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·临床研究·

# 不同矢状骨面型患者后牙颊舌向倾斜度及Wilson曲线曲度的CBCT测量研究

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**【摘要】** **目的** 研究不同矢状骨面型患者的后牙颊舌向倾斜度及Wilson曲线曲度,探讨不同矢状骨面型患者的后牙水平向倾斜代偿机制,为骨性错殆畸形治疗中后牙倾斜度控制提供参考依据。**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90例青少年及90例成人正畸治疗前的CBCT资料作为研究对象,两组样本中各包括矢状骨面型Ⅰ类、Ⅱ类、Ⅲ类各30例。分别测量每一侧由第一前磨牙至第二磨牙的所有后牙颊舌向倾斜度、第一磨牙及第二磨牙的Wilson曲线曲度,比较不同矢状骨面型的青少年及成人间的差异。**结果** 与Ⅰ类骨面型成人相比,Ⅱ类骨面型成人的上颌后牙倾斜度减小,下颌后牙倾斜度增大,差异有统计学意义;Ⅲ类骨面型成人上颌后牙倾斜度增大,下颌后牙倾斜度减小,差异有统计学意义;Ⅱ类骨面型成人第二磨牙的Wilson曲线曲度显著性增大,差异有统计学意义。与Ⅰ类骨面型青少年相比,Ⅲ类骨面型青少年的上颌后牙倾斜度增大,差异有统计学意义。不同矢状骨面型青少年下颌后牙倾斜度差异无统计学意义。对比青少年与成人,Ⅱ类骨面型成人上后牙更偏舌倾,除下颌第一磨牙外下颌后牙更偏直立;Ⅲ类骨面型成人下颌后牙除下颌第二磨牙外更偏舌倾,差异有统计学意义,上颌后牙无明显变化,差异无统计学意义。**结论** 上下后牙的颊舌向倾斜度及Wilson曲线曲度在不同矢状骨面型人群间存在差异,Ⅱ类骨面型人群以上后牙代偿性舌倾、下后牙代偿性直立为主。Ⅲ类骨面型人群以下后牙代偿性舌倾为主,上后牙维持原有的代偿性颊倾。

**【关键词】** 青少年；成人；正畸；后牙；颊舌向倾斜度；Wilson曲线曲度；矢状骨面型；锥形束CT；骨性错殆；代偿机制
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**Measurement of buccolingual inclination of posterior teeth and the curve of Wilson in patients with different sagittal skeletal patterns using cone-beam computed tomography**

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**【Abstract】** **Objective** To study the buccolingual inclination of posterior premolars and molars and the curve of Wilson in patients with different sagittal skeletal patterns, to explore the compensation mechanism of horizontal inclination of posterior teeth in patients with different sagittal skeletal patterns and to provide a reference for the control of posterior tooth inclination in the treatment of bone malocclusion. **Methods** This study was reviewed and approved by the Ethics Committee, and informed consent was obtained from the patients. Ninety CBCT scans of adults and ninety scans of adolescents before orthodontic treatment were evaluated in this cross-sectional study. There were 30 skeletal Class I,

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Class Ⅱ, and Class Ⅲ patients in the adult group and adolescent group. The inclination angles of posterior teeth and the curve of Wilson of first and second molars were measured, and data were analyzed between adolescents and adults with different sagittal skeletal patterns. **Results** Compared with skeletal Class Ⅰ adult patients, the upper posterior molar inclination of skeletal Class Ⅱ patients was significantly lower, and the lower posterior molar inclination was significantly higher. Compared with skeletal Class Ⅰ adult patients, the upper posterior molar inclination of skeletal Class Ⅲ adult patients was higher, and the lower posterior molar inclination was significantly lower. The Wilson curve of the second molar in skeletal Class Ⅱ adult patients was significantly higher than that in the other groups. Compared with skeletal Class Ⅰ adolescent patients, skeletal Class Ⅲ adolescent patients had a significantly higher upper posterior molar inclination; however, no difference was found between the inclination of the posterior teeth between skeletal Class Ⅰ, Class Ⅱ and Class Ⅲ adolescent patients. Comparing adolescent and adult samples, in skeletal Class Ⅱ patients, adults showed more lingual inclination than adolescents in the upper posterior teeth and less lingual inclination in the lower posterior teeth except for the mandibular first molar. Comparing adolescent and adult samples, in skeletal Class Ⅲ patients, adults showed more lingual inclination than adolescents in the lower posterior teeth except for the mandibular second molars and showed no difference in the upper posterior teeth. **Conclusions** The inclination of the posterior teeth and the curve of Wilson show significant differences between the three sagittal skeletal patterns. Compared with those of skeletal Class Ⅰ patients, the posterior teeth of skeletal Class Ⅱ patients show more lingual inclination in the upper arch and less lingual inclination in the lower arch. Meanwhile, posterior teeth of skeletal Class Ⅲ patients show more lingual inclination in the lower arch and maintain the inclination in the upper arch.

