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· 专家共识 ·

数字化口内扫描技术专家共识

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【摘要】 数字化口内扫描是近年口腔数字化技术的研究热点,成为口腔正畸、修复、种植的重要技术。数字化口内扫描的精确度和数据资料采集拼接的准确性是保证数字印模成功和加工制作效果的关键;而扫描仪特性、成像原理以及操作者扫描方式、扫描对象、口腔组织特殊性、修复设计方案等均会影响数据采集的准确性。仍有诸多操作者对于如何鉴别不同修复设计的扫描策略、扫描轨迹、如何减少数字化扫描误差等认识不足,且目前国内外学者关于数字化口内扫描技术尚未形成统一标准与共识。为了更好地帮助操作者应对口内扫描中遇到的难题,提高数字化扫描质量,本文集合了参与专家的共同意见,通过对现有证据的归纳鉴别,阐述数字化口内扫描误差的原因与应对方法,掌握不同口腔印模需求下的扫描策略。本专家共识认为,基于影响数字化口内扫描精度及扫描图像重现效果受诸多因素的影响,采用正确的扫描轨迹可缩短临床操作时间,提高扫描的精确性,扫描轨迹主要包括E字法、分段法和S型法等。①进行固定义齿修复时,建议先扫描基牙及前后两个邻牙,再把基牙区域挖出洞型,最后在基牙预备完成后补扫洞型缺口处,既可满足临床实际需求,同时也能得到最可靠的精度。②全口无牙颌行全口义齿修复时,在牙槽嵴底黏膜组织设定标记点、一次性捕获前庭区域的图像、采用不同类型的扫描路径如“Z”形、“S”形、颊腭、腭颊路径、分段扫描牙弓等策略,可以减少扫描误差和改善图像拼接以及重叠的问题。③对于种植修复,当进行种植体支持的单冠修复与小跨度上部结构修复时,建议先预扫所需牙弓,再把基牙区域挖出洞型,最后安装好种植扫描杆后再补扫洞型缺口处;当进行骨水平种植体冠修复时,可通过改良的间接扫描方法,将扫描过程分为三步:首先在口内扫描临时修复体和相邻两个牙位的牙齿与牙龈组织,然后在种植体上安装标准扫描杆并扫描全牙弓,最后在口外扫描临时修复体,以获取种植体颈部穿龈轮廓的三维形态,从而增加种植体周软组织扫描的稳定性,提高扫描还原度;对于牙列缺失种植固定桥修复,黏膜具有活动度增加了扫描难度,扫描仪难以分辨形态大小相同的扫描杆,易造成图像叠加错误,可以通过更改扫描杆的几何形状改变光学曲率半径,获得更高的种植数字化印模精确度。共识认为,随着扫描牙弓的范围越大,数据拼接次数增加,扫描精度随之下降;尤其是行全口种植修复印模时,由于口内存在不稳定、不平整的黏膜形态,且无相对明显、固定的参照物,易增加图像拼接处理的难度,造成精度不足,针对此类进行修复设计时,应谨慎选择数字化口内扫描方式获取模型数据,在缺失牙大于5颗时不宜使用数字化印模。

【关键词】 数字化; 扫描; 口内扫描; 数字化技术; 数字化口内扫描; 精确度; 修复; 种植

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Expert consensus on digital intraoral scanning technology YOU Jie¹, YAN Wenjuan¹, LIN Liting², GU Wenzhen², HOU Yarong³, XIAO Wei⁴, YAO Hui⁵, LI Yaner⁶, MA Lihui⁷, ZHAO Ruini⁸, QIU Junqi³, LIU Jianzhang⁹, ZHOU Yi¹⁰



