DENTOALVEOLAR SURGERY

Outcomes of Periradicular Surgery of Maxillary First Molars Using a Vestibular Approach: A Prospective, Clinical Study With One Year of Follow-Up

Sule Nur Kurt, DDS, PhD, Yakup Üstün, DDS, PhD,† Özgür Erdogan, DDS, PhD,‡ Burcu Evlice, DDS, PhD,§ Oguz Yoldas, DDS, PhD,|| and Haluk Öztunc, DDS, PhD¶*

Purpose: The aim of the present prospective, randomized, controlled, clinical study was to compare the outcomes of periradicular surgery of the maxillary first molar tooth using the vestibular approach between 2 preoperative radiologic evaluation methods: cone beam computed tomography (CBCT) and conventional radiography.

Patients and Methods: Periradicular surgery was applied to the maxillary first molar tooth in 40 patients. The patients were divided into 2 groups. The patients in group 1 underwent examination and preoperative planning with CBCT, and the patients in group 2 underwent examination and preoperative planning with conventional radiography. The outcomes of the treatment were evaluated radiographically and clinically, and the data were analyzed statistically.

Results: The mean operative time was significantly shorter in group 1 than in group 2. According to the radiographic and clinical healing criteria used in the present study, the healing of patients in group 1 was rated as a success in 35%, an improvement in 40%, and a failure in 25%. In the group 2 patients, healing was rated as a success in 42.1%, an improvement in 31.6%, and a failure in 26.3%. Sinus membrane elevation was performed in 92.3% of all patients. Sinus membrane perforation occurred in 20% of the patients in group 1 and 36.8% of the patients in group 2.

Conclusions: Periradicular surgery of maxillary first molars using a vestibular approach is a viable treatment method with a low complication rate. Preoperative CBCT examination demonstrated positive contributions to the treatment outcomes.

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Periradicular surgery of maxillary molar teeth is a complicated procedure because accessing the palatal root has been problematic. The neighboring anatomic structures, such as the maxillary sinus and the greater palatine artery, have restricted adequate exposure of the palatal roots of the maxillary molar teeth. The palatal root can be accessed using 2 approaches. The palatal approach necessitates the use of a palatal flap; this can be complicated by the risk of damage to the greater palatine artery, difficulty in manipulating the instruments, restriction of direct vision, and the need for a palatal stent, resulting in discomfort to the

*Surgeon, Private Practice, Adana, Turkey.

†Surgeon, Private Practice, Adana, Turkey.

‡Associate Professor, Department of Oral and Maxillofacial Surgery, Cukurova University Faculty of Dentistry, Adana, Turkey; and Lecturer, Department of Oral Surgery, Rangsit University Faculty of Dentistry, Pathumthani, Thailand.

§Assistant Professor, Department of Oral and Maxillofacial Radiology, Cukurova University Faculty of Dentistry, Adana, Turkey.

||Professor, Department of Endodontics and Restorative Dentistry, Cukurova University Faculty of Dentistry, Adana, Turkey.

¶Associate Professor, Department of Oral and Maxillofacial Radiology, Cukurova University, Adana, Turkey.

Address correspondence and reprint requests to Dr Erdogan: Rangsit University, Faculty of Dental Medicine, 52/347, Muang Ake Road, Pathum Thani, 12000, Thailand; e-mail: ozgerdogan@yahoo.com

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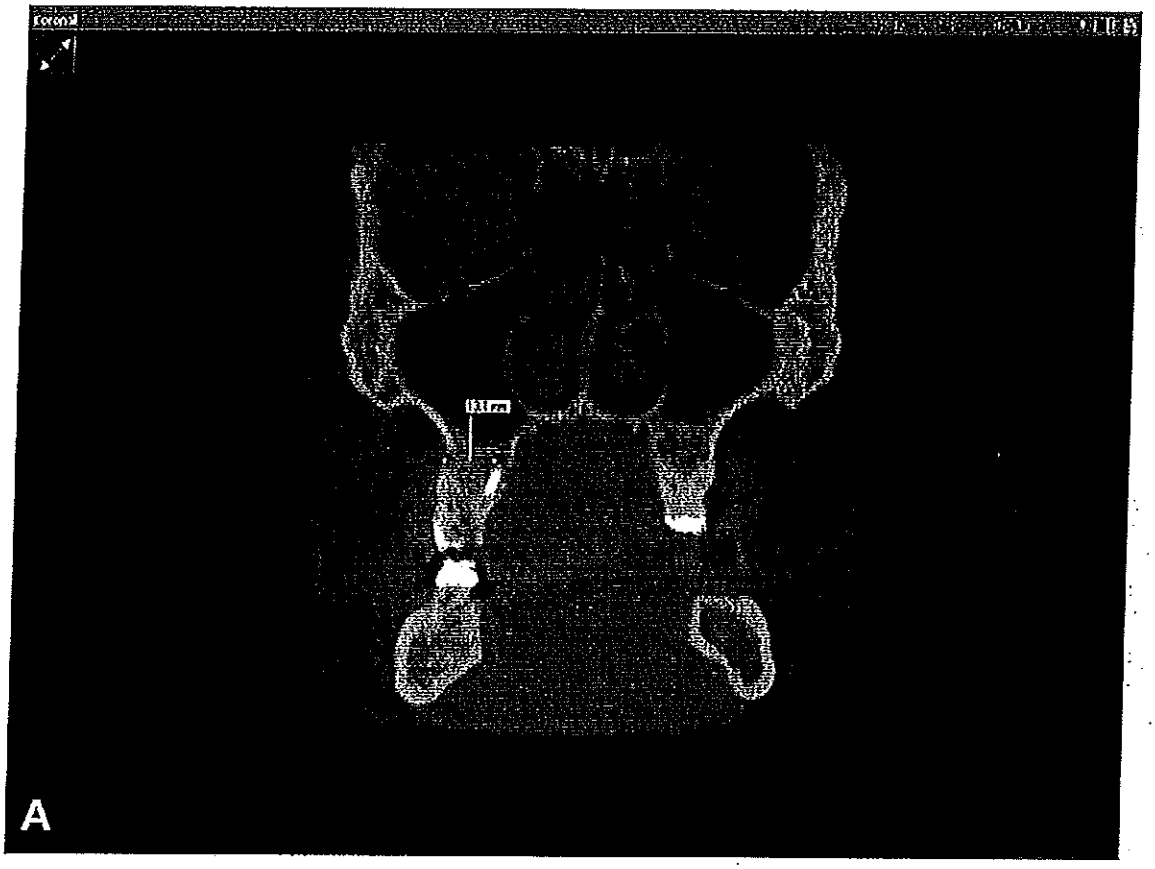

FIGURE 1. Measurement of the distance between the palatal root end and buccal cortex on *A*, coronal and *B*, cross-sectional slices. **(Fig 1 continued on next page.)**

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

patient and requiring laboratory work.[1] The vestibular approach carries the risk of maxillary sinus perforation and locating the palatal root can be difficult.

