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• 临床研究 •

华南地区成人上颌中切牙与牙槽骨相对位置关系CBCT分析

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【摘要】 目的 探究华南地区成人上颌中切牙在牙槽骨中的位置及其骨壁厚度特征,为上颌中切牙即刻种植术前设计提供临床参考。**方法** 获得医院伦理委员会审批及患者知情同意,采集2018年1月至2021年12月,南方医科大学口腔医院就诊的990例华南地区成人健康上颌中切牙患者的口腔锥形束CT(cone beam computer tomography, CBCT)影像,按性别和年龄分组。从CBCT影像中,确定适宜矢状面和标志点,分析牙根在牙槽骨位置关系,测量釉牙骨质界(cemento-enamel junction, CEJ)下4 mm、根中处和根尖处的唇侧及腭侧骨壁厚度,同时测量牙长轴与牙槽骨长轴夹角。比较不同性别组唇腭侧骨壁厚度,比较不同性别组及年龄组(20~39岁;40~59岁;60~79岁)牙齿长轴与牙槽骨长轴夹角关系。**结果** 华南地区成人上颌中切牙矢状面牙根在牙槽骨的唇腭侧位置关系存在显著差异,其中根尖在牙槽骨唇侧1/3处占比为95.8%(948/990),根尖在牙槽骨中1/3处的占比为4.1%(41/990),根尖在牙槽骨腭侧1/3处占比为0.1%(1/990);腭侧CEJ下4 mm、根中、根尖处骨壁厚度为 (1.82 ± 0.56) mm、 (3.20 ± 1.10) mm、 (7.70 ± 2.00) mm,均大于唇侧的 (1.21 ± 0.32) mm、 (0.89 ± 0.35) mm、 (1.86 ± 0.82) mm,差异有统计学意义($P < 0.05$);男性骨壁厚度普遍大于女性($P < 0.05$);男性牙与牙槽骨长轴夹角为 $14.77^\circ \pm 5.66^\circ$,女性为 $12.80^\circ \pm 5.70^\circ$,差异有统计学意义($P < 0.05$);40~59岁组和60~79岁组牙与牙槽骨长轴夹角均大于20~39岁组,差异有统计学意义($P < 0.05$)。**结论** 95.8%的华南地区成人上颌中切牙的牙根偏向唇侧骨壁,根尖处腭侧骨厚度大于唇侧;所测位点中,根中处唇侧骨壁厚度最小。华南地区成人中男性上中切牙与牙槽骨长轴夹角大于女性,且夹角随年龄增长而增大。上颌中切牙即刻种植术前需关注根周骨壁厚度和牙根与牙槽骨长轴夹角大小,合理选择种植方案。

【关键词】 锥形束CT; 上颌中切牙; 上切牙根位置; 即刻种植; 唇侧骨壁; 腭侧骨壁; 牙体长轴; 牙槽骨长轴

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CBCT analysis of the relative position between maxillary central incisors and alveolar bone in Southern Chinese adults DING Ziling, LIU Xin, YANG Xiaoyu, LIU Chufeng. Stomatological Hospital, School of Stomatology,

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【Abstract】 Objective Exploring the position and bone wall thickness characteristics of the maxillary central incisors in Southern Chinese adults to provide a clinical reference for the design of immediate maxillary central incisor implantation surgery. **Methods** The hospital ethics committee approved the study, and the patients provided informed consent. CBCT images of 990 adult patients (aged 20-79 years) from the Stomatology Hospital (January 2018 to December 2021) were categorized based on the dental arch form and age-sex groups. Sagittal CBCT images of the maxillary central incisors were used to measure the labial and palatal bone thickness wall at 4 mm the CEJ to apical, the middle

