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·临床研究·

上颌横向发育不足患者的腭中缝成熟度及腭部三维分析

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【摘要】 **目的** 探讨骨性Ⅰ类上颌横向发育不足和上颌横向发育正常患者上颌骨及腭部三维数据差异以及腭中缝成熟度差异,为正畸诊疗提供参考。**方法** 本研究已通过单位医学伦理委员会审查批准,并获得患者知情同意。66例锥形束CT资料完整清晰的骨性Ⅰ类错𬌗患者,其中男性22例,女性44例,平均年龄(14.39±1.68)岁。根据延世大学宽度分析法将其分为2组,上颌横向发育不足组33例,年龄(14.34±1.99)岁;上颌横向发育正常组33例,年龄(14.43±1.33)岁,测量并比较两组腭中缝成熟度分期(A~E期)、鼻底上颌骨性宽度(maxillary skeletal width on nasal floor,NF)、硬腭底上颌骨性宽度(maxillary skeletal width on hard palate,HP)、颊侧牙槽嵴顶上颌牙弓宽度(maxillary arch width on buccal alveolar crest,BAC)、舌侧牙槽嵴顶上颌牙弓宽度(maxillary arch width on lingual alveolar crest,LAC)、腭穹隆高度、腭部骨板厚度、腭部长度、腭部表面积以及腭部体积的差异。**结果** 上颌横向发育不足组腭中缝成熟度分期为D+E期的患者共11例,占比33%(11/33);而上颌横向发育正常组的D+E期患者共15例,占比45%(15/33),两组间无统计学差异。上颌骨及腭部三维数据分析结果显示:上颌横向发育不足组上颌骨性宽度[NF:(67.63±3.74) mm *vs* (71.49±5.11) mm;HP:(64.60±3.53) mm *vs* (68.40±4.64)mm]、上颌牙弓宽度[BAC:(56.88±2.25)mm *vs*(59.81±2.71)mm;LAC:(33.90±1.89)mm *vs* (36.91±2.20)mm]、腭部表面积[(1 170.80±126.48)mm^2 *vs*(1 264.76±140.10)mm^2]显著小于上颌横向发育正常组,而2组腭穹隆高度、腭部骨板厚度、腭部长度以及腭部体积的差异无统计学意义。**结论** 上颌横向发育不足的骨性Ⅰ类错𬌗患者,上颌骨性宽度以及牙弓宽度缩窄,腭部表面积减小,腭中缝成熟度较低,应抓住时机进行扩弓,以协调上下颌骨横向关系。

【关键词】 上颌横向发育不足; 腭中缝成熟度; 锥形束CT; 腭部表面积; 腭部体积; 腭穹隆; 牙弓宽度; 腭部长度

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Three-dimensional analysis of midpalatal suture maturation stages in patients with maxillary transverse deficiency

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【Abstract】 **Objective** To investigate the differences in three-dimensional maxillary and palatal parameters as well as midpalatal suture maturation stages between Skeletal Class I malocclusion patients with maxillary transverse deficiency (MTD) and normal maxillary transverse development, in order to provide clinical guidance for orthodontic diagnosis and treatment. **Methods** This study was approved by the institutional ethics committee and informed consent was obtained. Cone-bean CT data from 66 Skeletal Class I malocclusion patients [22 males, 44 females; age (14.39 ± 1.68)

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years] were analyzed. Based on Yonsei University width analysis, participants were divided into two groups: the maxillary transverse deficiency group [n = 33, age (14.34 ± 1.99) years] and the maxillary transverse normal group [n = 33, age (14.43 ± 1.33) years]. Parameters compared included midpalatal suture maturation stages (A-E), maxillary skeletal width on nasal floor (NF) and maxillary skeletal width on hard palate (HP), maxillary arch width on buccal alveolar crest (BAC) and maxillary arch width on lingual alveolar crest (LAC), palatal vault height, palatal bone thickness, palatal length, surface area, and volume. **Results** The proportion of patients with palatal suture maturity at stages D+E in the maxillary transverse deficiency group (33%, 11/33) was lower than that in the normal maxillary transverse development group (45%, 15/33), showing no statistically significant difference between the two groups. Compared to the maxillary transverse normal group, significant reductions were observed in the maxillary transverse deficiency group for maxillary widths [NF: (67.63 ± 3.74) mm *vs.* (71.49 ± 5.11) mm; HP: (64.60 ± 3.53) mm *vs.* (68.40 ± 4.64) mm], dental arch widths [BAC: (56.88 ± 2.25) mm *vs.* (59.81 ± 2.71) mm; LAC: (33.90 ± 1.89) mm *vs.* (36.91 ± 2.20) mm], and palatal surface area [(1 170.80 ± 126.48) mm^2 *vs.* (1 264.76 ± 140.10) mm^2]. No significant differences were noted in palatal height, bone thickness, length, or volume. **Conclusion** Skeletal Class I malocclusion patients with MTD have narrowed maxillary and dental arch widths, reduced palatal surface area, and delayed midpalatal suture maturation. Early maxillary expansion is recommended to harmonize jaw relationship.

