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·防治实践·

椅旁四面体定位技术制作导板拆除纤维桩1例及文献复习

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【摘要】 目的 探讨椅旁四面体定位技术制作导板拆除纤维桩的技术和效果。**方法** 对1例左上颌侧切牙慢性根尖周炎急性发作且需拆除纤维桩的患者，使用椅旁四面体定位技术制作导板拆除纤维桩。将锥形束CT（cone beam CT，CBCT）数据导入软件进行纤维桩拆除导板设计，利用四面体定位技术，将CBCT上的导板设计转移到实体模型上，制作导板引导拆除纤维桩，后行左上颌侧切牙根管治疗。通过文献回顾，评价四面体定位技术导板拆除纤维桩的效果。**结果** 四面体定位技术制作导板精准定位了纤维桩的位置和方向，具有低成本、快速的特点；对患者拆除纤维桩后使用根管预备器械可疏通根管，根管预备后热牙胶充填完成根管治疗，3个月后复查根尖片见根尖周透射影缩小。文献复习结果表明，导板拆除纤维桩治疗提供了一个可预测的结果和较低的医源性损害风险，可进行微创治疗，并减少椅旁时间。**结论** 在CBCT数据基础上使用四面体定位技术制作纤维桩拆除导板有助于降低纤维桩拆除风险，有快速、低成本、椅旁省时的特点，但其与三维打印导板的精确度比较有待进一步研究。

【关键词】 纤维桩；四面体定位；导板；锥束计算机断层成像；椅旁；三维打印；精确度；定位技术；根管再治疗；热牙胶充填技术；微创治疗
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Fabrication of guide and removal of fiber post by tetrahedron positioning technology at the chair side: a case report and literature review

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【Abstract】 Objective To explore the technology and efficacy of fabrication of a guide and removal of a fiber post by tetrahedron positioning technology at the chair side. **Methods** For one patient with acute chronic periapical periodontitis of the left maxillary lateral incisor who needed to have the fiber post removed, the chair side tetrahedral positioning technique was used to make a guide plate to remove the fiber post. Cone beam CT (CBCT) data were imported into the software to design the guide plate for fiber post removal. The guide plate design on CBCT was transferred to a solid model by using tetrahedral positioning technology. The guide plate was made to guide the removal of the fiber post, and then left maxillary lateral incisor root canal was performed. We evaluated the effect of fiber post removal with tetrahedral positioning technology by reviewing the literature. **Results** The guide plate made by tetrahedral positioning technology can accurately locate the position and direction of fiber posts at a low cost and with high speed. After the fi-

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ber post was removed, the root canal could be dredged by using root canal preparation instruments. After root canal preparation, the root canal was filled with warm gutta-percha to complete the root canal treatment. After 3 months, the apical radiograph showed that the transmission shadow of the apical area was reduced. The results of the literature review showed that the fiber post removal with guide plates provides a predictable result and a lower risk of iatrogenic damage. Minimally invasive treatment can be carried out, and chair time can be reduced. **Conclusion** On the basis of CBCT data, using tetrahedral positioning technology to make fiber post removal guides can help reduce the risk of fiber post removal and has the characteristics of speed, low cost and short chair side processing. However, the accuracy comparison between tetrahedral positioning technology and 3D printing guides needs further study.

【Key words】 fiber post; tetrahedron positioning technology; surgical guides; cone beam CT; chair side; three-dimensional printing; accuracy; positioning technology; root canal retreatment; warm gutta-percha filling technique; minimally invasive treatment

【Trial registration】 School and Hospital of Stomatology, Fujian Medical University, ChiCTR2100043416

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纤维桩在临床上已被广泛应用于口腔修复科，其具有粘接性能好、与牙体力学性能相近等优点；但在发生折断或根管治疗需要进行拆除时，这些优点也成为操作的障碍。锥形束CT（cone beam CT，CBCT）和三维打印导板技术的导板在口腔临床上的应用已经十分广泛，目前多用于种植和外科领域[1-3]，其应用于拆除纤维桩的报道较少[4]。数字化导板制作耗时较长，需要专用的三维打印设备，且多数不能椅旁完成，影响了其推广和普及。