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of the root, and the angle between the tooth long axis and the long axis of the alveolar process, to compare the thickness of the labial and palatal bone walls in samples of male and female patients, and to explore the relationship between the angle between the tooth long axis and the alveolar process long axis in samples of male and female patients in different age groups (20-39 years; 40-59 years; 60-79 years). **Results** Significant differences were found in the labiopallatine side of the alveolar bone of the maxillary incisor root position. A total of 95.8% (948/990) of the maxillary incisors were positioned more buccally, 4.1% (41/990) were positioned more midway, and 0.1% (1/990) were positioned more palatally. The thicknesses of the bone wall at the CEJ of 4 mm below the palatal side, the middle of the root, and at the apex were greater (1.82 ± 0.56 mm, 3.20 ± 1.10 mm, and 7.70 ± 2.00 mm, respectively) than those at the labial side (1.21 ± 0.32 mm, 0.89 ± 0.35 mm, and 1.86 ± 0.82 mm, respectively), with statistical significance ($P < 0.05$). Male bone wall thickness was generally greater than female bone wall thickness ($P < 0.05$). The angle between the long axis of male teeth and the alveolar bone was $14.77^\circ \pm 5.66^\circ$, while that of female teeth was $12.80^\circ \pm 5.70^\circ$, with a statistically significant difference ($P < 0.05$). The angle between the long axis of teeth and the alveolar bone in the 40-59-year-old group and the 60-79-year-old group was greater than that in the 20-39-year-old group, and the difference was statistically significant ($P < 0.05$). **Conclusion** A total of 95.8% of adults in South China have maxillary central incisors with root deviation toward the labial bone cortex. The thickness of the labial bone wall is much thinner than that of the palatal bone wall, which is the middle of the thickness of the root. In Southern Chinese adults, the angle between the upper central incisor and the long axis of the alveolar bone in males is greater than that in females, and the degree of the angle increases with age. It is recommended to pay attention to the thickness of the bone wall around the root and the angle between the teeth before immediate implantation surgery to choose a reasonable implantation plan.

【Key words】 cone-beam computed tomography; maxillary central incisor; upper incisors position; immediate implant; labial bone wall; palatal bone wall; the long axis of tooth; the long axis of alveolar bone

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随着种植技术的不断发展和普及,即刻种植因其可缩短患者缺失牙的时间、维持拔牙位点的软硬组织空间等优点,已成为较常用的治疗手段。上颌中切牙是美学区最重要位置,在进行即刻种植时,通常对唇侧骨壁厚度及跳跃间隙有一定要求,国际口腔种植学会(International Team for Implantology, ITI)指南建议拔牙窝骨壁完整,唇颊侧骨壁 ≥ 1 mm,种植体颈部平台与颊侧骨壁内侧至少有2 mm间隙^[1]。有学者研究表明,不同地域的人群,上颌前牙的牙根位置、骨壁厚度差异很大^[2-4]。华南地区人群上前牙唇侧骨壁通常偏薄,常不足1 mm,拔牙后还有牙槽骨水平向和垂直向吸收,增加了轮廓美学和红色美学风险^[5]。如何在这类人群的中切牙即刻种植中以修复为导向将种植体植入在正确的三维位置,获得良好的初期稳定,甚至实现即刻修复,这需要充分分析了解患者原有根骨关系及余留骨量和成骨空间。为丰富前牙根骨关系解剖数据库,本研究将通过分析华南地区990例成年健康上颌中切牙患者的锥形束CT(cone-beam computed tomography, CBCT),测量其

唇腭侧不同位点的骨壁厚度、牙长轴与牙槽骨长轴相对角度,为临床上颌中切牙即刻种植术前设计提供临床参考。

1 资料和方法

本研究经过南方医科大学口腔医院伦理委员会批准备案(2021-YW-44-001)。所有研究对象均签署知情同意书。

1.1 研究对象

选取2018年1月至2021年12月,南方医科大学口腔医院就诊的990例健康上颌中切牙患者的CBCT,男性316例,女性674例,年龄为20~79岁。

纳入标准:出生地为华南地区(身份证号码开头两位数字为“44”或“45”或“46”);年龄范围20~79岁,上颌前牙区牙列完整,无拥挤畸形;牙根完整无吸收,根尖孔发育完成;无前牙区牙病治疗和修复史,无严重牙体缺损;全口卫生状况良好;无明显牙周疾病;无影响骨代谢的全身系统性疾病;CBCT影像清晰。排除标准:上颌前牙牙根未发育完全;牙列严重拥挤;重度牙周炎;上颌中切牙有

任何形式的修复体或充填体;根尖周明显病理性因素包括根尖囊肿、牙根吸收或明显骨质丧失的影像;有钛板或腭修复体等颌面部修复材料人群;CBCT伪影大,影像不清晰。

1.2 研究方法

1.2.1 资料获取 选取锥形束CT机(NEWTOM VGi, CEFLA, 意大利)拍摄的符合纳入标准的990例患者的CBCT影像。参数为电压110 kV, 电流20 mA, 曝光时间8~12 s。