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【Abstract】 Digital intraoral scanning is a hot topic in the field of oral digital technology. In recent years, digital intraoral scanning has gradually become the mainstream technology in orthodontics, prosthodontics, and implant dentistry. The precision of digital intraoral scanning and the accuracy and stitching of data collection are the keys to the success of the impression. However, the operators are less familiar with the intraoral scanning characteristics, imaging processing, operator scanning method, oral tissue specificity of the scanned object, and restoration design. Thus far, no unified standard and consensus on digital intraoral scanning technology has been achieved at home or abroad. To deal with the problems encountered in oral scanning and improve the quality of digital scanning, we collected common expert opinions and sought to expound the causes of scanning errors and countermeasures by summarizing the existing evidence. We also describe the scanning strategies under different oral impression requirements. The expert consensus is that due to various factors affecting the accuracy of digital intraoral scanning and the reproducibility of scanned images, adopting the correct scanning trajectory can shorten clinical operation time and improve scanning accuracy. The scanning trajectories mainly include the E-shaped, segmented, and S-shaped methods. When performing fixed denture restoration, it is recommended to first scan the abutment and adjacent teeth. When performing fixed denture restoration, it is recommended to scan the abutment and adjacent teeth first. Then the cavity in the abutment area is excavated. Lastly, the cavity gap was scanned after completing the abutment preparation. This method not only meets clinical needs but also achieves the most reliable accuracy. When performing full denture restoration in edentulous jaws, setting markers on the mucosal tissue at the bottom of the alveolar ridge, simultaneously capturing images of the vestibular area, using different types of scanning paths such as Z-shaped, S-shaped, buccal-palatal and palatal-buccal pathways, segmented scanning of dental arches, and other strategies can reduce scanning errors and improve image stitching and overlap. For implant restoration, when a single crown restoration is supported by implants and a small span upper structure restoration, it is recommended to first pre-scan the required dental arch. Then the cavity in the abutment area is excavated. Lastly, scanning the cavity gap after installing the implant scanning rod. When repairing a bone level implant crown, an improved indirect scanning method can be used. The scanning process includes three steps: First, the temporary restoration, adjacent teeth, and gingival tissue in the mouth are scanned; second, the entire dental arch is scanned after installing a standard scanning rod on the implant; and third, the temporary restoration outside the mouth is scanned to obtain the three-dimensional shape of the gingival contour of the implant neck, thereby increasing the stability of soft tissue scanning around the implant and improving scanning restoration. For dental implant fixed bridge repair with missing teeth, the mobility of the mucosa increases the difficulty of scanning, making it difficult for scanners to distinguish scanning rods of the same shape and size, which can easily cause image stacking errors. Higher accuracy of digital implant impressions can be achieved by changing the geometric shape of the scanning rods to change the optical curvature radius. The consensus confirms that as the range of scanned dental arches and the number of data concatenations increases, the scanning accuracy decreases accordingly, especially when performing full mouth implant restoration impressions. The difficulty of image stitching processing can easily be increased by the presence of unstable and uneven mucosal morphology inside the mouth and the lack of relatively obvious and fixed reference objects, which results in insufficient accuracy. When designing restorations of this type, it is advisable to carefully choose digital intraoral scanning methods to obtain model data. It is not recommended to use digital impressions when there are more than five missing teeth.

【Key words】 digitization; scanning; intraoral scanning; digital technology; digital intraoral scanning; accuracy; prosthodontics; implant dentistry

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数字化口内扫描技术是指通过光学传感器扫描,将捕捉到的口腔内软硬组织表面形态图像转为数字信号,输出为图像文件。通过图像拼接技术输出静态、二维图像,也可获取动态、三维数据资料,以及交互式浏览的虚拟现实图像等^[1]。目前随着数字化技术的飞速发展,数字化口内扫描技术(intraoral digital scanning technology)已广泛应用于口腔临床工作中。传统印模方法需要通过模型灌注、翻制后获得口腔内组织形态,操作时间长、印模材料易引起患者不适,同时由于温度、湿度、调拌时间和手法、气泡等因素可引起模型变形,精确度降低^[2]。与传统印模技术相比,数字化印模不但节约了传统印模及翻制耗费的时间、材料,也能减少传统印模的误差,同时还能对扫描结果进行编辑处理和修复,提高扫描效率和操作便利性^[3]。但对于无牙颌松软牙槽嵴,活动义齿游离端缺失伴余留牙有牙周炎的病例,以及颌骨缺损赈复体印模等特殊情况的患者,仍需更多证据资料证明数字化印模的优势。同时,数字化口内扫描仪类型多样,成像原理不一,操作者扫描方式、扫描对象口腔组织特殊性、修复体设计方案,以及扫描仪特性等因素均会影响数据获取的准确性^[4]。本文集合参与专家的共同意见,通过对国内外现有证据的归纳鉴别,从数字化扫描的类型与原理、导致扫描误差的原因与应对方法、不同口腔印模需求下的扫描策略等方面展开阐述。旨在为临床实践过程中遇到的难题提供可参考的解决方案,有效避免影响扫描精确度和数据再现性的不利因素,提高临床工作质量与效率。

