

# Traumatic displacement of teeth into maxillary sinus and the retrieval assisted by computer-assisted navigation

## A case report

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### Abstract

**Rationale:** Traumatic displacement of teeth into the maxillary sinus is rare. This report described a case of 2 molars accidentally displaced into the maxillary sinus and the retrieval of teeth assisted by computer-assisted navigation.

**Patient concern:** A 16-year-old male patient suffered from maxillofacial trauma with the first and second molars in the left maxilla were missing, and an orificium fistula to the maxillary sinus appeared in the dentition region of molars.

**Diagnose:** The tomography revealed 2 tooth-like hyperdensity images in the left maxillary sinus.

**Intervention:** Computer-assisted navigation surgery was scheduled for the retrieval surgery, and the displaced teeth were removed from the maxillary sinus smoothly.

**Outcomes:** The patient displayed uneventful wound healing without postoperative complications in the maxillary sinus.

**Lessons:** Surgeons should be alert to the presence of missing teeth in maxillofacial trauma and avoid missed diagnosis, and computer-assisted navigation is recommended for the retrieval of teeth displaced into the maxillary sinus.

**Abbreviation:** CT = computed tomography.

**Keywords:** computer-assisted navigation, displacement of teeth, maxillary sinus, minimally invasive, retrieval

## 1. Introduction

Displacement of teeth into the maxillary sinus is rare, mostly secondary to congenital fetal development, iatrogenic, or traumatic occasion.<sup>[1–3]</sup> Traumatic tooth displacement into the maxillary sinus is likely to combine with severe maxillofacial trauma, such displacement is often accompanied with a series of serious complications, such as acute or chronic sinusitis, nasal sinus fistula, pain, and so on.<sup>[4–7]</sup> Therefore, early retrieval of this

“special foreign body” has been recognized by clinicians even if they are asymptomatic.<sup>[6,8,9]</sup>

Alveolar pathway and Caldwell-Luc operation are 2 main methods in the retrieval of the displaced tooth into the maxillary sinus, and most clinicians are in favor of the application of endoscope in the surgical retrieval.<sup>[5,8]</sup> As computer-assisted navigation technology is applied in maxillofacial surgery, it has proven to be a useful planning and targeting tool for the retrieval of foreign bodies in the head and neck area.<sup>[10,11]</sup> The technique of computer-assisted navigation has been used successfully for the removal of foreign bodies in the complex, deep maxillofacial regions. This technique, however, has not been reported in the retrieval of the displaced tooth into the maxillary sinus. Computer-assisted navigation allows visualization of the foreign bodies and surgical instruments simultaneously, relating them to the patient’s images. Therefore, this technique can make the operation more accurate and intuitive. A case of 2 molars that were accidentally displaced into the maxillary sinus and successfully removed assisted by the computer-assisted navigation is reported in this article.

## 2. Case report

A 16-year-old male patient suffered from maxillofacial trauma in a traffic accident and received emergency debridement in the local hospital. Three days later, the patient was referred to the authors’ hospital for further treatment of maxillofacial fractures. Physical examination showed that there were alveolar fracture and gingival laceration in the right maxilla. The first and second molars in the left maxilla were missing, and an orificium fistula to the maxillary sinus appeared in the dentition region of molars

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**Figure 1.** An orificium fistula to the left maxillary sinus appeared in the dentition region of molars, and the first and second molars were missing.

(Fig. 1). The patient underwent a computed tomography (CT) and panoramic tomography. The tomography revealed two tooth-like hyperdensity images in the left maxillary sinus (Fig. 2), in addition to the left maxillary alveolar fractures, left lateral pterygoid fractures, bilateral condylar fractures, and the left mandible body fracture. The Ethics Committee of School and Hospital of Stomatology, Wuhan University gave approval for this case report. Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Considering the complexity of this case, computer-assisted navigation surgery was scheduled for the retrieval of the 2 molars displaced into the maxillary sinus. The navigation system used in this case was the Vector Vision 2 navigation system (BrainLAB, Feldkirchen, Germany). Before the surgery, continuous fine-cut (0.625 mm) CT data were imported to the system to accomplish pre-surgical planning, followed by labeling the 2 displaced molars (Fig. 3). The operation was performed under general