1.2.2 测量平面获取 在横截面上选取牙根周径最大处使矢状面经过唇腭侧面最凸位置, 在冠状面上选取切缘中点和根尖点获取矢状向截面, 即为测量平面。

1.3 测量内容

上颌中切牙矢状向牙根位置分类: 根据上颌中切牙矢状面上连接唇腭侧釉牙骨质界(cemento-enamel junction, CEJ)最低点连线并绘制直线L1, 从上颌中切牙根尖最凸点画出另一条直线L2平行于L1。将牙槽嵴的宽度以L2线处于唇腭侧骨皮质层最外两点间线段均等划分为3部分, 根据根尖位于牙槽骨不同部分, 分为偏唇侧类、中间类、偏腭侧类(图1)。上颌中切牙唇腭侧骨壁厚度及牙长轴与牙槽骨长轴夹角测量示意图(图2)。

1.4 统计学分析

采用SPSS 25.0软件进行统计学分析。定量资料符合正态分布, 用均数 $\pm$ 标准差表示, 两组间比较采用 t 检验, 三组间比较采用单因素方差分析和LSD两两比较, $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 牙根在牙槽骨内的位置关系

根尖在牙槽骨唇侧1/3处占比为95.8% (948/990), 根尖在牙槽骨中份1/3处的占比为4.1% (41/990), 根尖在牙槽骨腭侧1/3处占比仅为0.1% (1/990)。

2.2 唇腭侧骨壁厚度

2.2.1 不同位点唇腭侧骨壁厚度比较 在三对测量位点中, 唇侧牙根中点处骨壁偏薄, 为 (0.89 ± 0.35) mm, 腭侧骨壁厚度从CEJ下4 mm到根尖处逐渐增长。比较两侧的3个位点显示, 腭侧上的CEJ下4 mm、根中、根尖处骨壁厚度均大于唇侧, 差异有统计学意义($P < 0.05$)(表1)。

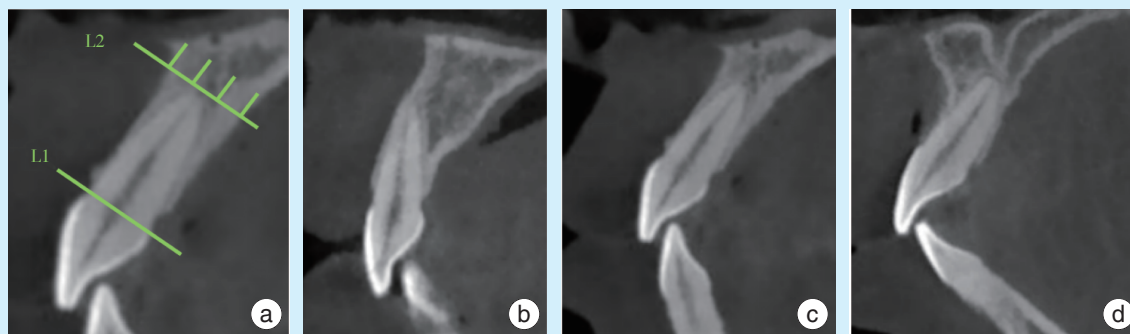
2.2.2 不同性别唇腭侧骨壁厚度比较 男女间唇侧CEJ下4 mm骨壁厚度差异无统计学意义($P > 0.05$)。男性根中处和根尖处骨壁厚度大于女性($P < 0.05$); 男性腭侧CEJ下4 mm、根中处、根尖处骨壁厚度大于女性($P < 0.05$)(表2)。

2.3 偏唇类唇腭侧骨壁厚度测量

当根尖位置为偏唇类时(95.8%, 948/990), 男性唇侧根中和根尖处骨壁厚度大于女性, 差异有统计学意义($P < 0.05$); 男性腭侧CEJ下4 mm、根中、根尖处骨壁厚度均大于女性, 差异有统计学意义($P < 0.05$)(表3)。