**【Key words】** adolescents; adults; orthodontics; posterior teeth; buccolingual inclination; curve of Wilson; sagittal skeletal pattern; cone-beam computer tomography; skeletal malocclusion; mechanism of compensation

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牙𬌗结构的平衡和稳定是正畸治疗追求的目标。全口咬合的支撑依赖于正确的后牙颊舌向倾斜度。Wilson[1]率先报道了正常天然磨牙的正常倾斜角度,即上磨牙颊倾、下磨牙舌倾。在冠状面上,倾斜的上下后牙咬合面形成一条凸向下凹向上的曲线,称之为Wilson曲线。Andrews[2]在正常𬌗的六个关键中也提出,上下后牙牙冠长轴应具有一定的倾斜度,才能建立正常的后牙咬合关系。因此,充分了解后牙颊舌向倾斜度可为正畸治疗提供必要的参考。

不同的上下颌骨位置关系引导牙列在萌出建𬌗中发生必要代偿,不仅包括三维空间上位置的代偿,更包括倾斜度的代偿[3-4],如Ⅱ类人群的下前牙代偿性唇倾及Ⅲ类人群的下前牙代偿性舌倾[5]。单一维度的上下颌骨矢状向差异在三维方向上对牙𬌗结构产生影响。水平向上,后牙往往发生位置与倾斜度的变化[6],但针对此问题,少有相关文献报道。因此,本研究旨在测量不同矢状骨面型青少年与成人的后牙颊舌向倾斜度,以骨性Ⅰ类患者作为标准,探讨不同矢状骨面型患者后牙在颊舌向倾斜度上的代偿机制,为正畸治疗解决上下牙弓宽度不调提供必要的参考。

## 1　资料和方法

本研究已获得深圳市人民医院伦理委员审批通过(批号:2022-071),已获得患者知情同意。

### 1.1　临床资料

选取2013年7月至2022年10月于深圳市人民医院口腔医学中心就诊的青少年(13~17岁)及成人患者(18~30岁)各90例,拍摄头颅定位侧位片及锥形束CT。根据ANB角度测量值分为骨性Ⅰ类(0.7°<ANB≤4.7°)、骨性Ⅱ类(ANB>4.7°)、骨性Ⅲ类(ANB≤0.7°),各30例,共180例样本。

纳入标准:垂直骨面型为均角型,否认相关正畸治疗史;无明显后牙段拥挤不齐(拥挤度<2 mm);无后牙锁𬌗、反𬌗;无明显腭盖高拱;后牙段牙体结构健康,无明显龋坏,牙冠及牙根完整,无明显牙周组织破坏;后牙段牙齿数量正常,无缺牙(不含第三磨牙缺失)。

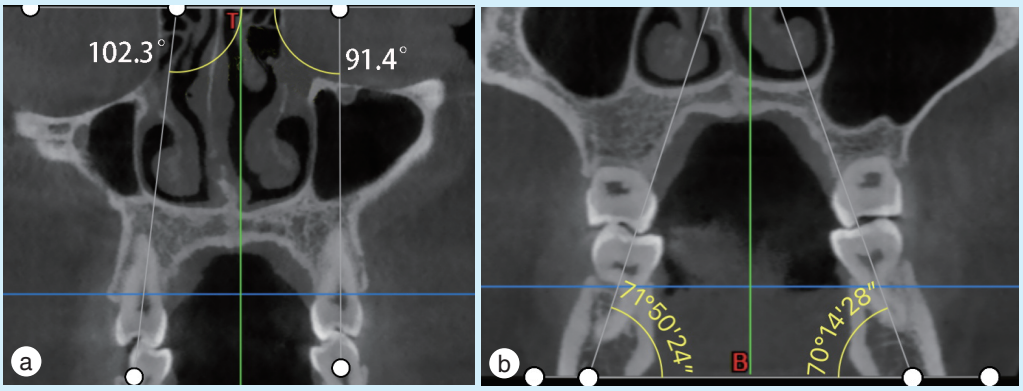
排除标准:上下颌骨基骨宽度差异大于5 mm;

