[DOI]10.12016/j.issn.2096-1456.2024.04.005

·临床研究·

埋伏上切牙正畸牵引的临床分析

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【摘要】　目的　探讨埋伏阻生上切牙正畸牵引对牙根、牙周软硬组织的影响。**方法**　本研究已通过单位伦理委员会审查批准，并获得患者知情同意。选取2018年01月—2022年12月完成阻生上切牙正畸牵引的患者40例，选择对侧同名牙根尖孔未发育完成的为A组（23例），对侧同名牙根尖孔发育完成的为B组（17例）。利用锥形束CT（cone beam CT，CBCT）测量A、B组埋伏的上切牙牵引前后的牙根长度，比较患牙牵引后与对侧同名牙以及1年后患牙的牙槽骨（牙槽骨宽度、唇侧骨板厚度、牙槽骨高度）及角化龈宽度变化。**结果**　埋伏上切牙牵引后牙根长度较牵引前均有所增长（$P<0.05$）；A组牵引后的牙槽骨宽度接近对侧同名牙牙槽骨宽度（$P>0.05$），而B组牵引后的牙槽骨宽度无法达到对侧同名牙厚度，差异具有统计学意义（$P<0.05$），A、B组牵引后的唇侧骨板均无法达到对侧同名牙的高度及厚度（$P<0.05$），角化龈宽度也显著小于对侧同名牙（$P<0.05$）；但A组1年后的回访中，角化龈宽度显著增长（$P<0.05$）。**结论**　对埋伏上切牙牵引，有利于埋伏的上切牙牙根生长、牙槽骨的改建和角化龈的生长，但仍无法达到与对侧同名牙完全对称的状态。

【关键词】　埋伏牙；　角化龈宽度；　牙槽骨宽度；　牙根长度；　锥形束CT；　正畸牵引；　前牙美学；　牙龈生物型
【中图分类号】　R78　**【文献标志码】**　A　**【文章编号】**　2096-1456（2024）04-0273-07
【引用著录格式】　郭苏莹，陆史俊，丁元凤. 埋伏上切牙正畸牵引的临床分析[J]. 口腔疾病防治，2024，32(4)：273-279. doi:10.12016/j.issn.2096-1456.2024.04.005.

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Clinical analysis of orthodontic traction of impacted upper incisors

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【Abstract】　Objective　To study the effect of orthodontic traction on the roots and periodontal soft and hard tissues of buried obstructed upper incisors. **Methods**　This study was reviewed and approved by the ethics committee, and informed consent was obtained from the patients. From January 2018 to December 2022, 40 patients who underwent orthodontic traction on impacted upper incisors were selected; those whose contralateral homonymous apical foramen was not developed were placed in group A (23 cases), and those whose contralateral homonymous apical foramen was developed were placed in group B (17 cases). Software was used to measure the root length of the impacted upper incisors in groups A and B on cone beam CT (CBCT) images before and after traction and compare the changes in alveolar bone (alveolar bone width, labral bone plate thickness, and horizontal height of alveolar bone) and keratinized gingival width between each impacted upper incisor and the corresponding contralateral tooth immediately and one year after traction. **Results**　The root length of the impacted upper incisors increased after traction compared to before traction ($P<0.05$). The width of the alveolar bone at the completion of traction in group A was similar to that of the contralateral homonymous tooth ($P>0.05$), whereas the width of the alveolar bone at the completion of traction in group B did not reach that of the contralateral homonymous tooth, with a significant difference in width ($P<0.05$). Neither the labial bone plate height or width in group A or B reached that of the contralateral homonymous tooth after traction ($P<0.05$). The keratinized gingival width on the affected side was also significantly smaller than that on the contralateral side ($P<0.05$), but

【收稿日期】2023-05-22；　**【修回日期】**2023-11-29
【基金项目】江苏省自然科学基金青年基金项目（BK20200208）
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it was increased significantly in group A at the one-year follow-up visit ($P < 0.05$). **Conclusion**　Tooth traction is conducive to impacted upper incisor root growth, alveolar bone reconstruction and keratinized gingival growth but cannot produce complete symmetry with respect to the contralateral side.