2.4 中间类唇腭侧骨壁厚度测量

当根尖位置为中间类时(4.1%, 41/990), 男性唇、腭侧根尖处骨壁厚度大于女性, 差异有统计学意义($P < 0.05$); 其余各组间差异无统计学意义(表4)。



a: tripartite fixed-point diagram, L1: a line of the lowest point of the labial-palatal CEJ on the sagittal surface of the maxillary central incisor, L2: a line parallel L1 through the most convex point of the root tip of the maxillary central incisor; b: sagittal views of 1/3 lip; c: intermediate; d: 1/3 palatine

Figure 1 Classification of sagittal position by CBCT

图1 CBCT矢状向位置分类

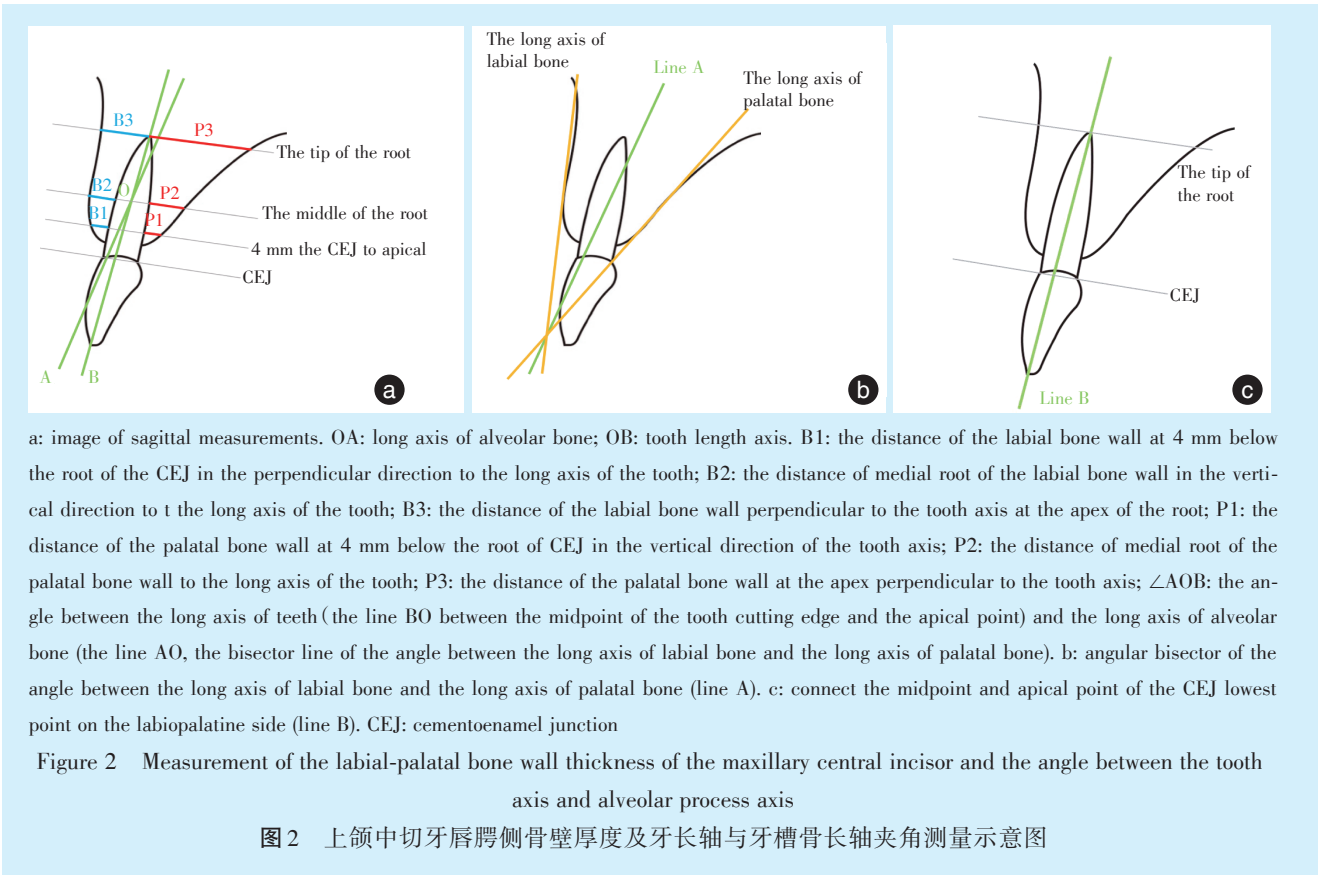


表 1 不同位点唇腭侧骨壁厚度的测量

Table 1 The thickness of the labial and palatine bone wall at different sites				mm, $\bar{x} \pm s$
Groups	Labial bone	Palatine bone	<i>t</i>	<i>P</i>
4 mm the CEJ to apical	1.21 ± 0.32	1.82 ± 0.56	-29.722	< 0.001
The middle of the root	0.89 ± 0.35	3.20 ± 1.10	-62.052	< 0.001
The tip of the root	1.86 ± 0.82	7.70 ± 2.00	-85.163	< 0.001

CEJ: cemento enamel junction

表 2 不同性别唇腭侧骨壁厚度的测量

Table 2 The thickness of the labial and palatine bone wall in different sexes							mm, $\bar{x} \pm s$
Groups	Labial bone			Palatine bone			
	4 mm the CEJ to apical	The middle of the root	The tip of the root	4 mm the CEJ to apical	The middle of the root	The tip of the root	
Male (<i>n</i> = 316)	1.21 ± 0.33	0.94 ± 0.34	2.01 ± 0.86	1.97 ± 0.66	3.77 ± 1.20	8.68 ± 2.01	
Female (<i>n</i> = 674)	1.20 ± 0.32	0.87 ± 0.35	1.80 ± 0.79	1.75 ± 0.50	2.94 ± 0.94	7.24 ± 1.82	
<i>t</i>	0.318	3.266	3.866	5.998	11.861	11.229	
<i>P</i>	0.751	0.001	< 0.001	< 0.001	< 0.001	< 0.001	