曾有正颌外科史、颅面综合征(如唇腭裂)、面部不对称、下颌骨肥大、上呼吸道病变、上呼吸道感染、慢性口呼吸、永久性打鼾、外伤史、腺样体及扁桃体肥大等呼吸系统疾病。

1.2　测量方法

所有CBCT影像均使用NewTom VGI CBCT系统(维罗纳,意大利)扫描采集。扫描设置要求患者采用自然头位,牙尖交错位咬合。拍摄视野为15 cm×15 cm。所有CT图像的空间分辨率分别为300 μm、110 kV和78.59 mAs。CBCT数据使用NNT Viewer软件测量。在轴位、矢状位和冠状位对CBCT图像进行评估。在轴位及矢状位调整截面位置,在冠状位平面测量牙齿倾斜度和Wilson曲线角度。测量前重定位图像,以使眼耳平面(FH平面)和眼眶间线(连接眼眶边缘下点的线)平行于水平线。

作眼眶间线平行线,并以此作为基线,所有角度测量以此为参考。经过后牙牙冠咬合面颊舌向中心点与牙冠颈部颊舌向中心点作被测牙的牙体长轴,测量牙体长轴与基线间夹角(图1),得到以下测量值:上颌第一前磨牙倾斜度(U4I)、上颌第二前磨牙倾斜度(U5I)、上颌第一磨牙倾斜度(U6I)、上颌第二磨牙倾斜度(U7I)、下颌第一前磨牙倾斜度(L4I)、下颌第二前磨牙倾斜度(L5I)、下颌第一磨牙倾斜度(L6I)、下颌第二磨牙倾斜度(L7I)。经过上颌磨牙的近中颊尖与近中舌尖作直线,左右两侧直线相交所形成夹角角度作为Wilson曲线角度,得到第一磨牙Wilson曲线曲度(Wilson-6)和第二磨牙Wilson曲线曲度(Wilson-7)[7]。2周后,随机抽取其中20例样本再次测量,组内相关系数最低为0.958,提示测量结果可靠,可排除测量者误差。




a: in the maxilla, the line across the central point of the buccolingual width of the occlusal surface of the molar tooth and the cervical part of the anatomical crown as the tooth long axis were used to measure the angle between the tooth axis and baseline. b: in the mandible, the line across the central point of the buccolingual width of the occlusal surface of the molar tooth and the cervical part of the anatomical crown as the tooth long axis were used to measure the angle between the tooth axis and baseline. baseline: connect the inferior border of the orbital rims which was parallel to the floor

Figure 1　Measurement of the inclination of the maxillary posterior teeth and mandibular posterior teeth in patients with different sagittal skeletal patterns

**图1**　不同矢状骨面型患者上颌和下颌后牙颊舌向倾斜度的测量

1.3　统计学分析

所有数据均采用SPSS18.0(SPSS公司,伊利诺伊州,美国)进行分析,数据的正态分布使用Kolmogorov-Smirnov检验进行评估。若数据呈正态分布,组间比较采用方差分析,Tukey检验用于两两比较,显著性水平为0.05。

## 2　结　果

共采集180例样本,其中青少年90例(男52例,女38例),平均年龄(14.7±2.3)岁,成人90例(男44例,女46例),平均年龄(25.3±5.2)岁。根据以往研究,矢状骨面型的性别差异并无统计学意义[7],因此将男女数据合并统计。Kolmogorov-Smirnov检验表明所有定量变量均呈正态分布($P>0.05$)。

2.1　不同矢状骨面型人群的后牙颊舌向倾斜度比较

90例成人患者的后牙颊舌向倾斜度见表1,不同矢状骨面型成人后牙倾斜度差异具有统计学意义。与Ⅰ类骨面型成人比较,Ⅱ类骨面型成人的

上颌后牙倾斜度减小，下颌后牙倾斜度增大，差异均具有统计学意义（$P<0.05$）；Ⅲ类骨面型成人的上颌后牙倾斜度增大，下颌后牙倾斜度减小，差异均具有统计学意义（$P<0.05$）。不同矢状骨面型成人的第一磨牙的Wilson曲线曲度无明显差异，第二磨牙的Wilson曲线曲度差异具有统计学意义（$P<0.05$）。

