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Healing Outcome after Maxillary Sinus Perforation in Endodontic Microsurgery

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Purpose: The purpose of the present retrospective cohort study was to investigate the incidence of sinus perforation during endodontic microsurgery and to assess healing of cases with sinus perforation.

Materials and Methods: Clinical and radiographic records were collected from patients who were treated with endodontic microsurgery in the Microscope Center of the Department of Conservative Dentistry at Yonsei University College of Dentistry, Seoul, Korea, between March 2001 and January 2016. To determine the incidence of sinus perforation, all cases involving maxillary premolar and molar teeth were assessed, and cases with perforation of maxillary sinus during the procedure were counted. To assess the outcome of the endodontic microsurgery, cases with sinus perforation were recalled at least 1 year after surgery.

Result: Two hundred and forty-nine maxillary premolars and molars were treated with endodontic microsurgery. Among these cases, 16 cases had sinus perforations. Overall incidence of sinus perforation was 6.4%. Thirteen cases with sinus perforation were followed up for 1 year after endodontic microsurgery. Outcome assessment revealed that 2 of 13 cases with sinus perforation had failed. The success rate of endodontic microsurgery with sinus perforation was 84.6%.

Conclusion: Endodontic surgery performed using microsurgical techniques decreases the risk of sinus perforation. Predictable outcomes of endodontic microsurgeries and healing of sinus membrane can be expected with adequate treatment steps and careful periodic follow-ups in cases with maxillary sinus perforations.

Key Words: Endodontic microsurgery; Maxillary sinus; Outcome; Perforation

Introduction

The maxillary sinus, one of the paranasal sinuses, has a close anatomic relationship with maxillary teeth. The floor of the maxillary sinus is formed by the alveolar process of the maxilla, and may

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extend between the roots of posterior upper molars. Sometimes root tips may penetrate into the sinus cavity without covering bony lamella. The sinus membrane is lined with ciliary mucosae that produce a constant flow of mucus[1,2].

Because of the close proximity of the maxillary sinus to upper molar apices, the maxillary sinus has been a primary anatomic structure to consider during dental procedures, especially in nonsurgical and surgical endodontic treatment[1,2]. Periapical and periodontal diseases may extend into the maxillary sinus and disrupt the sinus tissue, leading to sinusitis. During endodontic surgery, resecting root apex or removing granulation tissue may result in perforation of maxillary sinus mucosa. In such cases, sinus mucosal thickening and signs of sinusitis can occur because of the entrance of foreign materials during the procedure or persistent periapical infection[3,4].

In recent years, microsurgical techniques of endodontic surgery have been developed, which use a microscope and ultrasonic preparation instruments during the procedure[5]. With endodontic microsurgery, anatomical structures and root apices in the surgical field can be explored more accurately, and surgical trauma can be minimized. Such advancement of microsurgical techniques allows a more predictable clinical outcome of surgical endodontic treatment than conventional surgeries[6,7].

Incidence of sinus perforation during endodontic surgery ranged from 9.6% to 50.0% in a few reports[3,4,8-12] and has not been updated recently. These results are mainly based on conventional surgical techniques, with the exception of one study[9]. Further, little investigation has been done to date regarding clinical significance of oroantral communication in healing of surgically treated teeth and maxillary sinus.

The purpose of the present retrospective cohort study was to investigate the incidence of sinus perforation during endodontic microsurgery and assess healing of cases with sinus perforation.

Materials and Methods

1. Case Selection

This study was approved by the Institutional Review Board, Yonsei University College of Dentistry, Seoul, Korea (No. 2004-2). Clinical and radiographic records were collected from the Microscope Center of Department of Conservative Dentistry at Yonsei University College of Dentistry, Seoul, Korea. The data were from patients who treated using the endodontic microsurgery protocol of the center between March 2001 and January 2016. To determine the incidence of sinus perforation, all cases involving maxillary premolar and molar teeth were identified. Among these cases, cases with perforation of the maxillary sinus during the procedure were counted. To assess the outcome of endodontic microsurgery, cases with sinus perforation were recalled at least 1 year after surgery to calculate success rate. All cases had complete clinical records of patient information, clinical diagnosis, complications and follow-up radiographs. Cases lacking any of this information were excluded.

2. Treatment Procedure

All surgical procedures were performed with an operating microscope (OPMI Pico; Carl Zeiss, Gottingen, Germany) by a single clinician (E.K.). Under local anesthesia, a full-thickness flap was reflected. Osteotomy toward the tooth apices was performed with a round bur under copious water irrigation. After curettage of periapical granulation tissue, hemostasis of bony crypt was achieved with epinephrine or saline-soaked cotton pallets. Approximately 2 to 3 mm of the root tip was resected with a tapered fissure bur. The root surfaces were inspected with micromirrors (Obtura Spartan, Fenton, MO, USA) at 20× to 26× magnification after methylene blue staining.

