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·临床研究·

# 骨性Ⅰ类错𬌗不同垂直骨面型患者下颌横向关系研究

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**【摘要】 目的** 研究骨性Ⅰ类错𬌗不同垂直骨面型与下颌牙弓宽度、基骨弓宽度及牙齿颊舌向倾斜度的相关性。**方法** 收集62例骨性Ⅰ类错𬌗患者的CBCT资料，根据GoGn-SN角分为3组，高角组19例、均角组22例、低角组21例，用Dolphin imaging进行三维重建，分别测量下颌尖牙、第一前磨牙、第一磨牙间的牙弓和基骨弓宽度及牙齿颊舌向倾斜度并进行统计学分析。**结果** 3组下颌各段牙弓宽度的差异无统计学意义（$P>0.05$）；低角组患者的下颌尖牙间基骨弓宽度和第一前磨牙间基骨弓宽度大于均角组和高角组（$P<0.05$）；高角组患者的尖牙颊舌向倾斜度和第一前磨牙颊舌向倾斜度大于均角组和低角组（$P<0.05$）。磨牙间基骨弓宽度与颊舌向倾斜度在3组间的差异无统计学意义（$P>0.05$）。Pearson检验表明：下颌尖牙间基骨弓宽度、第一前磨牙间基骨弓宽度与GoGn-SN角呈负相关；排除下颌牙弓宽度和基骨弓宽度的影响，下颌尖牙和第一前磨牙的颊舌向倾斜度与GoGn-SN角间仍然存在显著正相关关系（$P<0.05$）。**结论** 骨性Ⅰ类错𬌗不同垂直骨面型间的基骨弓宽度差异主要体现在尖牙段和前磨牙段，牙体颊舌向倾斜度的差异主要是对下颌平面角的不同进行代偿。临床中应针对差异采用个体化方案以达到矫治的长期疗效。

**【关键词】** 骨性Ⅰ类错𬌗；垂直骨面型；下颌骨；基骨；牙弓宽度；颊舌向倾斜；锥形束CT；三维测量
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**Study on the transverse relationship of the mandible between different skeletal vertical patterns in patients with skeletal Class Ⅰ malocclusion**

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**【Abstract】 Objective** To analyze the correlation between skeletal vertical patterns and mandibular dental arch width, basal arch width and the dental buccolingual inclination of patients with skeletal Class Ⅰ. **Methods** The CBCT data of 62 skeletal Class Ⅰ malocclusion patients were collected and divided into a high-angle group with 19 cases, a mean-angle group with 22 cases, and a low-angle group with 21 cases according to the GoGn-SN angle. Mandible 3D reconstruction of the three groups was performed using Dolphin software, and dental arch widths, basal arch widths and buccolingual inclination of canines, first premolars and first molars, were measured and statistically analyzed respectively. **Redults** Mandibular dental arch width showed no significant difference among the three groups ($P>0.05$). The basal arch widths of mandibular canines and first premolars in low-angle group were larger than those in the other groups ($P<0.05$). The buccolingual inclinations of mandibular canines and first premolars in high-angle group were

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larger than those in the other groups ($P < 0.05$). The buccolingual inclination and basal arch width of the first molars among the three groups showed no significant differences ($P > 0.05$). Pearson correlation tests showed that the basal arch widths of mandibular canines and first premolars were negatively correlated with GoGn-SN angle. Excluding the influence of dental arch width and basal arch width, there was still a significant positive correlation between the buccolingual inclination of mandibular canines and first premolars and the GoGn-SN angle ($P < 0.05$). **Conclusion** The width of the basal bone arch between different skeletal vertical patterns mainly differs in the canine segment and the premolar segment, and the difference in the buccolingual inclination of the teeth is mainly to compensate for the difference in the GoGn-SN angle. In clinical practice, individualized therapy should be adopted according to the differences to achieve the long-term efficacy of correction.