**表1**　不同矢状骨面型成人后牙颊舌向倾斜度及Wilson曲线曲度

Table 1　The buccoligual inclination of posterior teeth and the curve of Wilson in adults with different sagittal skeletal patterns　°, $\bar{x}\pm s$

| | Skeletal Clas Ⅰ ($n$ = 30) | Skeletal Clas Ⅱ ($n$ = 30) | Skeletal Class Ⅲ ($n$ = 30) | $F$ | $P$ |
|---|---|---|---|---|---|
| U4I | 89.2 ± 4.9$^a$ | 85.0 ± 4.3$^a$ | 91.1 ± 6.6$^b$ | 20.14 | < 0.001 |
| U5I | 90.7 ± 4.5$^b$ | 87.4 ± 4.9$^a$ | 94.3 ± 7.6$^c$ | 20.81 | < 0.001 |
| U6I | 93.8 ± 5.6$^b$ | 91.9 ± 4.9$^a$ | 98.4 ± 4.6$^c$ | 26.38 | < 0.001 |
| U7I | 103.6 ± 3.8$^b$ | 97.1 ± 4.5$^a$ | 107.3 ± 6.1$^c$ | 67.07 | < 0.001 |
| L4I | 82.7 ± 6.6$^a$ | 86.3 ± 6.6$^b$ | 81.5 ± 7.8$^a$ | 7.50 | < 0.001 |
| L5I | 78.4 ± 5.6$^b$ | 81.0 ± 4.9$^c$ | 75.3 ± 6.6$^a$ | 14.69 | < 0.001 |
| L6I | 75.3 ± 4.8$^b$ | 77.9 ± 5.7$^c$ | 73.1 ± 5.2$^a$ | 12.14 | < 0.001 |
| L7I | 73.1 ± 6.1$^b$ | 74.3 ± 7.6$^b$ | 69.5 ± 6.7$^a$ | 8.01 | < 0.001 |
| Wilson-6 | 157.7 ± 6.2 | 160.7 ± 8.0 | 157.1 ± 8.4 | 1.94 | 0.149 |
| Wilson-7 | 143.8 ± 9.2$^b$ | 149.5 ± 9.7$^c$ | 140.3 ± 12.1$^a$ | 5.97 | 0.003 |

a < b < c was found in pairwise comparison. Significanct difference was found between a and b, b and c, a and c. U4I\U5I\U6I\U7I: inclination of upper first premolar, second premolar, first molar and second molar. L4I\L5I\L6I\L7I: inclination of lower first premolar, second premolar, first molar and second molar. Wilson-6\Wilson-7: the wilson curve of first molar and second molar. Skeletal Class I: 0.7° < ANB ≤ 4.7°. Skeletal Class II: ANB > 4.7°. Skeletal Class Ⅲ: ANB ≤ 0.7°. The curve of Wilson: the tips of mesiobuccal and mesiolingual cusps of maxillary first and second molars along the buccal groove were connected and the formed angles were measured

90例青少年患者的后牙颊舌向倾斜度见表2，不同矢状骨面型青少年的后牙倾斜度差异亦具有统计学意义，且差异只表现在上颌，而在下颌后牙区，颊舌向倾斜度差异无统计学意义。在上颌后牙区，仅表现为Ⅲ类骨面型青少年的上颌后牙倾斜度较Ⅰ类明显增大，差异具有统计学意义（$P<0.05$）；而Ⅱ类骨面型青少年的上颌后牙倾斜度与Ⅰ类差异无统计学意义。第一磨牙与第二磨牙的Wilson曲线曲度在三种矢状骨面型间的差异无统计学意义。

### 2.2　青少年及成人后牙颊舌向倾斜度的比较

各类矢状骨面型青少年与成人上下颌后牙的颊舌向倾斜度见表3～表5。在Ⅰ类骨面型人群中，除下颌第一前磨牙外，成人上下颌后牙倾斜度与青少年的差异无统计学意义。

**表2**　不同矢状骨面型青少年后牙颊舌向倾斜度及Wilson曲线曲度

Table 2　The buccoligual inclination of posterior teeth and the curve of Wilson in adolescents with different sagittal skeletal patterns　°, $\bar{x}\pm s$

