesion; Endo + endo-perio, both isolated endodontic lesion and endodontic-periodontal lesion; Lt, left; Mn, mandibular teeth; Mx, maxillary teeth; Rt, right.

a higher success rate in the permanently restored group (85.3%) than the temporarily restored group (42.9%). This difference was also significant ($P = .012$).

Of the 491 cases recalled, 441 cases were related to an isolated endodontic lesion, and 50 cases were related to an endodontic-periodontal combined lesion. With regard to the isolated endodontic lesion, the variables found to be significant were the tooth position ($P < .001$), root-filling length ($P = .016$), and restoration at follow-up ($P = .008$) (Table 1).

For logistic regression, an almost-full model was considered first. The nonsignificant predictors for R^2, such as age, root-filling material, and density, were excluded. Table 3 lists the point estimate, 95% confidence intervals of the odds ratios, and the *P* value of the significant remaining parameters. Sex (female), tooth position (anterior), lesion type (endodontic lesion), and root-end filling material (MTA and Super EBA) were found to have a positive effect on the outcome (Table 3). On the other hand, with the isolated endodontic lesion, only the tooth position (anterior) was significant (Table 3).

Discussion

The prognostic factors are considered for case selection and treatment in apical surgery. In addition, it is helpful when the treatment outcome is expected, and apical surgery can be weighed against alternative treatments. This study examined the predictors that were discussed with respect to the specific data reported in the literature along with the preoperative factors that have received the most attention. This study showed that several factors, such as sex, tooth position, lesion type, and root-end filling material, have a significant effect on the healing outcome of endodontic microsurgery but failed to show a difference between a previously reported study dealing with traditional apical surgery and the present study dealing with endodontic microsurgery. Nevertheless, it is likely that preoperative factors, particularly the tooth position, have a higher weight on the healing outcome than intra- and postoperative factors.

In many studies, the patient's age and sex have no significant effect on the treatment outcome (12, 13, 18). In the present study, various healing outcomes were observed according to the age group and sex ($P < .05$). The highest success rate was reported in patients in their 20s and tended to decrease as the patients aged. Generally, younger patients have a better healing potential. However, a longer follow-up could make this difference weak. Males have a poorer success rate than females. Statistical differences between the sex group appears to be generated from the total sample discrepancy and may not be clinically significant.

The anterior teeth and the premolar and molar teeth had a significantly different success rate of microsurgery. The anterior teeth tended to have a higher success rate than the other tooth groups (15), which might be caused by the specific convenience of access and the root anatomy (1). Indeed, the use of an operating microscope does not enhance access (15). On the other hand, no significant difference was observed between the maxillary and mandibular groups or in the right- and left-side groups.

In the present study, the preoperative signs and/or symptoms did not influence the outcome of endodontic microsurgery, even though von Arx et al (7) reported that pain at the initial examination was the only significant predictor. Endodontic microsurgery with transillumination and magnification might completely eradicate the source of reinfection regardless of the tooth status.

The root-filling status preoperatively can be characterized by the material, density, and length. The root-filling materials and density does not affect the outcome of microsurgery (5, 6). However, after

TABLE 2. Interexaminer Reliability in Evaluating Preoperative and Postoperative Radiographs

Factors	Agreement (%)	Cohen kappa value
Periapical radiolucency type	97.59	0.88
Root filling density	92.07	0.84
Root filling length	91.67	0.83
Postoperative radiographs	98.96	0.94

defining an adequate length as a filling within 2 mm from the apex, teeth with an inadequate root-filling length showed a significantly higher success rate than those with an adequate root-filling length (P = .020). Barone et al (6) also reported that a preoperative root-filling length has a significant effect. The unfilled portion of the root canal in the short root fillings might be the main infected site, and the extruded portion beyond the root end may help with persistent disease. Because these are resected during the surgical procedure, the surgical approach will enable a successful outcome in inadequately root-filled teeth (19, 20).

There were no significant differences in the previous endodontic treatment, initial treatment, or retreatment (P = .321). With traditional endodontic surgery, the surgical approach to seal the bacteria within the canal might be ineffective. Therefore, the outcome of endodontic surgery for previously treated teeth might be compromised. On the other hand, according to the microsurgical principles with a microscope, biocompatible materials can seal off all potential routes of microbial escape from the root canal system within the follow-up period (21).

Many studies reported that resurgery has a very poor success rate compared with the initial endodontic surgery (22, 23). On the other hand, a previous study reported that the causes of failure of the first endodontic surgery were related to an incomplete surgical technique. Therefore, the use of a microsurgical technique resulted in a high clinical success rate even in endodontic resurgery (21). Wang et al (18) suggested that the modified case selection and techniques may have been responsible for their higher healing rate after resurgery than in previous studies.

A periodontally involved lesion is believed to have an adverse effect on the outcome of apical surgery. Therefore, most studies evaluating the potential prognostic factors for the healing outcome in apical surgery excluded those teeth presenting with an apicomarginal defect or a deep probing depth $\geq$ 4 mm. Indeed, some studies suggested a poor prognosis for teeth with a periodontally involved lesion with a lower healing rate (10, 24, 25). Therefore, the lesion type is a significant predictor (P = .008).

In previous studies, the intraoperative factors included many items related to the technical procedure, such as the level of apical resection, degree of beveling, presence/absence of a root-end filling, method of root-end preparation, root-end filling depth, magnification, and illumination (4, 6). However, the potential confounding effects of multiple variables increased with the increasing number of variables. This makes an analysis of the effect of different variables on the prognosis more complex, which may lead to different conclusions. The surgical procedures in the present study were performed under the strict manual of microsurgical techniques regardless of the operators. Endodontic microsurgery uses a dental operating microscope to allow a more precise procedure with little or no bevel of the root-end resection and root-end preparation with the aid of an ultrasonic tip to a depth of 3 to 4 mm (12). It provides a predictable treatment with a much higher success rate (9) and reduces the various intraoperative factors affecting the outcome.