With the introduction of cone beam computed tomography (CBCT), precise positioning of the palatal root has become possible preoperatively.[1] The CBCT examination will also allow a thorough evaluation of the individual maxillary sinus anatomy. Therefore, the vestibular approach for periradicular surgery of maxillary molar teeth has become a feasible alternative to the palatal approach.

A limited number of clinical studies have evaluated the success rate of periradicular surgery of maxillary molar teeth.[2-4] None of the previous studies had evaluated the outcomes with maxillary first molars specifically. The success rates of periradicular surgery of molar teeth have varied from 33 to 97%.[2]

In the vestibular approach, passage of the instruments through the maxillary sinus to access the palatal root of a molar tooth can be achieved using 2 methods. The classic approach has been the transantral approach, in which the sinus membrane is perforated intentionally and the palatal root is accessed and resected.[5,6] The transantral approach involves the risk of displacement of foreign objects into the sinus, which can result in serious sinus complications. In another technique, the palatal root is accessed after elevation of the sinus membrane, leaving the sinus membrane intact.[7] This approach can be considered less traumatic than the transantral approach, with a decreased risk of sinus complications.

The aim of the present prospective, randomized, controlled, clinical study was to evaluate and compare the outcomes of periradicular surgery of maxillary first molar teeth using the vestibular approach with 2 preoperative radiologic evaluation methods: CBCT and conventional periradicular radiography. The palatal roots were accessed using the sinus membrane elevation technique. Follow-up examinations to evaluate the outcomes were performed for 12 months.

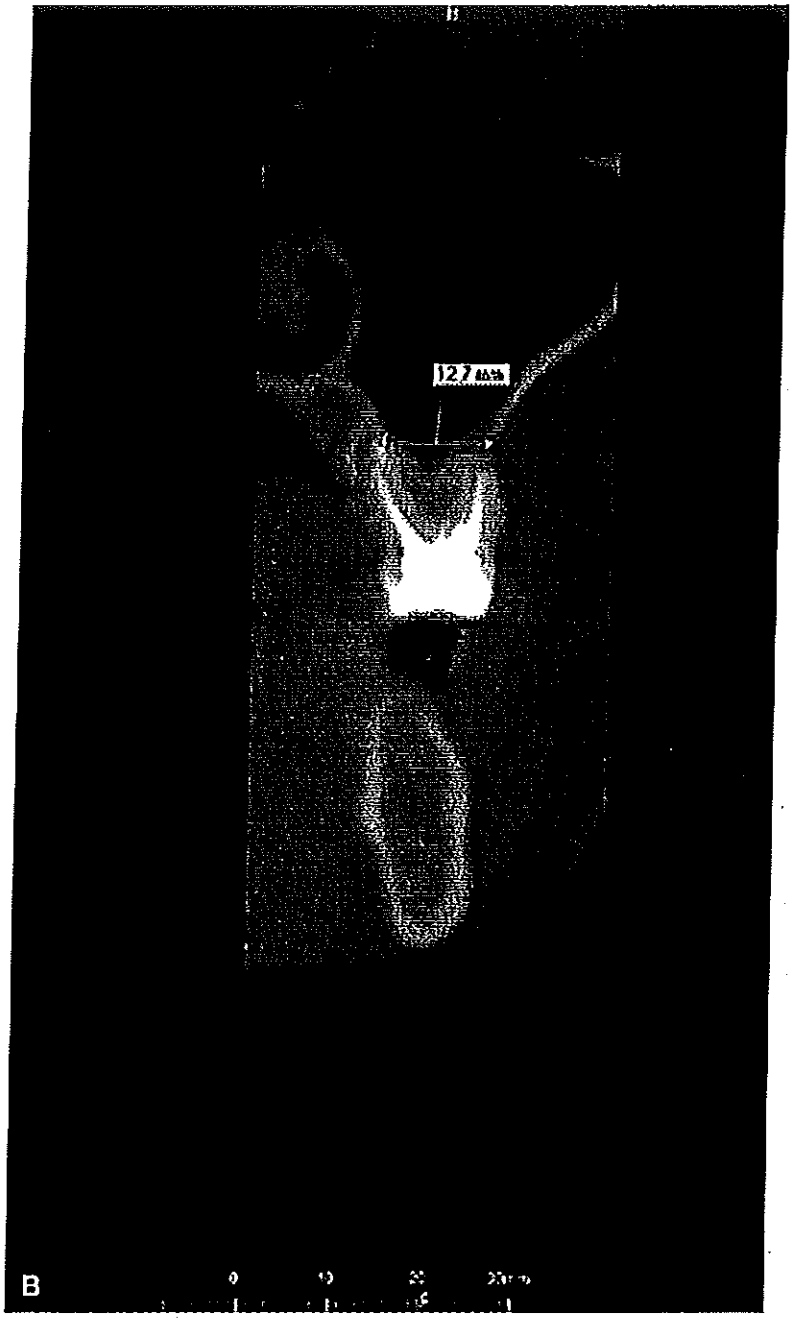

FIGURE 1 (cont'd).