| | Skeletal Clas Ⅰ ($n$ = 30) | Skeletal Clas Ⅱ ($n$ = 30) | Skeletal Class Ⅲ ($n$ = 30) | $F$ | $P$ |
|---|---|---|---|---|---|
| U4I | 89.7 ± 5.4$^a$ | 89.6 ± 4.8$^a$ | 92.6 ± 4.5$^b$ | 5.36 | 0.005 |
| U5I | 91.2 ± 5.3$^a$ | 90.5 ± 4.9$^a$ | 96.3 ± 5.4$^b$ | 16.88 | < 0.001 |
| U6I | 94.6 ± 4.9$^a$ | 94.2 ± 3.5$^a$ | 99.9 ± 4.7$^b$ | 24.51 | < 0.001 |
| U7I | 101.9 ± 7.0$^a$ | 101.9 ± 5.0$^a$ | 109.9 ± 6.3$^b$ | 26.09 | < 0.001 |
| L4I | 86.3 ± 7.2 | 87.4 ± 5.4 | 85.0 ± 5.6 | 1.93 | 0.148 |
| L5I | 80.0 ± 5.5 | 79.0 ± 4.5 | 80.2 ± 5.0 | 0.89 | 0.411 |
| L6I | 76.7 ± 4.6 | 75.0 ± 6.0 | 77.4 ± 6.2 | 2.70 | 0.070 |
| L7I | 71.7 ± 6.0 | 71.3 ± 7.6 | 70.8 ± 6.6 | 0.24 | 0.786 |
| Wilson-6 | 157.0 ± 8.4 | 155.0 ± 6.5 | 154.7 ± 7.8 | 2.40 | 0.099 |
| Wilson-7 | 143.7 ± 10.7 | 145.8 ± 8.9 | 139.8 ± 9.2 | 2.31 | 0.106 |

a < b < c was found in pairwise comparison. Significanct difference was found between a and b, b and c, a and c. U4I\U5I\U6I\U7I: inclination of upper first premolar, second premolar, first molar and second molar. L4I\L5I\L6I\L7I: inclination of lower first premolar, second premolar, first molar and second molar. Wilson-6\Wilson-7: the wilson curve of first molar and second molar. Skeletal Class I: 0.7° < ANB ≤ 4.7°. Skeletal Class II: ANB > 4.7°. Skeletal Class Ⅲ: ANB ≤ 0.7°. The curve of Wilson: the tips of mesiobuccal and mesiolingual cusps of maxillary first and second molars along the buccal groove were connected and the formed angles were measured

在Ⅱ类骨面型人群中，成人上颌后牙倾斜度较青少年减小，差异有统计学意义。下颌后牙除第一前磨牙外，其余后牙均表现为成人倾斜度较青少年增加，且差异具有统计学意义。成人下颌第一磨牙的Wilson曲线曲度也较青少年增大，差异具有统计学意义。第二磨牙Wilson曲线曲度在两者间的差异无统计学意义。

在Ⅲ类骨面型人群中，成人上颌后牙的颊舌向倾斜度虽然较青少年倾斜度减小，除上颌第二磨牙外，其余上颌后牙间差异均无统计学意义。在下颌后牙区，除下颌第二磨牙外的所有下颌后牙均表现为成人患者的倾斜度较青少年减小，差异具有统计学意义。成人下颌第一磨牙的Wilson曲线曲度也较青少年增大，差异具有统计学意义。第二磨牙的Wilson曲线曲度在两者间的差异无统计学意义。

**表3**　Ⅰ类骨面型青少年与成人后牙倾斜度及Wilson曲线曲度的比较

Table 3　The comparison of buccoligual inclination of posterior teeth and the curve of Wilson in skeletal Class Ⅰ adolescents and adults　°, $\bar{x} \pm s$

| | Adults ($n$ = 30) | Adolescents ($n$ = 30) | $t$ | $P$ |
|---|---|---|---|---|
| U4I | 89.2 ± 4.9 | 89.7 ± 5.4 | −0.53 | 0.598 |
| U5I | 90.7 ± 4.5 | 91.2 ± 5.3 | −0.61 | 0.536 |
| U6I | 93.8 ± 5.6 | 94.6 ± 4.9 | −0.83 | 0.407 |
| U7I | 103.6 ± 3.8 | 101.9 ± 7.0 | 1.70 | 0.091 |
| L4I | 82.7 ± 6.6 | 86.3 ± 7.2 | −2.79 | 0.006 |
| L5I | 78.4 ± 5.6 | 80.0 ± 5.5 | −1.56 | 0.121 |
| L6I | 75.3 ± 4.8 | 76.7 ± 4.6 | −1.64 | 0.101 |
| L7I | 73.1 ± 6.1 | 71.7 ± 6.0 | 1.22 | 0.224 |
| Wilson-6 | 157.7 ± 6.2 | 157.0 ± 8.4 | 0.32 | 0.746 |
| Wilson-7 | 143.8 ± 9.2 | 143.7 ± 10.7 | 0.01 | 0.985 |