The effect of a root-end filling material is the most commonly studied factor among the intraoperative factors. Recently, biocompatible materials, such as IRM, Super EBA, and MTA, have been used with the microsurgical technique. Two randomized controlled trials comparing MTA with IRM cement in periapical endodontic surgery showed no significant differences between them (14, 26). *In vitro* studies comparing MTA with Super EBA reported similar results of periapical bone regeneration and the leakage test (27, 28). Moreover, a prospective clinical study evaluating the outcomes of microsurgery showed no significant differences between MTA and Super EBA (10). In this study, there were only significant differences for the root-end filling material between IRM and MTA (logistic regression, P = .009). Eugenol leaching from the IRM may reduce the healing potential, and moisture in the surgical procedure can reduce the sealing ability of the IRM (29).

The effects of the operator skill have received less attention. It is normally assumed that faculties with considerable experience have a higher success rate than residents. Lustmann et al (19) reported that even if there were significant differences between the operators, the classification of the surgeon according to the number of years in practice proved to be irrelevant. On the other hand, one study reported that teeth treated by postgraduate dental students had a significantly higher survival probability than those treated by staff, which was attributed to case selection (24). In this study, no significant differences were observed between the healing outcome of the faculties and residents. Residents in Yonsei are trained under the supervision of faculty with a strict manual of endodontic microsurgery from the second year, and third year residents are fully experienced. Therefore, it is natural that that success rate of residents would be comparable to that of faculty.

With regard to the coronal seal, Rahbaran et al (5) reported that a tooth with a good coronal restoration had three times the odds of having complete periapical healing than that without a restoration. Rapp et al (30) hypothesized that the likelihood of complete healing was greater when a permanent restoration was present. On the other hand, one study with an assessment of the 4- to 10-year outcome of apical surgery, prospectively, concluded that the restoration at follow-up had no significant healing rate differential (6). In this study, the healing outcome was related to the restoration at follow-up. On the other hand, under the control of some variables, the restoration had no significant influence at follow-up (logistic regression, P = .133). The possibility of reinfection from an insufficient crown restoration might be compensated for by the tight seal of the root-end filling.

Although endodontic periodontally involved teeth are in the endodontic domain, the prognosis of the teeth depends on the periodontal support and endodontic microsurgical treatment (31). Therefore, the predisposing factors of an isolated endodontic lesion after endodontic microsurgery would be different from those of an endodontic periodontally involved lesion. With the isolated endodontic lesion, the tooth position (anterior), root-filling length (adequate), and restoration at follow-up were significant at the 95% confidence level. The tooth position, however, was the only predictor reaching significance under the control of significant factors according to logistic regression (P < .05). An isolated endodontic lesion might reduce the effect of many variables in the outcome of endodontic microsurgery. Nevertheless, the results from the logistic regression model should not be overrated because the coefficient of the determination was only 0.134 (32).

Retrospective studies are subject to various forms of bias that may distort their conclusions. Because most of the data depend on previous

TABLE 3. Logistic Regression Model

Variables	Endo + endo-perio				Endo			
	Point estimate	95% confidence interval		*P* value	Point estimate	95% confidence interval		*P* value
		Lower	Upper			Lower	Upper	
Sex								
Female versus male	1.789	1.031	3.104	.039	1.345	0.730	2.476	.341
Tooth position								
Anterior versus premolar	2.888	1.527	5.463	.001	3.524	1.785	6.960	.000
Tooth position								
Anterior versus molar	2.349	1.128	4.890	.022	2.303	1.013	5.232	.046
Root filling length								
Inadequate versus adequate	1.684	0.965	2.938	.066	1.818	0.982	3.366	.057
Lesion type								
Endo versus endo-perio	2.566	1.183	5.564	.017	—	—	—	—
Lesion type								
A versus B	—	—	—	—	2.239	0.628	7.986	.214
Lesion type								
A versus C	—	—	—	—	2.198	0.589	8.199	.241
Root-end filling material								
MTA versus Super EBA	1.978	0.962	4.067	.064	1.877	0.885	3.984	.101
Root-end filling material								
MTA versus IRM	2.417	1.251	4.668	.009	1.837	0.893	3.782	.099
Permanent restoration at follow up								
Yes versus no	4.597	0.630	33.546	.133	4.008	0.554	28.984	.169

Endo, isolated endodontic lesion; Endo + endo-perio, both isolated endodontic lesion and endodontic-periodontal lesion.
The coefficient of determination, 0.134 (total); the coefficient of determination, 0.112 (isolated endodontic lesion).

records, which were obtained by each operator before the study was designed, bias can occur at the stage of case selection as well as during the evaluation of the preoperative and postoperative factors. An attempt was made to compensate for this limitation with a re-evaluation of the pre- and postoperative radiographs by two examiners, and very good kappa values were obtained.

In conclusion, endodontic microsurgery is effective. The potential prognostic factors on the outcome include sex, tooth position, lesion type, and root-end filling material. The tooth position was found to be a pure predictor of an endodontic lesion affecting the clinical outcome. Nevertheless, statistical differences do not necessarily have great explanatory power because logistic regression models only yield small coefficients of the determination. Further randomized prospective studies will be needed to assess the potential prognostic factors on the outcome of endodontic microsurgery with adequate power.

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