CASE SERIES

Management of Intraoperative Endo-Sinus Communications in Maxillary Posterior Teeth: A 15-Case Series

ABSTRACT

Background: *The anatomical relationship between posterior maxillary teeth and the maxillary sinus may predispose to intraoperative complications during endodontic treatment. While sodium hypochlorite extrusion into the sinus has been sporadically reported, no case series has described direct intraoperative endo-sinus communications.*

Methods: *Fifteen cases of intraoperative endo-sinus communication were documented during root canal treatment or retreatment of maxillary premolars and molars. Clinical signs included profuse bleeding synchronous with respiration, the presence of nasal mucus in the pulp chamber, disappearance of sodium hypochlorite solution, and contamination of paper points. In all cases, a Valsalva maneuver was performed and confirmed the presence of communication. Management strategies included immediate obturation when the canal could be dried or hemostasis achieved, or provisional sealing with Teflon and IRM with or without calcium hydroxide dressing when immediate obturation was not possible. Patients were followed clinically and radiographically..*

Results: *In 4 cases (26.7%), endodontic obturation was completed in a single visit, while in 11 cases (73.3%) obturation was postponed. Among the latter, 4 cases received calcium hydroxide dressing and 7 had no intracanal medicament. In all cases, the communication resolved spontaneously within one week. At a mean follow-up of 3.9 years (range: 1–10 years), no patient developed persistent sinonasal symptoms or radiographic evidence of sinus pathology.*

Conclusions: *This case series provides the first clinical description of intraoperative endo-sinus communications. When promptly recognized and appropriately managed, these events do not appear to compromise the long-term prognosis of endodontic treatment. Careful preoperative radiographic assessment, accurate working length determination at the first appointment, and controlled instrumentation are essential to prevent recurrence. Different obturation techniques may be successfully applied, with bioceramic sealers offering potential advantages in postoperative comfort.*

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Introduction

The maxillary sinus is the largest of the paranasal sinuses, with development beginning in the third month of fetal life and continuing throughout adolescence. Its morphology and degree of pneumatization are highly variable, and in the posterior maxilla, close anatomical relationships often exist between the sinus floor and the roots of premolars and molars (1). While first premolars are usually distant from the sinus, the second premolars and molars frequently present close proximity. CBCT studies report that up to 15–25% of second premolars and 40–45% of molar roots protrude into the sinus cavity, with the mesiobuccal root of the second molar and the palatal root of the first molar most commonly involved (2–5). Such anatomical variability underscores the clinical importance of accurate preoperative assessment (Fig. 1).

In oral and maxillofacial surgery, several complications have been associated with sinus involvement. Extractions of posterior maxillary teeth may result in oroantral communications (OAC), displacement of root fragments, or subsequent development of chronic sinusitis (6). Implant surgery also presents challenges, particularly in the atrophic posterior maxilla where sinus augmentation is often required to achieve adequate bone volume (7–10).

Endodontic procedures can also involve the maxillary sinus. The intimate anatomical relationship between posterior maxillary teeth and the sinus floor means that endodontic pathoses and treatments may have direct consequences for sinus health (11). Extrusion of filling materials or irrigants beyond the apical foramen may lead to sinus involvement, foreign body reactions, or acute sinusitis (Fig. 2). Although sodium hypochlorite (NaOCl) accidents are rare, isolated case reports have documented its accidental extrusion into the maxillary sinus with severe inflammatory consequences (12–14).

Intraoperative complications may also occur during endodontic procedures when overinstrumentation leads to perforation of the Schneiderian membrane. In such cases, a positive Valsalva maneuver can be observed, often accompanied