U4I\U5I\U6I\U7I: inclination of upper first premolar, second premolar, first molar and second molar. L4I\L5I\L6I\L7I: inclination of lower first premolar, second premolar, first molar and second molar. Wilson-6\Wilson-7: the wilson curve of first molar and second molar. Skeletal Class Ⅰ: 0.7° < ANB ≤ 4.7°. Skeletal Class II: ANB > 4.7°. Skeletal Class Ⅲ: ANB ≤ 0.7°. The curve of Wilson: the tips of mesiobuccal and mesiolingual cusps of maxillary first and second molars along the buccal groove were connected and the formed angles were measured

**表4**　Ⅱ类骨面型青少年与成人后牙倾斜度及Wilson曲线曲度的比较

Table 4　The comparison of buccoligual inclination of posterior teeth and the curve of Wilson in skeletal Class Ⅱ adolescents and adults　°, $\bar{x} \pm s$

| | Adults ($n$ = 30) | Adolescents ($n$ = 30) | $t$ | $P$ |
|---|---|---|---|---|
| U4I | 85.0 ± 4.3 | 89.6 ± 4.8 | −5.43 | < 0.001 |
| U5I | 87.4 ± 4.9 | 90.5 ± 4.9 | −3.44 | < 0.001 |
| U6I | 91.9 ± 4.9 | 94.2 ± 3.5 | −3.04 | 0.002 |
| U7I | 97.1 ± 4.5 | 101.9 ± 5.0 | −5.51 | < 0.001 |
| L4I | 86.3 ± 6.6 | 87.4 ± 5.4 | −1.02 | 0.308 |
| L5I | 81.0 ± 4.9 | 79.0 ± 4.5 | 2.33 | 0.021 |
| L6I | 77.9 ± 5.7 | 75.0 ± 6.0 | 2.69 | 0.008 |
| L7I | 74.3 ± 7.6 | 71.3 ± 7.6 | 2.19 | 0.029 |
| Wilson-6 | 160.7 ± 8.0 | 155.0 ± 6.5 | 2.05 | 0.036 |
| Wilson-7 | 149.5 ± 9.7 | 145.8 ± 8.9 | 1.55 | 0.124 |

U4I\U5I\U6I\U7I: inclination of upper first premolar, second premolar, first molar and second molar. L4I\L5I\L6I\L7I: inclination of lower first premolar, second premolar, first molar and second molar. Wilson-6\Wilson-7: the wilson curve of first molar and second molar. Skeletal Class Ⅰ: 0.7° < ANB ≤ 4.7°. Skeletal Class II: ANB > 4.7°. Skeletal Class Ⅲ: ANB ≤ 0.7°. The curve of Wilson: the tips of mesiobuccal and mesiolingual cusps of maxillary first and second molars along the buccal groove were connected and the formed angles were measured

**表5**　Ⅲ类骨面型青少年与成人后牙倾斜度及Wilson曲线曲度的比较

Table 5　The comparison of buccoligual inclination of posterior teeth and the curve of Wilson in skeletal Class Ⅲ adolescents and adults　°, $\bar{x} \pm s$

| | Adults ($n$ = 30) | Adolescents ($n$ = 30) | $t$ | $P$ |
|---|---|---|---|---|
| U4I | 91.1 ± 6.6 | 92.6 ± 4.5 | −1.34 | 0.181 |
| U5I | 94.3 ± 7.6 | 96.3 ± 5.4 | −1.53 | 0.129 |
| U6I | 98.4 ± 4.6 | 99.9 ± 4.7 | −1.62 | 0.109 |
| U7I | 107.3 ± 6.1 | 109.9 ± 6.3 | −2.02 | 0.047 |
| L4I | 81.5 ± 7.8 | 85.0 ± 5.6 | −2.61 | 0.011 |
| L5I | 75.3 ± 6.6 | 80.2 ± 5.0 | −4.24 | < 0.001 |
| L6I | 73.1 ± 5.2 | 77.4 ± 6.2 | −3.69 | < 0.001 |
| L7I | 69.5 ± 6.7 | 70.8 ± 6.6 | −0.95 | 0.344 |
| Wilson-6 | 157.1 ± 8.4 | 154.7 ± 7.8 | 2.80 | 0.007 |
| Wilson-7 | 140.3 ± 12.1 | 139.8 ± 9.2 | 0.15 | 0.878 |

U4I\U5I\U6I\U7I: inclination of upper first premolar, second premolar, first molar and second molar. L4I\L5I\L6I\L7I: inclination of lower first premolar, second premolar, first molar and second molar. Wilson-6\Wilson-7: the wilson curve of first molar and second molar. Skeletal Class Ⅰ: 0.7° < ANB ≤ 4.7°. Skeletal Class II: ANB > 4.7°. Skeletal Class Ⅲ: ANB ≤ 0.7°. The curve of Wilson: the tips of mesiobuccal and mesiolingual cusps of maxillary first and second molars along the buccal groove were connected and the formed angles were measured

