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· 综述 ·

## 上颌窦对上颌后牙显微根尖手术的影响

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**【摘要】** 显微根尖手术是临床上保存牙髓根尖周病患牙的有效手段之一,也是治疗其疑难病例的必备技术。但由于位置靠后操作空间狭小、根尖与上颌窦毗邻,导致在上颌后牙区进行根尖外科手术仍存在一定挑战。本文就上颌窦与上颌后牙解剖关系、对显微根尖手术影响以及辅助技术如:3D打印手术导板、超声骨刀等在上颌后牙区手术中的应用进行总结。文献复习结果表明,上颌后牙根尖与上颌窦空间关系通常分3类:根尖突进上颌窦底;根尖与上颌窦底相接触;根尖和上颌窦底之间有间隙或空间。术前CBCT检查后结合患牙根尖周和上颌窦状态以及根尖病损到上颌窦距离评估手术难度,术中应用导板、内窥镜、超声骨刀等以使手术更加安全可靠和精准微创,但后者在临床上的普及仍需进一步推广。目前尚缺乏高质量的上颌后牙区现代显微根尖手术长期疗效的临床研究。

**【关键词】** 显微根尖手术; 上颌后牙区; 上颌窦; 锥形束CT; 3D打印手术导板; 超声骨刀; 内窥镜

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**The influence of the maxillary sinus on maxillary posterior tooth endodontic microsurgery** SUN Mingxin, SONG Dongzhe, HUANG Dingming. State Key Laboratory of Oral Diseases & National Clinical Research Center for Oral Diseases & Department of Cariology and Endodontics, West China Hospital of Stomatology, Sichuan University, Chengdu 610041, China

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**【Abstract】** Endodontic microsurgery is one effective method for preserving teeth affected by periapical disease, and is also an essential technique for treating difficult cases. However, due to the restricted operating space at the posterior site and the proximity of the root apex to the maxillary sinus, endodontic surgery in the posterior maxillary area represents great challenges. This article summarizes the anatomical relationship between the maxillary sinus and the maxillary posterior teeth, the influence on endodontic microsurgery, and the application of assistive techniques on maxillary posterior teeth, such as 3D-printed surgical guides and ultrasonic osteotomes. Literature review results show that the spatial relationship between the apex of maxillary posterior teeth and the maxillary sinus is usually divided into three categories: the apex enters the maxillary sinus; the apex contacts the bottom of the maxillary sinus; and there is a distance between the apex and the bottom of the maxillary sinus. CBCT should be performed before the operation, and the periapical state of the tooth and the maxillary sinus and the distance between the lesions and the sinus floor should be considered to evaluate the difficulty of the operation. Meanwhile, during surgery, equipment such as surgical guides, endoscopes and ultrasonic osteotomes should be used to ensure that the operation is safer, reliable, precise and less invasive, but the clinical popularity of ultrasonic osteotomes still needs further promotion. Moreover, high-quality clinical studies

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on the long-term effects of micro-apical surgery in the posterior maxillary area are still lacking.

**【Key words】** endodontic microsurgery; maxillary posterior area; maxillary sinus; CBCT; 3D-printed surgical guide; ultrasonic osteotome; endoscope

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随着显微根尖手术的发展,越来越多的经传统根管治疗及再治疗无法挽救的患牙得到保留。增强的放大设备、较小的截根角度、超声倒预备和新型生物相容性充填材料的应用,使手术成功率已高达90%以上<sup>[1]</sup>。上颌后牙因根管系统解剖复杂,传统根管治疗中感染控制相对困难,是最常见的需要进行根尖手术的牙齿之一。由于该区域位置靠后、根尖特别是腭根尖到颊侧骨板距离较远且有上颌窦的存在,手术难度往往较大。然而,已有多项研究报道<sup>[2-3]</sup>,接近上颌窦的患牙也可以有较好的手术效果。因此,掌握上颌窦解剖生理特征、与后牙关系及该区域手术特点,对术前评估操作难度、规避术中风险、提高术后远期疗效至关重要。本文就上颌窦与上颌后牙解剖关系、对显微根尖手术影响以及3D打印手术导板、超声骨刀等辅助技术在上颌后牙区手术中的应用进行综述。