【Key words】 impacted teeth; keratinized gingiva width; alveolar bone width; root length; cone beam CT; orthodontic traction; anterior tooth aesthetics; gingival biotype

J Prev Treat Stomatol Dis, 2024, 32(4): 273-279.

【Competing interests】 The authors declare no competing interests.

This study was supported by the grants from Jiangsu Provincial Natural Science Foundation Youth Fund Project (No. BK20200208).

埋伏牙是混合牙列阶段较为常见的一种错𬌗畸形，常由乳牙早失、牙外伤、遗传等因素导致[1]。部分患者的埋伏牙在替牙早期易被发现，而此时年轻恒牙的根尖孔尚未发育完成，但埋伏牙由于受到软、硬阻力或牙胚方向不正等原因的影响，无法自行萌出。年轻恒牙的上皮根鞘、根尖牙乳头与根尖孔及牙髓组织的连接比较疏松，当受到外力或炎症压力时，容易导致主牙根发育停滞[2]，对牙根的生长发育产生影响，从而影响牙齿的萌出。目前临床上不会单纯的拔除，尝试正畸牵引埋伏前牙入牙列[3]。牙龈生物型反映了牙周软组织及其牙槽骨组织的特征[4]，不同牙周生物型对于牙龈退缩及牙龈乳头存留等相关[5]，而厚龈型更有利于牙齿的稳固和对炎症的抵抗[6]，也对维持牙周健康有着重要的意义[7]。目前在临床上锥形束CT（cone beam CT，CBCT）主要应用于对正畸牵引后硬组织的常规测量，对于正畸牵引后埋伏牙的牙周情况研究较少。本研究拟对上切牙埋伏阻生的牵引治疗后的牙根、牙槽、牙龈做进一步研究分析。

1　资料和方法

1.1　研究对象

经苏州口腔医院伦理委员会批准及患儿和家属知情同意（批号：SZKQYY-2018-ZJ006），选取2018年01月—2022年12月在我院正畸一科就诊的上颌切牙埋伏阻生的患者40例。纳入标准：①影像资料完整；②埋伏牙牙周膜清晰；③单侧埋伏上切牙牙长轴与对侧同名牙成角≤90°；④牙根弯曲成角＜90°；⑤牙根根尖孔未闭合；⑥对侧同名牙正常萌出到位；⑦牙周状况良好。排除标准：①近期外伤史；②影像资料不完整；③埋伏牙无牙周膜清晰影像；④牙根已吸收；⑤牙根弯曲成角≥90°；⑥上前牙严重牙周炎症；⑦埋伏牙位置过深或发生根骨粘连；⑧全身系统性疾病。将纳入病例分为两组：①A组：对侧同名牙根尖孔未发育完成23例（年龄7～10岁，男10例，女13例，埋伏上切牙25颗，其中参与1年回访的埋伏牙10颗）；②B组：对侧同名牙根尖孔已发育完成17例（年龄11~15岁，男6例，女11例，埋伏上切牙17颗，其中参与1年回访的埋伏牙7颗）。

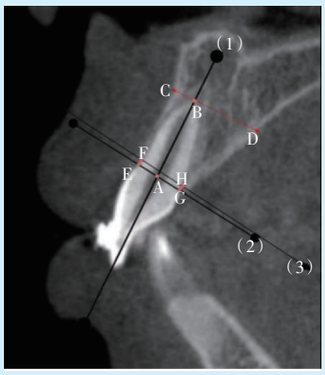
1.2　临床操作

根据患者的牙列情况，制定适合患者的矫正方案。由同一医师对埋伏阻生的上切牙进行闭合式牵引。外科辅助开窗，通过CBCT观察埋伏牙的位置情况和邻牙关系，与口腔颌面外科医师共同选择开窗位置和方向。外科翻瓣去骨后暴露埋伏牙最凸点，在保证视野足够的情况下，减少创伤，避免因开窗范围过大而导致术后牙龈萎缩或瘢痕明显。酸蚀清理暴露出的牙面，用光固化树脂改良型正畸粘接用玻璃离子水门汀（GC Fui Ortho LC）粘接单眼扣，0.25 mm的结扎丝穿入单眼扣后拧紧，末端回弯超出翻瓣黏膜，用弹力线将结扎丝末端固定在牵引装置上，然后缝合，在后期每间隔1个月复诊，通过调整结扎丝和弹力线加力，不大于0.59 N，待埋伏牙露龈后可使用细弓丝辅助排入牙列。