本文报道使用四面体定位技术，制作纤维桩拆除导板，对1例上颌侧切牙进行治疗并进行文献复习，为临床CBCT及三维打印导板技术应用于纤维桩拆除提供依据。

1　资料和方法

1.1　病例资料

患者，女性，35岁。主诉左上前牙肿痛1周就诊。患者2年前左上前牙因“蛀牙”在外院治疗并修复，近1周肿痛不适，今来本院要求治疗。否认心血管、糖尿病等系统性疾病病史，否认传染病病史及过敏史。检查：左上颌侧切牙见冠修复体，叩痛（+），松动Ⅰ°，根尖区扪痛，未见瘘管。影像学检查：左上颌侧切牙根尖周见6 mm×7 mm低密度透射影像，根充影像严密性差，欠填2 mm，根管中上段影像密度较低，判断为纤维桩修复。邻牙未见明显松动，咬合关系正常。临床诊断：左上颌侧切牙慢性根尖周炎急性发作。

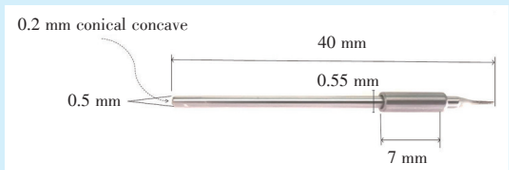
治疗计划：拟拆除左上颌侧切牙冠修复体，在导板引导下拆除纤维桩后行左上颌侧切牙根管治疗，择期修复。患者拍摄CBCT并制取上颌印模。将CBCT数据导入软件进行分析，模拟纤维桩拆除设计导板。利用四面体定位技术，将CBCT上的导板设计转移到上颌模型上，制作导板引导拆除纤维桩。本研究经福建医科大学附属口腔医院伦理学委员会批准，患者知情同意。临床试验注册号：ChiCTR2100043416。

1.2　材料和设备

导板制作所需的材料和设备如下：CBCT iCAT（KaVo，德国），医学图象处理软件Mimics 10.0（Materialise，比利时）。如图1所示，自制圆柱状导柱长度40.00 mm，直径0.5 mm，一端有尖，另一端中心点有0.2 mm浅凹，便于固定圆规针尖；自制长度7.00 mm，内径0.55 mm钛导环；使用圆规H2030（英雄，中国）和鹅颈管（乐迪，中国）组合制成三脚圆规（实用新型专利，一种用于制作口腔种植导板的定位装置，专利号ZL202020154231.9）。电子数显卡尺ARTPOL（江苏靖江量具有限公司，中国）。光固化暂时冠树脂Revotek LC（GC，日本）。

1.3　四面体定位导板的方法

空间的几何体至少四个面，四面体是空间最简单的几何体。已知四面体三个点的位置及这三个点到第四点的位移，可定位第四点的位置[5]，这是



The length of the self-made cylindrical guidepost was 40.00 mm, and the diameter was 0.5 mm. There was a tip at one end and a 0.2 mm conical concave at the center of the other end, which was convenient for fixing the tip of the compass. The length and inner diameter of the self-made titanium guide ring were 7.00 mm and 0.55 mm, respectively. The self-made cylindrical guidepost, compass H2030 and gooseneck tube were combined to make a tripod compass