**【Key words】** skeletal Class Ⅰ malocclusion; vertical facial pattern; mandible; basal bone; arch width; buccolingual inclination; CBCT; three-dimensional measurement

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牙颌横向关系的平衡是保证咬合功能和维持正畸疗效长久性的因素之一[1]，对于面部外型及美学微笑也至关重要[2]。既往对于牙颌的研究多集中于矢状关系对横向关系的影响[3-4]，但垂直向上的差异也会通过牙与下颌骨的相互协调进而表现在牙弓、基骨弓的横向变化[5]，同时牙齿也会通过不同程度的倾斜来弥补骨骼的差异[6]，代偿的过程中牙根与骨皮质的相对位置关系发生改变，使得牙根有可能与骨皮质相接触出现骨皮质支抗，降低牙齿移动效率[7]，甚至出现骨开窗、骨开裂[8]，因此要对不同垂直骨面型横向关系的差异有充分的认知。本研究利用锥形束CT（cone-beam computed tomography，CBCT）对骨性Ⅰ类错𬌗不同垂直骨面型患者下颌牙弓、基骨弓及牙齿倾斜度的相关指标进行测量，探讨下颌横向对于垂直向的代偿情况及相关规律。

## 1　资料和方法

### 1.1　研究对象

选取2018年9月至2020年9月就诊于山西医科大学第一附属医院口腔正畸科的骨性Ⅰ类错𬌗患者共62例，采用中国人正常𬌗Steiner分析法[9]对患者进行分类，高角组患者19例（37.7° < GoGn-SN）；均角组患者22例（27.3° ≤ GoGn-SN ≤ 37.7°）；低角组患者21例（GoGn-SN < 27.3°）。

纳入标准：①0° < ANB角 < 4.7°；②年龄 ≥ 18周岁，牙列完整：第三磨牙除外；③前牙拥挤度 ≤ 4 mm、前牙段间隙 ≤ 2 mm，后牙段无拥挤；④牙周健康；⑤无颜面部不对称；⑥下颌无缺失牙、大面积牙体缺损及冠修复体；⑦无正畸或正颌手术史；⑧无唇腭裂及先天颅面畸形。

### 1.2　图像采集

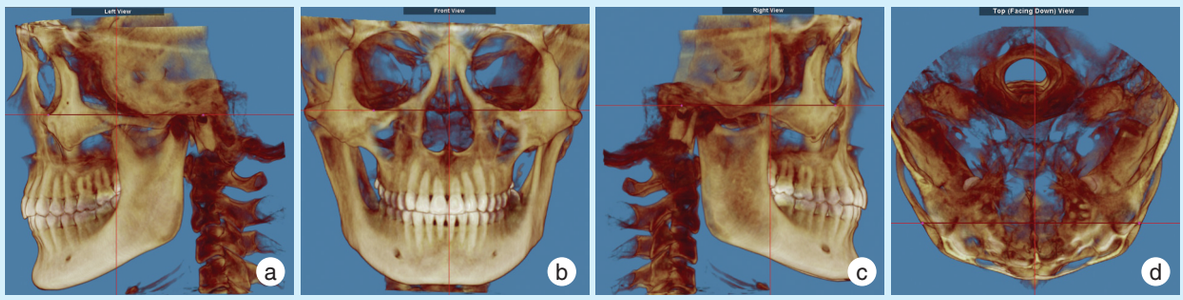
所有患者均站立，呈牙尖交错位，由山西医科大学第一附属医院口腔影像科专业人员拍摄，使用锥形束CT（NewTom VG10048S，Verona，意大利）对颅面部进行扫描。该研究获得山西医科大学口腔医院伦理委员会的批准。

### 1.3　测量方法

将CBCT数据导入Dolphin imaging 11.0软件（Dolphin，USA）进行三维重建。为获得更精准的测量结果，进行头位校准，基准平面定义为眶耳平面即过双侧眶下点和解剖耳点所构成的平面，冠状面为垂直于眶耳平面且经过双侧颧弓根点所形成的平面（图1）。

1.3.1　牙弓宽度的测量　牙弓宽度为左右两侧同名牙临床牙冠轴面中心（facial axis，FA）的连线所构成的直线距离。DW3：下颌两侧尖牙FA点间的距离；DW4：下颌两侧第一前磨牙FA点间的距离；DW6：下颌两侧第一磨牙FA点间的距离（图2）。

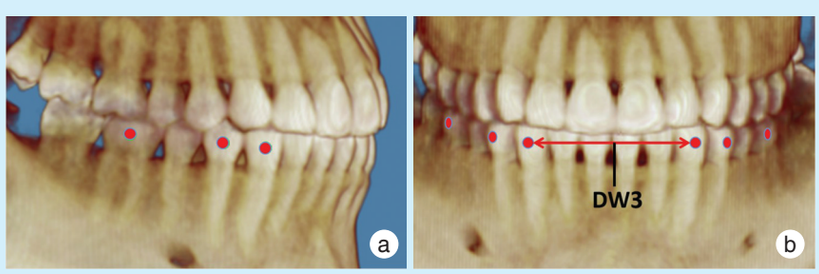
1.3.2　基骨弓宽度的测量　基骨弓宽度为左右两侧同名牙根尖点的连线所构成的直线与颌骨外表面交点间的距离。多根牙在最短牙根的根尖点所在的水平面上取多个牙根的中心即多根牙的根尖点。BW3：下颌两侧尖牙根尖点间的距离；BW4：下颌两侧第一前磨牙根尖点间的距离；BW6：下颌两侧第一磨牙根尖点间的距离（图3）。