anesthesia. At the beginning of the operation, after fixing the reference frame to the patient's head with a headband, a Z-touch laser pointer (a laser scanner) was used to scan the face for surface registration and a pair of forceps was prepared to clamp and remove the teeth, registered to be visualized in real time on the patient's images. At first, the navigation probe examined the maxillary sinus through the original wound so as to verify the exact location of the molars (Fig. 4). Under the guidance of the computer-assisted navigation, the tip of the registered forceps was then inserted accurately into the maxillary sinus through the original wound to detect the exact anatomical location of the molars. The molars were carefully clamped and removed 1 by 1 (Fig. 5). In the meantime, careful inspection and irrigation with saline solution were performed, and alveolar fracture fragments were removed. Finally, the orificium fistula of the maxillary sinus was closed by a flap from the buccal vestibular sulcus (Fig. 6). Subsequently, the reduction and fixation of the bilateral condyles and the left mandible body were completed.

The whole retrieval surgery assisted by computer-assisted navigation was smooth. The time duration of the surgery using navigation system was 50 minutes. The use of computer-assisted navigation during the procedure made locating and removing the teeth easier, therefore avoiding excessive dissection of anatomic structures. The postoperative course was uncomplicated and the patient was discharged without sign of infection in the maxillary sinus when the patient was discharged. After 6 months follow-up, the patient displayed uneventful wound healing (Fig. 7) without postoperative complications in the maxillary sinus.

### 3. Discussion

Tooth trauma is a series of injuries in periodontal tissue, dental pulp tissue or dental hard tissue facing a variety of mechanical forces.<sup>[12]</sup> Intrusive luxation is often the result of an axial impact in the apical direction, moving the tooth within the alveolar bone. Because of association with the comminuted fracture of alveolar bone, this kind of dental injury cannot be reimplanted ordinarily and should be removed as early as possible in order to prevent infection.<sup>[3]</sup> In general, the intrusive pathway is mostly paralleled



**Figure 2.** The panoramic tomography shows 2 molars displaced into the left maxillary sinus.

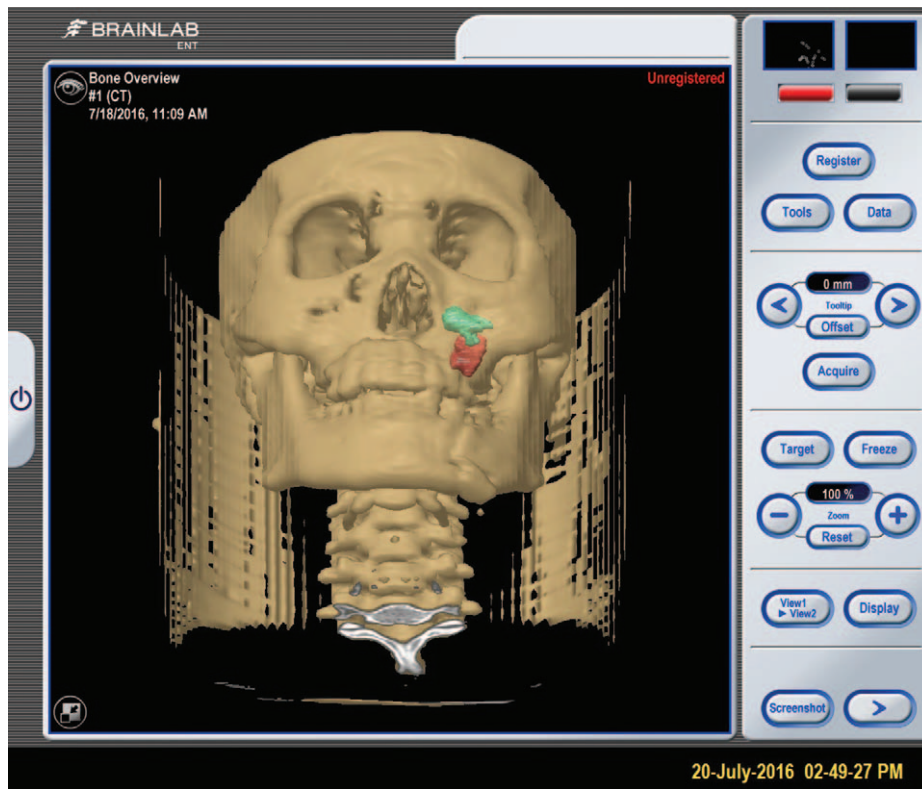


Figure 3. In the pre-surgical plan, the 2 molars were labeled with different colors in the navigation system.