## 1 上颌窦解剖生理特征

自Nathaniel Highmore于1651年首次报告以来,上颌窦在上颌牙齿治疗中的影响被越来越多的讨论。为保证手术安全有效进行,良好的解剖生理学知识是术者所必需掌握的。上颌窦位于双侧上颌骨内,是最大的一对鼻旁窦,也最先发育,在成人平均体积约为15 mL。通常呈金字塔状,底部为鼻腔外侧壁,顶端延伸至颧骨,上壁为眶底,由含有眶下神经血管束的薄层骨组成;窦底为上颌骨的牙槽突,由前向后盖过上颌前磨牙及磨牙根尖;外侧壁将窦腔与颧下窝、翼腭窝的内容物分开<sup>[4]</sup>。上颌窦开口于内侧壁中上部,呈椭圆形或裂隙状,经中鼻道与鼻腔相通。

上颌窦内衬黏膜为假复层纤毛柱状上皮,由鼻腔黏膜延续而来,也称施耐德膜(Schneiderian membrane),呼吸时纤毛摆动将黏液和废弃物经上颌窦口送入鼻腔排出体外,以维护窦腔内环境的健康。有学者发现,上颌后牙根尖周炎使窦底黏

膜发生病理性改变的几率增加,且其发生率与根尖病变大小无关而与两者之间的空间关系有关<sup>[5]</sup>。

上颌窦内可存在骨隔,Underwood于1910年首先对其进行了报道,其为皮质骨在窦底形成的骨嵴向各个方向延伸,通常沿颊腭向,可单侧或双侧发生,大多为不完全型。骨隔的存在增加了手术过程中黏膜穿孔和出血的几率<sup>[6]</sup>。

上牙槽后动脉(the posterior superior alveolar artery, PSAA)为上颌动脉的分支,沿上颌窦外侧壁内侧由后向前延伸,是走行于上颌窦区域的重要血管,其末端微血管常与眶下动脉末端形成微循环血管网,供应上颌窦侧壁及黏膜血运。术中损伤此血管将引起出血,影响手术视野<sup>[7]</sup>。

## 2 上颌窦与后牙空间关系及其临床意义

锥形束计算机断层扫描(cone-beam computed tomography, CBCT)是显微根尖手术前的常规检查手段,也是最有效的临床诊断工具。通过CBCT检查,可准确判断上颌窦黏膜状态<sup>[8]</sup>、外侧骨板厚度、PSAA走行以及牙根弯曲角度和根尖病损大小等与操作密切相关的各要素。并且,CBCT相较于根尖片及全景片不会引起牙齿及其周围结构的形变和重叠<sup>[9]</sup>。因此,上颌后牙区显微根尖手术前常使用CBCT评估根尖与上颌窦的空间关系。

上颌后牙牙根与上颌窦的关系通常分为3类(图1):①根尖突进上颌窦底;②根尖与上颌窦底相接触;③根尖和上颌窦底之间有间隙或空间。当上颌后牙根尖与上颌窦底距离越近时,手术过程中发生黏膜穿孔、口腔-上颌窦交通等风险明显增加<sup>[3,10]</sup>。

上颌前磨牙牙根与上颌窦关系密切的发生率较低,突入型在第一前磨牙0~3.02%,第二前磨牙0~12.97%,性别、左右对结果的影响差异无统计学意义<sup>[10-14]</sup>,前磨牙手术较为安全且少见并发症发生。然而,上颌磨牙牙根与上颌窦的各关系类型发生率在不同研究中有所差别(表1)。