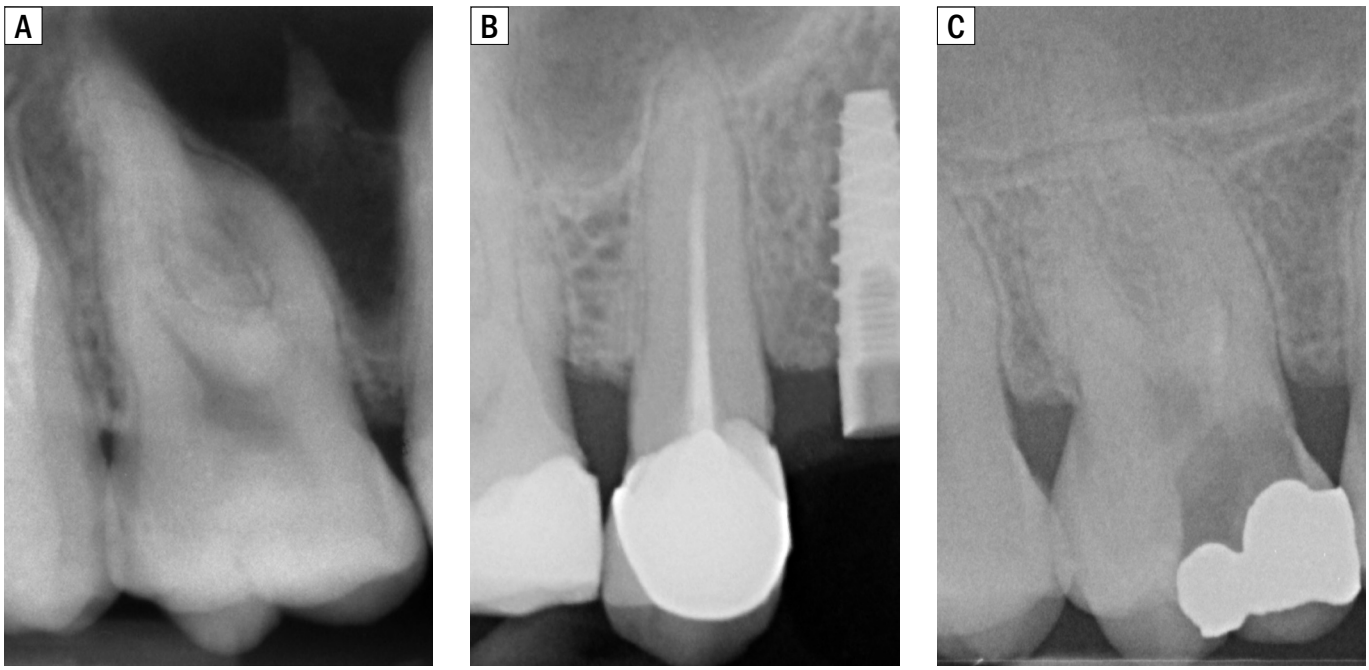


Figure 1
Periapical radiographs of maxillary posterior teeth showing different anatomical relationships with the maxillary sinus. **(A)** First maxillary molar with a very pneumatized sinus, in close contact with the root apices. **(B)** Maxillary premolar with minimal penetration into the sinus cavity. **(C)** Maxillary molar in which the palatal root shows direct relationship with the sinus floor.

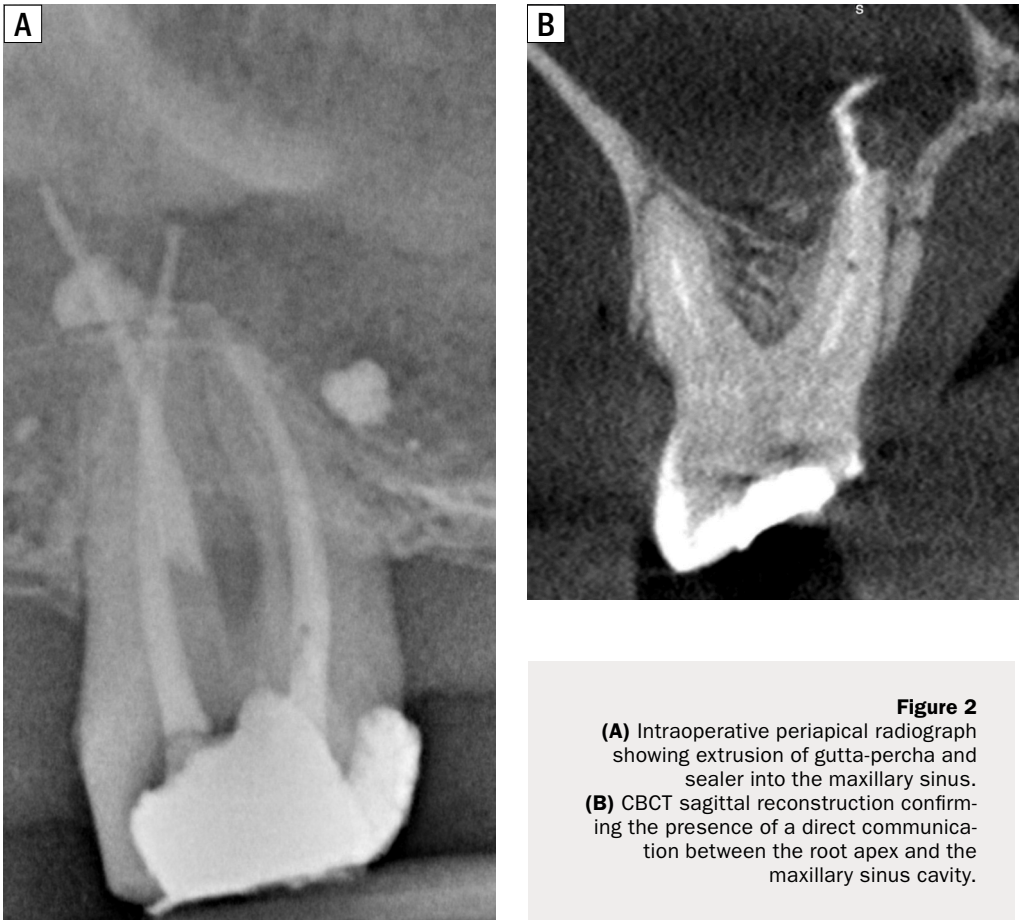


Figure 2
(A) Intraoperative periapical radiograph showing extrusion of gutta-percha and sealer into the maxillary sinus.
(B) CBCT sagittal reconstruction confirming the presence of a direct communication between the root apex and the maxillary sinus cavity.

by bleeding and the leakage of nasal mucus into the operative field (15). This clinical scenario represents a direct communication between the root canal system and the maxillary sinus. At present, no intraoperative endo-sinus communications have been reported in the literature, and consequently no clinical guidelines are available on how to manage this complication. The present case series is the first to describe and document the management of such endo-sinus communications.
This study addresses a current gap in the literature, as no systematic case series on intraoperative endo-sinus communications has yet been reported. The objective of the present work was therefore to document the clinical presentation, management strategies, and outcomes of 15 such cases, with the aim of providing practical guidance for clinicians confronted with this rare but clinically significant complication.

Management of Cases

All patients included in this series presented with a maxillary premolar or molar requiring endodontic treatment or retreatment due to extensive carious destruction, prosthetic needs, or persistent periapical pathology. Each patient provided written informed consent before undergoing endodontic therapy. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki.
All patients signed written informed consent for treatment and for the use of anonymized images. Preoperative periapical radiographs revealed a close anatomical relationship between the treated roots and the maxillary sinus floor. In

some patients, cone-beam computed tomography (CBCT) was performed and confirmed the proximity.