Figure 1　Design of guide bar and guide ring

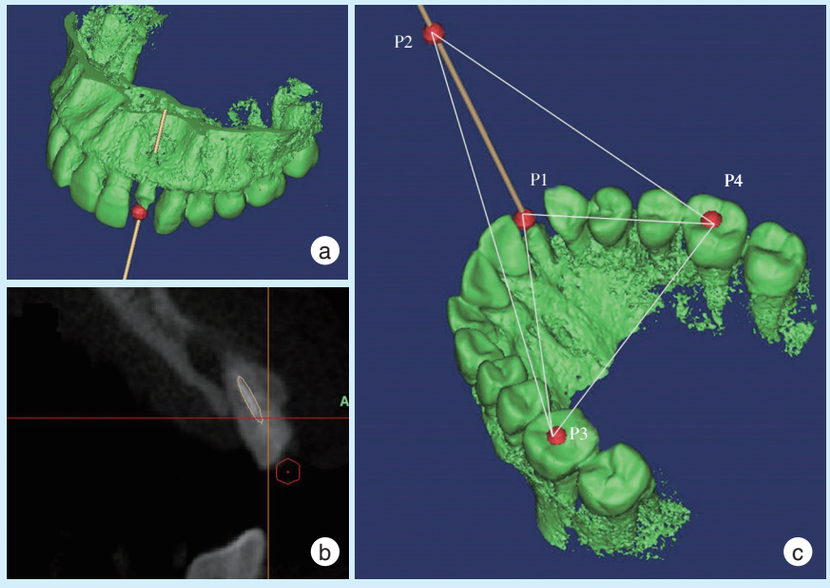
图1　导柱和导环设计

四面体定位技术在种植导板中应用的基础。该方法在拆除纤维桩中应用时，在CBCT数据中将已知的三个点定为纤维桩拆除进入点P1（即纤维桩的断端）、以及牙列模型上可清晰辨认的两个点P3、P4（如两个第一磨牙的中央窝），通过CBCT数据设计导板拆除纤维桩的方向，并获得该方向上的一个点P2到已知三点的距离，可将数字化模型中的导板设计转移到实物的牙列模型上。

1.4　在软件中进行导板设计

使用CBCT对该患者上颌牙列及牙槽骨进行扫描。CBCT扫描电压120 kV，扫描电流5.00 mA，曝光时间7.0 s，分辨率0.2 mm，图像矩阵大小800 × 800 pixels，轴层厚0.2 mm，共得到304幅二维扫描断层图像。将数据以DICOM（digital imaging and communications in medicine）格式保存，并导入Mimics 10.0进行处理，建立包含牙体和上颌牙槽骨的三维形态模型。

在Mimics 10.0中设计纤维桩拆除方向，将纤维桩口内露出部分定为P1。沿点P1向𬌗方延长40 mm（即自制圆柱状导柱长度）取点P2。16和26中央窝取点P3和P4，并测量P2-P3，P2-P4的距离（图2）。



a: design of the direction for removing the fiber post; b: demolition along the root canal and fiber post direction. c: fixed point and length measurement between each point by tetrahedron positioning technology. Point 2 (P2) was taken by extending 40 mm (the length of self-made cylindrical guidepost) from point 1 (P1) to the occlusal side. Point 3 (P3) and point 4 (P4) were taken from the central fossa of 16 teeth and 26 teeth, and the P2-P3 and P2-P4 distances were measured.

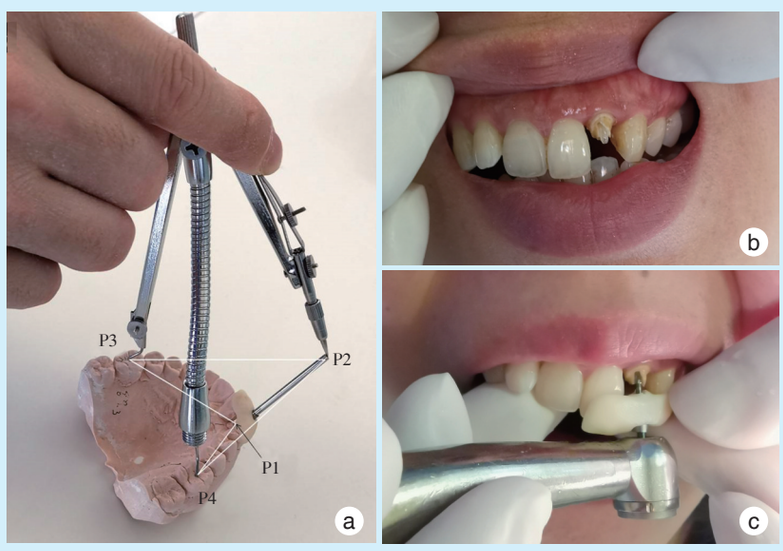
Figure 2　Design of the tetrahedral positioning guide based on CBCT data