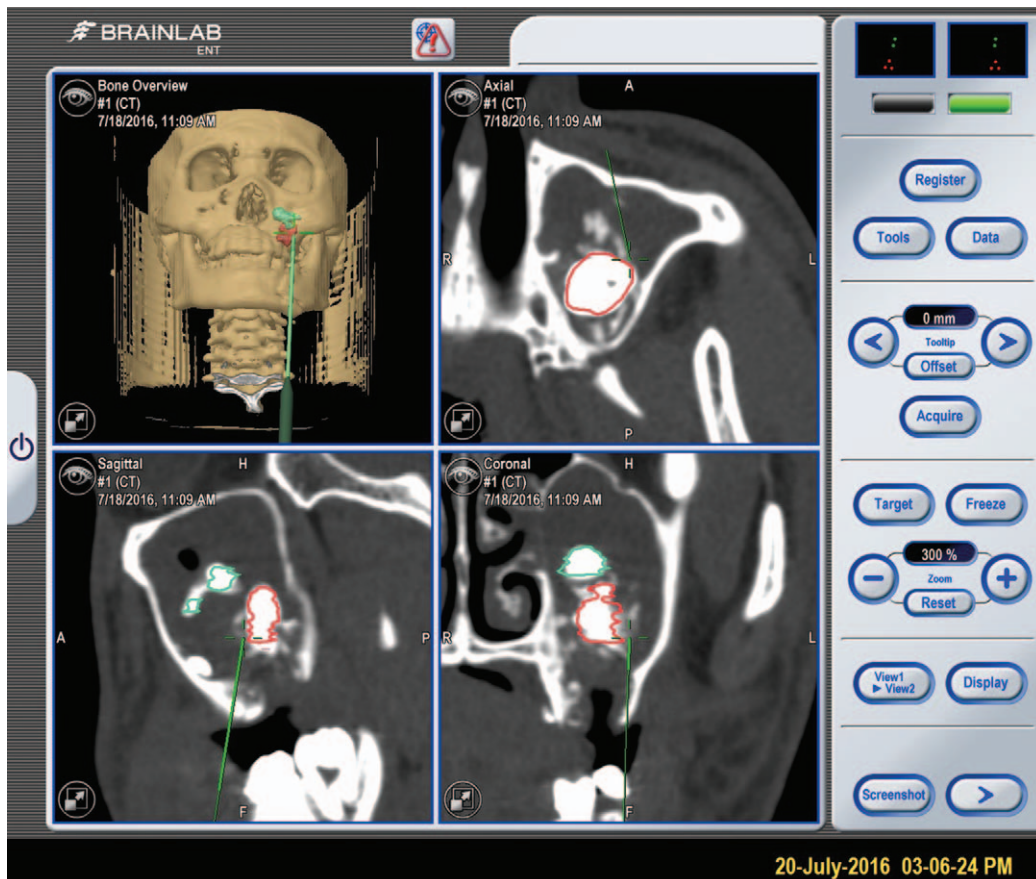
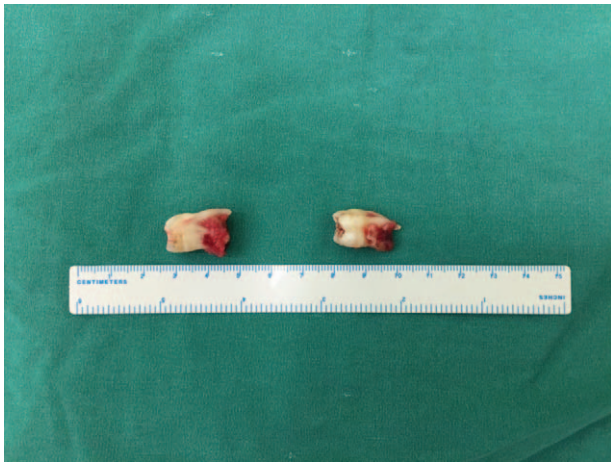
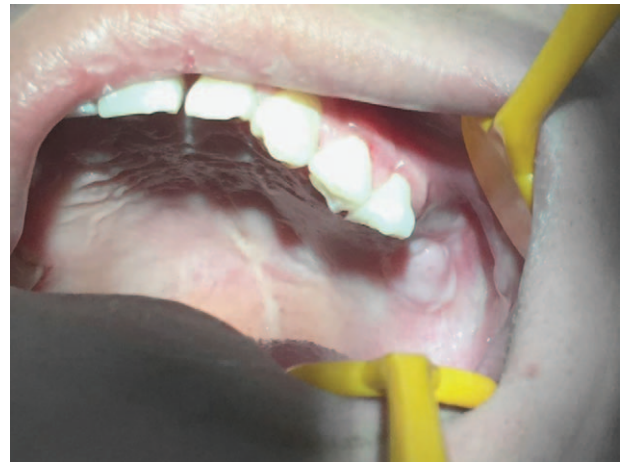