1 影响数字化口内扫描精度的因素与应对决策树

影响数字化口内扫描精度的因素主要有操作者因素、仪器设备因素、环境因素、被扫描对象因素。影响因素与应对决策见图1。

1.1 操作者因素

1.1.1 扫描角度 数字化口内扫描并重建口腔组织三维图像数据受扫描角度的影响,DeLong等^[5]研究发现,当扫描镜头与翻制的模型表面垂线之间的角度大于60°时,扫描精确度明显下降。因

此,扫描光线应尽量与牙面垂直。

1.1.2 扫描距离和深度 扫描距离是指被扫描物表面至扫描头尖端的距离,扫描深度为扫描仪可以捕获可靠数据的焦点深度。每一种型号的扫描仪都有最佳扫描距离和焦点深度,因此操作者准确掌握采用仪器的最佳扫描参数是确保精度的最可靠方法^[6]。

进行口内数字化扫描时,推荐采用执笔式握住扫描头手柄位置,以邻牙作为支撑点,保持扫描头始终平衡、匀速推进,获取的影像位置位于视野中部,扫描头方向与牙体长轴垂直;扫描距离为2.5~5.0 mm,方向小于30°,并确保与前一位置有50%数据重叠;分别获取目标牙齿的近、远中、邻接关系及邻牙图像数据;全口牙列扫描时间建议控制在3~5 min,时间过长时,操作者与患者易疲劳,因此导致的扫描位置移动会影响成像效果^[7]。

1.1.3 扫描范围 扫描牙弓的范围与模型精度呈反向关系,扫描范围小于半个牙弓时的精确度高于全牙弓^[8]。这可能是由于随着扫描区域扩大,捕获图像更多,扫描仪的内置程序需要进行更多次的图像拼接与三维影像建立,误差也相应增加。因此在制作修复冠、种植上部冠或牙位跨度短的固定义齿时,目前更推荐半牙弓扫描的方式。

1.1.4 补扫 重新补扫会降低模型的精确度^[9],建议一次扫描成功,尽量减少初次扫描出现遗漏区域。为了最大限度提高精确度,软件程序设置已扫描或预扫描存在的数据不得再次进行编辑,从而保证已存在的数据不会被覆盖,而孔洞信息能够通过再次补扫进行有效补充^[10]。

1.2 仪器设备因素

1.2.1 扫描仪类型 不同类型的扫描系统都有自身的参数特点,操作者应充分了解产品特性,例如扫描速度、扫描头大小、软件功能、无线选择、制造商的支持等,结合临床需求,选择适合的数字化扫描系统以达到最佳修复效果^[11]。

1.2.2 扫描头大小 Hayama等^[12]研究报道,扫描头大小与精确度存在相关性,扫描头越大,模型精确度越高。这可能是由于扫描头过小时,仪器在后期需要处理更多的拼接图片,从而更容易失真。

但需要注意的是,扫描头过大时会对患者开口度要求变高,临床应综合考虑被扫描对象开口度与印模精度需求选择合适大小的扫描头。

1.2.3 扫描仪的校准 虽然数字化扫描仪设定的程序会根据上次校准间隔时间和达到一定的扫描次数时自动发出警示,但建议在每次扫描前均进行校准。目前 iTero Element (Align Technologies) 和 Trios 5 (3Shape A/S IOSs) 具有自动校准系统,其他的口扫仪大多需要操作者自行手工校准^[13]。

