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拔牙矫治后前牙区牙槽骨变化的研究进展

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【摘要】 正畸治疗牙齿移动过程中,传统观点认为牙槽骨会跟随牙齿以1:1的比例改建,张力侧骨新生、压力侧骨吸收以维持牙槽骨的平衡。但是近年研究显示,一些正畸治疗后的患者出现了骨丧失,说明牙槽骨并不是即刻跟随牙齿发生等比例改建。前牙大范围移动后周围牙槽骨形态的变化一直是临床医生关注的焦点,本文通过回顾既往文献,就正畸患者拔牙矫治后前牙区牙槽骨变化的相关内容进行综述。综述结果表明,前牙大范围移动后,前牙牙根舌/腭侧根颈部点处的牙槽骨较易出现骨缺损。随着影像学技术的发展,不同于以往采用二维影像对牙槽骨进行研究,现多使用锥形束CT进行测量分析,其结果更加精确,但目前基于锥形束CT的前牙区牙槽骨形态变化的多因素研究较少。基于三维影像对不同年龄段患者前牙区牙槽骨长期变化的对比研究,以及不同骨面型、牙齿移动方式等与牙槽骨改建的相关性研究是未来研究的重点。

【关键词】 拔牙矫治; 前牙内收; 牙槽骨改建; 牙槽骨高度; 牙槽骨厚度; 骨新生; 骨吸收; 头颅侧位片; 锥形束CT

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【Abstract】 It has been traditionally believed that a 1:1 cortical bone remodeling/tooth movement ratio has been preserved during orthodontic treatment for tooth movement, with the alveolar bone on the tension side growing and the alveolar bone on the pressure side resorbing to maintain the balance of the alveolar bone. However, recent studies have shown that alveolar bone loss has been found in patients who have undergone orthodontic treatment, suggesting that the alveolar bone does not change as the teeth change over time. Whether the morphology of the alveolar bone will change when the anterior teeth are moved has been the clinical focus. The changes of anterior alveolar bone in patients who have undergone tooth extraction after orthodontic treatment were summarized by literature review in this paper. The results of the review showed that the alveolar bone at the lingual/palatal root-cervical site of the anterior root is more prone to bone loss after extensive movement of the anterior teeth. With the development of imaging technology, CBCT is now more commonly used for analysis instead of two-dimensional images for measurement, as its results are more accurate. However, there are few multifactorial studies in which CBCT has been used to assess the morphological changes in the alveolar bone. The focus of future research is to compare the long-term changes in the anterior alveolar bone of patients of different ages based on three-dimensional imaging, and to study the correlation between different skeletal features, tooth movement patterns and alveolar bone remodeling.

【Key words】 extraction treatment; retraction of anterior teeth; alveolar bone remodeling; alveolar bone height; alveolar bone thickness; new bone formation; bone resorption; lateral cephalometric; CBCT

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牙齿移动使牙槽骨发生改建是正畸治疗的基础。持续性正畸力使牙槽骨压力侧出现骨吸收,张力侧有新骨沉积。以往认为牙槽骨跟随牙齿移动发生改建,牙移动前后其结构和骨量不变。但是近年研究报道,正畸牙大范围移动后,牙槽骨可能出现骨丧失^[1-2]。正畸患者出现骨丧失这一现象引起了临床医生的高度重视。本文通过回顾既往文献,就正畸患者前牙移动前后前牙区牙槽骨的变化和骨丧失的防治相关内容进行综述。

1 前牙区牙槽骨骨开裂和骨开窗

骨开裂是指累及牙槽嵴边缘的牙根表面骨覆盖的V形缺损,骨开窗是指牙根表面未累及牙槽嵴边缘的牙槽骨缺损^[3]。Coşkun等^[4]发现未经正畸治疗的患者,前牙区唇侧牙槽骨常出现骨开裂和骨开窗,尤其以下颌前牙多见。我国骨性Ⅲ类患者出现骨开窗和骨开裂的比例很高,并且侧切牙和尖牙较中切牙更易出现骨开窗^[5]。尽管目前普遍认为骨开窗/骨开裂的发生与正畸治疗有关,但Sun等^[6]认为骨开裂/骨开窗可能是生理缺陷而不是病理缺陷,正畸医生在治疗前应了解先天牙槽骨缺损的存在和严重程度,在诊疗过程中应尽量避免可能出现的并发症。Cha等^[7]认为治疗前上颌切牙区牙槽骨的骨开裂与治疗后出现牙根外吸收存在相关性,对于需要大范围移动的正畸牙,骨缺损的存在可能影响后期牙槽骨改建。因此正畸医生在临床上为患者制定治疗方案时,应充分考虑到患者初始牙槽骨的状态。