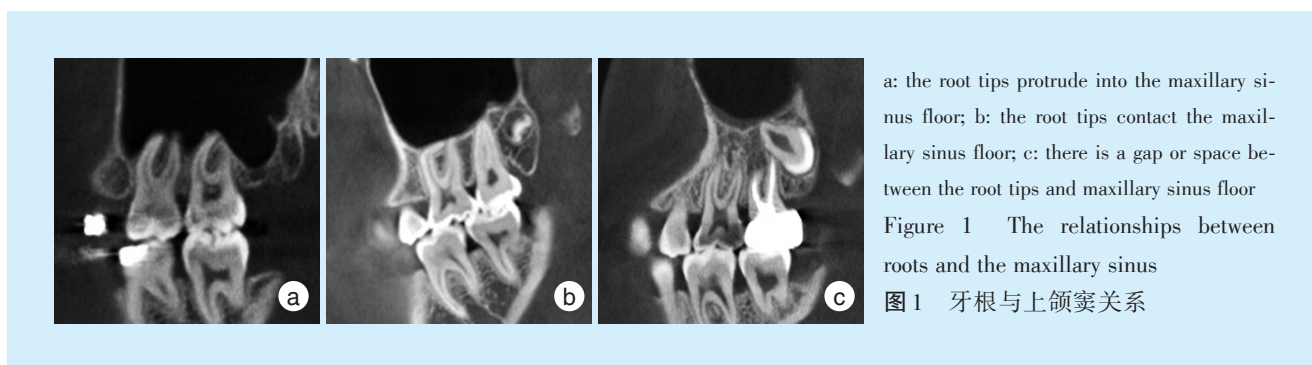


表1 上颌后牙根尖与上颌窦关系的研究文献总结

Table 1 Summary of the literature on the relationships between the root tips of the maxillary posterior teeth and the maxillary sinus

Author	Year	Country	Age Average/range	Tooth/type	MFM			MSM			MFP(%)	MSP(%)	Classification criteria
					MB(%)	DB(%)	P(%)	MB(%)	DB(%)	P(%)			
Zhang et al <sup>[15]</sup>	2019	China	26.2/18-45	I	52.70	55.40	61.00	62.00	58.2	45.80	-	-	Type I: the root tip enters or touches the sinus floor without a continuous bone plate
				II	22.90	21.10	14.60	19.40	22.10	22.90	Type II: the root tip contacts the sinus with a continuous plate or a distance < 2 mm		
				III	24.50	23.00	23.80	18.60	19.70	31.30	Type III: the distance between the root tip and the sinus floor is > 2 mm		
Nino-Barrera et al <sup>[10]</sup>	2017	Colombia	N/18-65	2	5.70	6.40	12.50	6.80	5.90	7.65	0.20	3.95	Type 1: the root tip is located below the maxillary sinus Type 2: the root tip is located in the maxillary sinus
Jang et al <sup>[14]</sup>	2017	Korea	24/15-82	2	12.36	11.03	15.93	13.57	9.74	4.68	0.04	3.70	Type 1: the root tip is outside the maxillary sinus Type 2: the root tip protrudes into the maxillary sinus
Tian et al <sup>[13]</sup>	2016	China	34.04/14-81	IS	22.14	21.14	28.84	24.58	16.32	12.11	3.02	12.97	Type IS: the root tip is located above or protrudes into the maxillary sinus
				CO	35.70	34.31	33.08	43.07	39.91	36.48	13.97	30.56	Type CO: the root tip is in contact with the sinus floor
				OS	42.16	44.55	38.09	32.35	43.77	51.41	83.02	56.50	Type OS: the root tip is located below or away from the sinus
Ok et al <sup>[11]</sup>	2014	Turkey	N/14-84	1	26.40	25.90	34.20	30.90	30.50	30.90	1.20	8.10	Type 1: the root tip protrudes into the sinus
				2	34.70	34.10	27.90	36.70	34.90	32.50	6.50	20.20	Type 2: the root tip is in contact with the sinus floor
Pagin et al <sup>[12]</sup>	2013	Brazil	44.5/21-76	1	5.50	7.40	8.30	9.20	5.00	10.60	1.30	8.30	Group 1: the root tip contacts the sinus without entering it and its contour is not raised
				2	3.20	1.80	5.50	12.90	8.30	4.10	0.00	0.90	Group 2: the root tip protrudes into the sinus with the contour elevated
Jung et al <sup>[16]</sup>	2012	Korea	28.8/20-53	0	29.50	28.90	34.30	24.10	24.70	42.80	-	-	Type 0: the root tip is away from the sinus floor
				1	10.20	12.00	6.60	24.70	25.90	19.30	Type 1: the root tip contacts the sinus floor		
				2	27.70	28.90	37.30	14.50	15.10	24.70	Type 2: the root tip contacts the sinus laterally without entering it		
				3	32.50	30.10	21.70	36.70	34.30	13.30	Type 3: the root tip protrudes into the sinus		

MFM: maxillary first molar; MSM: maxillary second molar; MFP: maxillary first premolar; MSP: maxillary second premolar; MB: mesiobuccal root; DB: distobuccal root; P: palatal root