1.3　研究方法

由同一名医师筛选出符合条件的42颗埋伏牙。将CBCT影像（KaVo OP3D Pro测量结果、DICOM数据集）导入测量软件（CS 3D Imaging Software系统），进行图像处理和三维重建，通过调整经过根尖和切端的矢状面，获得埋伏牙最长截面，在此截面上选取实验需要的点进行测量。对患牙及对侧同名牙的角化龈宽度进行测量。数据由该医师在4周内测量完成，每份测量3次，取平均值。根长参照Gribel等[8]、Kim等[9]测量方法，测量根长、牙槽骨宽度、唇侧骨板厚度、牙槽骨高度、角化龈宽度。①根长：根尖点到唇腭侧釉牙骨质界连线与牙长轴交点的长度（弯根取唇腭侧釉牙骨质界中

点与根尖点连线长度)。②唇、腭侧牙槽骨高度:唇、腭侧釉牙骨质界至牙槽嵴顶的长度。③唇侧骨板厚度:过根尖点与牙长轴垂直的唇侧垂线长度。④牙槽骨宽度:过根尖点与牙长轴垂直的垂线长度。⑤角化龈宽度:游离龈缘中点到膜龈联合线的垂直长度。图1为测量截图示例。



Line segment (1): the long axis of the tooth; line segment (2): the connection between the root tip and the lip and palate side; line segment (3): the connection of the alveolar crest on the lip and palatal side; A: the intersection between the tooth and the long axis; B: root point; C: the intersection between the apical point and the vertical line in the labial alveolar bone; D: the intersection of the apical point and the vertical line of the alveolar bone on the palatal side; E: labial cemento-enamel junction; F: the apx of the labral alveolar crest; G: the lateral cemento-enamel junction of the palate; H: the apex of the alveolar ridge on the palatal side

Figure 1　Screenshot of cone beam CT sagittal measurement of root length and periodontal hard tissue width of maxillary mesial incisors

图1　上颌中切牙牙根长度、牙周硬组织宽度锥形束CT矢状向测量截图

1.4　统计学方法

SPSS 27.00对数据进行统计学分析,符合正态分布,使用配对t检验比较埋伏牙牵引前后的差异,使用独立样本t检验比较埋伏牙牵引后和对侧同名牙的差异,检验水准$\alpha = 0.05$。

2　结　果

2.1　两组牵引前后的牙根长度的比较

A、B组牵引前后的牙根长度均增加,差异有统计学意义(A组:$P < 0.001$,B组:$P = 0.001$)(表1)。

2.2　牵引完成后患牙与对侧同名牙的牙槽骨及角化龈宽度测量比较

A组:牵引后与对侧同名牙的唇侧骨板厚度、唇侧牙槽骨高度、角化龈宽度均存在差异,差异有统计学意义($P < 0.05$);与对侧同名牙的牙槽骨宽度、腭侧牙槽骨高度接近($P > 0.05$)(表2)。B组:牵引后与对侧同名牙的牙槽骨(牙槽骨宽度、唇侧骨板厚度、牙槽骨高度)、角化龈宽度均存在差异,差异有统计学意义($P < 0.05$)(表3)。