1.3 环境因素

1.3.1 环境温度 环境温度是一个可影响扫描精度的变量,推荐环境温度保持在 15 ~ 30 °C,可获得更好的扫描效果。同时,在使用口内扫描仪前进行校准,也可降低环境温度导致的误差^[14]。

1.3.2 环境湿度 有学者对比了不同湿度条件下,扫描精度无差异;而 Park 等^[15]提出使用口内扫描仪的适宜空气湿度为 45%,仍需进一步研究环境湿度变化对扫描效果的影响;建议使用前对扫描头重新进行校准,以降低环境湿度导致的误差。

1.3.3 照明光源强度 环境光源如牙椅灯光、自然光线、房间灯光等照明的强度显著影响口内扫描的精确度,大部分系统的性能在 1 000 lx 环境光照条件下效果更好^[16]。在关闭牙椅灯光,保持诊室顶灯照明时,基本可以达到口内扫描所需的最佳照明条件^[17]。但由于操作空间可能受天气、空间布局的影响,常规光线环境如未能保持 1 000 lx 的光源强度,可通过仪器实现照明条件的标准化。

1.4 被扫描对象因素

1.4.1 牙齿位置 有研究对比了 5 种扫描系统在扫描不同牙位时的精确度,结果显示,越靠近远中的牙齿扫描精度越低,这可能是由于后牙的解剖结构更复杂,需要扫描仪识别的几何结构面更多^[18]。

1.4.2 邻间隙 即预备牙与基牙之间的距离。邻间隙的存在或基牙与相邻牙距离过短,会限制扫描仪的光线入射角度,增加了数据获取难度,导致扫描精度降低^[19-20]。当基牙与邻牙之间的间隙距离小于 3 mm 时,扫描误差的大小根据扫描头偏向已预备基牙(颊侧、舌侧、近中、远中)的方向不同而有所差异^[21-23];随着邻间隙距离的增加,预备牙边缘扫描区域的扫描误差减少^[24-25]。

1.4.3 口内修复体 因为不同材料的反射率存在差异,扫描对象口腔内原有的修复体会对扫描的准确性和精度造成影响。

1.4.4 预备体质量 基牙预备后的形状、位置、牙龈高度、预备边缘线的距离等也是影响扫描效果的因素,因此减少预备体的尖锐角度和不均匀表面倒凹、预备体终止线位于龈上、制备内线圆钝的直角肩台等,均可以提高扫描精确性^[19]。进行口内扫描前,使用排龈膏、排龈线等手段充分暴露预备体边缘线,可降低扫描难度,并提高扫描的精确性。

1.4.5 缺牙区域黏膜活动度 黏膜活动度是影响口内扫描精确度的一个变量。已有研究证明^[26-30],在扫描活动度小的附着龈和腭侧黏膜时,数字化扫描方法与传统印模方法的精确度无显著差异。但是,对于扫描过程中产生较大活动度的黏膜,不管是哪种型号的口扫仪,都难以准确再现其组织形态。此类患者若选择口内扫描印模,建议在黏膜活动区域增加人工标记点,以减少扫描误差^[29]。