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Patients and Methods

A total of 40 patients (18 females and 22 males) who fulfilled the clinical and radiologic inclusion criteria were included in the present study. The inclusion criteria were as follows: *1)* patients referred for periradicular surgery of an upper first molar tooth because of an unhealed periradicular lesion despite conventional root canal treatment, a retained root canal instrument fragment, overflowing of root canal–filling material, or any other idiopathic reason; *2)* American Society of

FIGURE 2. Measurement of the distance between *A*, the mesial and distal root tips and *B*, the mesial root and sinus. Relationship between the palatal root and maxillary sinus. *C*, Sinus floor elevation requirement can be predicted on this cone beam computed tomography image because the inferior border of the sinus expands between the buccal and palatal roots. **(Fig 2 continued on next page.)**

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Anesthesiologists (ASA) class 1 or ASA class 2 according to the ASA classification[8]; *3)* age older than 18 years; and *4)* patients with periodontally healthy adjacent teeth.

The patients were excluded in the case of significant systemic medical status (ASA class 3 or higher), acute sinusitis, pregnancy or risk of pregnancy, large lesions that affected the neighboring teeth, the presence of periodontal pathologic features, radiolucency at the bifurcation region, smoking habit, a history of radiotherapy at the maxillofacial region, osteoporosis requiring medical therapy, metastatic cancer, alcoholism or drug abuse, and physical or mental disability that prevented patient cooperation. The study was performed in accordance with the ethical rules of the Declaration of Helsinki, and the ethical committee of Cukurova University approved the present study (ethical committee report no. 21.05.2009:5:13). All patients agreeing to participate were apprised of the aims, principles, possible risks, complications, and benefits verbally and in writing and gave their informed consent before inclusion.

RANDOMIZATION AND STUDY GROUPS

The patients were divided into 2 groups randomly using a block randomization technique.[9] The patients who underwent examination and preoperative planning using CBCT were included in group 1. The patients who underwent examination and preoperative planning using conventional radiography were included in group 2.

PARAMETERS

CBCT images were obtained of all patients preoperatively and at 12 months postoperatively for comparative purposes between the 2 groups. Additionally, standardized periradicular dental radiographs and panoramic radiographs were obtained preoperatively and at 6 and 12 months postoperatively. All radiographs

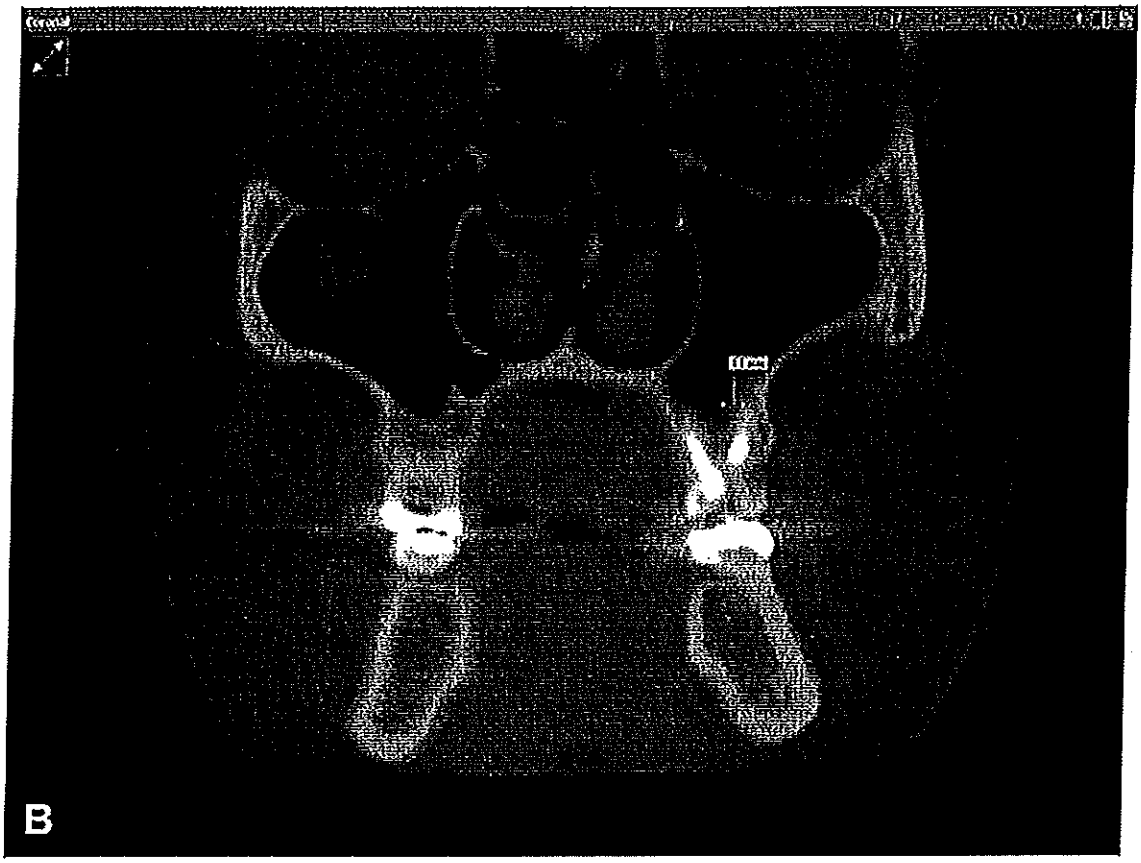

FIGURE 2 (cont'd). (Fig 2 continued on next page.)

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

were evaluated by the same person. The CBCT scans were obtained using an Iluma CBCT device (Imtec Imaging, Ardmore, OK). Panoramic radiographs were obtained using a Planmeca panoramic radiography device (Planmeca USA, Roselle, IL). Periradicular radiographs were obtained using a Philips dental radiography device (Dens-O-Mat Oralix Mobile, Gendix Dental Systems, Milan, Italy).

The following clinical symptoms were evaluated preoperatively and at the follow-up examinations: pain reported by the patient, tenderness on apical palpation of the buccal and palatal aspects of the tooth, and tenderness on horizontal and vertical percussion; the values for all 3 were recorded on a visual analog scale (VAS). The VAS scores were prepared on a linear line of 10 cm, starting from 0 to 10 cm and divided into 10 equal distances, with 0 indicating no pain or tenderness and 10, unbearable pain or tenderness. The presence of swelling, sinus tracts, fluctuation, erythema, or abscess was noted, and the mobility index and periodontal index of the tooth were measured.