Cone-beam computed tomography (CBCT) examinations were acquired when necessary with a Carestream 8100 unit (Carestream Health, USA), using a limited field of view (5 × 5 cm) and a voxel size of 0.2 mm.

Endodontic procedures were initiated with a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) to establish the working length. The working length was determined using the Morita TriAuto ZX2 apex locator integrated with endodontic motor (J. Morita Corp., Osaka, Japan) and confirmed radiographically only in doubtful cases. Canal patency was maintained with a size 10 K-file.

Canal shaping was carried out with the ProTaper Gold system (Dentsply Maillefer, Ballaigues, Switzerland), used according to the manufacturer's instructions, and completed once the instrument flutes were filled with clean dentin debris.

Irrigation was performed with 5.25% sodium hypochlorite (Niclor; Ogna, Muggiò, Italy), delivered in three aliquots of 5 ml each using dedicated irrigation cannulas (IrriFlex; PD Produits Dentaires, Vevey, Switzerland) positioned 2 mm short of the root apex.

When an intraoperative communication was suspected, NaOCl irrigation was discontinued and replaced by the iVac negative pressure system. A final rinse with 10% EDTA (Tubuliclean; Ogna, Muggiò, Italy) was then performed.

During or towards the end of canal preparation, four different intraoperative findings were observed:.

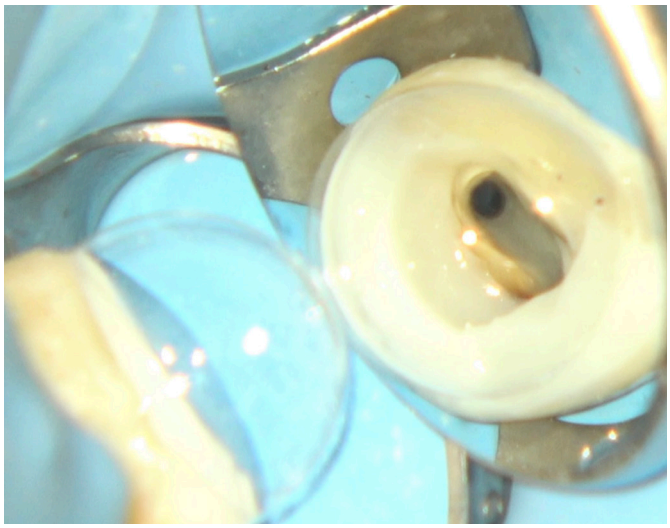
1. Profuse bleeding into the pulp chamber, which, being synchronous with respiration, was cyclically re-aspirated into the canal system (Fig. 3).
2. Presence of nasal mucus in the pulp chamber, clearly of paranasal origin (Fig. 4).
3. Disappearance of sodium hypochlorite solution from the pulp chamber during irrigation.
4. Paper points contaminated with blood or nasal mucus during canal drying.

In all 15 cases, a Valsalva maneuver was performed intraoperatively to confirm Schneiderian membrane perforation. The maneuver was positive in every patient, demonstrating the presence of an iatrogenic communication between the endodontic space and the maxillary sinus.

Following confirmation of endo-sinus communication, the management strategy was adapted to the intraoperative conditions of the canal system. When the canal could be adequately dried, or hemostasis was obtained with the aid of topical hemostatic agents (10), endodontic obturation was completed in the

Figure 3
Clinical image extracted from an intraoperative video during the Valsalva maneuver. The palatal canal shows an endo-sinus communication with profuse bleeding. The blood outflow, synchronous with respiration, was so intense that it splashed against the mouth mirror.

Figure 4
Clinical image extracted from an intraoperative video during the Valsalva maneuver. Nasal mucus from the sinus extrudes through the palatal canal, forming a visible bubble at the canal orifice, confirming the presence of an endo-sinus communication.