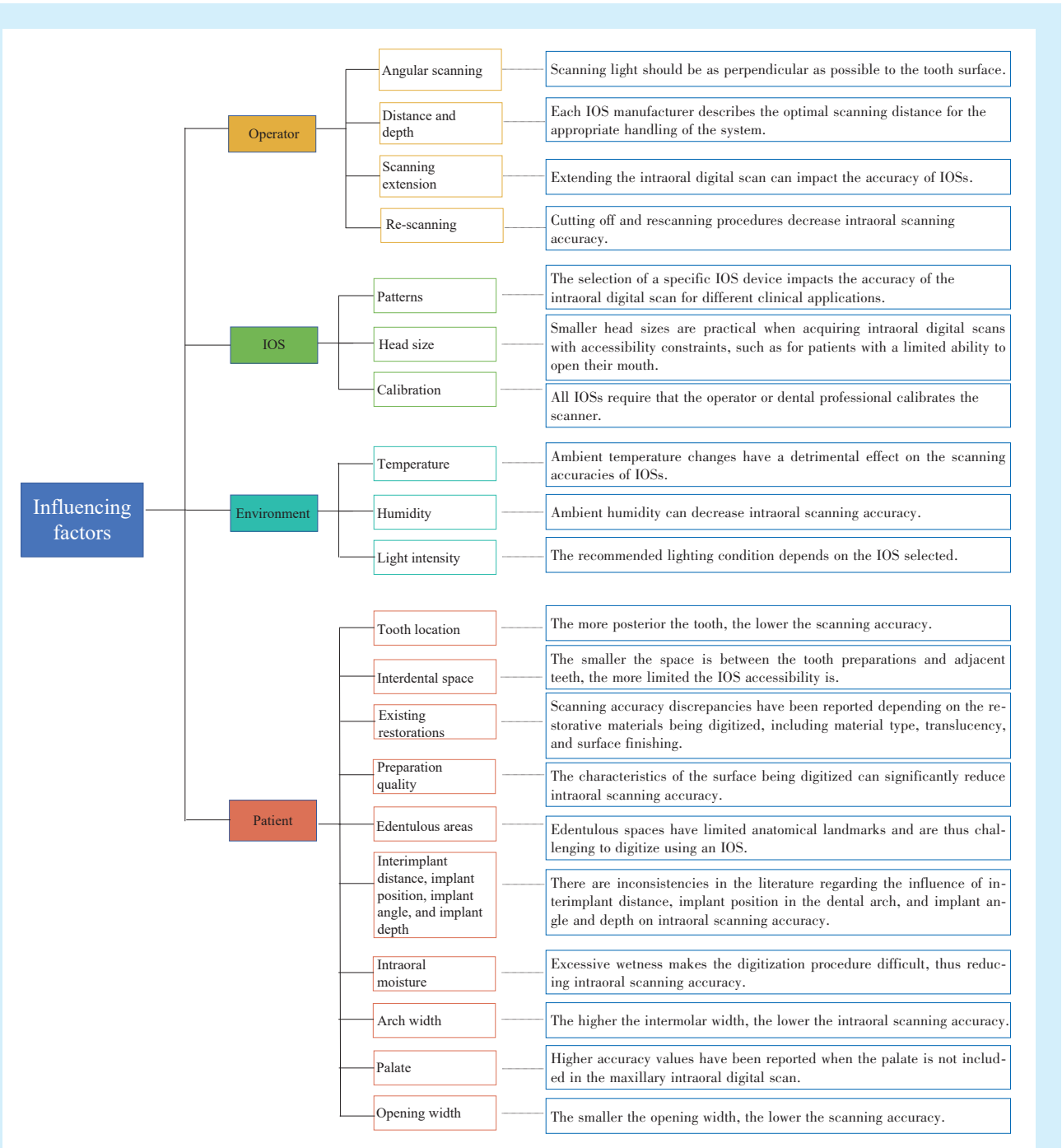
1.4.6 种植体间距、位置、角度和深度 两个相邻种植体之间的距离、种植体在牙弓中的位置、种植体的角度和深度是影响口腔内的扫描精度的变量^[31]。由于种植体间距增大时基台水平印模的精确度降低,且种植体角度较大时,由于扫描仪探头无法完全获取倾斜种植体颈部的扫描杆信息,种植体间距与角度越大时,误差相应增加^[32-33]。种植体植入较深或牙龈较厚时,使用更长的扫描杆可以减少误差。

1.4.7 口腔湿润环境 口腔内的唾液、龈沟液、血液等会降低扫描的精确度与真实性^[34-35]。牙齿表面反射的光源受水的折射作用,会影响扫描效果,因此,建议扫描前充分隔湿,并使用三枪气吹干扫描区域附着的液体。

1.4.8 牙弓宽度 牙弓宽度越大,扫描精度越差^[36-37],这可能与扫描时获取了更多的组织图像及更易捕捉黏膜组织数据资料有关。应根据临床实际需要限定扫描区域,减少印模误差。

1.4.9 腭侧黏膜组织 如果口扫包含了过多腭部范围,扫描精度会降低,因此扫描时应尽量避免腭部软组织结构的数据采集,采取稳步平移的方法推进,根据扫描区域及时更换扫描头方向^[38]。