Ok等<sup>[11]</sup>发现第一磨牙腭根与上颌窦关系最密切,其次为第二磨牙近颊根,但不同报道中发生率仍有较大的不同<sup>[13-14]</sup>;Zhang等<sup>[15]</sup>的研究显示中国人上颌第二磨牙近颊根最易突入上颌窦,且突入型发生率与年龄呈正相关;Pagin等、Jung等<sup>[12,16]</sup>认为第二磨牙近颊根最常突入上颌窦,第二磨牙远颊根次之,但韩国人突入率要高于巴西人。造成这些差异的原因与分类标准、纳入人群的种族不同有关(表1)。

当根尖与窦底关系密切时,根尖周炎、牙周炎等牙源性感染可通过根尖周血管、淋巴管、骨小梁等进入上颌窦,引起牙源性上颌窦炎<sup>[17]</sup>,甚至突破牙周支持组织及上颌窦底皮质骨板进入窦内引起“牙-窦综合征”(endo-antral syndrome, EAS)。EAS有以下特征:①患牙根尖靠近上颌窦底;②根尖有透射影;③窦底皮质骨板影像消失;④上颌窦内有不同程度阻射影(比较对侧窦腔有助于鉴别诊断);⑤团块状阻射影不与牙根相连,也不与牙槽窝硬骨板相连(代表窦黏膜局部肿胀增厚)<sup>[18]</sup>。通过非手术根管治疗、根管再治疗或手术治疗后大部分EAS均能治愈。但由于根尖及周围病变与上颌窦黏膜相连,不但增加了治疗过程中器材进入上颌窦的风险,也使术中黏膜穿孔、出血,术后感染的风险升高<sup>[19]</sup>。因此,术前利用CBCT识别窦底与病变牙根的空间关系将有利于术者制定治疗方案,提高手术成功率。

### 3 上颌窦相关的显微根尖手术

#### 3.1 上颌后牙区根尖手术的特殊考量

上颌后牙根尖邻近上颌窦,术前规划时有其特殊考量。若根尖远离上颌窦,窦内无明显病变且患者无鼻窦炎症,手术可常规进行。若患者有严重的上颌窦炎、鼻窦阻塞或上颌窦瘘时,应建议患者先于耳鼻喉科就诊,减轻上颌窦炎急性症状后再决定手术时机<sup>[20]</sup>。对于根尖与窦底相接触或根尖突入窦底的患牙,除了术中谨慎操作外,还应要求术者能识别施耐德膜,区分窦底黏膜与肉芽组织。施耐德膜呈淡蓝色,显微镜下可见小血管穿过窦膜,而肉芽组织呈红色,常伴有纤维化,可含脓性分泌物甚至颗粒。无法区分上颌窦黏膜时,可嘱患者捏住鼻子轻轻呼气,可见窦底黏膜因呼气产生的负压而“颤动”<sup>[21]</sup>。当后牙根尖位于上颌窦内时,手术难度大大增加,可翻瓣后行上颌窦底提升术,再截除病变根尖<sup>[22]</sup>。