2.3　牵引后患牙正畸治疗结束1年后的根长、牙槽骨及角化龈宽度测量比较

A组:牵引1年后,患牙的根长、唇侧牙槽骨高度和角化龈宽度较牵引完成时有显著变化,且差异有统计学意义($P < 0.05$),牙槽骨(牙槽骨宽度、唇侧骨板厚度、腭侧牙槽骨高度)与完成时比较无显著差异($P > 0.05$)(表4)。B组:牵引1年后,患牙的根长、牙槽骨(牙槽骨宽度、唇侧骨板厚度、牙槽骨高度),角化龈宽度与牵引完成时比较无显著差异($P > 0.05$)(表5)。

表1　两组牵引前后的牙根长度比较

Table 1　Comparison of root length before and after traction in groups　$\bar{x} \pm s$

	Root length/mm	
	Group A	Group B
Before traction	8.39 ± 1.53	9.94 ± 1.48
After traction	10.13 ± 0.99	11.55 ± 0.98
t	−7.398	−3.991
P	< 0.001	0.001

Group A: the apical foramen of the contralateral tooth has not been developed; Group B: the apical foramen of the contralateral tooth has been developed

表2　A组牵引完成后患牙与对侧同名牙的牙槽骨及角化龈宽度测量结果比较

Table 2　Comparison of alveolar bone and KGW measurements of the impacted teeth and the contralateral tooth after traction in group A　$\bar{x} \pm s$

	The width of the alveolar bone/mm	Lip side bone plate thickness/mm	Labial alveolar bone horizontal height/mm	Horizontal height of the alveolar bone/mm	KGW/mm
Impacted teeth	10.71 ± 0.98	2.75 ± 1.08	1.84 ± 0.49	0.86 ± 0.71	3.82 ± 0.59
The contralateral tooth of the same name	10.94 ± 0.99	4.73 ± 0.98	1.24 ± 0.47	0.78 ± 0.49	5.96 ± 0.31
t	−0.800	−6.796	4.465	0.579	−15.887
P	0.78	< 0.001	0.001	0.560	< 0.001

Group A: the apical foramen of the contralateral tooth has not been developed; KGW: keratinized gingival width

表3　B组牵引完成后患牙与对侧同名牙的牙槽骨及角化龈宽度测量比较

Table 3　Comparison of alveolar bone and KGW measurements of theimpacted teeth and the contralateral tooth after traction in group B　$\bar{x} \pm s$

	The width of the alveolar bone/mm	Lip side bone plate thickness/mm	Labial alveolar bone horizontal height/mm	Horizontal height of the alveolar bone/mm	KGW/mm
Impacted teeth	10.49 ± 1.00	3.06 ± 0.58	1.53 ± 0.27	1.31 ± 0.20	3.73 ± 0.38
The contralateral tooth of the same name	11.57 ± 0.58	4.04 ± 0.68	1.14 ± 0.23	0.95 ± 0.29	5.71 ± 0.39
t	−3.834	−4.523	4.557	4.188	−14.978
P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Group B: the apical foramen of the contralateral tooth has been developed; KGW: keratinized gingival width

表4　A组牵引1年后患牙的根长、牙槽骨及角化龈宽度变化

Table 4　Changes in root length, alveolar bone, and keratinized gingival width of impacted teeth in Group A after one year of traction　$\bar{x} \pm s$

	Root length	The width of the alveolar bone	Lip side bone plate thickness	Labial alveolar bone horizontal height	Horizontal height of the alveolar bone	KGW/mm
After traction	9.95 ± 1.03	10.97 ± 1.16	2.83 ± 1.1	1.83 ± 0.35	0.94 ± 1.04	3.87 ± 0.57
One year after traction	11.45 ± 0.68	11.10 ± 1.19	3.09 ± 1.28	1.49 ± 0.34	0.92 ± 0.89	4.76 ± 0.66
t	−4.022	−1.998	−1.924	5.346	0.349	−4.346
P	0.003	0.077	0.087	0.001	0.74	0.002

Group A: the apical foramen of the contralateral tooth has not been developed; KGW: keratinized gingival width

表5　B组牵引1年后患牙的根长、牙槽骨及角化龈宽度变化

Table 5　Changes in root length, alveolar bone, and keratinized gingival width of impacted teeth in Group B after one year of traction　$\bar{x} \pm s$