1.4.10 张口度 被扫描对象开口度较小时,需要不断调整扫描头在口腔中的位置,因此取像角度和稳定性会受到限制,光学扫描精度明显下降。评估患者口腔情况,合理使用开口器或由助手配合牵拉口角等方式,有利于改善张口程度、保持扫描过程的稳定性。



IOS: intraoral scanner

Figure 1 Factors affecting the accuracy of digital intraoral scanning and the corresponding decision tree

图1 影响数字化口内扫描精度的因素与应对决策树

2 数字化口内扫描的扫描轨迹分类

数字化口内扫描图像重现效果受患者开口度、唾液、口内空间等诸多因素的影响,采用正确的扫描轨迹可缩短临床操作时间,提高扫描的精确性。扫描轨迹主要包括E字法、分段法和S型法等^[39-41]。

2.1 E字法

从一侧末端磨牙开始扫描咬合面直至另一侧末端磨牙,前牙区域呈Z字摆动;转至舌/腭侧,从末端磨牙远中依次扫描至另一侧末端磨牙;转至颊侧,从末端磨牙远中返回另一侧末端磨牙;最后呈波浪线型扫描左右两侧的咬合关系。扫描过程

中,光学扫描镜头始终保持与牙面平行。

2.2 分段法

按照牙齿长轴中线将口内组织分成4个象限,分别为左上、右上、左下、右下,每个区域均按照E字法,依次扫描咬合面→舌侧面→颊侧面,最后呈波浪线型扫描左右两侧的咬合关系。扫描过程光学扫描镜头始终保持与牙面平行。