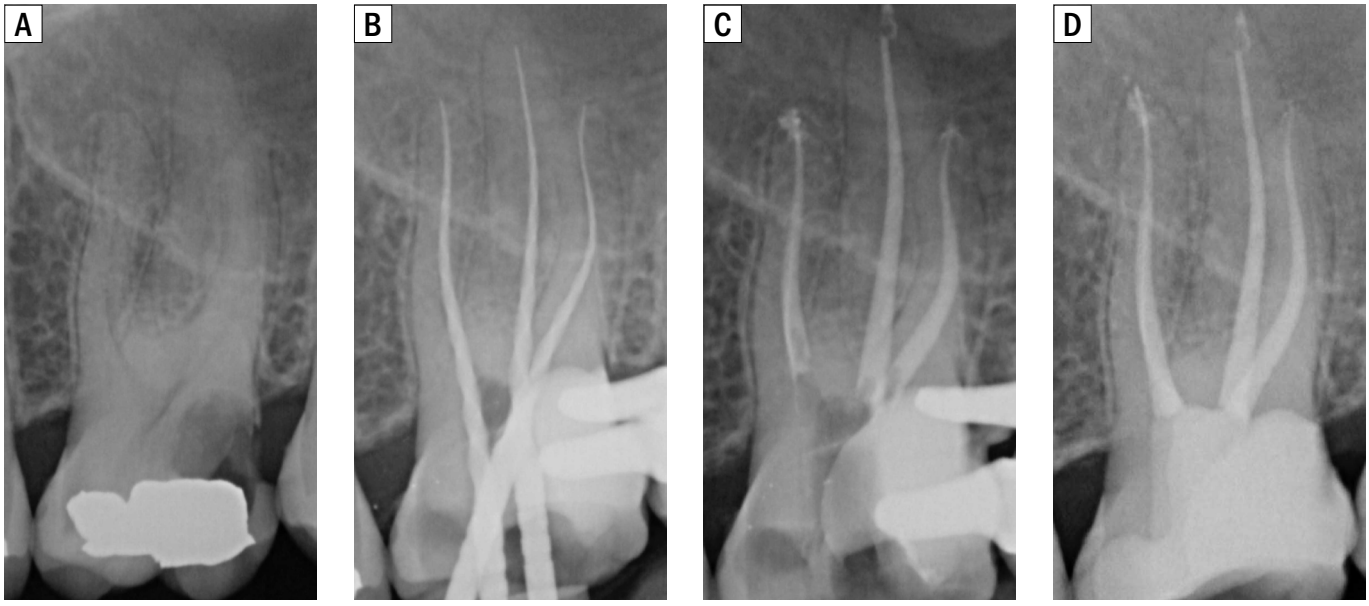


Figure 5
Case of endo-sinus communication involving the mesial root, managed in a single visit.
(A) Preoperative periapical radiograph.
(B) Working length radiograph.
(C) Postoperative radiograph after endodontic Coneless obturation.
(D) Three-year follow-up radiograph showing complete healing and absence of sinus involvement.

same visit. Conversely, when persistent bleeding or nasal mucus prevented satisfactory drying, obturation was postponed. In these cases, the canals were provisionally sealed with teflon and temporary restorative material. At the operator's discretion, an inter-appointment dressing with calcium hydroxide was placed, while in other cases no intracanal medicament was used.
When required, hemostasis was achieved with 38% ferric sulfate (galenic preparation) applied using paper points at working length.
When intracanal medicament was inserted, a calcium hydroxide paste (Stomidrox; Stomygel SRL, Rome, Italy) was placed for 1–2 weeks until the subsequent appointment.
Obturation was performed with different techniques. In cases of single-cone or warm vertical compaction, ProTaper Gold conform-fit gutta-percha cones (Dentsply Maillefer, Ballaigues, Switzerland) were used. In cases of coneless obturation, the Obtura III Max device (Obtura Spartan, Algonquin, IL, USA) was employed. A bioceramic sealer (Ceraseal; Meta Biomed, Cheongju, Republic of Korea) was applied in all cases. No collagen barrier was placed. Temporary sealing was standardized using Teflon tape followed by IRM (Dentsply Sirona, Charlotte, NC, USA). All patients were subsequently recalled for completion of endodontic treatment and were monitored both clinically and radiographically to assess healing and exclude persistence of sinus-related symptoms.
Postoperative instructions included informing patients about the possibility of mild nasal bleeding, advising against Valsalva maneuvers or nose blowing. No antibiotics were prescribed, and analgesics were recommended only as needed.

Results

A total of 15 cases of intraoperative endo-sinus communication were documented. All patients presented with a positive Valsalva maneuver, confirming the presence of a communication between the root canal system and the maxillary sinus.
In 4 cases (26.7%), the canals could be adequately dried, or hemostasis was achieved with the aid of topical hemostatic agents, and endodontic obturation was completed in a single visit. (Fig. 5)
In the remaining 11 cases (73.3%), pro-