Group B	Root length	The width of the alveolar bone	Lip side bone plate thickness	Labial alveolar bone horizontal height	Horizontal height of the alveolar bone	KGW/mm
After traction	11.15 ± 0.61	10.47 ± 1.03	2.95 ± 0.50	1.54 ± 0.37	1.34 ± 0.23	3.70 ± 0.37
One year later traction	11.32 ± 0.72	10.74 ± 0.77	3.01 ± 0.47	1.42 ± 0.31	1.26 ± 0.22	3.81 ± 0.31
t	−1.297	−2.244	−2.401	2.301	2.121	−2.066
P	0.242	0.066	0.053	0.061	0.078	0.084

Group B: the apical foramen of the contralateral tooth has been developed; KGW: keratinized gingival width

2.4　埋伏上切牙正畸牵引典型案例

A组典型病例，患者，男，年龄10岁，治疗前11垂直向骨埋伏阻生（图2a）；51滞留，21萌出到位（图2b）。外科开窗+正畸闭合式牵引11（图2c）；治疗结束后11牵引到位（图2d）；拆除矫治器，11、21、22唇侧保持丝保持（图2e）。

B组典型病例，患者，男，年龄11岁，治疗前11垂直向骨埋伏阻生（图3a）；12萌出、扭转，21、22萌出到位（图3b）。外科开窗+正畸闭合式牵引11（图3c）；治疗结束后11牵引到位（图3d）；拆除矫治器，11、12、21、22唇侧保持丝保持（图3e）。

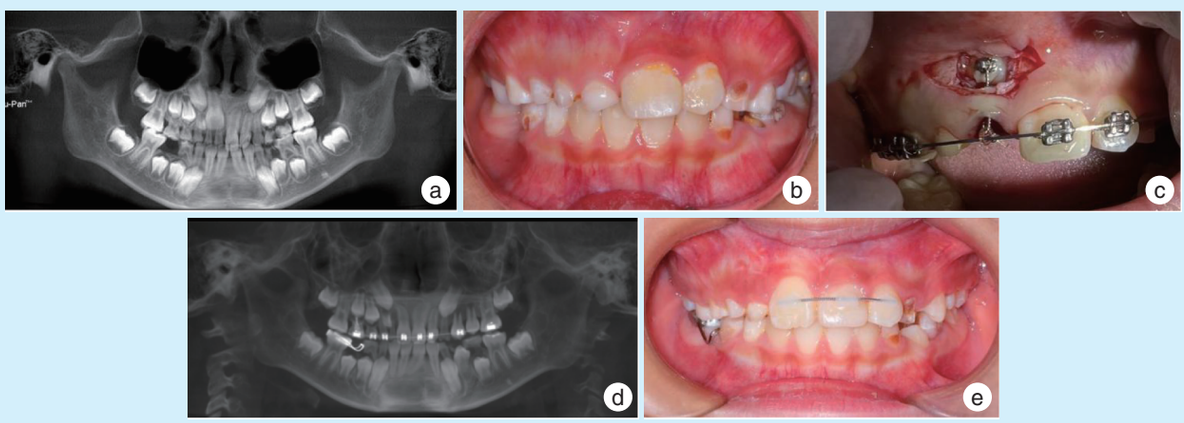
3　讨　论

3.1　CBCT在正畸牵引中的运用

高分辨率CBCT可显示清晰的三维图像[10]，可评估埋伏阻生牙的牙根发育及周围组织结构，为外科开窗、正畸牵引和后期观察牙根、牙槽骨情况等提供帮助[11]。在本研究的埋伏牙牵引中，主要为翻瓣闭合牵引[12]，CBCT在矫正前期的方案设计、风险评估以及观察牙体和牙周组织提供了可靠数据，在后期随访观察中，CBCT也提供了有力的数据证明。