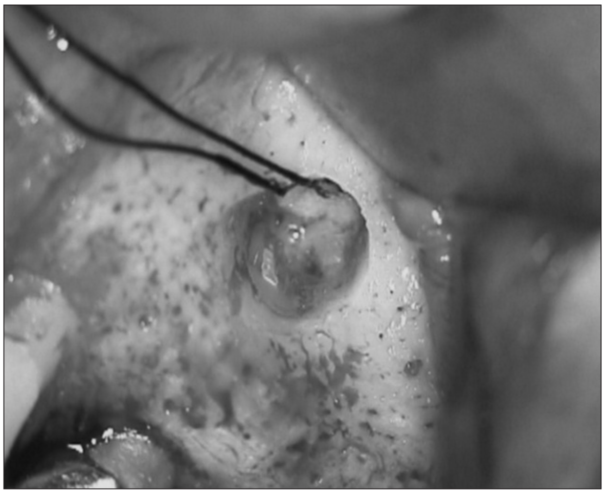

Fig. 1. Cotton packing on aperture site of a sinus perforation to prevent entrance of foreign body materials or debris.

The root-end cavities were prepared with KIS ultrasonic tips (Obtura Spartan) and filled with Super EBA (Harry J. Bosworth, Skokie, IL, USA) or ProRoot MTA (Dentsply, Tulsa, OK, USA). When perforation of the maxillary sinus was detected during the procedure, an adequately sized, silk-tied cotton pellet was placed on the perforation site to block the aperture from entrance of foreign body materials and secondary infection (Fig. 1). After root-end filling and cleaning of the root surface, the wound site was primarily closed with 5-0 monofilaments. After the surgical procedures, antibiotics (3 times per day for 5 days) were prescribed.

3. Follow-Up

Patient records, including clinical and radiographic information, were updated at every recall visit. The patients were followed up at 6 and 12 months after the treatment, and every year thereafter. The clinical exam evaluated signs and/or symptoms, mobility, tenderness to percussion or palpation, periodontal status, sinus tract formation, postoperative complications and type of restoration. Periapical radiographs of the treated teeth were taken at every recall visit.

4. Assessment of Outcome

Outcome assessment of cases were done at least 1 year after treatment by evaluating clinical findings and postoperative radiographs. Classification of healing, based upon radiographic evaluation and using the criteria developed by Rud et al.[13] and Molven et al.[14] was as follows: (1) complete healing, (2) incomplete healing, (3) uncertain healing, and (4) unsatisfactory healing. The two examiners who standardized the evaluation criteria appraised the postoperative radiographs independently. If any disagreement existed between the examiners, the final decision was made by discussion until consensus was reached. Success was determined as radiographic evidence of complete or incomplete healing and a clinical absence of signs or symptoms. Any case with existing clinical signs and/or symptoms or radiographic evaluations of uncertain or unsatisfactory healing was considered a failure.

Result

Two hundred forty-nine maxillary premolars and molars were treated with endodontic microsurgery. When the cases were counted per tooth type, 71 cases were first premolars, 89 cases were second premolars, 85 cases were first molars, and 4 cases were second molars. Among these 249 cases, 16 cases had sinus perforations. Three cases had exposure of the Schneiderian membrane, but did not have full perforations. All 19 cases were diagnosed as symptomatic apical periodontitis with previous endodontic treatment. The mean age of patients with sinus perforations was 40 years old. Seven patients were male and 9 patients were female. Overall incidence of sinus perforation was 6.4%. The details of the teeth with sinus perforations categorized by tooth type are shown in Table 1.

Thirteen cases with sinus perforation were followed up for 1 year after endodontic microsurgery. Outcome assessment revealed that 2 of 13 cases with sinus perforation have failed. One involved the

Table 1. The distribution of the teeth treated and incidence of sinus perforation per tooth type

Tooth type	Number of treated teeth	Number of sinus perforations	Sinus perforations per tooth (%)	Ratio of tooth types in sinus perforations (%)
First premolar	71	1	1.4	6.25
Second premolar	89	5	5.6	31.25
First molar	85	9	10.5	56.25
Second molar	4	1	25.0	6.25
Total	249	16	-	100.00

second premolar, and the other involved the first molar. The success rate of endodontic microsurgery with sinus perforation was 84.6%. None of the patients with sinus perforation had symptoms or signs of postoperative complication, such as acute or chronic sinusitis.