【Key words】 maxillary transverse deficiency; midpalatal suture maturation; cone-beam computed tomography; the surface area of palate; the volume of palate; the palatal vault; the width of the arch; the length of the palate

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上颌横向发育不足(maxillary transverse deficiency)是常见的错𬌗畸形之一,临床表现为腭盖高拱、单侧或双侧后牙反𬌗、微笑时颊廊过大等[1]。根据Björk等[2]的研究,上颌横向宽度的生长发育一直持续到青少年晚期,而腭中缝的生长在其中发挥着关键作用。腭中缝的钙化程度随着年龄的增长逐渐增加,但发生融合的时间因人而异,融合时间15岁~19岁不等[3]。有学者发现,一些罹患综合征(如唇腭裂)的患者上颌骨周围骨缝过早融合,致使上颌骨生长发育受限,临床表现为上颌骨三维方向上的发育不足[4]。因此,腭中缝的钙化融合情况在一定程度上影响着上颌骨横向宽度的发育。

上颌横向发育不足,常伴随上下颌骨矢状向以及垂直向不调[5],却在临床上容易被忽视[6],而正畸治疗后维持长期稳定性,不仅需要上下牙齿尖窝相对,也包括上下颌骨三维方向的协调[1],因此,上颌骨横向发育不足的诊断与治疗非常重要。上颌横向发育正常时,腭部形态正常,此时舌体紧贴上腭,以对抗后牙区颊肌以及前牙区唇肌向内的力量[7],维持口腔内外肌肉力量平衡。发育正常的腭部作为上颌的重要组成部分,在咀嚼、发音、呼吸、吞咽等功能中发挥着重要作用[8-9]。

探究腭中缝成熟度与上颌横向发育之间的关系,分析上颌横向发育不足对上颌骨以及腭部所带来的一系列变化,不仅有利于完善正畸术前的诊断,对正畸治疗方案的制订也发挥着重要作用,然而,目前该方面的研究不足。本横断面研究通过分析测量骨性I类错𬌗畸形患者的CBCT数据,探讨上颌横向发育不足患者的腭中缝成熟度,腭部三维方向以及表面积、体积的改变,为正畸医师临床决策提供一定参考。

1 资料和方法

1.1 研究对象

本研究经陆军军医大学第二附属医院伦理委员会审核通过(审批号:2024-研第338-01)。本次研究样本选取了2022年1月至2024年4月在陆军军医大学第二附属医院口腔科就诊的错𬌗畸形患者,经筛选后,总计纳入66例锥形束CT资料完整清晰,符合条件的患者,其中男性22例,女性44例。

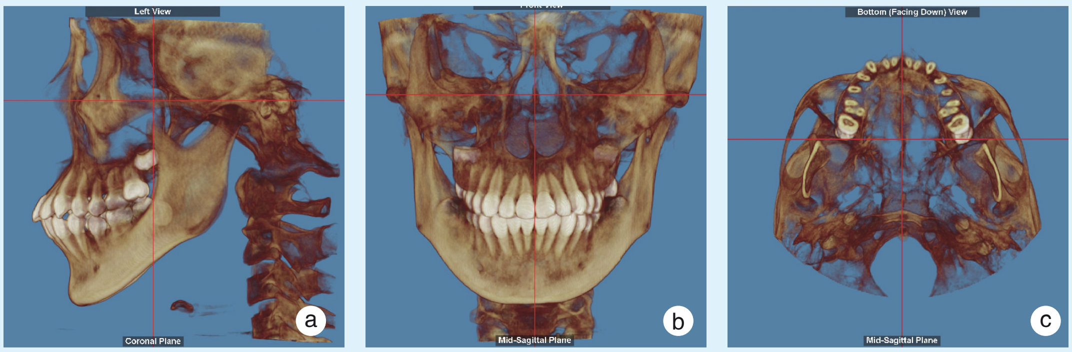
纳入标准:①年龄11~18岁;②恒牙列,无牙齿缺失,4颗第一磨牙萌出至𬌗平面,有咬合接触,根分叉完整,无累及根分叉等牙体牙周组织疾病;③上下牙列的拥挤度均不超过4 mm;④骨性I类错𬌗