3.2　正畸牵引治疗对牙根的影响

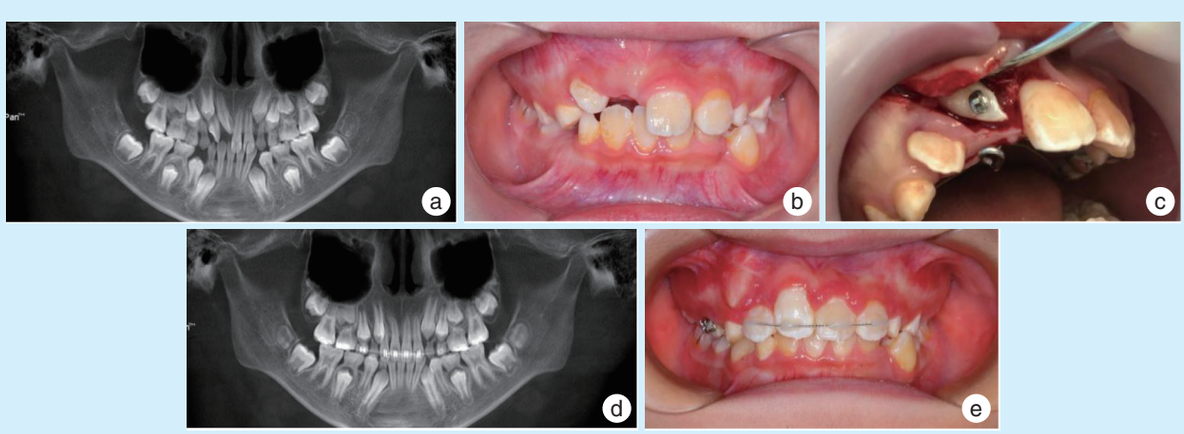
在正畸治疗过程中，牙根吸收是常见的风险[13]，应注意力的方向和大小控制[14]，禁重而持续的力，牵引力一般不超0.59 N[15]，以免激惹牙髓或引起牙周组织炎症等。3～6个月拍片观察牙位情况，调整力的方向，及时分析潜在的软、硬组织阻力[16]，避免造成不必要的邻牙损伤和牙根外吸收[17]。在本研究中，正畸牵引后的牙根均较牵引



a: pretreatment CBCT showed 11 vertical bone ambush impacted, unclosed apical foramen, 12 small teeth, 21 the apical aperture was not closed, 74 the residual roots, 85 early loss; b: poor oral hygiene, 51, 52 stranded, 21, 22 sprout in place; c: surgical window exposure 11, splice buckle-ligation wire combination, orthodontic closed pull 11 to move; d: end of treatment CBCT showed 11 traction in place, root parallelism of the maxillary incisor is acceptable, 85 existing gaps are maintained; e: the intraoral photo at the end of treatment showed 11, 21 inconsistent labial gingival height, 11, 21, 22 the labial side remained filament maintained

Figure 2　The apical foramen of the contralateral tooth has not been developed, 11 CBCT screenshots and oral photos before and after impacted orthodontic treatment

图2　对侧同名牙根尖孔未发育完成，11埋伏阻生正畸治疗前后锥形束CT及口内照片



a: pretreatment CBCT showed 11 vertical bone ambush impacted, unclosed apical foramen, 21 the apical aperture was closed; b: poor oral hygiene, no oral presence in 11, 12 the torsion is uneven, 21, 22 sprout in place; c: surgical window exposure 11, splice buckle-ligation wire combination, orthodontic closed pull 11 to move; d: end of treatment CBCT showed 11 traction in place, root parallelism of the maxillary incisor is acceptable; e: the patient showed poor oral hygiene, red gingival swelling in the maxillary anterior tooth area, 11, 21 labial gingival height inconsistency, 11, 12, 21, 22 the labial side remained filament maintained

Figure 3　The apical foramen of the contralateral tooth has been developed, 11 CBCT screenshots and oral photos before and after impacted orthodontic treatment