Discussion

Due to its intimate anatomical relationship with maxillary premolars and molars, the maxillary sinus membrane is often perforated during endodontic surgeries on the upper teeth. Oroantral communication by perforation of the maxillary sinus membrane can result not only from accidental events, but also from pathological sinus membrane exposure due to the extension of periapical inflammation[15]. Particular attention is needed in these cases to prevent spread of pathogens originating from apical periodontitis or the entrance of foreign body material during surgery.

There are several reports of endodontic surgery in premolar and molar teeth aid in determining the incidence of sinus perforation. Ericson et al.[3] reported 18% of sinus perforations in 159 premolar and molar apicoectomies. Freedman and Horowitz[4] reported 10.4% perforations following 472 cases. Oberli et al.[9] revealed 9.6% of sinus perforation from 125 roots. Some authors investigated sinus perforation by limiting analysis solely to molar teeth: Ioannides and Borstlap[8] found 14.8% perforations from 47 maxillary molar and Rud and Rud[10] found 50% perforations in 200 cases of first maxillary molars.

The present study showed 6.4% of sinus perforations in 249 surgeries involving premolar and molar teeth, which is a fairly lower rate of incidence than previous studies have reported. Oberli et al.[9] commented that a conventional technique using amalgam as a retrograde filling material makes a large bony defect on the surgical lesion, and may increase the rates of sinus perforation. Since microsurgical techniques utilize high magnification of 10× and ultrasonic instruments for preparation of root-end cavity, the size of the osteotomy is smaller than that of conventional methods. The fact that the microsurgery was performed on the cohort of the present study might explain the low incidence of sinus perforations.

When sinus perforations were calculated per tooth type, the rates of incidence increased with teeth located more posterior in the oral cavity (Table 1). This result corresponds to a recent study[16] that evaluated vertical and horizontal relationships between maxillary sinus floor and the root apices of posterior teeth using cone-beam computed tomographic (CBCT) scanning. They reported the frequency of protrusion of a root apex into the maxillary sinus floor significantly increased toward the posterior teeth and mesiobuccal root of the second molar had the shortest mean vertical distance. This result is in agreement with other studies regarding the proximity of posterior teeth and the maxillary sinus[17-19].

The present study showed that first molars accounted for over 50% of 16 cases with sinus perforations. The proportion of first molar perforations increased from previous studies, in which surgery involving premolars resulted in the largest number of sinus perforations[3,4]. This result may be explained by an increase in the number of molar surgeries as molar teeth become more accessible with endodontic microsurgery as compared to conventional surgery.

Correlation between maxillary sinus perforation and outcome of endodontic surgery has been concern to clinicians. Some clinical studies have reported the prognoses of endodontic surgeries, which had maxillary sinus membrane perforations: Watzek et al.[20] found no significant difference in healing rate between patients with and without sinus membrane exposure after evaluating 146 apical surgery cases. Ericson et al.[3] also observed no difference in apicoectomy outcomes between groups with and without oroantral communication. These results demonstrated that sinus membrane perforations during surgical procedures do not have a detrimental effect on the clinical outcome of the treatment[1]. The present study also showed a high clinical success rate (84.6%) of surgery in 13 cases with sinus perforations. There were 2 failed cases with sinus perforation (Fig. 2). One had a recurred sinus tract after a year of surgery (Fig. 2A~D). Resurgery of the tooth revealed that vertical root fracture was the reason of the failure. The other had increased periapical radiolucency 6 years after the surgery, in spite of complete healing at 18-month follow-up (Fig. 2E~H). Incidents of recurred apical periodontitis in both cases were unrelated to sinus perforation during the surgery.

The fact that none of the patients with sinus perforations had postoperative complications of the maxillary sinus reflects that the mucosa at the perforation site had healed well after surgery. Freedman and Horowitz[4] also found no sinusitis or sinus membrane hyperplasia in 49 patients with sinus perforations, and only three cases had polyps in the sinus, with no purulent discharge. Fig. 3 presents one of the cases with sinus perforations. The left maxillary first molar of a 51-year-old female patient had apical periodontitis on the mesiobuccal root, close to the maxillary sinus floor. Mucosal thickening of the maxillary sinus was observed in preoperative CBCT (Fig. 3A). At 15-month follow-up after endodontic microsurgery, the tooth showed complete healing and the mucosal thickening of