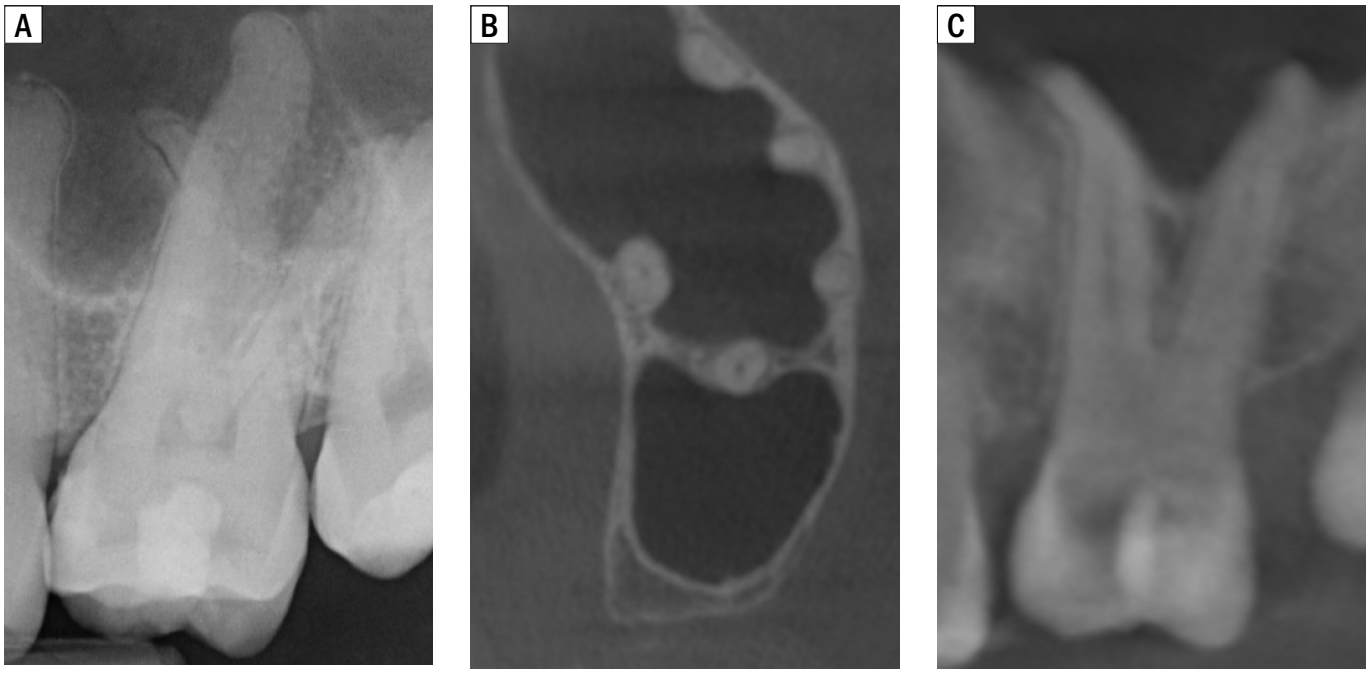


Figure 6 Preoperative assessment of a maxillary molar scheduled for endodontic treatment due to pulpitis. The complex root anatomy and suspected sinus involvement prompted a CBCT evaluation prior to therapy. **(A)** Periapical radiograph showing a close relationship between root apices and the maxillary sinus floor. **(B)** CBCT axial slice confirming apical protrusion into the sinus cavity. **(C)** CBCT coronal view demonstrating the protrusion of all root apices into the sinus.

fuse bleeding or nasal mucus prevented immediate obturation. These cases were managed with a two-visit approach, sealed provisionally with Teflon and IRM. Among them, 4 cases (26.7%) received an interappointment dressing with calcium hydroxide, while in 7 cases (46.7%) no intracanal medicament was placed (Fig. 6,7).

All patients were recalled for comple-

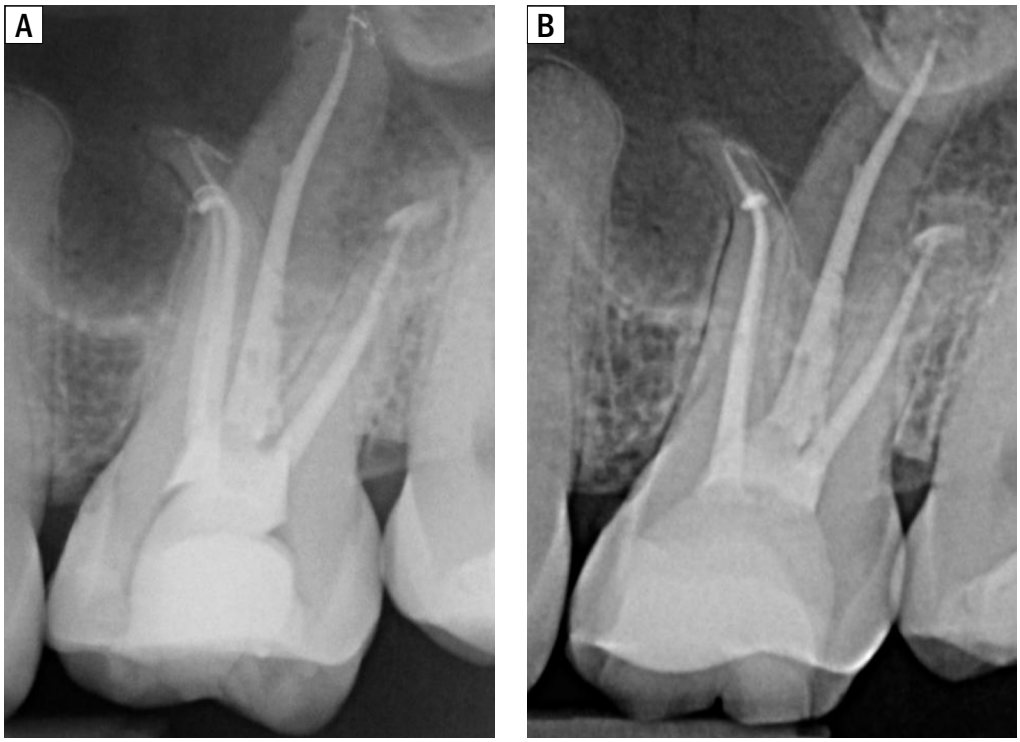


Figure 7 Same case as in Figure 6, managed in two visits. The tooth was obturated using the coneless endodontic technique. **(A)** Postoperative periapical radiograph after completion of root canal treatment. **(B)** Four-year follow-up radiograph showing stable periapical healing and absence of sinus-related complications.

Case	Age/Sex	Tooth	Root involved	Intraoperative findings	Management	Follow-up
1	M	17	P	Paper points contaminated with blood/mucus	Immediate obturation	4 Y
2	M	16	D	Paper points contaminated with blood/mucus	Immediate obturation	3 Y
3	M	16	M	Disappearance of NaOCl	Immediate obturation	4 Y
4	F	26	P	Nasal mucus in pulp chamber	Immediate obturation	10 Y
5	M	15	P	Paper points contaminated with blood/mucus	$Ca(OH)_2$ (Stomidrox)	1 Y
6	M	26	P	Profuse bleeding synchronous with breathing	$Ca(OH)_2$ (Stomidrox)	2 Y
7	M	27	M	Paper points contaminated with blood/mucus	$Ca(OH)_2$ (Stomidrox)	5 Y
8	F	16	D	Paper points contaminated with blood/mucus	$Ca(OH)_2$ (Stomidrox)	3 Y
9	M	16	M	Paper points contaminated with blood/mucus	No medication	4 Y
10	M	26	P	Disappearance of NaOCl	No medication	1Y
11	M	26	P	Profuse bleeding synchronous with breathing	No medication	4 Y
12	M	16	M	Profuse bleeding synchronous with breathing	No medication	6 Y
13	F	17	P	Profuse bleeding synchronous with breathing	No medication	3 Y
14	M	27	P	Profuse bleeding synchronous with breathing	No medication	7 Y
15	M	16	P	Disappearance of NaOCl	No medication	1 Y

Table 1
Summary of 15 cases of intraoperative endo-sinus communication

tion of endodontic treatment and were followed clinically and radiographically. The mean follow-up period was 3.9 years (range: 1–10 years). No patients reported persistent sinonasal symptoms or complications during the observation period.
Clinical details of 15 cases of intraoperative endo-sinus communication, including tooth, root involved, intraoperative findings, management, and follow-up are shown in Table 1.