关系：0°<ANB<4°。

排除标准：①有正畸治疗史；②牙龈红肿、牙龈溢脓、牙槽骨吸收等牙周炎症状；③有颅颌面部不对称、畸形及综合征等有可能影响骨缝成熟度的疾病；④有外伤史。

1.2　数据采集

所有锥形束 CT 的采集均在患者开始口腔治疗前完成，拍摄时患者取坐位，调整患者头位，使眶耳平面平行于地面，牙齿处于最大咬合接触位，呼吸保持均匀稳定，不吞咽，CT 拍摄采用 KAVO（盈纬达，美国）公司机器 OP 3D Vision 进行（电压 120 kV，电流 5 mA，层厚 0.3 mm）。符合纳入排除标准患者的锥形束 CT 均以 DICOM 格式保存，然后导入 Dolphin Imaging（version 11.8）软件，重建头颅三维图像。之后在 Orientation 界面中，对重建的头颅三维图像进行头位校正（图 1）：①侧面观：眶下缘点与外耳道最上缘点连线与水平线平行；②正面观：双侧眶下点连线平行于水平线；③底面观：前鼻嵴点与枕骨大孔前缘点连线与垂直线平行。



a: the line connecting the infraorbital margin point and the uppermost edge point of the external auditory canal is parallel to the horizontal line (lateral view). b: the line connecting the bilateral infraorbital points is parallel to the horizontal line (frontal view). c: the line connecting the anterior nasal spine point and the anterior edge point of the foramen magnum is parallel to the vertical line (bottom view)

Figure 1　3D reconstruction of head orientation before measurements

图 1　数据测量前的 3D 重建头位校准

1.3　数据测量

1.3.1　腭中缝成熟度分期

腭中缝成熟度分期根据 Angelieri 等[10]提出的方法进行评估。经前述头位校准之后，在横截面上逐张浏览，选取最清晰以及最大程度展示的腭中缝影像的横截面进行分期评价。

Angelieri 等[10]将腭中缝成熟度划分为 A~E 五期（图 2）：A 期腭中缝处几乎为一条高密度的直线，没有或有少量的相互交错；B 期腭中缝处为一条高密度的波浪线；C 期有两条平行的锯齿状高密度线相互接近，部分区域被小的低密度影分开；D 期腭部的腭中缝融合，但前颌骨部分仍可看见腭中缝；E 期前颌骨部分的腭中缝也完全融合。

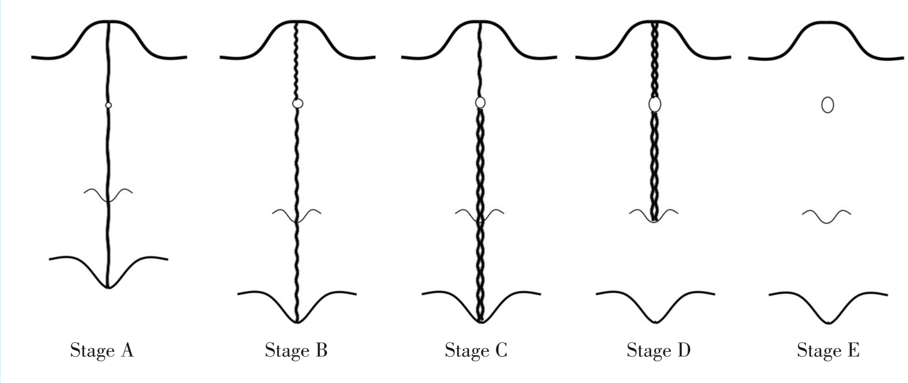
根据前人研究，腭中缝成熟度处在 A~C 期时，对上颌进行传统扩弓可以获得良好的效果[11]，而腭中缝成熟度在 D 期及以上时，腭中缝成熟度较高，上颌传统扩弓会有较大副作用导致效果不佳[12-13]。因此，本次研究将腭中缝成熟度 D 期和 E 期归为一类，C 期及以下归为另一类。