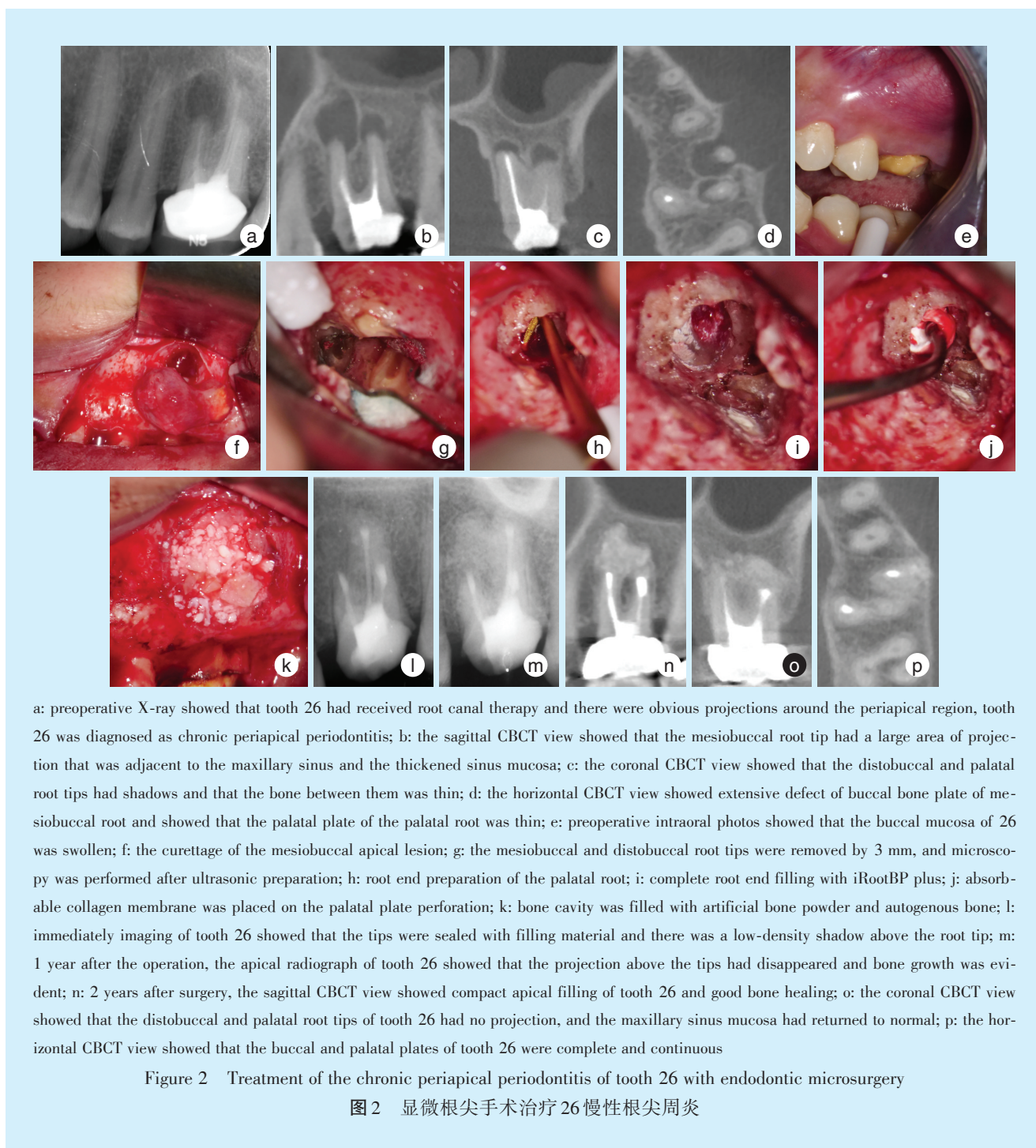
#### 3.2 上颌第一磨牙腭根手术入路考量

上颌第一磨牙腭根常与上颌窦关系密切,对于上颌第一磨牙腭根手术有颊侧和腭侧入路两种。当仅有腭根病变时建议首先考虑腭侧入路,若颊腭根均有病变,则应视具体情况而选择手术入路。应当注意的是,当选择颊腭侧两个切口时,最好分次进行手术,以避免造成穿通性病损,且单个切口能减轻患者痛苦、降低术后感染的发生,进而促进预后。

图2为1例26根管治疗术后颊侧牙龈瘘道迁延不愈,转诊行显微根尖手术治疗的临床病例。因该牙根管充填尚可,根尖病损范围大,再次行非手术根管再治疗疗效无法确定,因此,为保存患牙经患者同意选择显微根尖手术治疗。26术后2年回访,颊侧牙龈瘘道愈合,无咬合不适,根尖区扪诊无疼痛及肿胀,CBCT示iRootBP plus倒充填严密,颊腭侧骨板完整,根尖可见牙周膜生成和骨质愈合。

该病例26因颊腭根尖均有病损且其间骨量少,因此可在颊侧入路的同时调整患者体位和显微镜角度,尽量在直视下彻底刮除病变。由于术前CBCT提示病变上界距上颌窦底很近,术中谨慎刮除病变以防造成上颌窦暴露。颊侧入路的优点是仅一个切口即能完成颊腭根手术,损伤较小,且缩短了治疗周期。但为了保证去骨车针、超声工作尖等手术器械能顺利进入到较深的腭根根尖而去除了过多的颊侧骨板。