PREOPERATIVE RADIOGRAPHIC EVALUATION

The patients in group 1 underwent radiologic evaluation of their preoperative CBCT images. The distance between the palatal root tip and vestibular cortex was measured on the coronal and cross-sectional slices (Fig 1). The distance between each root and maxillary sinus was measured, and the relationship of the root to the maxillary sinus was scored. Score 1 corresponded to a distinct distance between the root and sinus; score 2 corresponded to direct contact of the root and sinus; and score 3 corresponded to the presence of the root in the sinus (Fig 2, Table 1).[10] The largest diameter of the lesion was measured on the coronal, axial, sagittal, and cross-sectional slices, and a CBCT periradicular index (CBCTPAI) score was obtained. The CBCTPAI scoring system was developed by Estrela et al[11] and was determined using criteria established from measurements of periradicular radiolucency interpreted on CBCT scans. The details of this scoring system are listed in Table 2. The maxillary sinus was evaluated with regard to any pathologic features.

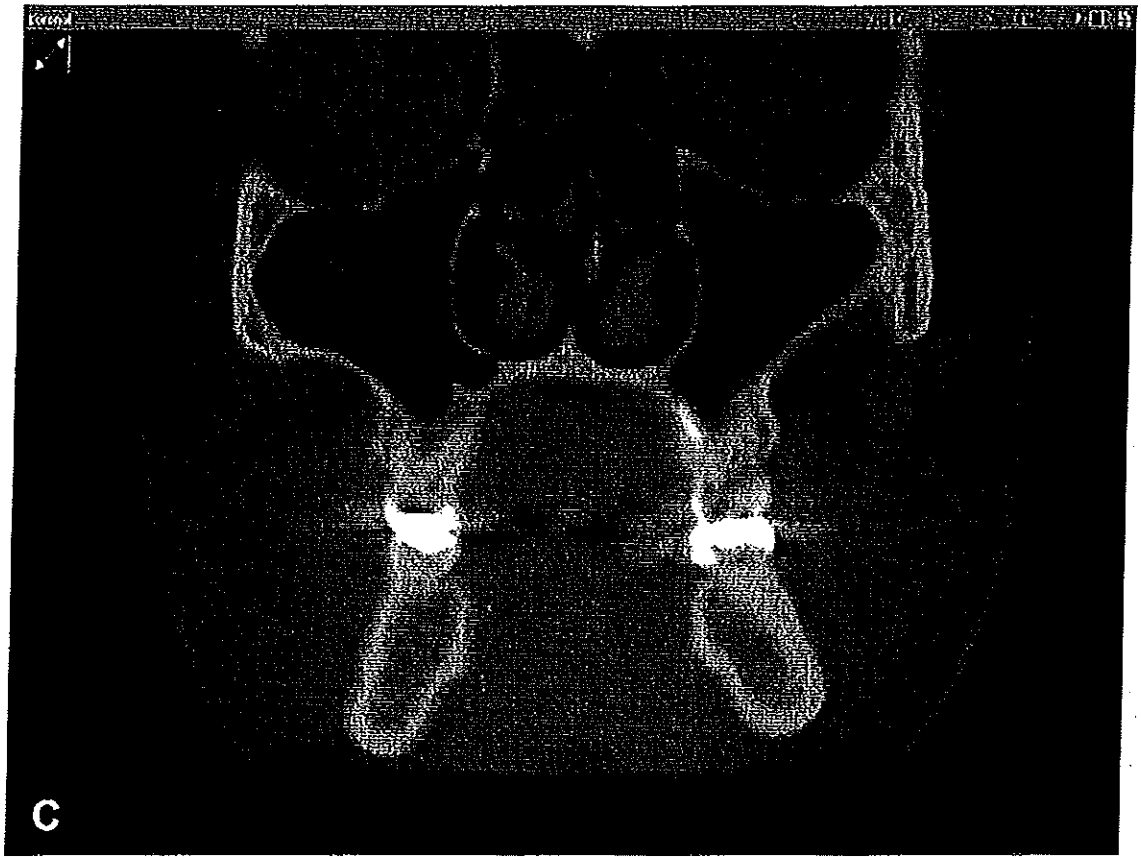

FIGURE 2 (cont'd).

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

The patients in Group 2 underwent preoperative evaluations of their conventional radiographs (panoramic and periradicular dental radiographs) only. Preoperative CBCT images had also been taken of the patients in group 2. However, their CBCT images were not evaluated preoperatively. In group 2, the relationship between the maxillary sinus and the root apices, the presence of a lesion around the roots,

Table 1 SCORES FOR DISTANCE BETWEEN TOOTH APEX AND MAXILLARY SINUS

Distance Between Tooth Apex and Maxillary Sinus	Score
Distant	1
Contact	2
In the sinus	3

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Table 2 DESCRIPTION OF CONE BEAM COMPUTED TOMOGRAPHY PERIRADICULAR INDEX SCORING

Score	Quantitative Numeric Change in Bone Mineral Structure
0	No lesion
1	Diameter of periapical radiolucency = 0.5-1 mm
2	Diameter of periapical radiolucency = 1-2 mm
3	Diameter of periapical radiolucency = 2-4 mm
4	Diameter of periapical radiolucency = 4-8 mm
5	Diameter of periapical radiolucency = 8 mm
Score (n) + B	Expansion on periapical cortex
Score (n) + D	Destruction on periapical cortex

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

FIGURE 3. Intraoral photograph showing the flap technique used.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

periodontal health, and the shape of the roots were evaluated on the radiographs.

SURGICAL TECHNIQUE

All operations were performed by the same surgeon—a senior oral and maxillofacial surgery resident under the supervision of an attending surgeon—with the same surgical technique. All operations were performed under 3.5× magnification using a personal surgical loupe with the patient under local anesthesia. Articaine 4% with epinephrine 1/100,000 was injected for local anesthesia of the posterior superior alveolar nerve, greater palatine nerve, and additional peripheral nerves.