Discussion

In this case series, we report 15 instances of intraoperative endo-sinus communication that occurred during root canal treatment or retreatment of maxillary posterior teeth in close proximity to the sinus floor. All patients presented with a positive Valsalva maneuver, confirming the presence of a direct communication between the endodontic space and the sinus cavity. To our knowledge, this is the first case series describing such a complication, as the literature to date has reported only three isolated cases of sodium hypochlorite extrusion into the maxillary sinus (12–14).
The distribution of affected teeth and roots in our sample was consistent with previous CBCT studies investigating the anatomical relationships between posterior maxillary teeth and the sinus. Large radiological investigations have shown that only 1–2% of first premolars and up to 15–25% of second premolars are in contact with or protrude into the sinus, whereas the prevalence increases markedly for molars, with 40–45% of first molar roots and up to 45% of second molar roots projecting into the sinus cavity (2–5). Root-specific analyses confirm that the mesiobuccal root of the second molar and the palatal root of the first molar are most frequently involved, with frequencies ranging from 30–40% in different populations (3,6). These anatomical data explain why, in our series, the majority of endo-sinus communications occurred in molars, while only a few premolars were affected.
Furthermore, studies have demonstrated that younger individuals tend to present shorter distances between apices and the sinus floor, with a higher prevalence of root protrusion into

the sinus cavity (4,7,8). Although age distribution was not a primary focus of our series, this factor may represent an additional risk variable when planning endodontic treatment in the posterior maxilla.

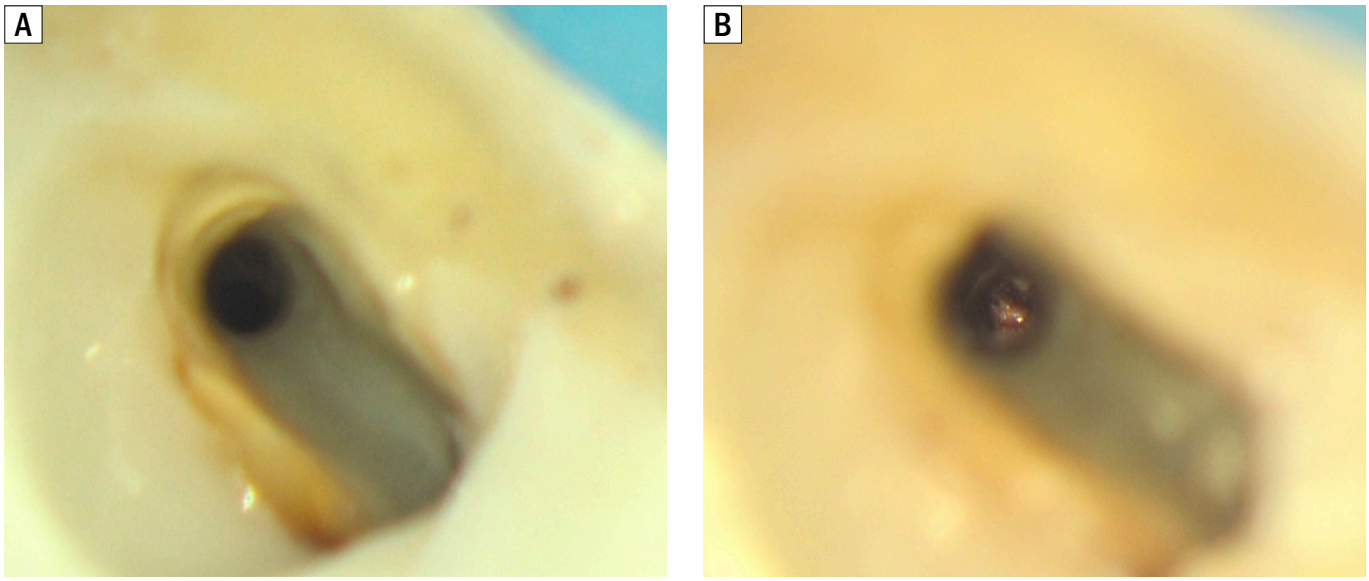
Intraoperative signs observed in our series included profuse bleeding synchronous with respiration, the presence of nasal mucus in the pulp chamber, disappearance of sodium hypochlorite, and contamination of paper points with blood or mucus. In all cases, the Valsalva maneuver confirmed the presence of communication, underscoring its utility as a simple intraoperative diagnostic tool (15).

Management depended on the possibility of drying the canal and controlling bleeding. In four cases (26.7%), obturation was completed in a single visit. In the remaining eleven cases (73.3%), definitive obturation was postponed, with provisional sealing using Teflon and IRM. Among these, four cases received calcium hydroxide as an interappointment dressing, while seven had no intracanal medicament. Importantly, in all cases the communication resolved spontaneously within one week, (Fig. 8) and no differences were observed in clinical outcome between teeth that received calcium hydroxide and those that did not.

At follow-up (mean: 3.9 years; range: 1–10 years), none of the patients developed persistent sinonasal symptoms or radiographic evidence of chronic sinusitis. These findings indicate that, when promptly recognized and managed, intraoperative endo-sinus communications may have a benign course and do not compromise the long-term prognosis of endodontic treatment.