当腭根根尖病变距颊侧骨板过远且上颌窦底最低点位于腭根之颊侧时,颊侧入路不但面临器械长度不足的可能,更有可能引起上颌窦黏膜穿孔。此时,腭侧入路将成为一种可行的方法。Lee等<sup>[23]</sup>对35例行上颌第一磨牙腭根腭侧手术入路的患者为期3.5年的随访表明,成功率为91%,3例失败病例均在术后1年内发生。术后腭大动脉和神经损伤的发生率很低。随着CBCT信息可与高分辨率口腔内扫描相结合,3D打印手术导板的应用不断完善,尤其在涉及上颌窦、腭大神经血管束、牙弓后方这些复杂解剖学情况下。利用导板可进行微创、精确的一步式截骨术和根尖切除术,并避免对关键神经血管的损害从而使临床治疗更加简洁和安全<sup>[24]</sup>。但在显微镜下行腭侧手术也有其局限性,常常需要口镜辅助,且必须不断保持镜面干燥。患者呈向后躺、下巴抬起、嘴巴大张的尴尬姿势并且操作时要防止损伤患者气道。因此,腭侧



a: preoperative X-ray showed that tooth 26 had received root canal therapy and there were obvious projections around the periapical region, tooth 26 was diagnosed as chronic periapical periodontitis; b: the sagittal CBCT view showed that the mesiobuccal root tip had a large area of projection that was adjacent to the maxillary sinus and the thickened sinus mucosa; c: the coronal CBCT view showed that the distobuccal and palatal root tips had shadows and that the bone between them was thin; d: the horizontal CBCT view showed extensive defect of buccal bone plate of mesiobuccal root and showed that the palatal plate of the palatal root was thin; e: preoperative intraoral photos showed that the buccal mucosa of 26 was swollen; f: the curettage of the mesiobuccal apical lesion; g: the mesiobuccal and distobuccal root tips were removed by 3 mm, and microscopy was performed after ultrasonic preparation; h: root end preparation of the palatal root; i: complete root end filling with iRootBP plus; j: absorbable collagen membrane was placed on the palatal plate perforation; k: bone cavity was filled with artificial bone powder and autogenous bone; l: immediately imaging of tooth 26 showed that the tips were sealed with filling material and there was a low-density shadow above the root tip; m: 1 year after the operation, the apical radiograph of tooth 26 showed that the projection above the tips had disappeared and bone growth was evident; n: 2 years after surgery, the sagittal CBCT view showed compact apical filling of tooth 26 and good bone healing; o: the coronal CBCT view showed that the distobuccal and palatal root tips of tooth 26 had no projection, and the maxillary sinus mucosa had returned to normal; p: the horizontal CBCT view showed that the buccal and palatal plates of tooth 26 were complete and continuous

Figure 2 Treatment of the chronic periapical periodontitis of tooth 26 with endodontic microsurgery

图2 显微根尖手术治疗26慢性根尖周炎

手术入路对术者自身的技术水平要求较高。此外,腭侧组织比颊侧黏膜厚、弹性小,有更坚韧的纤维与腭侧牙槽骨附着,增加了皮瓣处理的难度。临床中应根据术前CBCT检查仔细评估术区解剖结构,分析不同手术入路的利弊再结合科室技术水平最终制定出对患者最有利的治疗方案。