1.3.2　腭部三维数据测量

头位校准后，先进行延世大学牙弓基骨宽度分析测量[14]。在冠状面上对四颗第一磨牙的根分叉进行定点，然后测量上下颌根分叉点间宽度，所得上颌宽度减去下颌宽度，即是延世大学宽度指数。当该指数小于-2.26 mm 时，患者可被诊断为上颌横向发育不足。依据延世大学宽度指数对所有患者进行分组，小于-2.26 mm 的归为上颌横向发育不足组，其余的归为上颌横向发育正常组。其余腭部三维数据的测量同样在矢状面以及冠状面上完成[15-16]（图 3）。

（1）鼻底上颌骨性宽度（maxillary skeletal width on nasal floor，NF）、硬腭底上颌骨性宽度（maxillary skeletal width on hard palate，HP）：在上颌第一磨牙根分叉处截面，与锥形束 CT 上水平线平行，并和鼻底及硬腭底部相切时的上颌骨性宽度。

（2）颊侧牙槽嵴顶上颌牙弓宽度（maxillary arch width on buccal alveolar crest，BAC）、舌侧牙槽



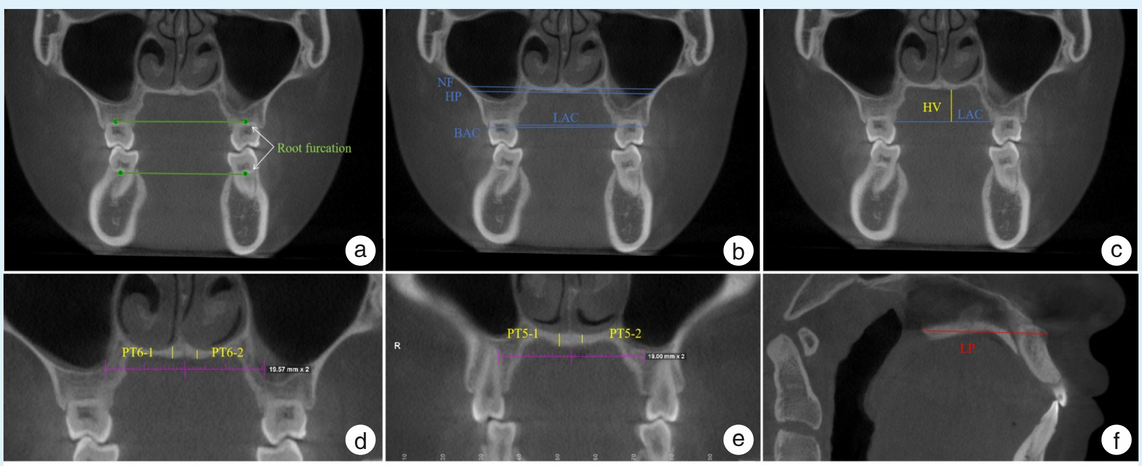
In stage A of midpalatal suture maturation, the midpalatal suture is almost a straight high-density sutural line with no or little interdigitation. In stage B, the midpalatal suture appears as a scalloped high-density line. In stage C, the midpalatal suture appears as two parallel, scalloped, high-density lines that are close to each other and separated by small low-density spaces in some areas. In stage D, the fusion of the midpalatal suture has occurred in the palatine bone, while fusion has not yet occurred in the maxillary portion of the suture. In stage E, fusion of the midpalatal suture has occurred in the maxilla

Figure 2　Schematic drawing of the maturation stages observed in the midpalatal suture

图2　腭中缝成熟度分期示意图

嵴顶上颌牙弓宽度（maxillary arch width on lingual alveolar crest，LAC）：在上颌第一磨牙根分叉处截面，双侧上颌第一磨牙颊侧牙槽嵴顶相连的距离代表BAC；双侧上颌第一磨牙舌侧牙槽嵴顶相连的距离代表LAC。

（3）腭穹隆高度（the highness of palatal vault，HV）：在上颌第一磨牙根分叉处截面，从腭部底最低点做与LAC相垂直的线得到的高度。



a: the points on picture a are the root furcation of four first molars, which were used to conduct the Yonsei index's analysis; b: NF and HP means maxillary skeletal width on nasal floor and maxillary skeletal width on hard palate at the first molar level, separately; b: BAC and LAC indicates maxillary arch width on buccal alveolar crest and maxillary arch width on lingual alveolar crest at the first molar level, separately; c: HV indicates the highness of the palatal vault perpendicular to LAC; d: PT6 indicates the palatal thickness at 3 mm from the midpalatal suture at the first molar level; e: PT5 indicates the palatal thickness at 3 mm from the midpalatal suture at the second premolar level; f: LP indicates the length of the palate at the sagittal view between the upper central incisors