Another relevant clinical aspect is the determination of working length (WL) in maxillary posterior teeth. Electronic apex locators are widely considered reliable, but their accuracy may be compromised when root apices are in contact with the sinus cavity. An ex vivo study demonstrated that the Root ZX apex locator significantly overestimated the real WL in palatal roots communicating with the sinus, while no error was observed in roots without such relationship (17). This finding is crucial, as inaccurate WL determination in these cases may increase the risk of overinstrumentation, extrusion of irrigants, or debris into the sinus. For this reason, in clinical practice, WL determination should always be confirmed radiographically when treating teeth in close proximity to the sinus floor.

Figure 8
Endo-sinus communication involving the palatal root (apical size #50). **(A)** Intraoperative microscopic view showing the communication as a dark area, resembling the appearance of post-extraction sockets with sinus opening. **(B)** One-week recall without interappointment dressing: the sinus membrane can be visualized at the apical level. In such cases, particular caution is required to avoid patency filing or overinstrumentation, which could recreate the communication.



In addition, shaping of curved canals with NiTi rotary systems can progressively modify canal curvature, leading to WL changes. An in vitro study showed that overinstrumentation in curved canals resulted in canal straightening and a mean WL variation of 0.4–0.5 mm (18). This highlights the importance of frequent WL reassessment during shaping procedures to prevent inadvertent overinstrumentation and possible perforation of the sinus floor.

Accurate preoperative radiographic assessment is also essential in preventing and recognizing endo-sinus communications. While CBCT provides the most precise evaluation of root–sinus relationships, periapical and panoramic radiographs remain the first-line diagnostic tools in daily practice. Importantly, clinicians should not only look for the apparent projection of the root apex into the sinus cavity, but also for indirect radiographic signs that may indicate close anatomical contact. These include interruption of the cortical outline of the sinus floor, absence of the periodontal ligament space, apical darkening of the root, and upward curving of the sinus floor enveloping the apex. The presence of multiple signs significantly increases the likelihood of true root protrusion into the sinus, as confirmed by CBCT (19). Careful evaluation of these features on preoperative radiographs may therefore provide an early warning and help prevent inadvertent intraoperative complications.

An important aspect of case management is the chemomechanical cleaning phase. Adequate irrigation protocols, combined with negative pressure delivery—particularly when communication is suspected—are crucial to minimize the risk of extrusion into the sinus and to ensure effective microbial control. This is consistent with recent evidence emphasizing both the safety and efficacy of optimized irrigation strategies (20).

Limitations

A precise assessment of maxillary sinus involvement was limited by the use of non-standardized imaging. Ideally, a baseline preoperative CBCT (limited field of view, low-dose) and a follow-up CBCT would be required to objectively document the extent of Schneiderian membrane involvement and to demonstrate healing versus persistence (e.g., resolution of mucosal thickening or closure of the communication). Reliance on intraoperative signs (such as a positive Valsalva maneuver) and periapical radiographs alone may lead to misclassification. Future prospective studies should incorporate standardized CBCT protocols, while maintaining adherence to the ALARA principle to minimize radiation exposure. Where feasible, adjunctive outcome measures—such as ENT evaluation or sinonasal symptom scoring—should also be included.

Conclusions

This case series documents, for the first time, intraoperative endo-sinus communications during root canal treatment of maxillary posterior teeth. These events, although rare, can be promptly recognized through characteristic clinical signs and confirmed by the Valsalva maneuver.

The communication resolved spontaneously within one week in all cases, and no differences were observed between teeth medicated with calcium hydroxide and those managed without interappointment dressing. Endodontic treatment was successfully completed in all patients without subsequent sinonasal complications.

An important aspect not to be underestimated is the accurate determination of working length at the first appointment, in order to avoid tearing the sinus membrane again at a subsequent visit. Once the communication has been controlled, different obturation techniques can be employed successfully. Recent evidence indicates that bioceramic sealers, in particular, may reduce pos-

toperative discomfort while ensuring long-term success rates comparable to conventional methods (21).
Careful radiographic assessment, accurate and repeatedly verified working length determination, and controlled canal instrumentation are therefore essential to minimize the risk of this complication and ensure favorable long-term outcomes. These findings are in line with previous clinical reports that emphasize the challenges posed by anatomical variability of root canal systems and the importance of meticulous radiographic and clinical evaluation (22).

Conflict of Interest and Funding

The authors declare that they have no conflicts of interest related to this study. No external funding was received for the conduct of this research or for the preparation of this manuscript.

Authors' Contributions

C. B. and **F. C.** conceived the study, performed the clinical treatments, collected data, and contributed to manuscript drafting.
F. S. assisted in the clinical management of cases and data collection.
E. N. S. carried out the radiographic analysis and contributed to case documentation.
S. H. and **A. S.** contributed to data interpretation and critically revised the manuscript for important intellectual content.
E. P. supervised the study design and contributed to the final revision of the manuscript.