### 3.3 上颌后牙区显微根尖手术并发症

上颌后牙区根尖手术常涉及上颌窦,术中除要保护邻牙牙根外还应小心上颌窦黏膜穿孔、出

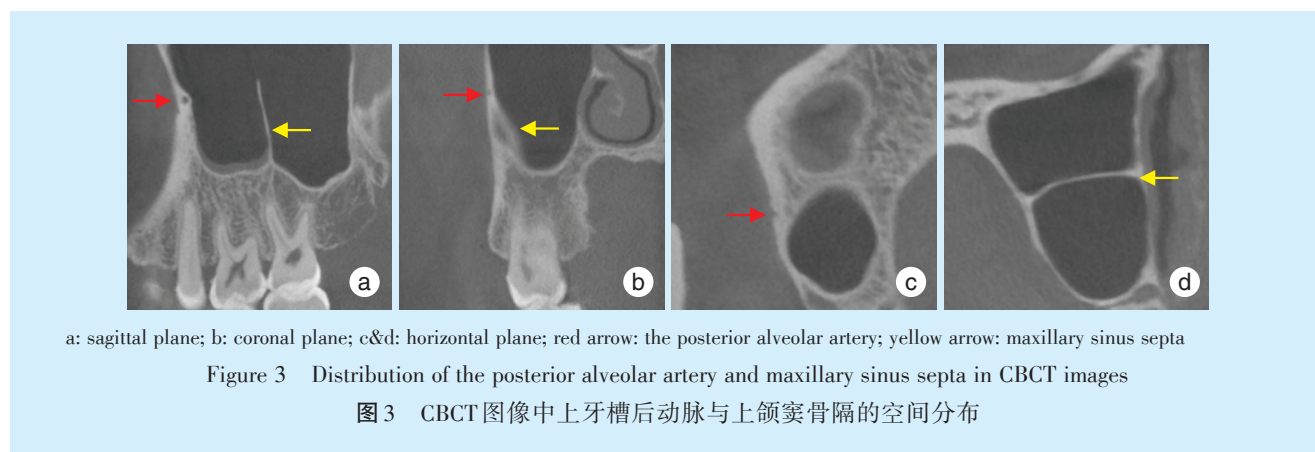
血及异物进入上颌窦的发生。施耐德膜创伤将抑制纤毛活性,造成粘液形态改变从而导致对感染抵抗力降低,还可能出现术后鼻出血、上颌窦阻塞以及急性或慢性上颌窦炎<sup>[25]</sup>。因此,为防止术中损伤上颌窦黏膜,有学者建议截根前用湿纱布覆盖窦底黏膜,将根尖用缝线固定后一次性切断根尖而不是多次磨除,以减少碎屑产生和根尖掉入上颌窦<sup>[21]</sup>。上颌后牙根尖切除术中窦底穿孔发生率依次为:上颌磨牙(23.0%)、上颌第二前磨牙

(10.4%)、上颌第一前磨牙(2.0%)<sup>[26]</sup>,其发生率大小与根尖和上颌窦密切程度正相关。

若术中不慎发生黏膜穿孔,应根据穿孔大小及时处理<sup>[27]</sup>:①穿孔小于2 mm,无需做特殊处理;②穿孔小于5 mm,可适当剥离周围黏膜使黏膜松解而关闭创口;③穿孔大于5 mm时,用可吸收膜覆盖穿孔部位以隔离骨替代材料,促进黏膜愈合<sup>[28]</sup>;④穿孔大于10 mm时,应用邻近软组织瓣来关闭穿孔。术后应预防性使用抗生素7~10 d,同时可服用非甾体类解热镇痛药。术后嘱患者避免引起上颌窦内压急剧升高的动作与活动,并定期复诊,且需告知患者术后数日手术侧鼻腔可能有血性物流出,以免患者紧张恐慌。对于既往慢性

上颌窦炎病史的患者,尤应注意上颌窦开口的通畅。必要时预防性使用鼻腔喷雾剂及鼻血管收缩剂等。发生窦底黏膜穿孔后,只要规范处理,对手术成功率影响很小<sup>[25]</sup>。

上颌窦黏膜血供丰富,手术过程中伤及血管虽然不会危及生命,但会影响操作视野,还可能引起术后出血和血肿的形成。因此,术前应利用CBCT在第一前磨牙至第二磨牙间,根据不同平面断层扫描所见上牙槽后动脉骨孔、上颌窦骨隔的三维分布来观测上牙槽后动脉和骨隔的空间走行以免引起术中出血<sup>[29]</sup>(图3)。此外,其他并发症可有术后上颌窦炎、骨替代材料或胶原膜暴露、良性阵发性体位性眩晕等。



### 3.4 上颌后牙区显微根尖手术预后

文献中报道上颌后牙根尖外科手术的成功率在48%~88%。Beck-Broichsitter等<sup>[3]</sup>对149例上颌后牙术后10年的追踪观察发现手术成功率为48.3%; Von Arx等<sup>[30]</sup>在一项使用MTA作为倒充填材料的研究中发现上颌后牙术后10年成功率为82.1%,且磨牙成功率高于前磨牙,术后1年和术后5年成功率无明显差异,但术后10年的成功率要显著低于术后1年和术后5年。两项研究之间较大的差异可能是由于后者使用了现代显微根尖手术设备所引起。Garcia等<sup>[2]</sup>发现术后1年成功率为75%,10%的病变尚在愈合中,与上颌窦关系密切的后牙手术失败率要高于距上颌窦远的患牙。因此,非手术治疗无法治愈的上颌后牙并不是显微根尖手术的“禁区”,精细的手术治疗可以达到较好的预后,但当患牙与上颌窦关系密切时术前规划应更加严谨缜密。