a-c: anteroposterior and lateral calibration is performed through the FH plane; d: transverse calibration is performed according to the bilateral root of the zygoma points; FH plane: Frankfort horizontal plane

Figure 1　Orientation of CBCT images

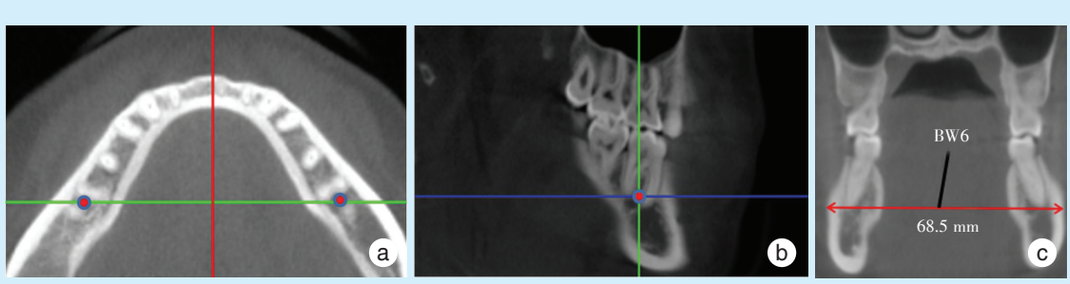
**图1**　CBCT图像校准




a: locate the axial center of the clinical crown (FA); b: taking DW3 (indicated as the red arrow line segment) as an example, the dental arch width is distance between the FA points of the homonym teeth, DW3: distance between FA points of the canines on both sides of the mandible

Figure 2　Measurement of the dental arch width

**图2**　牙弓宽度的测量



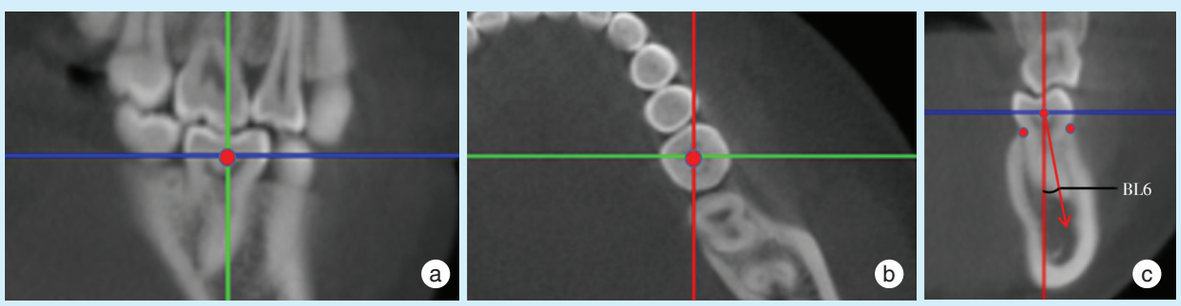

a: locate the apical point on the transverse plane; b: locate the apical point on the sagittal plane; c: taking BW6 (indicated as the red arrow line ) as an example, the basal arch width is the distance between the points with which the line through the apical points of the homonym teeth on the coronal plane intersects the outer surface of the jaw; BW6: distance between apical points of the first molars on both sides of the mandible

Figure 3　Measurement of the basal arch width

**图3**　基骨弓宽度的测量

1.3.3　牙齿颊舌向倾斜度的测量　解剖牙冠中心为冠状面、矢状面和横断面上牙冠中心点。牙长轴定义解剖牙冠中心与牙颈部连线中点的连线。牙齿的颊舌向倾斜度为牙长轴与垂直于眶耳平面

的线形成的下内角，舌向倾斜记为(+)，颊向倾斜记为(-)。BL3：下颌尖牙颊舌向倾斜角度；BL4：下颌第一前磨牙颊舌向倾斜角度；BL6：下颌第一磨牙颊舌向倾斜角度(图4)。




a: locate the center of the anatomical crown on the transverse plane; b: locate the center of the anatomical crown on the sagittal plane; c: taking BL6 (indicated as the red arrow line segment) as an example, the dental buccolingual inclination is the angle between the sagittal plane and the line through the center of anatomical crown and the center of dental cervix on the coronal plane; BL6: the buccolingual inclination of first molars