图2　基于CBCT数据的四面体定位导板设计

1.5　导板制作与导板纤维桩拆除

将患者冠修复体拆除后，可见纤维桩的一端暴露在口内，拆除入口明确。将软件中的设计转移到实体模型上。首先，制取上颌印模并灌注超

硬石膏模型。在模型纤维桩口内露出部分的中心点磨深0.2 mm浅凹，即为P1对应位置。第二，将三脚圆规的两个圆规脚置入16和26中央窝，即为P3和P4对应位置，和另一脚的长度分别设定为P2-P3，P2-P4的距离。第三，将圆柱状导柱尖端置于浅凹内，另一端用三脚圆规固定在P2点，四点连线形成稳定的四面体，即可定位纤维桩拆除的方向。将导环套入导柱内，用光固化暂时冠树脂与相邻牙固定，光固化完成导板制作，并在导板引导下拆除纤维桩。钻针为无锥度圆柱形，直径0.5 mm，仅尖端5 mm有切削端，与种植牙导板的钻针与导环类似。见图3。



a: the guide was made on the plaster cast, firstly, the central point of the exposed part of the fiber post was ground to a depth of 0.2 mm conical concave, which was the position corresponding to point 1 (P1), secondly, the two feet of the tripod compass were placed in the central fossa of 16 teeth and 26 teeth, which were the positions corresponding to point 3 (P3) and point 4 (P4), the length of the tripod compass and the other foot were set to the distance of point 2 (P2)-P3 and P2-P4, respectively, thirdly, the tip of the cylindrical guide bar was placed in the shallow concave, and the other end was fixed at P2 with a tripod compass, the four points were connected to form a stable tetrahedron, which could locate the direction of fiber post removal; b: after removal of the crown restoration, the fiber post hindered root canal retreatment; c: the fiber post was removed by the guide

Figure 3　Guide fabrication and fiber post removal of 22 tooth

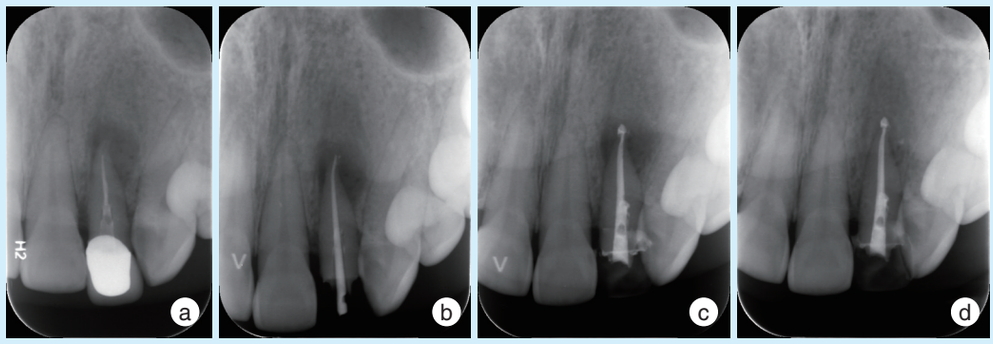
图3　导板制作和22纤维桩拆除

1.6　纤维桩拆除后行根管治疗

术前左上颌侧切牙左侧上颌侧切牙根尖区呈低密度透射图像，根管充填紧密性差，根管中上段影像密度较低，判断为纤维桩修复（图4a）。拆除纤维桩后使用根管预备器械可疏通根管（图4b），根管预备后热牙胶充填完成根管治疗（图4c）。3个月后复查根尖片见根尖区透射影缩小（图4d）。