### 3.5 辅助技术在上颌窦相关后牙手术中的应用

#### 3.5.1 3D打印数字化手术导板 在根尖接近上颌

窦的上颌后牙根尖手术中,准确的根尖定位和去骨开窗是手术的操作难点,保证安全完整地切除根尖是手术成功的关键。随着数字化技术在口腔领域的应用越来越广泛,计算机辅助设计与制作的手术导板为这类复杂病例的精准高效实施提供了新的方向。

Tavares等<sup>[31]</sup>利用3D打印手术导板成功实施了一例根尖与上颌窦底接触的上颌第二前磨牙手术,术中无黏膜暴露和神经血管损伤,术后患者无不适。术后6个月CBCT检查显示根尖切除准确,根尖周组织愈合正常。Lara-Mendes等<sup>[32-33]</sup>认为3D打印手术导板在治疗与上颌窦关系密切的患牙时是一个个性化的可靠技术手段。

#### 3.5.2 超声骨刀

超声骨刀可选择性切割矿化组织,同时保留软组织,可最大限度保护上颌窦黏膜及邻近神经血管。而且由于其对骨质的热损伤小还可减轻患者术后不适,提升整体预后。术中换用不同型号的工作尖与传统金刚砂车针和去骨钻相比,超声骨刀切除的根尖切面粗糙度小,表面更

光滑<sup>[34]</sup>。此外,超声骨刀配备的无菌冲洗系统和发光二极管可提高手术视野的可视性及操作的安全性。Lee等<sup>[35]</sup>利用超声骨刀对根尖突入上颌窦的第一磨牙行上颌窦外侧壁骨开窗及根尖切除术,成功避免了黏膜穿孔的发生。同时,还利用术中截取的自体骨移植达到了满意的预后。

**3.5.3 内窥镜** 相比于其他放大设备,内窥镜探头直径小而灵活,可以轻易进入窦底与根尖之间的腔隙,使术者可在短时间内从各个方向检查牙根表面和窦底黏膜的完整性。通过内窥镜的冲洗装置,还可避免碎屑进入上颌窦。当病变侵入上颌窦内时,在内窥镜辅助下实施根尖切除并同期修复黏膜穿孔可以取得更好的疗效<sup>[36]</sup>。但目前国内缺乏这方面的报告,仍需更多的临床研究来证实内窥镜在上颌后牙区显微根尖手术中的有效性。

**3.5.4 浓缩生长因子** 浓缩生长因子(concentrate growth factors, CGF)是通过差速离心血液样品制备的第三代血小板浓缩物,其中含有更丰富的生长因子,纤维蛋白基质的拉伸强度和黏度更高,体内作用时间更长,促进组织再生能力更强。研究表明<sup>[37]</sup>,CGF可有效治愈黏膜小穿孔,促进大穿孔的迅速修复闭合,且能降低因上颌窦黏膜穿孔引发术后感染的风险。此外,CGF还能促进新骨形成,有效缩短骨质愈合时间,提高患者术后生活质量<sup>[28]</sup>。

#### 4 小 结

操作空间狭小及上颌窦的存在增加了上颌后牙区显微根尖手术难度,然而,术前CBCT检查可使术者根据不同位置的区域形态,掌握病变根尖与上颌窦底关系、评估手术风险从而降低意外发生。3D打印手术导板、内窥镜和超声骨刀等先进技术设备的使用可使术者在原有经验的基础上更好、更便捷地完成复杂的临床操作,实现最佳的治疗效果。但目前国内仍缺少关于上颌后牙显微根尖手术长期预后的临床研究,且在手术入路设计、病变定位及微创治疗等方面有待进一步发展。

**【Author contributions】** Sun MX wrote the article. Song DZ, Huang DM guided the writing of the article. All authors read and approved the final manuscript as submitted.

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