图3　对侧同名牙根尖孔发育完成，11埋伏阻生正畸治疗前后锥形束CT及口内照片

前生长，A组中牵引1年后的牙根也较牵引完成时有所增长，这也表明更早期的埋伏牙牵引能促进根尖未发育完成的牙根进一步生长，对牙根的生长发育有积极作用[18]，这与Zasčiurinskienė等[19]研究结果一致。因此早期检测和干预阻生牙，建立生理上正常的咬合是必要的[20]。

3.3　正畸牵引治疗对牙周组织的影响

由于埋伏牙的迟萌，无法与邻牙形成及时的邻接关系，对牙龈高度有不同程度的影响，所以牵引后的牙龈高度与对侧同名牙存在差异，也给后

续修复带来困难，同时影响了前牙美学效果[21]。正畸牵引埋伏牙的主要目的是将埋伏的功能牙排入牙列，对比以往单纯拔除的方法，保留了天然功能牙，恢复了牙龈原有的物理支撑，结合上皮和结缔组织在牙齿上能重新建立生物附着，软组织更加稳定，也维护了前牙区的美观[5]。在本研究中，A组牵引后的牙槽骨宽度和腭侧牙槽骨高度可以接近对侧同名牙的牙槽嵴宽度，而B组的结果显示，牵引后的牙槽骨宽度和腭侧牙槽骨高度与对侧同名牙的测量结果存在明显差异。A组牵引后1年后的唇侧牙槽骨高度与牵引后即刻相比差异具有统计学意义，而B组的唇侧牙槽骨高度在牵引后1年无显著变化，这可能是由于埋伏牙的非按时萌出，无法及时形成良好的牙槽窝，牙槽嵴顶的改建也无法正常进行，因此牵引后的牙槽骨高度无法达到与对侧同名牙同一高度[22]。在对侧同名牙根尖孔未闭合时期，患者可能处于生长发育高峰期，骨组织改建相较活跃，因此A组在牵引至牙列正常位置后，牙槽骨的适应性较B组好，骨丧失可能会有较好的恢复。Ruíz-Mora等[23]的研究也表明越早的牵引埋伏牙，对牙周组织的改建越有利。A、B组中唇侧骨板厚度，和牙槽嵴高度明显不及对侧同名牙，提示唇侧牙槽骨的发育不足[24]，牙周生物型由牙龈表型（指牙龈的三维体积）和骨形态型（颊骨板厚度）决定[25]，进而影响了角化龈宽度，导致前牙牙龈形态不对称，影响颌面部的美观协调[26]。

角化龈较坚韧，能抵挡一定的外部刺激，有稳定龈缘的作用[27]，也可阻挡牙龈炎症的蔓延，而相对于厚龈型，薄龈型治疗的美学风险更大[6]，并且容易出现并发症，有学者认为，牵引后的角化龈宽度与对侧同名牙差异不明显[28]，但在本研究中，牵引后的角化龈宽度仍无法达到与对侧同名牙完全对称的状态，也提示了牵引后牙齿的美学效果和稳固性较对侧同名牙差。在患牙1年后的随访中，A组的角化龈宽度有增加，B组变化较小，但均无法达到对侧同名牙角化龈宽度。在正面观上有较明显的差异，从而在前牙美学效果上产生了一定的影响，不同人群对中切牙龈缘高度不对称的敏感性和可接受度不同[29]，因此对于要求更好牙周条件的患者可以尝试游离龈移植（free gingival graft，FGG）等方法来增加颊侧角化龈宽度[30-31]。

综上，早期正确的埋伏牙牵引有利于埋伏阻生牙牙根的生长、牙槽骨的改建和角化龈的生长，但仍无法达到与对侧同名牙完全对称的状态。目前在临床上CBCT主要应用于对正畸牵引后硬组织的常规测量，而对于前牙美学区域软组织形态的测量分析也应是埋伏尖牙牵引效果评价的重要指标之一，最终的牙周健康也是评估阻生牙治疗成功与否的关键。

【Author contributions】 Guo SY designed the study, collected, processed and analyzed the data and wrote the article. Ding YF and Lu SJ designed the study, analyzed the data, revised the article. All authors read and approved the final manuscript as submitted.

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（编辑　周春华）

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