After the patient displayed sufficient anesthetic effect, an intrasulcular incision with a vertical releasing incision was made in the distobuccal region of the maxillary second premolar tooth, and a mucoperiosteal flap was reflected (Fig 3). The buccal bone was osteotomized using steel round burs. The bone osteotomy sizes were selected according to the smallest size possible for sufficient visualization of the 3 roots of each tooth. The dimensions of the bone windows were recorded (Fig 4). To remove the bone in close proximity to the maxillary sinus, a round diamond bur was used to preserve the sinus membrane. In cases in which the maxillary sinus blocked access to the palatal root, the sinus membrane was elevated superiorly after removing a sufficient amount of bone from the lateral aspect of the sinus (Fig 5). The sinus membrane was elevated using curved sinus elevators (Dentium Advanced Sinus Kit, Implantium, Shrewsbury, UK). The apical lesions were removed and curetted, and 3-mm root-tip resection was performed perpendicular to the long axis of the root using a fissure bur with copious irrigation with sterile saline. The root-tip cavity was prepared 3 mm in depth and parallel to the long axis of the tooth using an ultrasonic diamond-coated retrotip. All root-tip cavities were filled with mineral trioxide aggregate. In cases in which the visibility of the palatal root was restricted because of continuous bleeding or other reasons, only apical resection was performed, and neither root-tip cavity preparation nor retrograde filling was performed. The area was irrigated with saline and mainly sutured using 4-0 Vicryl suture.

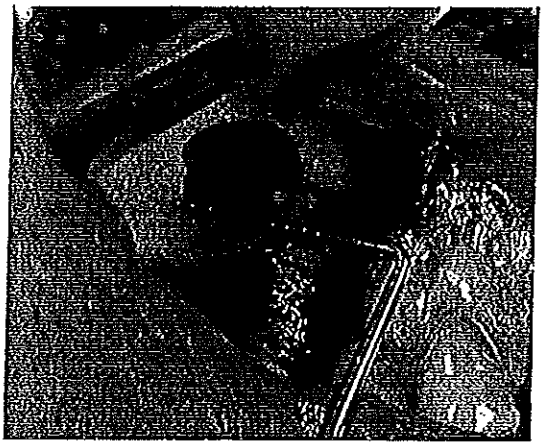

FIGURE 4. Intraoral photograph showing the bone osteotomy. The diameter of the osteotomy window was measured using a periodontal probe.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Antibiotics (oral amoxicillin 1 g, twice daily for 1 week), analgesics (oral flurbiprofen, 100 mg, twice daily), and chlorhexidine mouth rinse (twice daily for 1 week) were prescribed postoperatively. In the case of sinus membrane perforation, a decongestant and antihistamine combination pill (loratidine 5 mg, pseudoephedrine 120 mg, twice daily, orally, for 5 days) was prescribed.

The data recorded during surgery included the date of the operation, dimensions of the bone cavity measured using a periodontal probe, measurements of the distance between the maxillary sinus and each root apex, characterization of the lesion if present, application of retrograde filling for each root, use of sinus floor elevation, complications, and operation time (time elapsed from the first incision to the last suture).

EVALUATION OF HEALING

Apical lesions were evaluated on CBCT images obtained 12 months postoperatively. The healing criteria classification described by Zetterqvist et al[12] in 1991 and developed by Jesslén et al[13] in 1995 was used. According to this classification, success would correspond to complete healing of the former