2 评估牙槽骨形态变化的方法

以往骀翼片^[8]、根尖片^[9]、头颅定位侧位X线片^[1,10]等多用来评估牙槽骨形态的变化。但二维图像受解剖结构的影响较大,存在重叠、放大失真等局限性,无法保证测量的准确性。锥形束CT (cone beam computed tomography, CBCT)作为三维影像诊断技术,具有扫描时间短、辐射剂量小、空间定位准确等优势。CBCT对牙槽骨进行线性测

量的准确性和可靠性已得到多方面证实^[11-14]。

对于牙槽骨高度的测量,Sun等^[10]基于头颅侧位片,以牙槽嵴顶点至腭/下颌平面的距离为参照,反映前牙区高度变化。考虑到牙根吸收和切缘磨损的可能性,较多学者^[2,9,15]选择以釉牙骨质界(enamel cemental junction, CEJ)至牙槽嵴顶的距离反映牙槽骨高度的变化。Elnagar等^[1]以腭/下颌平面为水平参照线,连接中切牙唇侧CEJ和根尖点为垂直参照线,再均分为四条水平线分别测量唇、舌侧厚度。也有学者以CEJ为参照点,沿牙长轴向根方绘制参照线,测量牙槽骨厚度^[2]。但牙长轴在移动过程中会发生变化,治疗前后牙槽骨测量位点其实并不一致。尽管目前普遍认可CBCT线性测量的精确性,但有学者表示当对较薄的骨皮质结构进行高度测量时,特别是当骨厚度小于0.6 mm时,三维影像的扫描结果可靠性下降,结果精确度下降^[16]。

3 拔牙矫治对前牙区牙槽骨形态变化的影响

Janson等^[9]研究发现,青少年患者和成年患者治疗后,上颌中切牙牙槽骨高度变化的降低无差异。但该研究是基于根尖片进行评估,而对于不同年龄段患者的改建反应,后续仍需使用三维影像进行更精确的研究。Zhang等^[17]基于CBCT评估发现,成年双颌前突患者治疗后,前牙舌侧牙槽骨高度显著降低,且下颌舌侧骨丧失程度大于上颌。上下颌不同程度的变化可能与骨骼结构本身差异有关,下颌前牙区牙槽骨唇舌向宽度较上颌更窄,在前牙移动过程中,下颌牙根更容易接近骨皮质。沈娇乡等^[18]基于CBCT评估的研究表明,上颌切牙腭侧牙槽嵴顶处于应力集中区,根颈部位牙槽骨是吸收高风险区。安氏Ⅱ类1分类患者上颌前牙唇倾度大,在治疗过程中应避免在牙槽骨尤其是根颈部位产生应力集中。正畸治疗虽然造成了一定的骨吸收,但临床检查发现患者前牙较牢固,牙根的稳定取决于三维方向骨量的约束。

Siregar等^[19]研究发现,治疗后下颌切牙区舌侧

牙槽骨厚度变化较唇侧更明显。在治疗中,要格外注意牙根与舌侧牙槽骨的位置关系,尽量避免牙根接触骨皮质,可能出现牙根吸收、医源性牙槽骨缺损等不利反应。Sun等^[10]报道了462例单颌拔除前磨牙的青少年患者,治疗后除下颌唇侧外,上、下颌牙槽骨厚度均显著降低,但上颌唇侧牙槽骨厚度的变化与Dhanani等^[20]、Hong等^[21]的研究结果不同,可能是因为前者样本人群为青少年,而后者研究人群年龄均大于16岁,成年人骨改建反应更慢,治疗后唇侧骨吸收不足,出现暂时性增厚的情况,其长期变化仍需进一步研究。但是以上学者关于唇侧牙槽骨厚度变化的研究结果略有不同,这可能与学者选择测量的位点不完全一致,以及不同年龄段患者骨改建存在差异有关。同时部分正畸患者前牙内收后,唇侧皮质骨吸收不足,导致唇侧牙槽表面出现结节状突起,出于美观方面考虑,后期可能需要进行牙周修整^[21-22]。

4 影响前牙区牙槽骨改建的因素

4.1 牙移动和牙槽骨形态

在前牙内收过程中,牙移动速率越快,骨量变化越明显^[23]。对于唇倾度较大的前牙,牙齿控根内收时,舌侧牙槽骨高度降低幅度大于倾斜内收^[24]。临床医师在诊疗过程中应控制牙齿移动速率和方式,并重点监测舌侧牙槽骨变化。同时牙槽骨的改建受限于牙槽骨形态。有报道,不同垂直骨面型患者的牙槽骨厚度存在差异:低角组最大,均角组次之,高角组最小^[25-26]。此外矢状骨面型^[26-27]也是牙槽骨厚度的影响因素。治疗前前牙区牙槽骨厚度越薄,治疗后出现前牙区牙槽骨缺损的概率越大^[28]。在治疗过程中,应当充分考虑不同垂直、矢状骨面型前牙区牙槽骨厚度的差异,并为患者制定个性化治疗方案。

目前国内外学者多集中于某种特定矫治器的回顾性研究,不同矫治器的对比研究较少报道。前牙区牙槽骨的改建可能更多与施加力的大小、牙齿移动的速率^[23]和方式^[24]等有关。