## 3　讨　论

影响后牙颊舌向倾斜度的因素包括年龄、矢状骨面型、垂直骨面型、基骨弓宽度、腭穹隆高度及后牙段拥挤度等[8-10]。合理的颊舌向倾斜度是建立稳定后牙咬合的重要因素，因此区分不同骨面型及发育阶段的研究可提示后牙倾斜度在不同人群间的差异和增龄性变化下的代偿机制，为正畸治疗中协调后牙宽度不调提供参考。

锥形束CT引入颌面结构形态研究之后，基于CBCT三维重建技术的扫描测量为后牙倾斜度提供了更为精确的测量手段[11-15]。Kasai等[16]定义后牙牙体长轴为牙冠1/2中点及牙根尖1/3中点的连线。本研究参考Alkhatib等[17]的研究方法，采用临床冠咬合面中心点及牙颈部中心点的连线作为目标牙的牙体长轴，可有效避免牙冠形态及牙根畸形变异所产生的测量误差。

既往研究中，并未发现人种差异对后牙倾斜的影响，因此本研究未对纳入对象的人种来源作严格限定[11-12, 17-18]。本研究纳入标准限定垂直骨面型为均角型，排除了上颌骨垂直向发育差异及腭盖深度差异，降低了腭盖深度对后牙颊舌向倾斜

度测量的干扰误差[19]。

回顾以往研究，仅Golshah等[7]的研究对不同矢状骨面型进行区分。其研究样本量较少，仅为66例成人，不包含青少年样本，且未对纳入样本的后牙段拥挤度作明确限制。后牙段拥挤常表现为磨牙或前磨牙的异常舌倾或颊倾，伴有锁𬌗、反𬌗，这无疑影响对代偿程度评价的准确性。因此本研究在扩大样本量及年龄层次的同时，明确规定纳入样本不存在明显后牙段拥挤。

本研究发现，不同骨面型的成人后牙颊舌向倾斜度存在差异，差异有统计学意义（$P<0.05$）。较之Ⅰ类骨面型患者，Ⅱ类骨面型患者的上颌后牙偏舌倾，下颌后牙偏直立。反之，Ⅲ类骨面型患者的上颌后牙偏颊倾，下颌后牙偏舌倾。这提示，若上下颌骨矢状向关系协调，上下后牙可自然保持直立。若矢状向关系不调，后牙在水平向发生代偿性倾斜，以此建立咬合及最大接触面的尖窝关系。值得注意的是，Ⅱ类骨面型成人的下后牙仍保留一定程度舌倾，仅较Ⅰ类骨面型成人的下后牙偏直立，其倾斜度在86.3°～76.3°之间，尚未达到完全直立（90°），即各类矢状骨面型人群的下颌后牙均表现为舌倾，仅在舌倾幅度上存在差异。

较之I类骨面型青少年，Ⅱ类骨面型青少年的后牙倾斜度均不存在明显差异，Ⅲ类骨面型青少年的下后牙倾斜度同样不存在明显差异；差异最主要体现在Ⅲ类骨面型青少年的上后牙，较Ⅰ类明显颊倾，差异有统计学意义。这提示，无论上下颌骨矢状向是否存在不调，下颌后牙均以正常倾斜角度萌出并建𬌗。这可能与下颌本身的解剖生理结构有关[20-23]。Ⅱ类骨面型青少年的上颌后牙可以正常倾斜角度萌出建𬌗，Ⅲ类骨面型青少年的上颌后牙在萌出早期即存在明显的颊倾代偿。这点在国内外研究中尚未见有相关报道。推测原因，上颌骨量较下颌更容易出现不调，Ⅱ类骨面型患者上颌骨量多数正常，后牙以正常角度萌出可满足上牙列萌出需要。Ⅲ类骨面型青少年伴有不同程度的上颌骨发育不足，上后牙需代偿性颊倾才能满足上牙列萌出的间隙需求。

比较青少年与成人在后牙倾斜度上的差异，发现Ⅱ类骨面型成人的上后牙较青少年更偏舌倾，下后牙则更偏直立。Ⅲ类骨面型的成人下后牙较青少年的更偏舌倾，上后牙无明显变化。结合上述比较结果，推测Ⅱ类骨面型患者在青少年期并未表现出明显的后牙倾斜度代偿，而成人阶段所表现的后牙倾斜可能是牙𬌗、骨骼、肌肉相互引导与协调，进而产生适应性代偿的结果，表现为上后牙逐步舌倾，下后牙逐步直立。Ⅲ类骨面型患者则稍有不同，成人阶段的后牙仅表现为下后牙的代偿性舌倾，这可能与在青少年期就存在上颌后牙萌出方向的代偿，进而后期上后牙代偿空间不足有关。