Figure 4. One of the 2 molars in maxillary sinus was tracked under the guidance of the navigation system.



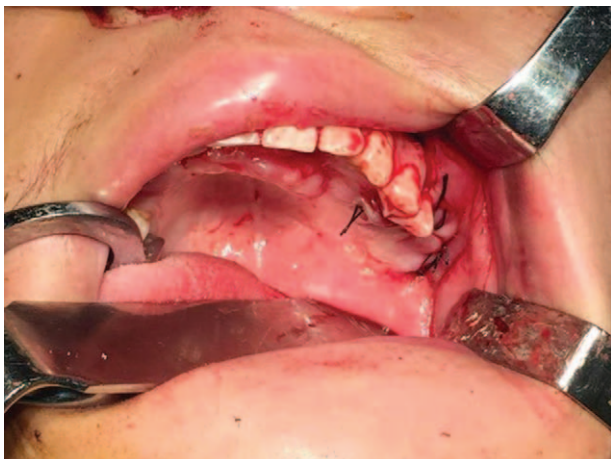
**Figure 5.** The 2 displaced molars removed from the maxillary sinus.



**Figure 7.** After 6 months follow-up, the patient displayed uneventful wound healing.

to the long axis. Owing to more exposure of the anterior alveolar area, tooth dislocation is likely to take place in the anterior area rather than the posterior area.<sup>[1,13]</sup> Relatively posterior anatomic position and multiple roots are the reasons why the posterior teeth are seldom involved unless the impact force is considerable.<sup>[1,3,14]</sup> When suffering from injury, however, the maxillary sinus can be involved in the anatomic structure where completely intrusive teeth are displaced.<sup>[3]</sup> There are 3 main reasons to explain this phenomenon: first, maxillary sinus is the largest sinus and constitutes the main body of maxilla; second, maxillary sinus is located in the most prominent part of maxillofacial region; and third, the inferior wall of maxillary sinus is very thin, approximately 1 to 7 mm.<sup>[15]</sup> All the same, the case of traumatic teeth displaced into the maxillary sinus is still rare. To our knowledge, only 6 cases have been reported on the Pubmed and Medline databases in English-language literature.<sup>[2,3,9,13,14,16]</sup> These reported cases of traumatic teeth displaced into the maxillary sinus are presented in Table 1.

In the present case, the patient suffered from 2 molars displaced into the maxillary sinus with multiple maxillofacial fractures.



**Figure 6.** The orificium fistula of the maxillary sinus was closed by a flap from the buccal vestibular sulcus.

When exploring the mechanism of the dislocated molars, the authors believed that the impact force should be from the bottom-up, and it was concentrated not only on the condylar neck but also on the left upper molars, resulting in the molars being forced to displace into the maxillary sinus, accompanied with the fractures of bilateral condyles. This procedure has been mentioned by other authors.<sup>[1,2,14,16]</sup>