4.2 全身因素

一些慢性疾病,诸如牙周炎、糖尿病、骨质疏松症等骨代谢的病理状态会影响接受正畸治疗患者牙周组织的改建过程。牙周炎会导致牙槽骨等牙周组织的炎症性破坏^[29],牙槽骨高度降低,出现应力集中的可能性增大,易引起牙根颈部骨丧失。但也有研究表明经过定期治疗的牙周炎患者

治疗后并不会加重骨丧失^[30]。糖尿病患者的骨代谢表现为骨吸收大于形成的不平衡状态,最终可能引起骨量减小^[31]。

4.3 年龄和性别

正畸牙移动过程中还需要考虑患者的年龄。有报道成年患者拔牙矫治后上颌切牙区腭侧牙槽骨高度约降低1.89 mm、下颌切牙区舌侧约降低3.95 mm^[17]。青少年患者拔牙矫治后上、下颌切牙区腭/舌侧牙槽骨高度平均分别降低0.93 mm、2.12 mm^[32]。成年患者腭/舌侧高度变化量远大于青少年,这提示两者骨改建速度及效果存在差异。Jäger等^[2]的研究表明,30岁以上的成年人牙槽骨丧失风险增大。成人患者缺乏生长潜力,其牙槽骨的动态改建能力下降,如果正畸牙移动超出牙槽骨的改建能力,那么牙齿将可能突破牙槽骨,从而导致前牙出现骨丧失。而青少年患者处于生长发育高峰期,这一阶段牙槽骨仍继续生长,这种生长特殊性使青少年患者的牙周组织受到机械力刺激后,相较于成年人,在随访期,正畸治疗造成的骨丧失可能会有更好的恢复。

Elnagar等^[1]的研究表示20~35岁患者正畸治疗后,牙槽骨厚度的变化与性别无关。Janson等^[9]也认为对于不同年龄段的拔牙矫治患者,治疗后其牙槽骨高度的变化无性别差异。但是限于目前的研究,基于三维影像对不同年龄段、不同性别前牙区牙槽骨改建差异的相关内容尚未见报道,后期应当通过进一步的高质量研究和长期观察来评估其差异性。

5 前牙区牙槽骨变化的术后随访

Liu等^[33]报道青少年拔牙矫治患者在随访期,下颌切牙阻抗中心及往下3 mm处舌侧牙槽骨厚度增加。Wang等^[32]发现青少年双颌前突患者拔牙矫治后出现前牙区牙槽骨骨丧失,但经过18~24个月的保持后,舌侧根颈部有新生骨生成。Bae等^[34]对一名成年上颌前突女性前牙腭侧牙槽骨的研究结果显示,治疗后上颌切牙除根尖部位外,其余位点出现了牙槽骨缺损;在经过约10年的保持后,发现该位点腭侧根部大部分被骨覆盖,并可见较厚的皮质骨。有学者^[35-36]认为尽管经过足够长时间,正畸治疗后前牙区的牙槽骨似乎并没有恢复至初始水平。Son等^[35]对11例保持时长超过5年的患者进行CBCT研究发现,约1/4的患者上颌前牙区牙槽骨未恢复。骨新生有一定限度,当牙

槽骨缺损超过了这一限度之后,可能会造成无法恢复的医源性骨缺损。Liu等^[33]表示牙槽骨改建完成时长至少为2年。但国内外正畸患者后续更长随访时间的牙槽骨变化,尤其是前牙区牙槽骨变化的研究尚未见报道。

6 前牙区牙槽骨丧失的防治

前牙大范围移动后,牙槽骨的变化与多种因素相关^[21]。矫治力的施加应尽可能轻且均匀,控制牙移动的速率,在青少年时期进行矫治有利于前牙区牙槽骨的恢复。无托槽隐形矫治器有助于维护口腔卫生,可能减小牙周炎患者骨丧失的风险^[36]。同时由于骨改建机制涉及分子水平,多种通路影响破骨细胞和成骨细胞的生成和凋亡。Lu等^[37]的研究认为局部注射甲状旁腺激素或甲状旁腺激素相关肽水凝胶能有效加速成骨细胞的生成。但目前研究多集中于细胞实验,相关的动物实验及临床试验尚待进一步研究。

7 小结与展望

综上所述,正畸治疗前牙移动过程中存在影响牙周组织的风险,应规避前牙过度内收造成不可逆的医源性骨丧失,从而损伤牙周组织健康。目前尚缺乏基于三维影像对不同年龄段患者前牙区牙槽骨长期变化的对比研究,以及不同骨面型、牙齿移动方式、速率等与前牙区牙槽骨改建的相关性研究;青少年与成年患者前牙区牙槽骨改建的对比分析,对于临床指导前牙内收具有重大意义。对前牙区牙槽骨改建的相关分子机制详细阐述,也是后期研究的重点。

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