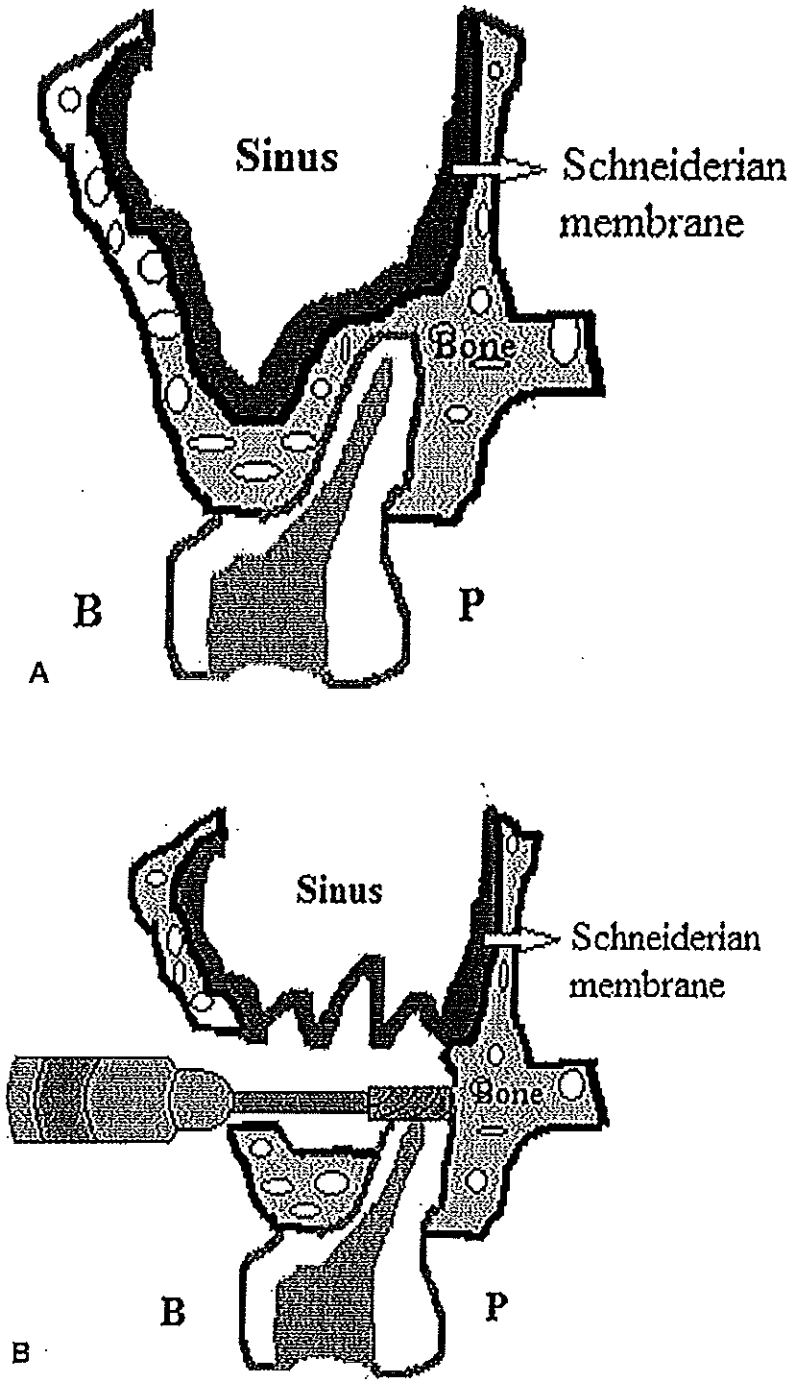

FIGURE 5. Drawings showing root end resection of palatal root after sinus membrane elevation. *A*, Clinical situation in which inferior border of the maxillary sinus lies inferior to the palatal root end. *B*, Sinus membrane was elevated superiorly, and the root end was accessed.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

radiolucency without any clinical signs or symptoms, improvement to a decrease in the lesion size of more than 50% without any clinical signs or symptoms, and failure to a decrease in the lesion size of less than 50% or the presence of any clinical signs or symptoms.

STATISTICAL ANALYSIS

The data were analyzed statistically using the Statistical Package for Social Sciences, version 15.0 (SPSS, Chicago, IL), software package with Kendall's *W* test and the Mann-Whitney *U* test.

Results

No statistically significant difference was found between the 2 groups with regard to age, gender, or operation side. Eight patients from group 1 and 11 from group 2 underwent surgery on the right first molar, and 11 patients from group 1 and 9 from group 2 underwent surgery on the left first molar.

One patient from group 2 was excluded from the present study. In that patient, the tooth was extracted during surgery because of extensive lesion involvement detected during the procedure. In another patient, the operated tooth had to be extracted 6 months postoperatively because of recurrent infections. Although the latter patient was included in the present study, some clinical and radiographic parameters could not be evaluated. The treatment outcome was considered a failure for this patient. Preoperative periapical radiographs of the patients are shown in Figure 6.

The mean height and width of the bone window created at the buccal aspect of the tooth was 8.2 mm × 10.4 mm in group 1 and 8.9 mm × 11.1 mm in group 2. No statistically significant difference was found between the 2 groups in the bone window size.

Retrograde root-tip preparation and retrograde filling could not be applied to the palatal roots in 25 patients because of the factors described in the "Patients and Methods" section. No statistically significant difference was found between the 2 groups regarding the use of retrograde filling (Table 3). Retrograde filling was applied to all mesiobuccal and distobuccal roots in all patients in both groups.

The overall mean distance between the tip of the palatal root and the buccal cortical plate was 11.94 mm in 39 patients. The distribution of the measurements within the groups is listed in Table 4. When the relationship between the root apices and the maxillary sinus was considered, most of the roots presented a distant relationship with the sinus (Table 5).

The preoperative CBCTPAI score showed that most patients had a periapical radiolucency diameter of 4 to 8 mm (score 4) in both groups. The CBCTPAI scores obtained at 12 months postoperatively showed that most patients had a score of 0 (no radiolucency) in both groups. According to the CBCTPAI results, the periapical lesions had healed completely in 16 patients, had healed partially in 12, were unchanged in 8, and had worsened in 2 of the 38 patients. The preoperative and postoperative CBCTPAI scores for both groups are listed in Tables 6 and 7.

The clinical symptoms encountered preoperatively and at the follow-up examinations included swelling, sinus tract, fluctuation, erythema, and abscess (Table 8). Two patients in group 1 had a sinus tract at the last clinical examination (12 months). Of the 2 patients, 1 had erythema at the apical region of the related tooth.

The VAS scores of pain, tenderness on palpation, and tenderness on percussion in any of the vertical or horizontal directions showed no statistically significant difference between the 2 groups at any of the follow-up sessions ($P > .05$). The examinations were performed at the preoperative visit and 1 week and

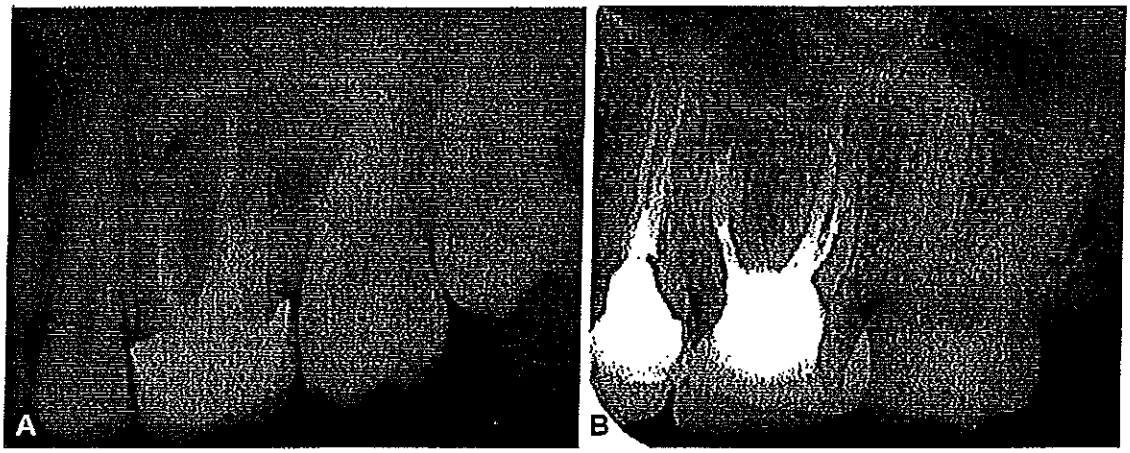

FIGURE 6. Periapical radiographs of 2 patients, who were excluded because of extraction of the related tooth. *A*, The lesion at the buccal aspect of the buccal roots caused severe bone loss, which was detected after flap elevation. *B*, Radiograph showing status of the related tooth that was extracted 6 months postoperatively.