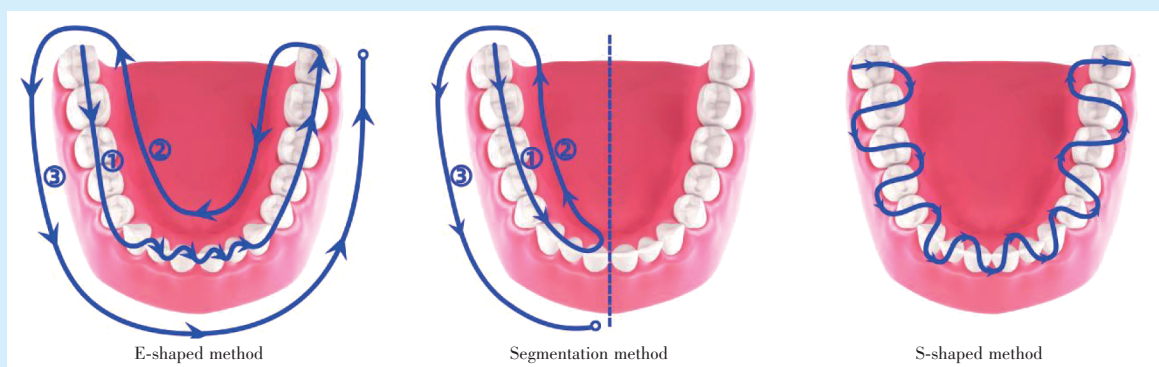
2.3 S型法

扫描顺序为颊侧面至咬合面至舌/腭侧面,呈S

型依次扫描每一个牙齿。

牙弓远端的牙齿容易形成遗漏区域,颌面转舌侧面/唇颊侧面时,倾斜、成弧度转动扫描头,避免“直角式”转动产生的图片拼接问题。

正畸数字化印模制取可根据临床实际需要选择合适的扫描轨迹,总体原则是获取全牙弓及牙龈组织的完整图像。以下颌模型为例,操作轨迹示意图见图2。



E-shaped method: ① the occlusal surface should be scanned from one end molar to the other end molar, with the anterior tooth area swinging in a Z-shaped pattern; ② after turning to the tongue/palate side, scan from the distal end of the molars to the other end in sequence; ③ after turning to the buccal side, return from the distal end of the molars to the other end of the molars; and, finally, the bite relationship should be scanned on both sides in a wavy pattern. Segmentation method: ① the oral tissue should be divided into four quadrants according to the midline of the tooth's long axis, namely, upper left, upper right, lower left, and lower right; ② the occlusal surface should be scanned in sequence from the lingual side to buccal side for each zone according to the E-shaped method; ③ the occlusal relationship should be scanned on both sides in a wavy pattern. The optical scanning lens always remains parallel to the tooth surface during scanning. S-shaped method: scanning is performed from the buccal side to the occlusal surface to the lingual/palatal side in an S-shaped sequence for each tooth. The teeth at the distal end of the dental arch are prone to forming residual pores. When the maxillofacial surface is turned to the lingual/buccal side, the scanning head is tilted and rotated in an arc to avoid image stitching problems caused by right-angle rotation, which can improve the accuracy of the scanning data

Figure 2 Schematic of the digital intraoral scanning trajectory

图2 数字化口内扫描轨迹示意图

3 针对不同修复类型的扫描策略推荐

临床常见的修复体类型主要包含固定义齿、活动义齿与种植义齿。数字化口内扫描技术在固定义齿修复中应用较为广泛,但由于黏膜组织具有活动性、口腔内无固定扫描标记点,图像拼接处理难度较大,从而影响扫描的精确度。目前进行半口、全口活动义齿或种植义齿修复,仍推荐传统印模方法。如何解决数字化口内扫描的技术瓶颈问题尚需更多临床证据支持。

3.1 固定义齿

3.1.1 扫描头选择 由于固定义齿行口内数字化印模时,所需扫描范围可限于基牙附近区域,使用较小的扫描头,即可达到模型精确度要求^[15],同

时还可提高患者的舒适度。

3.1.2 扫描区域 获得相对完整的牙列数据,需要进行多次三维数据拼接处理,将口内扫描单次取像拟合为三维图形的过程,取像次数越多则拟合导入的偏差越大,因此扫描完整牙弓进行三维重建的误差要大于局部牙弓^[11],临床操作时应根据基牙预备的范围选择合适扫描区域。

3.1.3 扫描策略 扫描精度随着牙弓长度和牙位的增加,测量可信度降低^[22,36],这是由于扫描区域跨度大时,获取完整图像需要多次扫描轨迹的变化和移动,则建立三维影像耗费的时间、图片更多,多次图像拼接后造成的误差更大。进行固定义齿修复时,建议先扫描基牙及前后两个邻牙,再

把基牙区域挖出洞型,最后在基牙预备完成后补扫洞型缺口处^[11]。既可满足临床实际需求,同时也能得到最可靠的精度。

3.2 活动义齿

目前数字化印模应用于活动义齿修复的研究主要为少数牙缺失的活动修复^[2, 28, 42]。然而由于口腔黏膜组织的活动性和表面唾液覆盖形成光滑面的条件限制,扫描镜头移动时图像拟合困难,数据重现度和精确性均较低^[28, 42]。因此,活动义齿,尤其是全口义齿仍是口内数字化印模技术的攻克难点,目前尚未形成共识。但临床上张口受限、咽反射严重、对印模材料过敏的病例,采用传统印模技术难以保证模型精确度和印模制取成功率者,可试行数字化口内扫描获取图像数据。

3.2.1 扫描标记点 行全口义齿修复时,由于口内无固定标记点,同时受牙槽黏膜的活动性影响,扫描难度进一步加大。因此,为牙槽嵴底黏膜组织设定标记点,是提高扫描精确度的一个方法。研究表明,在上腭部、牙槽嵴顶等易移动的黏膜组织区域使用光固化氢氧化钙涂抹、树脂小球、氧化铝等形成人工标志点^[28, 42],或使用软组织重衬材料整塑不规则的黏膜组织边缘,改善无牙颌数字化口内印模的义齿适合性,可以降低扫描误差。

3.2.2 扫描特殊区域 全口无牙颌行口内扫描时,前庭区域黏膜弯曲幅度较大,位置最浅,是最难实现扫描重现的区域。建议一次性捕获前庭区域的图像,可以减少由于扫描头反复前后移动补扫引起的光源反射位置变化造成的误差^[2]。