正如Andrews正常𬌗六个关键理论所言，具有恰当的颊舌向倾斜度的牙冠在咬合功能中具有最大的牙尖接触面积[2]，但关于wilson曲线在治疗后是否应该保持平坦，一直存在不同观点[7]。因此，获得恰当的磨牙倾斜度及Wilson曲线曲度是正畸治疗中不容忽视的一部分[24-25]。比较三种矢状骨面型人群的Wilson曲线曲度，发现第二磨牙的Wilson曲线曲度在成人间存在明显差异，Ⅱ类骨面型成人的Wilson曲线最为平坦，这点与Golsha等[7]的研究结论一致。在比较青少年的Wilson曲线曲度后，发现不同矢状骨面型人群间的差异无统计学意义。纵向比较青少年与成人的Wilson曲线曲度，结果显示Ⅰ类骨面型青少年的Wilson曲线不存在明显变化，Ⅱ类及Ⅲ类骨面型成人第一磨牙的Wilson曲线明显较青少年平坦。这提示青少年在后牙萌出建𬌗初期，磨牙并未因矢状骨面型的不同而产生差异性的代偿倾斜，而在后牙长期功能性运动的影响下，磨牙的代偿性倾斜显现，Wilson曲线逐步趋向平坦。

牙𬌗、骨骼及肌肉等诸多因素共同参与了牙颌构建，维持着上下牙列咬合的平衡与稳定[26-27]。正畸治疗应利于三者在三维方向上的平衡稳定，顺应生理趋势。手术病例术前正畸需去除后牙的代偿性倾斜[28-31]，匹配终末骨骼关系下的上下牙弓宽度[32]。Ⅱ类骨面型患者需颊倾上后牙、舌倾下后牙。反之，Ⅲ类骨面型患者需舌倾上后牙、颊倾下后牙，这是术前正畸常见的后牙去代偿方式。针对非手术病例的掩饰治疗亦需要关注后牙倾斜度的调控。正畸减数治疗可造成牙弓不同程度缩窄，但骨性Ⅱ类错𬌗患者的下后牙应当维持代偿性直立状态，下牙弓宽度缩窄无疑对于下颌磨牙倾斜度的控制是不利的。这也提示Ⅱ类骨面型患者需注意避免因减数而造成的下颌磨牙过度舌倾，丧失后牙咬合的平衡与稳定。Ⅲ类骨面型患者的掩饰性治疗，尽可能采取舌倾下后牙的策略，而非颊倾上后牙。在下颌弓丝的选择上，可以采用圆丝或小尺寸的方丝，以利于实现下后牙的代

偿性舌倾。骨性Ⅱ类青少年常伴有上颌牙弓的狭窄，但其上颌后牙并未出现明显的颊向倾斜代偿，由此推测上牙弓的缩窄可能是由于上后牙近中舌向扭转、上牙弓呈尖圆形及基骨宽度不足。在Ⅱ类骨面型青少年上颌宽度的设计中，应当以调整上颌弓形，整体扩宽上牙弓及基骨为主，避免单纯后牙颊倾形式的牙性扩弓，以期获得扩弓效果的稳定性。

由于条件限制，本研究选择的青少年与成人样本隶属于不同的样本群体，通过两类人群的结果比较推测磨牙倾斜度随年龄增长的变化趋势。在未来的研究工作中，在增加样本量的同时，可采用对青少年样本的跟踪随访，观察个体磨牙倾斜度随年龄的变化趋势，更为准确地阐述磨牙倾斜度的增龄性变化。

综上，本研究结果显示，上下后牙的颊舌向倾斜度及Wilson曲线曲度在不同矢状骨面型人群间存在差异，不同矢状骨面型人群的上下后牙在水平向上存在差异化的代偿机制。Ⅱ类骨面型人群以上后牙代偿性舌倾、下后牙代偿性直立为主。Ⅲ类骨面型人群以下后牙代偿性舌倾为主，上后牙维持原有的代偿性颊倾。这为错𬌗畸形的手术与非手术治疗后牙转矩控制提供了数据支持，为理解牙𬌗结构的三维向生理匹配与代偿机制提供了实验依据。

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