Table 3. CONDUCTION OF RETROGRADE FILLING

Group	Retrograde Filling	
	Yes	No
1	6	14
2	8	11
Total	14	25

$P = .367$ between groups 1 and 2.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

1, 3, 6, and 12 months postoperatively. Significant statistical improvements were seen in all VAS parameters at the subsequent follow-up sessions in both groups, except for the VAS measurement of pain in group 1.

The maxillary sinus membrane had to be elevated in 36 of 39 patients (92.3%). Sinus membrane perforation occurred in 11 patients, 4 in group 1 and 7 in group 2. No statistically significant difference was found between the 2 groups in the occurrence of sinus membrane perforation (Table 9). None of the patients with sinus membrane perforation reported any significant postoperative symptoms. No other intraoperative or postoperative complications occurred.

The mean operation time was 44.5 minutes for group 1 and 66.05 minutes for group 2 (Table 10). The difference was statistically significant ($P < .05$).

The healing score according to the CBCT examination at 12 months postoperatively was rated as success in 35% of the patients, improvement in 40%, and failure in 25% in group 1. In group 2, healing was rated as success in 42.1% of the patients, improvement in 31.6%, and failure in 26.3% (Table 11). The buccal window had not ossified completely in most of the patients on the CBCT scans.

Discussion

Periradicular surgery of the maxillary posterior teeth is considered an alternative treatment to root amputation or extraction.[1] No prospective clinical study has been published that has specifically evaluated the outcomes of periradicular surgery of the maxillary first molar teeth.[14-19] The present study was a prospective, randomized, controlled, clinical study that evaluated the contribution of CBCT to the diagnosis, treatment planning, and outcomes of periradicular surgery of the maxillary first molar teeth using a vestibular approach.

Table 4. DISTANCE BETWEEN PALATAL ROOT AND BUCCAL CORTICAL PLATE

Group	Case (n)	Mean ± SD (mm)	Minimum	Maximum
1	20	12.36 ± 1.38	9.9	14.6
2	19	11.52 ± 1.59	8.3	14.0
Total	39	11.94 ± 1.52	8.3	14.6

Abbreviation: SD, standard deviation.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Table 5. RELATIONSHIP BETWEEN ROOT APEX AND MAXILLARY SINUS

Variable	Group 1 (n)	Group 2 (n)	Total (n)
Mesial root and maxillary sinus			
Distant	19	9	28
Contact	1	4	5
In the sinus	0	6	6
Distal root and maxillary sinus			
Distant	16	10	26
Contact	3	4	7
In the sinus	1	5	6
Palatal root and maxillary sinus			
Distant	10	2	12
Contact	2	2	4
In the sinus	8	15	23

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Periradicular surgery of the palatal root of maxillary first molars through the palatal approach requires relatively invasive and laborious surgery because of the need for an extensive palatal flap design and the risk of significant hemorrhage from the greater palatine artery.[1] In our study, the palatal approach was avoided, and access to the palatal root was achieved by the vestibular approach. No intraoperative severe hemorrhage was encountered in any of the surgeries.

Periapical radiographs provide significant information about the progression, regression, and continuity of apical periodontitis.[20,21] However, the periradicular region cannot correctly be evaluated in some instances using periapical radiographs, although all parameters will be correct. The difficulty occurs in particular in the maxillary molar region, where several anatomic structures, such as zygomatic process, maxillary sinus, roots of the teeth, or palatal cortical bone create superposition. In 1 patient from the conventional radiography group, the buccal bone had resorbed completely, although no periodontal pocket, abscess, or mobility was present in the preoperative clinical examination. The wide bone loss could not be detected on the periapical radiographs, because it was located on the buccal side of the tooth. We decided to extract the tooth instead of conducting periradicular surgery after flap elevation. This type of inaccurate treatment planning can be avoided with the routine use of CBCT before periradicular surgery.

Table 6 PREOPERATIVE CONE BEAM COMPUTED TOMOGRAPHY PERIRADICULAR INDEX SCORES

	CBCTPAI Score						
Group	0	1	2	3	4	5	Total
1	2 (10.0)	0 (0.0)	0 (0.0)	4 (20.0)	9 (45.0)	5 (25.0)	20 (100)
2	1 (5.6)	1 (5.6)	0 (0.0)	2 (11.1)	10 (55.6)	4 (22.2)	18 (100)
Total	3 (7.9)	1 (2.6)	0 (0.0)	6 (15.8)	19 (50.0)	9 (23.7)	38 (100)

Data presented as n (%).
Abbreviation: CBCTPAI, cone beam computed tomography periradicular index.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

One major difficulty with the vestibular approach is locating the palatal root. It is the main time-consuming part of the surgery. Locating the root sometimes causes a redundant amount of bone removal. With the use of CBCT, precise localization of the palatal root will be possible preoperatively. It reduces the operation time and prevents the redundant bone removal. The mean duration of surgery was more than 20 minutes shorter in group 1, in which the location of the palatal root can be determined in 3 dimensions using CBCT examination.

The use of CBCT for periradicular surgery can help in understanding the related anatomy. Rigolone et al[1] measured the mean distance between the buccal cortex and the buccal side of the palatal root of the maxillary first molars on CBCT images from 43 patients. They found that this distance was 9.73 ± 1.20 mm. In our study, the mean value for the same distance was 11.94 ± 1.52 mm. Low et al[22] evaluated the proximity of the roots of the maxillary posterior teeth to the maxillary sinus. Of 29 first molars, the roots were in close contact with the maxillary sinus membrane in 70% of the cases.[22] In our study, we evaluated the proximity of the roots to the maxillary sinus for each root separately. We found that 70% of the palatal roots were in contact with, or inside, the sinus, and the mesiobuccal and distobuccal roots were mostly located away from the sinus.