3.2.3 扫描轨迹 行数字化口内扫描时,上颌从牙槽嵴开始,覆盖腭侧,最后到达颊侧和唇部前庭区;下颌从脊嵴起至前庭,止于舌侧。或采用不同类型的扫描路径如“Z”形、“S”形、颊腭、腭颊路径,改善图像拼接以及重叠问题^[43]。有学者研究发现,对半个牙弓以上的范围进行数字化口内印模数据采集时,采取分段扫描牙弓,可以减少扫描误差^[44]。

3.3 种植义齿

3.3.1 扫描策略 种植体支持的单冠修复与小跨度上部结构修复:采用数字化印模技术可以获得与传统印模相同的精确度^[31]。且由于口内扫描的高效、便利性和舒适感,操作者和被操作对象更倾向选择数字化扫描进行模型数据采集。此类种植上部修复模型制备时推荐的扫描方法是:先预扫

所需牙弓,再把基牙区域挖出洞型,最后安装好种植扫描杆后再补扫洞型缺口处^[32]。

骨水平种植体冠修复:进行口内数字化印模时,取出种植体上部临时修复配件后易发生软组织快速坍塌变形,导致经过塑形的牙龈形态难以被迅速捕捉,深处的穿龈轮廓也无法被扫描仪精确复刻,扫描难度增加。可通过改良的间接扫描方法,将扫描过程分为三步^[33, 38]:首先在口内扫描临时修复体和相邻两个牙位的牙齿与牙龈组织,然后在种植体上安装标准扫描杆并扫描全牙弓,最后在口外扫描临时修复体,以获取种植体颈部穿龈轮廓的三维形态。从而增加种植体周软组织扫描的稳定性,提高扫描还原度。

牙列缺失种植固定桥:黏膜具有活动度增加了扫描难度,扫描仪难以分辨形态大小相同的扫描杆,易造成图像叠加错误,可以通过更改扫描杆的几何形状改变光学曲率半径,获得更高的种植数字化印模精确度^[26-27]。

3.3.2 局限性 2018年ITI共识会议提出,对于牙弓跨度大,尤其是全口无牙颌的种植体上部模型,虽然已有研究证实口内扫描精度可以满足临床要求,但多数学者认为目前数字化口内印模技术的精度无法取代传统印模,其广泛应用仍需要更多的科学研究证明^[45]。现有研究指出,随着扫描牙弓的范围越大,数据拼接次数增加,扫描精度随之下降;尤其是行全口种植修复印模时,由于口内存在不稳定、不平整的黏膜形态,且无相对明显、固定的参照物,易增加图像拼接处理的难度,造成精度不足^[46]。因此,针对此类进行修复设计时,应谨慎选择数字化口内扫描方式获取模型数据,在缺失牙大于5颗时不宜使用数字化印模。

4 小结

数字化口内扫描技术是实现数字化种植、修复的关键步骤,具有高效、快捷、舒适、精确度高等特点,逐渐成为口腔模型制备的重要技术,学者的关注度和相关研究日益增加。数字化口内扫描技术的专家共识,有利于临床工作者掌握影响口内数字化印模技术还原度与准确性的相关因素及应对策略,从而实现最佳的印模效果和精确度。

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【通信作者简介】 游杰,副主任护师,南方医科大学南方医院口腔科护士长;现任中华护理学会口腔护理专业委员会专家库成员、中华口腔医学会口腔护理专业委员会委员、广东省护士协会口腔美容护士分会会长、广东省护理学会口腔科护理专业委员会副主任委员、广东省口腔医学会护理专业委员会副主任委员、广东省医院协会口腔医疗管理分会委员、《南方护理学报》审稿专家;从事口腔颌面外科及口腔门诊的临床护理工作多年,具备丰富的口腔医学临床护理经验,尤其在口腔数字化扫描的临床应用与研究方面积累了丰富的经验。主持制订多项口腔专科护理操作规程和口腔科交叉感染控制规范。发表核心期刊论文34篇;主持和参与省级、院校级科研项目5项;主编专著1部,副主编2部,参编专著6部;承担校级教改项目2项,发表教学论文1篇。