Figure 4　Measurement of the buccolingual inclination

**图4**　牙齿颊舌向倾斜度的测量

测量工作由同一人在不同时间段进行，每一个测量项目测量3次取平均值作为最终测量值。

### 1.4　统计学分析

采用SPSS 21.0软件进行数据分析，计数资料以例数描述；计量资料经Shapiro-Wilk正态性检验均为$P>0.05$，故计量资料采用均数±标准差描述，多组间比较用方差$F$检验分析，组间两两比较用LSD-$t$法。GoGn-SN角与牙弓宽度、基骨弓宽度和牙齿颊舌向倾斜度的关系用Pearson相关性分析，GoGn-SN角与牙齿颊舌向倾斜度的关系用偏相关分析，$P<0.05$时为差异有统计学意义。

## 2　结　果

由表1结果可得，下颌尖牙、第一前磨牙、第一磨牙间牙弓宽度在不同组的差异均无统计学意义($P>0.05$)。下颌尖牙和第一前磨牙的基骨弓宽度差异有统计学意义($P<0.05$)，且组间两两比较为低角组大于均角组和高角组($P<0.05$)；均角组大于高角组但组间差异无统计学意义($P>0.05$)。3组第一磨牙间基骨弓宽度的差异无统计学意义($P>0.05$)(表1)。

下颌尖牙和第一前磨牙在不同组颊舌向倾斜度的差异有统计学意义($P<0.05$)，且组间两两比较为高角组大于均角组和低角($P<0.05$)；均角组大于低角组但组间差异无统计学意义($P>0.05$)。磨牙倾斜度3组间比较差异无统计学意义($P>0.05$)(表2)。

下颌尖牙、前磨牙间的基骨弓宽度与GoGn-SN角间均呈负相关关系($P<0.05$)，而磨牙的基骨弓

**表1**　骨性Ⅰ类错𬌗患者不同垂直骨面型下颌牙弓宽度、基骨弓宽度比较

Table 1　Comparison of the mandibular dental arch widths or the basal arch widths of different skeletal vertical patterns in patients with skeletal Class Ⅰ malocclusion　$\bar{x}\pm s$, mm

| Groups | $n$ | DW3 | DW4 | DW6 | BW3 | BW4 | BW6 |
|---|---|---|---|---|---|---|---|
| Mean-angle group | 22 | 29.84 ± 1.27 | 39.25 ± 1.37 | 54.88 ± 1.69 | 35.67 ± 2.82 | 43.29 ± 1.47 | 67.11 ± 1.78 |
| Low-angle group | 21 | 28.95 ± 1.25 | 39.35 ± 1.68 | 55.02 ± 1.87 | 37.39 ± 2.60[1)] | 45.02 ± 2.37[1)] | 67.94 ± 2.36 |
| High-angle group | 19 | 29.29 ± 1.49 | 39.42 ± 1.33 | 55.48 ± 1.43 | 35.28 ± 2.60[2)] | 42.69 ± 3.13[2)] | 66.89 ± 2.05 |
| $F$ | | 2.442 | 0.068 | 0.708 | 3.622 | 5.273 | 1.486 |
| $P$ | | 0.096 | 0.934 | 0.497 | 0.033 | 0.008 | 0.235 |

1): compared to the mean-angle group, $P<0.05$; 2): compared to the low-angle group, $P<0.05$; DW3: distance between FA points of the canines on both sides of the mandible; DW4: distance between FA points of the first premolars on both sides of the mandible; DW6: distance between FA points of the first molars on both sides of the mandible; BW3: distance between apical points of the canines on both sides of the mandible; BW4: distance between apical points of the first premolars on both sides of the mandible; BW6: distance between apical points of the first molars on both sides of the mandible

**表2**　骨性Ⅰ类错𬌗患者不同垂直骨面型下颌牙齿倾斜度比较

Table 2　Comparison of the mandibular buccolingual inclinations of different skeletal vertical patterns in patients with skeletal Class Ⅰ malocclusion　$\bar{x} \pm s$, °

| Groups | $n$ | BL3 | BL4 | BL6 |
|---|---|---|---|---|
| Mean-angle group | 22 | 4.63 ± 1.09 | 5.85 ± 0.97 | 14.23 ± 2.80 |
| Low-angle group | 21 | 4.22 ± 1.02 | 5.57 ± 1.19 | 14.13 ± 3.07 |
| High-angle group | 19 | 7.88 ± 2.23[1)2)] | 11.35 ± 1.68[1)2)] | 15.09 ± 3.79 |
| $F$ | | 34.34 | 124.90 | 0.53 |
| $P$ | | < 0.01 | < 0.01 | 0.59 |