Figure 3　Cone beam CT images showing analysis of dental arch basal bone width measurements used for the Yonsei index and the three-dimensional palate data

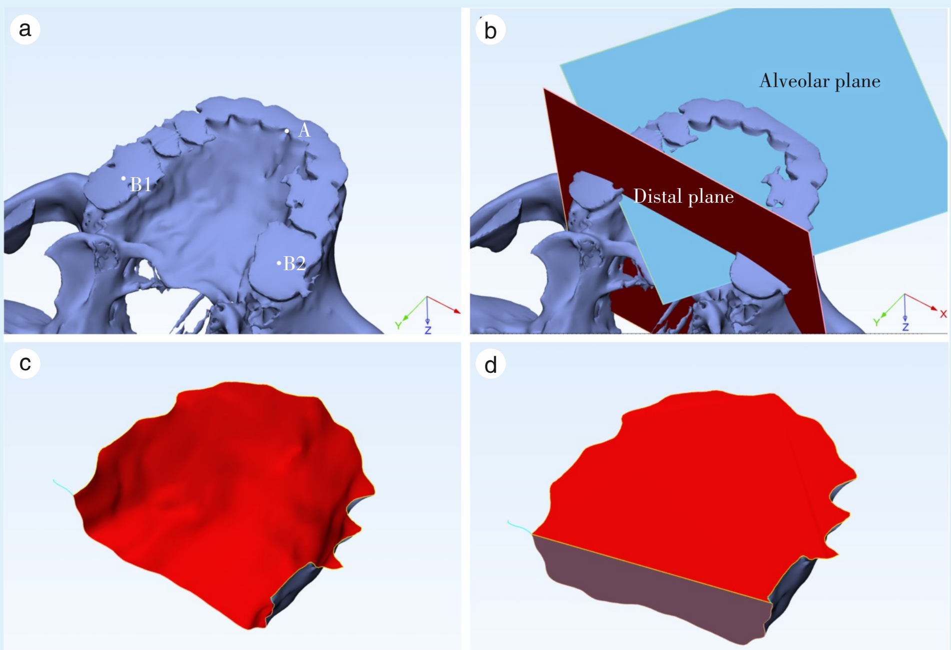
图3　延世大学牙弓基骨宽度分析及腭部三维数据在CBCT上的测量图

（4）第一磨牙双侧腭部骨板厚度（the palatal thickness of both sides on first molar，PT6-1， PT6-2）、第二前磨牙处双侧腭部骨板厚度（the palatal thickness of both sides on first molar and second premolar，PT5-1，PT5-2）：在上颌第一磨牙根分叉处以及上颌第二前磨牙处截面，与锥形束 CT 上水平线相垂直，距离腭中缝双侧 3 mm 处的腭部骨板厚度。双侧厚度数据取平均值。

（5）腭部长度（the length of hard palate，LP）：在矢状面上，上颌双侧中切牙之间，前鼻嵴点与后鼻嵴点相连得到的长度。

1.3.3　腭部表面积以及体积测量　腭部表面积以及体积的测量在 3-MATIC 软件上完成。

首先将 DICOM 文件导入 mimics 软件（version 21.0）中，新建蒙版，阈值定义为 0~3 070 Hu，运用高级分割单独分割出上颌骨腭部部分，并以 stl 格式文件导入至 3-MATIC 软件（version 13.0）。在 3-MATIC 软件里，单独提取出腭部表面，腭部的边界定义为上颌双侧第一磨牙远中至双侧中切牙中点之间腭侧牙槽骨最低点（图 4），此时可在软件参数界面得出腭部表面积（the surface area of palate）。再定义一个牙槽骨平面以及远中平面，用于计算腭部体积（the volume of palate）。牙槽骨平面（alveolar plane，AB1B2）为通过上颌双侧中切牙腭侧牙槽骨最低点连线的中点 A、上颌双侧第一磨牙远中牙槽骨最低点 B1、B2 三点创建的平面。远中平面（distal plane）为通过 B1、B2 两点并且垂直于牙槽骨平面的平面。在软件参数界面，可以得到腭部表面、牙槽骨平面及远中平面形成的物体体积。



a: point A is the midpoint of the line connecting the lowest point of the palatal alveolar bone of the bilateral central incisors, and points B1 and B2 are the lowest point of the distal alveolar bone of the bilateral first molars; b: the alveolar plane is the plane passing through points A, B1, and B2, and the distal plane is the plane passing through points B1 and B2 and perpendicular to the alveolar plane; c: the extracted palatal surface; d: the palatal cavity formed by the palatal surface and the alveolar plane and distal plane, which is used to calculate the palatal volume