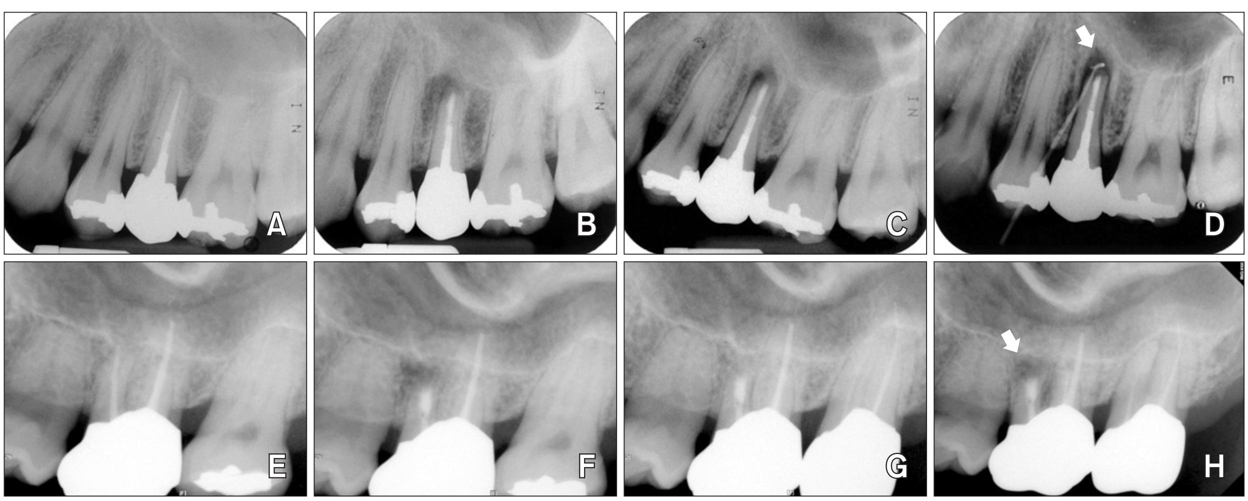

Fig. 2. Failed cases with sinus perforation. (A~D) Case of left maxillary second premolar. (A) Preoperative radiograph. (B) Postoperative radiograph. (C) Six-month follow-up radiograph. (D) Twelve-month follow-up radiograph with gutta-percha cone tracing through sinus tract. Note that perapical radiolucency had recurred (arrow). (E~H) Case of left maxillary first molar. (E) Preoperative radiograph. (F) Postoperative radiograph. (G) Eighteen-month follow-up radiograph. (H) Six-year follow-up radiograph. Periapical radiolucency on mesiobuccal root was detected (arrow).

Fig. 3. Preoperative and postoperative cone-beam computed tomography of sinus perforation case. (A) Periapical radiolucency on mesiobuccal root of left maxillary first molar before the surgery. Note that the periapical lesion extended to the floor of maxillary sinus and mucosal thickening of the maxillary sinus was observed. (B) The tooth showed complete healing and mucosal thickening of the maxillary sinus had subsided 15 months after endodontic microsurgery.

sinus had subsided (Fig. 3B). Perforation of sinus membrane healed with no adverse effect on the maxillary sinus and the treated tooth.

Recent development of CBCT scanning enables clinicians to prepare for the risk of sinus perforation. If the periapical radiolucency is close with maxillary sinus floor in preoperative CBCT, an osteotomy approach 2 to 3 mm more coronal than apices may be helpful to prevent perforation of the sinus membrane. When sinus perforation occurs, immediate, appropriate treatment steps appeared to be a precondition of the sinus membrane healing. The treatment protocol after sinus perforation includes cotton packing on the aperture site during the remainder of the surgical procedure to prevent entrance of foreign body materials or debris (Fig. 1), patient education (to avoid blowing the nose forcefully or sneezing with a closed nose that may cause a sudden change in pressure of the sinus cavity), antibiotic therapy, and postoperative CBCT if needed.

Conclusion

In conclusion, overall incidence of maxillary sinus perforation in the present study was 6.4%, which indicates that endodontic surgery with microsurgical techniques decreases the risk of sinus perforation. Nevertheless, sinus membrane perforation should be considered a possible risk, especially on molar teeth due to the close relationship between root apices and the maxillary sinus floor. Maxillary teeth with root apices adjacent to the maxillary sinus floor cannot be a contraindication of endodontic surgery, as the severe complications of sinus perforation is uncommon. Predictable outcomes of endodontic microsurgeries and healing of sinus membrane can be expected with adequate treatment steps and careful periodic follow-ups in cases with maxillary sinus perforations.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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