1): compared to the mean-angle group, $P < 0.05$; 2): compared to the low-angle group, $P < 0.05$; BL3: the buccolingual inclination of mandibular canines; BL4: the buccolingual inclination of first premolars; BL6: the buccolingual inclination of first molars

宽度与GoGn-SN角间无显著相关关系($P > 0.05$)。下颌尖牙、第一前磨牙颊舌向倾斜角度与GoGn-SN角间呈正相关关系($P < 0.05$),而第一磨牙的倾斜度与GoGn-SN角间无显著相关关系($P > 0.05$);牙弓宽度与GoGn-SN角间无显著相关关系($P > 0.05$)(表3)。

**表3**　骨性Ⅰ类错𬌗患者下颌横向距离或牙齿颊舌向倾斜度与GoGn-SN角的相关性分析

Table 3　Pearson correlation analysis of the GoGn-SN angle with mandibular transverse width or dental buccolingual inclination in patients with skeletal Class Ⅰ malocclusion

| Measuring project | $r$ | $P$ |
|---|---|---|
| DW3(mm) | 0.013 | 0.922 |
| DW4(mm) | 0.017 | 0.897 |
| DW6(mm) | 0.161 | 0.212 |
| BW3(mm) | -0.291 | 0.022 |
| BW4(mm) | -0.427 | 0.001 |
| BW6(mm) | -0.187 | 0.146 |
| BL3(°) | 0.670 | < 0.001 |
| BL4(°) | 0.851 | < 0.001 |
| BL6(°) | 0.086 | 0.506 |

DW3: distance between FA points of the canines on both sides of the mandible; DW4: distance between FA points of the first premolars on both sides of the mandible; DW6: distance between FA points of the first molars on both sides of the mandible; BW3: distance between apical points of the canines on both sides of the mandible; BW4: distance between apical points of the first premolars on both sides of the mandible; BW6: distance between apical points of the first molars on both sides of the mandible; BL3: the buccolingual inclination of mandibular canines; BL4: the buccolingual inclination of first premolars; BL6: the buccolingual inclination of first molars

排除下颌牙弓宽度和基骨弓宽度的影响,下颌尖牙和前磨牙的颊舌向倾斜度与GoGn-SN角间仍然存在显著正相关关系($P < 0.05$)(表4)。

**表4**　骨性Ⅰ类错𬌗患者牙齿颊舌向倾斜度与GoGn-SN角的偏相关性分析

Table 4　Partial correlation analysis between buccal lingual inclination of teeth and GOGN-SN angle in patients with skeletal Class Ⅰ malocclusion

| Measuring project | Partial correlation | |
|---|---|---|
| | $R$ | $P$ |
| BL3(°) | 0.635 | < 0.001 |
| BL4(°) | 0.842 | < 0.001 |
| BL6(°) | 0.104 | 0.429 |

The width of dental arch and the width of basal bone arch in the same dental position were taken as covariables

## 3　讨　论

自Andrews提出了“正常𬌗六项标准”的概念后[10],学者们意识到上下颌骨与牙体通过适当的倾斜,可形成最有利于𬌗力传导的方向,以便提高咀嚼效率,利于食物排溢,避免𬌗干扰等。充分理解牙颌系统为行使正常功能而产生的适应性变化,有利于临床矫治方案的制定。既往研究得出骨性Ⅱ类和Ⅲ类错𬌗畸形不同垂直骨面型的上下颌代偿规律[5,11-12],但对于横向关系的研究结果是基于矢状向和垂直向的共同作用,研究表明矢状向的发育差异会引起牙颌关系横向的代偿[13],骨性Ⅰ类错𬌗在矢状向相对颌骨发育正常,更有利于探究不同垂直骨面型对于下颌横向关系的影响。