Figure 4　Images showing measurements of the surface area and volume of the palate

图 4　腭部表面积及体积测量图

1.4　数据分析

1.4.1　一致性检验　所有的数据测量均由研究者在同一台电脑上测量所得，每隔两周重新测量，共得 3 次数据。对 3 次数据采用重复方差测量分析进行一致性检验，得 $P>0.05$ 后，取 3 次数据的均值进行后续统计学分析。

1.4.2　统计学分析　采用 SPSS 25.0 软件，用 Shapiro-Wilk 正态分布检验以及 Levene 方差齐性检验证实除腭中缝成熟度分期外，其余数据均符合正态分布并且方差齐。腭中缝成熟度分期进行频

数分布统计并进行卡方检验，其余数据进行两独立样本 t 检验，双侧 P<0.05代表数据差异有统计学意义。

2 结 果

2.1 基础数据

上颌横向发育不足组与上颌横向发育正常组的性别、平均年龄、ANB角、下颌平面角均无明显差异（表1）。

2.2 腭中缝成熟度分期

所有患者腭中缝成熟度分期均处于B~E期，其中上颌横向发育不足组D+E期患者共有11例，占比33%，上颌横向发育正常组D+E期患者共有15例，占比45%（表2），两组数据不存在统计学差异。

表1 研究人群的基础特征

Table 1 Basic characteristics of the research subjects $\bar{x} \pm s$

Parameter	Maxillary transverse deficiency group	Maxillary transverse normal group	t	P
Number of males	11	11		
Age of males/years	13.61±1.94	14.25±1.30	−0.91	0.375
Number of females	22	22		
Age of females/years	14.70±1.96	14.52±1.37	0.36	0.724
Average age of all/years	14.34±1.99	14.43±1.33	−0.22	0.827
ANB angle of all	2.21±1.05	2.35±0.98	−0.56	0.581
Mandibular plane angle of all/°	31.08±6.18	30.64±5.74	0.30	0.764

ANB: the angle formed by the subspinale, nasion, and supramental; mandibular plane angle: the angle between the SN plane (the plane formed by the line connecting the sella and the nasion) and the mandibular plane

表2 两组腭中缝成熟度分期比较

Table 2 Comparison of the stage of midpalatal suture maturation between two groups n(%)

Stage	Maxillary transverse deficiency group	Maxillary transverse normal group	χ^2	P
Stage A-C	22(67)	18(55)	1.015	0.314
Stage D-E	11(33)	15(45)		

In stage A, the midpalatal suture is almost a straight high-density sutural line with no or little interdigitation. In stage B of midpalatal suture maturation, the midpalatal suture appears as a scalloped high-density line. In stage C, the midpalatal suture appears as two parallel, scalloped, high-density lines that are close to each other and separated by small low-density spaces in some areas. In stage D, the fusion of the midpalatal suture has occurred in the palatine bone, while fusion has not yet occurred in the maxillary portion of the suture. In stage E, fusion of the midpalatal suture has occurred in the maxilla

2.3 腭部三维数据

腭部三维数据分析结果中，仅上颌骨性宽度（NF和HP）以及上颌牙弓宽度（BAC和LAC）的差异存在统计学意义（P<0.01）。

其中，上颌横向发育不足组的鼻底以及硬腭底的骨性宽度NF、HP显著小于上颌横向发育正常组。上颌横向发育不足组与上颌横向发育正常组鼻底上颌骨性宽度的均值差为3.86 mm，硬腭底上颌骨性宽度均值差为3.80 mm。上颌横向发育不足组的颊舌侧牙槽嵴顶上颌牙弓宽度BAC、LAC明显小于上颌横向发育正常组。上颌横向发育不足组与上颌横向发育正常组颊侧牙槽嵴顶上颌牙弓宽度的均值差为2.93 mm，在舌侧牙槽嵴顶上颌殆宽度均值差为3.01 mm（表3）。

而腭穹隆高度、腭部骨板厚度、腭部长度的2组差异则无统计学意义（P>0.05）。

2.4 腭部表面积以及体积

上颌横向发育不足组的腭部表面积（1 170.80±126.48）mm^{2}显著小于上颌横向发育正常组（1 264.76±140.10）mm^2，而两组腭部体积的差异则无统计学意义（P=0.072）（表3）。