2　讨　论

临床中常会出现纤维桩折断或需要拆除纤维桩进行根管治疗的情况。由于纤维桩的硬度等力学性能和牙体近似，且粘接性能良好，造成其不能像金属成品桩一样直接旋转拆除，给治疗带来障碍[6]。目前纤维桩主要采用以下四种方法进行拆除，①纤维桩拆除套装（fiber post removal kit）[7]，这种方法在拆除过程中不易确定桩道方向，且只针对某些产品的配套设备；②显微镜加超声拆除纤维桩，这种方法在显微镜下拆除，过程中可以明确看见纤维桩提高准确性，但Arukaslan等[6]研究显示该方法耗时较长，损失的牙体组织体积多于第一种方法，牙体的抗折性能下降[7-8]；③Er:YAG激光拆除纤维桩，目前仅见Deeb等[9]报告的体外研究，未进行临床应用，报告认为Er:YAG激光拆桩比超声快，该方法和超声拆除一样会造成牙体温度升高，但扫描电镜下未发现明显损伤，是一种可替代超声的拆桩方法；④导板拆除纤维桩，从2019



a: before treatment, the apical area of the left maxillary lateral incisor showed a low-density transmission image, and the root canal filling had poor tightness; b: at the test point, after the fiber post was removed, a smooth root canal passage was prepared to drain the apical inflammation; c: root canal filling; d: return visit 3 months after root canal filling, the range of low-density transmission images of the left maxillary lateral incisor was significantly reduced

Figure 4　Imaging data of apical radiographs of 22 tooth

图4　22根尖片影像学资料

年开始有少量临床病例报告[4,10-11]，均为三维打印导板，在切牙和磨牙都取得较好的短期疗效。导板拆除纤维桩的导板设计和制作和种植导板类似，主要有以下步骤：收集CBCT数据，重建牙体三维形状，收集和匹配光学扫描数据以及三维导板的设计和打印。从目前的临床应用和精确度评价分析，导板拆除纤维桩治疗提供了一个可预测的结果和较低的医源性损害风险，可进行微创治疗，并减少椅旁时间。但目前只是病例报告和体外研究报道，需要有更大样本的临床研究和更长的随访期，以及标准化的实验研究来完善。

四面体定位技术有快速和低成本的特点。软件设计拆除方向后，只需测量两点距离即可在模型上制作导板，节省了三维打印的时间和成本。步骤简单可程式化，CBCT自带的软件可实现模拟种植功能便可以设计纤维桩拆除导板，不需要使用特定软件。圆柱导柱、导环、三脚圆规等均非特殊设备，设备依赖性小，可椅旁完成。

目前多数导板依赖三维扫描、三维打印技术，其精确度和导板的精确度关系密切[12]。扫描数字化模型与CBCT模型的配准程度也对精确度有很大影响[13-14]。部分学者对导板的新技术作了探讨，可提高精确度，减少牙体组织破坏，但方法较为繁琐，或需要专用导航设备[15-18]。四面体定位技术避免了三维扫描、打印和配准中的误差，但需医师采用圆规等工具进行测量，受研究人员主观性、石膏模型精度、测量仪器精度、光固化材料收缩形变等影响，有一定局限性。

在CBCT数据基础上使用四面体定位技术制作纤维桩拆除导板是一种新方法，有助于降低纤维桩拆除风险，有快速、低成本、椅旁加工的特点，但其与三维打印导板的精确度比较有待进一步探讨。目前导板拆除纤维桩文献回顾的结论只基于病例报告和体外研究等有限和低水准的证据，需要更多的临床研究随访以及标准化的实验研究来完善。

【Author contributions】 Zhang WL processed the research and wrote the article. Wu WQ, Liao SH, Zou JB and Zhan XZ processed the research and revised the article. Lin J designed the study and reviewed the article. All authors read and approved the final manuscript as submitted.

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