CEJ: cemento enamel junction

2.5 牙长轴与牙槽骨长轴角度

男性的角度为 $14.77^\circ \pm 5.66^\circ$, 女性的角度为 $12.80^\circ \pm 5.70^\circ$, 差异有统计学意义 ($P < 0.05$)。按年龄段分组统计显示, 40 ~ 59 岁组、60 ~ 79 岁组角度大于 20 ~ 39 岁, 差异有统计学意义 ($P <$

0.05), 60 ~ 79 岁组与 40 ~ 59 岁组之间差异无统计学意义 ($P > 0.05$) (表 5)。

3 讨论

种植体准确的三维位置和足够的初期稳定性

表 3 不同性别下偏唇类唇腭侧骨壁厚度的测量

Table 3 Measurement of the thickness of the labial and palatal bone wall positioned more labial in different sexes mm, $\bar{x} \pm s$

Groups	Labial bone			Palatine bone		
	4 mm the CEJ to apical	The middle of the root	The tip of the root	4 mm the CEJ to apical	The middle of the root	The tip of the root
Male($n = 305$)	1.21 ± 0.33	0.93 ± 0.34	1.93 ± 0.70	2.01 ± 0.64	3.84 ± 1.16	8.80 ± 1.95
Female($n = 643$)	1.21 ± 0.32	0.86 ± 0.34	1.73 ± 0.62	1.77 ± 0.49	2.99 ± 0.92	7.37 ± 1.74
t	0.13	3.243	4.487	6.195	12.141	11.296
P	0.896	0.001	< 0.001	< 0.002	< 0.003	< 0.004

CEJ: cementoenamel junction

表 4 不同性别下中间类唇腭侧骨壁厚度的测量

Table 4 The thickness of the labial and palatal bone wall positioned more midway in different sexes mm, $\bar{x} \pm s$

Groups	Labial bone			Palatine bone		
	4 mm the CEJ to apical	The middle of the root	The tip of the root	4 mm the CEJ to apical	The middle of the root	The tip of the root
Male($n = 11$)	1.09 ± 0.35	1.19 ± 0.42	4.26 ± 1.58	1.08 ± 0.33	1.88 ± 0.51	5.52 ± 0.75
Female($n = 30$)	1.02 ± 0.26	1.02 ± 0.25	3.00 ± 1.18	1.25 ± 0.34	1.81 ± 0.64	4.57 ± 0.99
t	0.703	1.604	2.77	-1.478	0.321	2.885
P	0.486	0.117	0.009	0.148	0.750	0.006