3 讨 论

上颌横向发育不足是临床上常见的错殆畸形之一，但因临床表现不明显等常被忽视。上颌横向发育不足不仅会对正畸术后长期稳定性造成影响，还有可能影响舌体位置，从而对呼吸功能造成影响，损害全身系统健康。因此，阐明上颌横向发育不足时上颌骨发生的变化，对正畸治疗的病因分析、精确诊断、方案制订以及预后判断有着重要作用。

表3 两组腭部三维数据、表面积及体积比较

Table 3 Comparison of three-dimensional data, surface area, and volume of palate between two groups $\bar{x} \pm s$

Parameter	Maxillary transverse deficiency group	Maxillary transverse normal group	t	P
NF/mm	67.63±3.74	71.49±5.11	−3.50	0.001
HP/mm	64.60±3.53	68.40±4.64	−3.74	<0.001
BAC/mm	56.88±2.25	59.81±2.71	−4.78	<0.001
LAC/mm	33.90±1.89	36.91±2.20	−5.95	<0.001
PT6/mm	3.80±1.26	3.70±1.02	0.36	0.724
PT5/mm	4.89±1.84	4.41±1.43	1.17	0.246
HV/mm	11.24±1.79	11.18±2.69	0.11	0.909
LP/mm	47.88±2.67	47.49±2.68	0.59	0.557
Surface area of palate/mm^2	1 170.80±126.48	1 264.76±140.10	−2.86	0.006
Volume of palate /mm^3	10 680.52±1 972.57	11 611.42±2 163.79	−1.82	0.072

NF: maxillary skeletal width on nasal floor; HP: maxillary skeletal width on hard palate; BAC: maxillary arch width on buccal alveolar crest; LAC: maxillary arch width on lingual alveolar crest; PT: the palatal thickness; HV: the highness of palatal vault; LP: the length of hard palate

3.1 腭中缝成熟度变化

Björk等[2]的纵向研究结果显示，从4岁至成人阶段，腭中缝宽度增长量平均达到6.9 mm，且在横向生长的同时，腭中缝在矢状向上也同步发育直至17岁停止。因此，在CBCT应用于口腔诊断之前，正畸医师通常将年龄以及颈椎骨成熟度等评估生长发育的指标，用于指导进行上颌扩弓[17]。但是年龄仅能反映整体人群的腭中缝情况，对于个体患者，腭中缝的发育状况存在着一定程度的变异[4]。颈椎骨成熟度是一种间接评估腭中缝发育状况的方法，并不比年龄存在更多优势[17]。而采用CBCT对腭中缝融合状况进行直接观察及评估，可以更精准地把握合适的扩弓时机。

腭中缝成熟度直接决定了后续正畸治疗方案的制订[18]。对于上颌牙弓狭窄的患者，正畸医师通常采用上颌扩弓的治疗方式，来扩宽上颌牙弓，匹配下颌弓形。虽然本次研究结果显示在频数分布上骨性I类上颌横向发育正常组患者表现出比上颌横向发育不足组患者更高的腭中缝成熟度分期（45% *vs* 33%），但卡方检验结果表明，腭中缝成熟度分期与上颌横向发育之间无显著关联性，这可能与此次研究的样本量较小有关，后续的研究中需增加样本量以进一步探究两者之间的相关性。既往研究显示，对于腭中缝成熟度处于A~C期的患者，采用传统上颌快速扩弓可以获得良好的治疗效果[19]。对于腭中缝成熟度达到D及E期的患者，只有通过种植钉或者手术辅助上颌快速扩弓才能达到良好的骨性扩弓效果，以避免过度牙性扩弓带来的副作用[20-21]。而腭部骨板厚度，是进行种植钉辅助上颌快速扩弓的重要参考因素[22]，本次研究结果显示上颌第一磨牙以及第二前磨牙腭部骨板厚度在上颌横向发育不足组及上颌横向发育正常组之间无显著差异，表明上牙弓狭窄并不会影响上颌腭部骨板厚度，这将有益于后续治疗方案的制订，为选择种植钉辅助上颌快速扩弓提供基础条件[23]。此外本研究结果发现骨性I类上颌横向发育不足的患者，腭中缝成熟度更低更滞后，提示正畸医师不应该仅凭年龄来判断扩弓时机，对于牙弓狭窄者可结合锥形束CT腭中缝影像，适当放宽年龄限制，抓住时机选用合适的扩弓方式，以获得和谐的上下颌骨关系[24]。即使是腭中缝成熟度达到D期，传统上颌扩弓效果不佳，也无需担心腭部骨板厚度发生明显变化致使无法应用种植钉[25]，而应积极采用种植钉辅助上颌快速扩弓的方式[26]，匹配上下颌骨骨性宽度[27]，从而有利于正畸结果的长期稳定[5]。