先前研究多使用下颌石膏模型进行研究,采用前庭沟上方紧贴膜龈联合的最凸点(WALA嵴)描述基骨弓[14],但牙周软组织取印模有动度且牙龈厚度会影响测量准确性。本实验采用根尖点对基骨弓宽度进行测量,相对于WALA嵴,根尖点位于解剖结构内部且接近每个牙齿的阻力中心,降低了牙根变异对结果的干扰,定位更加准确[14]。以CBCT进行牙颌数据的相关研究已被证明相对可靠性[14],结合Dolphin imaging生成3D的可视化模型,易于测量并降低误差。

本研究中关于下颌牙弓宽度在3组间的差异无统计学意义,与Grippaudo等[5]的研究结果一致。多数学者认为牙弓宽度与下颌平面角有关。Chen等[12]的研究显示对于10~14岁安氏Ⅲ类错

矜儿童，高角组的上下颌牙弓宽度小于均角组和低角组。研究结果有差异的原因可能为：骨性Ⅰ类错矜畸形的上下颌骨较Ⅱ类、Ⅲ类正常，避免了矢状向骨性发育的差异引起牙齿过度代偿。

MOSS功能机制假说认为颌骨的生长发育与维持是继发的，是对其他组织原发过程的代偿反应[15]。基因决定下颌最初形态，之后下颌肌群通过应力刺激、内分泌或旁分泌等方式作用于下颌骨，下颌骨也产生多种因子影响肌肉组织，下颌骨、肌肉及其产物相互作用构成一个功能系统，从而形成表型，因此咀嚼肌的差异会伴随着下颌骨的变化[16]。不同垂直骨面型患者的下颌肌群在形态体积、牵拉力、机械势能和纤维组成等方面存在差异，低角患者相对于均角与高角患者的下颌肌群更强有力，所以有着较宽的横向面部尺寸[17]。本研究发现，低角组尖牙段、前磨牙段基骨弓宽度大于均角组和高角组，印证以上研究结论。下颌正常功能的行使是以颞下颌关节为支点，下颌肌群为动力[18]，本研究结果表明下颌第一磨牙间基骨弓宽度在低角组中最大、高角组中最小，但3组间的差异无统计学意义，原因可能为磨牙段较尖牙和前磨牙段距颞下颌关节更近，力臂短，下颌肌群在该处的力矩较小，作用于基骨后使3组间在磨牙段的差异不明显，但仍需进一步研究验证以上结论。也有研究表明不同垂直骨面型对此段基骨弓的宽度影响较小[11]。

本研究中，下颌尖牙、第一前磨牙的舌向倾斜度在3组间的差异有统计学意义，高角组舌倾程度大于均角组和低角组，舌倾程度与下颌平面角呈正相关，这与临床观察结果一致。Duan等[19]也有相同结论，其进一步研究表明相对于高角组和均角组，低角组的下颌前磨牙牙根距颊舌侧皮质骨距离最大，提示低角患者在前磨牙区有更大的扩弓及牙性代偿性倾斜的范围。下颌牙齿颊舌向倾斜度会因牙弓、基骨弓宽度的差异而改变，本研究结果表明骨性Ⅰ类错矜不同垂直骨面型下颌尖牙和第一前磨牙颊舌向倾斜度的差异主要是因GoGn-SN角的不同而引起的。

下颌第一磨牙的颊舌向倾斜度差异在本研究中无统计学意义，对此结果相关研究尚有分歧。有研究显示[20]，与高角组相比，低角患者第一磨牙会相对直立以便应对更大的咬合力[20]，所以高角组下颌第一磨牙的舌倾程度最大，低角组最小。Hwang等[1]发现尽管低角组下颌第一磨牙牙槽嵴顶下7 mm距离大于高角组，但3组下颌第一磨牙颊舌向倾斜度无差异，Feyza等[2]对135例骨性Ⅰ类错矜不同垂直骨面型的研究结果与Hwang的结果一致。分析原因可能为上颌横向发育停止在14岁，下颌在横向宽度的持续增长持续到18岁左右[21]，均角组和低角组患者相对于高角组在下颌骨横向的增长更为明显，所以在发育过程中由于下颌磨牙第一磨牙萌出早受力大，下颌第一磨牙会更加舌倾来保证咀嚼力通过牙长轴，维持后牙正常的覆盖。

综上所述，骨性Ⅰ类错矜不同垂直骨面型间的下颌横向差异主要体现在尖牙段和前磨牙段，其中基骨弓宽度与下颌平面角的大小呈负相关，牙体颊舌向倾斜度与下颌平面角的大小呈正相关，牙体颊舌向倾斜度的差异主要是对下颌平面角的不同进行代偿。临床中应针对差异采用个体化方案以达到矫治的长期疗效。

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