CEJ: cementoenamel junction

表 5 不同年龄牙长轴与牙槽骨长轴角度对比

Table 5 The angle between the upper anterior teeth and the long axis of the alveolar bone at different ages $^{\circ}$, $\bar{x} \pm s$

Age/year	Angle
20-39($n = 747$)	12.55 ± 5.60
40-59($n = 189$)	16.03 ± 5.35^a
60-79($n = 54$)	16.47 ± 5.54^a
F	38.202
P	< 0.001

a: $P < 0.05$ compared with age group of 20-39

是美学区即刻种植成功的必要条件^[6]。即刻种植可以缩短患者缺失牙时间、尽可能维持拔牙位点的软硬组织空间,成为上颌前牙区牙列缺损优先考虑方案。上颌前牙,尤其以中切牙为代表的牙槽骨唇腭侧骨壁厚度、牙根与牙槽骨长轴夹角等相对位置关系,对于即刻种植备洞点选择、初期稳定性获得,乃至基台及修复体选择,甚至近远期功能美学效果等都具有重要意义^[7]。

Chung 等^[8]对 250 颗上颌前牙测量,发现牙根尖偏唇侧占 94%,中间类占 5.6%,偏腭侧占 0.4%。关晓航等^[9]对 73 名成人上颌前牙的牙根位置进行研究,发现 94.98% 根尖为偏唇侧,5.02% 为中间类,

未发现偏腭侧情况。本研究方法与 Chung^[8]、关晓航等^[9]一致,得出的结果趋势也基本一致。大部分上颌中切牙牙根尖偏唇侧,腭侧有充足骨量提供良好的初期稳定性。此类型根骨关系行即刻种植时,在腭侧骨壁定位,指向腭侧根方,以期在腭侧获得足够骨量从而保证良好的初期稳定性,同时预留与唇侧骨壁间足够的跳跃间隙。Lau 等^[10]基于牙根在牙槽骨内的矢状向方向,利用牙长轴将牙槽骨长轴均分为三等分,对 170 颗上颌中切牙 CBCT 数据进行分析,得出 78.8% 牙根偏向唇侧,19.4% 位于中间,1.8% 偏向腭侧。本研究将根尖点所在平行于 CEJ 最低点连线根尖处线段三等分来获取牙根位置分类,与 Lau 等^[10]的结果相比,根尖偏唇类占比相对更高。这可能是分类方法的差异,后者因方法不同,使原本属于本研究中偏唇分类人群划分至中间类。所以不同研究方法可能导致结果的差异。但从大趋势观察,仍然是根尖偏唇侧类占绝对优势,也提示即刻种植时备洞定点和方向控制重点集中在腭侧^[11]。同时建议选用足够强度小直径种植体,使种植体与唇侧骨壁间预留足够的跳跃间隙(最好 ≥ 2 mm)并植入低替代率骨粉,以便更好地维持硬组织外形轮廓。若在此基础上可实现牙冠舌侧螺丝开口,临时修复体或

个性化愈合帽关闭并保留天然牙穿龈形态则更佳。当患者牙龈为薄龈生物型时可配合同期或延期软组织增量,以实现理想的美学效果。相对而言中间类单纯靠根方骨量获得初稳,偏唇类需在根尖唇侧获得初稳,都较难获得足够的骨接触面积,即刻种植概率均较偏唇类低。必要情况下,可位点保存后延期种植或结合骨增量手术种植^[12-13]。

Wang等^[14]对300例患者上颌前牙进行CBCT测量分析,发现其牙长轴与牙槽骨长轴夹角大部分 $\geq 10^\circ$;当夹角 $< 10^\circ$ 时,种植体角度接近天然牙方向;当夹角 $> 30^\circ$ 时,根尖区唇侧骨壁通常较薄,即刻种植后唇侧骨壁吸收风险极高,未来种植体与牙冠相对角度较大,需严格把握适应证和临床操作技巧,甚至放弃即刻种植改为延期以便寻找创造更好的骨量条件,将种植体植入在合适的三维位置。Kumar等^[15]建议上颌前牙区选择锥形种植体可减少骨穿孔,同时因锥形种植体挤压的植入方式,更易获得初期稳定性。鉴于本研究结果发现华南地区成人上颌中切牙即刻种植利用腭侧骨壁获得初期稳定的可能性较在唇侧和根尖位置获得初稳的可能性更大;牙冠与种植体间成角度的几率更大。建议术前运用CBCT评估位点三维位置并测量唇腭侧骨壁厚度和夹角大小,以确认种植体是否可以获得正确的三维位置和初期稳定性,若无法实现要求则需放弃即刻种植。