3.2 腭部三维方向变化

本研究结果显示，骨性I类上颌横向发育不足患者的上颌骨性宽度以及牙弓宽度显著减小；其在鼻底以及硬腭底部处的上颌骨性宽度，较横向发育正常者欠缺约3.8 mm；而在牙槽嵴处的上颌牙弓宽度，二者的差异约为3 mm。这表明，当出现基骨横向发育不足时，磨牙会出现颊倾代偿，增加牙弓宽度，从而掩盖横向发育不足，这与其他学者的研究结果是一致的[9, 28]。

而两组腭穹隆高度、腭部长度以及腭部骨板厚度的差异不存在统计学意义，说明出现上颌横向发育不足的骨性 I 类患者，尽管上颌骨横向宽

度发育受限,但不会影响腭部在长度以及高度方向的骨性发育,这可能与本次研究限定在骨性Ⅰ类患者中有关。有学者研究发现,骨性Ⅱ类以及Ⅲ类患者中,上颌横向发育不足的同时会出现上颌骨矢状向的发育受限[29-30]。临床上常将腭盖高拱作为上颌横向发育不足的临床表现之一[6, 31],但本次研究结果表明,上颌牙弓狭窄的患者,腭穹隆高度并未发生明显变化,一方面提示临床医生不能单纯以腭盖高拱来诊断上颌牙弓狭窄,容易漏诊,导致做出错误的临床诊疗计划;另一方面需要重新审视腭盖高拱的内在涵义,腭盖高拱通常为临床上对于所见到的腭部形态的描述,是一种视觉印象,但其并不一定代表腭部高度发生了明显增加,当上颌牙弓明显缩窄,而腭部高度不变时,给人的视觉印象仍是腭盖高拱。综上,本研究结果提示骨性Ⅰ类患者上颌牙弓狭窄不会影响腭穹隆高度、腭部骨板厚度及腭部长度。

3.3　腭部表面积及体积变化

本研究结果显示,骨性Ⅰ类上颌横向发育不足患者其腭部表面积显著小于横向发育正常者,这是上颌横向发育不足带来的另一个腭部变化。Phoenix等[32]的研究显示,上颌牙弓狭窄的患者,舌体位置明显低于牙弓宽度正常的患者,从而容易出现上气道通气量的下降[33],甚至导致阻塞性睡眠呼吸暂停低通气综合征[34-35]。这可能与上颌横向发育不足患者的腭部表面积变化有关。正常情况下,舌体应紧贴着上颌腭部,但由于横向发育不足患者腭部表面积减小,而舌体大小未发生改变,缩小的腭部表面积无法容纳原有的舌体,从而出现舌位被迫下降。而由于舌体位置的下降,上牙弓失去对抗颊侧肌肉的力量,内外肌动力的失衡将进一步加重牙弓狭窄[36]。因此对于骨性Ⅰ类上颌横向发育不足的患者,需要抓住时机进行上颌扩弓,恢复上颌腭部的表面积以及体积[37],这不仅有利于舌体位置的上抬[38-39],还可以增加气道通气量[40],恢复正常的口颌系统功能,促进全身健康。

正畸医师更容易关注到骨性Ⅱ类及Ⅲ类患者上下颌牙弓宽度不协调的问题,而骨性Ⅰ类患者的横向问题常被忽视。本研究结果提示骨性Ⅰ类上颌横向发育不足错𬌗患者较发育正常者,上颌骨性宽度以及牙弓宽度减小,腭部表面积减小,腭中缝成熟度较低。因此正畸医师在作术前诊断时不能忽视骨性Ⅰ类患者上下颌骨横向不匹配的问题,并应注意腭部表面积的减小,是否会导致舌体位置过低从而影响到气道功能。在制订方案时,即使患者处于青春期晚期,也应根据腭中缝成熟度情况,尽早进行上颌扩弓(传统上颌快速扩弓或者种植钉辅助扩弓)[18, 41],匹配上下颌骨宽度,恢复正常的口颌系统功能,获得长期稳定的治疗效果。

今后,还应对本研究的不足之处进行改善以及进一步研究,包括纳入更大的样本量,进一步探究腭中缝成熟度与上颌横向发育不足之间的因果关系等;也可以采用定量的腭中缝骨密度测量法[42-43]来评估腭中缝融合情况,以增强本研究的临床参考意义。

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