Referencess

1. *Kirkham-Ali K, Patel V, Davies J, Patel S. Comparison of cone-beam computed tomography and panoramic imaging in assessing the relationship between posterior maxillary tooth roots and the maxillary sinus: a systematic review. J Investig Clin Dent. 2019;10(4):e12402. doi:10.1111/jicd.12402*
2. *Ok E, Altunsoy M, Nur BG, Aglarci OS, Gungor E, Colak M. A cone beam computed tomography study of maxillary premolars and molars in relation to maxillary sinus and surrounding structures in a Turkish subpopulation. Surg Radiol Anat. 2014;36:907–14. doi:10.1007/s00276-014-1268-5*
3. *Kang SH, Kim BS, Kim Y. Proximity of posterior maxillary teeth to the sinus floor and buccal bone thickness: a CBCT analysis. J Endod. 2015;41:1839–46. doi:10.1016/j.joen.2015.08.010*
4. *Tian XM, Qian L, Xin XZ, Wei B, Gong Y. An analysis of the proximity of maxillary posterior teeth to the maxillary sinus using cone-beam computed tomography. J Endod. 2016;42:371–7. doi:10.1016/j.joen.2015.10.017*
5. *Themkumkwun S, Petpiroon N, Wongsirichat N. The relationship of maxillary posterior teeth and the maxillary sinus floor in a Thai population: a cone-beam computed tomographic study. Int J Oral Maxillofac Surg. 2019;48:1575–82. doi:10.1016/j.ijom.2019.05.016*
6. *Punwutikorn J, Waikakul A, Pairuchvej V. Clinically significant oroantral communications—a study of incidence and site. Int J Oral Maxillofac Surg. 1994;23:19–21. doi:10.1016/S0901-5027(05)80271-5*
7. *Scarano, A.; Luongo, R.; De Filippis, I.; Scarano, A.; Qorri, E.; Sforza, F.; Rampino, M.; Bugea, C. Fluid-dynamic crestal sinus floor elevation in atrophic posterior maxilla implant rehabilitation with hyaluronic acid: a prospective study. Materials 2025,18,2230. https:// doi.org/10.3390/ma18102230*
8. *Luongo R, Sgaramella N, Traini T, Bugea C. Graftless maxillary sinus floor augmentation with simultaneous porcine bone layer insertion: a 1- to 5-year follow-up study. Int J Oral Maxillofac Implants. 2020;35:808–15. doi:10.11607/jomi.7878*
9. *Stacchi C, Andolsek F, Berton F, Perinetti G, Navarra CO, Di Lenarda R. Intraoperative complications during sinus floor elevation with lateral approach: a systematic review. Int J Oral Maxillofac Implants. 2017;32:e107–18. doi:10.11607/jomi.4884*
10. *Scarano A, Cholakis AK, Piattelli A. Histologic evaluation of sinus grafting materials after peri-implantitis-induced failure: a case series. Int J Oral Maxillofac Implants. 2017;32:e69–75. doi:10.11607/jomi.5303*
11. *Hauman CH, Chandler NP, Tong DC. Endodontic implications of the maxillary sinus: a review. Int Endod J. 2002;35:127–41. doi:10.1046/j.1365-2591.2002.00510.x*
12. *Ehrich DG, Jolly DE, Mitchell DF. Sodium hypochlorite accident: inadvertent injection into the maxillary sinus. J Endod. 1993;19:180–2. doi:10.1016/S0099-2399(06)80507-4*
13. *Kavanagh CP, Taylor J. Inadvertent injection of sodium hypochlorite into the maxillary sinus. Br Dent J. 1998;185:336–7. doi:10.1038/sj.bdj.4809811a*
14. *Zairi A, Lambrianidis T. Accidental extrusion of sodium hypochlorite into the maxillary sinus. Quintessence Int. 2008;39:745–8. PMID:19093066*
15. *Jellinek EH. The Valsalva manoeuvre and Antonio Valsalva (1666–1723). J R Soc Med. 2006;99(9):448–51. doi:10.1258/jrsm.99.9.448*

16. Scarano A, Leo L, Lorusso F, Tagariello G, Falisi G, Bugea C, Rapone B, Greco Lucchina A, Di Carmine MS. Topical hemostatic agents in oral surgery: a narrative review. Eur Rev Med Pharmacol Sci. 2023;27:31332. doi:10.26355/eurrev_202304_31332. PMID:37129324
17. El Hachem R, Wassef E, Mokbel N, Abboud R, Zogheib C, El Osta N, Naaman A. Influence of the maxillary sinus on the accuracy of the Root ZX apex locator: an ex vivo study. Dent J (Basel). 2019;7:3. doi:10.3390/dj7010003
18. Yammine S, Jabbour E, Diemer F, Majzoub Z. Canal straightening following overinstrumentation with three nickel-titanium rotary instruments. J Int Soc Prev Community Dent. 2018;8:245–51. doi:10.4103/jispcd.JISPCD_18_18
19. Themkumkwun S, Kitisubkanchana J, Waikakul A, Boonsiriseth K. Maxillary molar root protrusion into the maxillary sinus: a comparison of cone beam computed tomography and panoramic findings. Int J Oral Maxillofac Surg. 2019;48:1570–6. doi:10.1016/j.ijom.2019.06.011
20. A Penukonda, Raghavendra;Teja, K; Kacharaju, K.; Yin, S; Mohan, D.;Sheun, L.;Cernera, M.; Iaculli, F. Comparative evaluation of smear layer removal with Ultra-X device and XP-Endo Finisher file system: an ex-vivo study . Giornale Italiano di Endodonzia November 2023, 37: 1-7. doi:10.32067/GIE.2023.37.01.18.
21. Bugea C, Cerutti F, Ongaro F, Sforza F, Scarano A, Rampino M, Luongo R, Pedullà E. Postoperative pain and one year follow up success rate of warm vertical compaction, single cone, coneless and bioconeless obturation methods. J Osseointegr 2022;14:209-216. Doi 10.23805/JO.2022.14.04.3
22. Bugea C, Pontoriero DIK, Rosenberg G, Suardi GMG, Calabria G, Pedullà E, La Rosa GRM, Sforza F, Scarano A, Luongo R, Messina G. Maxillary premolars with four canals: case series. Bioengineering. 2022;9:757. doi:10.3390/bioengineering9120757