It is possible that surgeons miss the diagnosis of the completely intrusive tooth when they treat the patients who suffer from maxillofacial trauma.<sup>[1,14,16]</sup> Tung et al reported 2 similar cases in 1997<sup>[14]</sup> and in 1998<sup>[3]</sup> respectively. A few days after the first surgery, the surgeons found pus overflow from the gingiva wound. The postoperative CT revealed there were teeth displaced into the maxillary sinus. Ruprecht and Halhoul<sup>[16]</sup> reported a case that a routine film revealed that there was a supernumerary tooth shifted into the maxillary sinus when the patient asked to repair the missing teeth 4 month after the trauma. Ertuğrul et al<sup>[9]</sup> reported an interesting case in 2012, in which the patient who had a history of trauma 18 years ago, was admitted to the department because of difficulty in nasal breathing and purulent anterior drainage from the nasal cavity. In the cases mentioned above, almost all surgeons attributed the misdiagnosis to maxillofacial fractures, and their analysis of those fractures distracted attention from tooth trauma. Although these potentially hazardous injuries occur rarely, they also should be carefully examined in order to ensure that there is no completely invasive tooth.<sup>[1,14]</sup> In the authors' opinion, another major reason is that medical imaging technology was not perfect 2 decades ago, so that some similar cases were missed. With the development and popularization of medical imaging technology, CT has already become an essential tool for the diagnosis of maxillofacial trauma; therefore the possibility of such misdiagnosis is greatly reduced. The careful examination of oral condition, however, is worth being emphasized once again when confronting maxillofacial trauma, including teeth, nasal cavity, nasopharynx, and pharyngeal.<sup>[1,2,9,14]</sup>

As for removing the displaced teeth from the maxillary sinus, previous reports show that there are 2 main methods: alveolar pathway and Caldwell–Luc operation. Additionally, some surgeons favor the application of endoscope in removing the displaced teeth from the maxillary sinus.<sup>[5,8]</sup> In this case, the removing operation was performed through the original wound

**Table 1****Reports of traumatic displacement of teeth into the maxillary sinus in English-language literature.**

case	Author	Age	Gender	Tooth	Number	Etiology	History of misdiagnosis
1	Ruprecht et al <sup>[16]</sup>	17	Female	Permanent incisor	1	Motor vehicle crash	Yes
2	Tung et al <sup>[14]</sup>	22	Male	Permanent molar	1	Motorcycle accident	Yes
3	Tung et al <sup>[3]</sup>	23	Male	Permanent molar	2	Motorcycle accident	Yes
4	Gumus et al <sup>[13]</sup>	15	Male	Permanent second premolar and molar	2	Fall	No
5	Cai et al <sup>[2]</sup>	17	Male	Permanent molar	1	Motorcycle accident	No
6	Ertugrul et al <sup>[9]</sup>	36	Male	Permanent molar	1	Traffic accident	Yes

assisted by computer-assisted navigation, avoiding excessive dissection of anatomic structures. Under the guidance of computer-assisted navigation, the displaced tooth can be targeted and captured precisely by the registered forceps, which is visualized in real time on the patient's images. The whole process is more visual and objective, respecting the principle of minimal invasion and reducing the operation time. Endoscopy is another objective method used to confirm the position of the displaced teeth in the maxillary sinus. The retrieval of the displaced teeth is also visual when the endoscope is used. The endoscope itself, however, could not be used to capture and remove the displaced teeth. Other surgical instruments for the retrieval would be used simultaneously, which obviously needs an extended surgical approach. Compared with the method of endoscopy, the technique of computer-assisted navigation makes the operation more intuitive and minimally invasive.

Computer-assisted navigation, however, still has some shortcomings in the removal of foreign bodies in the maxillofacial region, such as the limitation of tissue mobility where the foreign bodies are located.<sup>[10,17]</sup> Stein<sup>[17]</sup> reported that this limitation would be minimized if only a small degree of soft tissue manipulation was required. Gui et al<sup>[11]</sup> recommend that a duration of 1 month at least before surgical removal from soft tissue, because the development of fibrous connective tissue mass will help limit the movement of the foreign body. In the present case, the blood clot wrapped up the molars completely several days after the trauma, so the molars were relatively fixed in the maxillary sinus.

In summary, although the traumatic displacement of teeth into the maxillary sinus is rare, surgeons should be alert to the presence of missing teeth in maxillofacial trauma and avoid missed diagnosis. Computer-assisted navigation has the advantages of precise location, minimally invasive and visualization in the surgically removal of foreign bodies. It is recommended for the retrieval of teeth displaced into the maxillary sinus if one is prepared to assume its high cost.

### Author contributions

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**Methodology:** Zhi Li.

**Project administration:** Zhi Li.

**Resources:** Zhi Li.

**Supervision:** Zhi Li.

**Writing – original draft:** Hang Wang, Chan-Yuan Yang, Zhi Li.

**Writing – review & editing:** Zhi Li.

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