Tennekoon等^[16]研究发现雌激素和睾酮可以促进骨骼生长,生长发育高峰期牙槽骨发育加速,但随着年龄进一步增长,中老年时期各种激素水平下降,骨密度呈线性下降,可能引起牙槽骨吸收和唇侧凹陷,造成牙根与牙槽骨长轴相对角度增加。同时,随着牙周组织增龄性改变、咬合力向前的分力及口唇匝肌肌力减弱甚至患者张口呼吸等,都可能导致该夹角随着时间的增加而增大。所以,高龄患者前牙即刻种植时可能面临更大的角度调整需求。

研究报道,上颌中切牙唇侧骨壁厚度为 $0.55 \sim 1.93 \text{ mm}$ ^[17-19]。袁洁等^[17]对40名青年的120颗上颌前牙唇侧骨壁厚度进行测量分析,其中上颌中切牙唇侧牙槽骨平均骨厚度为 $(0.79 \pm 0.24) \text{ mm}$ 。Xu等^[18]在634例患者上颌中切牙CBCT中发现,在CEJ下4 mm处,男性唇侧骨壁厚度为 $(0.77 \pm 0.34) \text{ mm}$,女性唇侧骨壁厚度为 $(0.80 \pm 0.33) \text{ mm}$ 。Aljabr等^[19]在186例患者上颌前牙CBCT影像中发现,右侧上颌中切牙骨嵴顶下3 mm唇侧骨壁厚度为 $(1.02 \pm$

$0.20) \text{ mm}$,根中处为 $(0.85 \pm 0.28) \text{ mm}$,根尖处为 $(1.34 \pm 0.49) \text{ mm}$;左侧上颌中切牙骨嵴顶下3 mm唇侧骨壁厚度为 $(0.97 \pm 0.20) \text{ mm}$,根中处为 $(0.85 \pm 0.26) \text{ mm}$,根尖处为 $(1.41 \pm 0.52) \text{ mm}$ 。各研究间可能因地区、人种、样本量等影响因素存在较大差异。本研究发现华南地区成人上颌中切牙CEJ下4 mm处的唇侧骨壁厚度为 $(1.21 \pm 0.32) \text{ mm}$,牙根中点处唇侧骨壁厚度 $(0.89 \pm 0.35) \text{ mm}$;不同矢状向牙根分类下的唇侧骨壁厚度有显著差异,在CEJ下4 mm,根尖偏唇类的唇侧骨壁厚度大于中间类,在根中处和根尖处,根尖偏唇类的唇侧骨壁厚度均小于中间类。在三处测量位点的腭侧骨壁厚度,根尖偏唇类均明显大于中间类,且在根尖处最为明显,说明牙根位置处于偏唇类时更容易实现即刻种植,临床中可以利用充足的腭侧骨壁厚度和高度获得良好的种植初期稳定性。

综上所述,本研究通过对华南地区成人990例上颌中切牙CBCT影像资料分析,发现华南地区成人上颌中切牙牙根偏唇类占95.8%,中间类占4.1%,偏腭类占0.1%。在根中处,唇侧骨壁厚度最小;腭侧骨壁厚度在CEJ下4 mm处、根中处、根尖处逐渐递增。华南地区成人中男性上切牙与牙槽骨长轴夹角大于女性,且夹角度数会随着年龄增长而增大。建议行上颌中切牙即刻种植术前测量文中提及位点骨厚度及夹角大小,以评估即刻种植风险,实现可预期的种植修复理想三维位置、初期稳定性及美学修复效果。若结合术前CBCT、口扫等数据进行数字化种植修复设计,术前选择合适的种植体、基台、牙冠过渡期形态及骨增量策略则可以更好地利用患者已有解剖条件,实现更为精准快捷的前牙美学种植修复。

【Author contributions】 Ding ZL designed the study, collected and analyzed the data, wrote the article. Liu X collected and analyzed the data, revised the article. Yang XY, Liu CF designed the study, guided and critically reviewed the article structures. All authors read and approved the final manuscript as submitted.

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