Access to the palatal root through the vestibular approach requires advanced visualization and microsurgical equipment and experience in maxillary sinus surgery. All operations were performed using 3.5× magnification and a head lamp with an LED light source. The use of ultrasonic retrotips will reduce trauma because a smaller osteotomy will be required. In the present study, we also used ultrasonic retrotips.

A drawback of the vestibular approach is the requirement to manage the maxillary sinus membrane to access the palatal root. In our study, in 92.3% of patients, the maxillary sinus restricted access and, thus, had to be elevated. Within the routine application of maxillary sinus elevation procedures for dental implant surgery, well-designed equipment is available for atraumatic elevation of the sinus membrane. Perforation of the sinus membrane is quite common during periradicular surgery of maxillary roots owing to the close proximity to maxillary sinus.[1] Previous studies have reported an incidence of sinus membrane perforations during periradicular surgery of premolar and molar teeth of 10 to 50%.[23-25] Ericson et al[23] reported the occurrence of an oroantral communication in 29 of 159 maxillary premolar and molar teeth during periradicular surgery. In our study, the overall rate of sinus membrane perforation during the procedure was 29%. No difference was found between the 2 groups in the incidence of sinus membrane perforation.

Symptoms of sinusitis and thickening of the sinus mucosa can develop after periradicular surgery of the maxillary molar or premolar teeth. This situation has often been related to foreign material, such as a

Table 7 CONE BEAM COMPUTED TOMOGRAPHY PERIRADICULAR INDEX SCORES AT 12 POSTOPERATIVE MONTHS

	CBCTPAI Score						
Group	0	1	2	3	4	5	Total
1	7 (35.0)	0 (0.0)	1 (5.0)	7 (35.0)	4 (20.0)	1 (5.0)	20 (100)
2	9 (49.9)	0 (0.0)	1 (5.6)	5 (27.8)	3 (16.7)	0 (0.0)	19 (100)
Total	16 (42.1)	0 (0.0)	2 (5.3)	12 (31.6)	7 (18.4)	1 (2.6)	38 (100)

Data presented as n (%).
Abbreviation: CBCTPAI, cone beam computed tomography periradicular index.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Table 8. CLINICAL SYMPTOMS DETECTED

Variable	Preoperatively (n)	Postoperatively (n) 1 wk	1 mo	3 mo	6 mo	12 mo
Sinus tract						
Group 1	6	0	0	0	3	2
Group 2	3	0	0	2	2	0
Swelling						
Group 1	6	5	1	2	1	0
Group 2	6	2	0	0	0	0
Erythema or abscess						
Group 1	5	6	0	0	2	1
Group 2	5	5	0	1	2	0

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

resected root tip or endodontic filling material that displace into the sinus during the operation.[23] The complications of sinus membrane perforation without displaced foreign material have been minimal, and it has been thought that the perforated region on the sinus mucosa usually heals completely after successful periradicular surgery.[24] In different studies, it was reported that that ciliary mucosa covering the maxillary sinus had regenerated within several months after a Caldwell-Luc operation.[24,26,27] Furthermore, a study by Wallace[6] suggested that the transantral approach is an acceptable method for resection of the palatal roots of the maxillary molar teeth. In our study, none of the patients with sinus membrane perforation during surgery had symptoms of sinusitis during the postoperative follow-up period. In 2 patients, slight membrane thickening was apparent on the postoperative CBCT images.

According to the healing criteria used in the present study, 5 periapical lesions in group 1 and 5 periapical lesions in group 2 did not heal. Therefore, the success rate at 12 postoperative months was 75% for group 1 and 73.6% for group 2. A prospective clinical study by von Arx et al[2] evaluated the success rate of periradicular surgery of molar teeth. Using the same healing criteria used in our study, their success rate was 88%. In contrast to our study, they included all molar teeth (maxillary and mandibular first and second molars) in their study.[2] Nine maxillary first molars were included, and in 1 patient, the palatal root had been resected using a vestibular approach. The overall success rate at the first year was 88%; however, the success rate was not specified for the maxillary molars. In addition, the outcomes of the procedure will depend on other factors, including undiagnosed root fracture, dentinal tubules, or accessory root canals.

The success rates of the present study and that of previous studies can be considered lower than those with dental implant treatment, which has become a conventional rehabilitation method of extraction sockets.[28] However, the healing criteria used in the present study evaluated healing more strictly compared with the conventional implant success evaluation criteria.[29] Periradicular surgery of a maxillary molar tooth with an apical lesion can be an acceptable option for patients who refuse teeth extraction. Periradicular surgery is also a more inexpensive treatment option compared with dental implant therapy.[30] Although the success rate in our study can be considered acceptable, success was evaluated at 1 year postoperatively. Thus, more clinical studies with longer follow-up periods are needed for a better understanding of the outcomes of periradicular surgery of maxillary first molar teeth using a vestibular approach.

Table 9. SINUS MEMBRANE PERFORATIONS

Group	Sinus Perforation: Yes	No
1	4	16
2	7	12
Total	11 (28)	28 (71)

Data presented as n (%).

$P = .200$ between groups 1 and 2.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Table 10. MEAN OPERATIVE TIME

Group	Cases (n)	Mean ± SD	Minimum	Maximum
1	20	44.50 ± 16.77	25	80
2	19	66.05 ± 18.59	40	90
Total	39	55.09 ± 20.695	25	90

$P = .001$ between groups 1 and 2.

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

Table 11. DISTRIBUTION OF HEALING SCORES IN BOTH GROUPS

Group	Failure	Improvement	Success	Total
1	5 (25)	8 (40)	7 (35)	20 (100)
2	5 (26.3)	6 (31.5)	8 (42.1)	19 (100)
Total	10 (25.6)	14 (35.8)	15 (38.4)	39 (100)

Data presented as n (%).

Kurt et al. Periradicular Surgery of Maxillary First Molars Using Vestibular Approach. J Oral Maxillofac Surg 2014.

In conclusion, the vestibular approach could be an alternative technique to the palatal approach, which involves more risk of complications, for periradicular surgery of maxillary first molar teeth. Preoperative CBCT examination provides significant information about the location of the roots and their relationship to the maxillary sinus and can reduce the duration of surgery significantly.

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