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·正畸学专栏 防治实践·

正畸—正颌联合治疗成人骨性Ⅱ类错𬌗畸形1例及文献回顾

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【摘要】 **目的**　探讨成人骨性Ⅱ类错𬌗畸形患者正畸—正颌联合治疗的临床诊疗过程及治疗效果，为同类复杂骨性错𬌗畸形的多学科治疗提供参考。**方法**　本研究为单例回顾性病例报告，已获得医院伦理审查委员会批准及患者书面知情同意。本报告遵循CARE指南进行报告。报告1例成人男性骨性Ⅱ类高角错𬌗畸形多学科诊治病例。患者因牙列不齐、下颌后缩及侧貌改善诉求就诊，并自述夜间打鼾伴偶发憋醒。检查示凸面型、下颌后缩及颏部发育不足，上颌牙弓狭窄，上颌牙列轻度拥挤、下颌中度拥挤，前牙浅覆𬌗伴局部小开𬌗、Ⅱ°深覆盖，双侧尖牙及磨牙远中关系；影像学检查示上下颌前牙唇倾及咽气道偏窄，咽气道总体积为17.6 cm^3，最小横截面积为161.0 mm^2。术前正畸采用拔牙减数、微种植体支抗及转矩控制，完成牙列排齐整平，去除牙性代偿及控制垂直向；正颌手术纠正颌骨三维不调；术后正畸精细调整咬合关系。治疗结束后进行随访，及相关文献复习。**结果**　治疗后患者侧貌及咬合关系明显改善，面型趋于协调，前牙覆𬌗、覆盖恢复正常，双侧尖牙及磨牙关系达到安氏Ⅰ类。咽气道总体积增至27.0 cm^3，最小横截面积增至215.5 mm^2。治疗后3.5年临床随访显示，患者面部轮廓及咬合关系总体保持稳定。相关文献回顾显示，充分的术前去代偿和垂直向控制是成人骨性Ⅱ类高角患者正颌治疗的重要基础，下颌前徙及颌骨逆时针旋转有助于改善颌面关系和咽气道形态。**结论**　对于成人骨性Ⅱ类错𬌗畸形伴明显骨性不调及面型改善诉求的患者，正畸—正颌联合治疗可改善颌面部形态并重建稳定咬合关系，合理的治疗设计和全程控制是获得良好疗效的重要基础。

【关键词】 成人骨性Ⅱ类错𬌗；　正畸—正颌联合治疗；　下颌后缩；　术前正畸；　咽气道；　微种植体支抗；　下颌前牙；　病例报告
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Combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion: a case report and literature review

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【Abstract】 **Objective**　To investigate the treatment process and clinical outcomes of combined orthodontic-orthognathic treatment in an adult patient with skeletal Class II malocclusion, providing a point of reference for the multidisciplinary management of similar complex skeletal malocclusions. **Methods**　This study is a single-case retrospective case report, approved by the hospital ethics review committee and with written informed consent from the patient. The report adheres to the CARE guidelines. A case of an adult male with skeletal Class II hyperdivergent malocclusion

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is reported. The patient presented with dental irregularity, mandibular retrusion, a desire for facial profile improvement, and reported nocturnal snoring with occasional awakening due to a choking sensation. Clinical examination revealed a convex facial profile, mandibular retrusion, deficient chin projection, a constricted maxillary arch, mild maxillary crowding, moderate mandibular crowding, a shallow anterior overbite with localized open bite, second-degree increased overjet, and bilateral Class II canine and molar relationships. Imaging examinations showed proclination of the maxillary and mandibular anterior teeth and a relatively narrow pharyngeal airway. The total pharyngeal airway volume was 17.6 cm^3, and the minimum cross-sectional area was 161.0 mm^2. Presurgical orthodontic treatment involved tooth extraction, miniscrew anchorage, and torque control to achieve dental alignment and leveling, dental decompensation, and vertical control. Orthognathic surgery was then performed to correct the three-dimensional skeletal discrepancy, followed by postsurgical orthodontic refinement of the occlusion. Follow-up was conducted after the treatment, and relevant literatures were reviewed. **Results** After treatment, the patient showed marked improvement in facial profile and occlusal relationships, with improved facial harmony, normal anterior overbite and overjet, and bilateral Angle Class I canine and molar relationships. The total pharyngeal airway volume increased to 27.0 cm^3, and the minimum cross-sectional area increased to 215.5 mm^2. At a 3.5-year clinical follow-up, the facial profile and occlusal relationships remained generally stable. A literature review indicated that adequate presurgical decompensation and vertical control are important foundations for orthognathic treatment in adult patients with skeletal Class II hyperdivergent malocclusion, and that mandibular advancement and counterclockwise rotation of the jaws may contribute to improvements in dentofacial relationships and pharyngeal airway morphology. **Conclusion** For adult patients with skeletal Class II malocclusion accompanied by pronounced skeletal discrepancies and a desire for facial profile improvement, combined orthodontic-orthognathic treatment can improve dentofacial morphology and establish a stable occlusal relationship. Appropriate treatment planning and comprehensive control throughout treatment are important for achieving favorable clinical outcomes.

【Key words】 adult skeletal Class II malocclusion; combined orthodontic-orthognathic treatment; mandibular retrusion; presurgical orthodontics; pharyngeal airway; miniscrew anchorage; mandibular anterior teeth; case report

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成人骨性Ⅱ类错𬌗畸形是临床常见的牙颌面畸形之一，常表现为下颌后缩、前牙深覆盖、侧貌凸及唇颏关系不协调。对于生长发育已完成且骨性不调较明显的患者，单纯正畸掩饰治疗虽可改善口内咬合关系，但对颌骨三维关系和软组织侧貌的改善有限；正畸—正颌联合治疗可通过术前正畸去代偿、颌骨三维移动及术后咬合精细调整，实现牙列、颌骨的重建以及软组织的调整[1-2]。目前，此类患者治疗中前牙去代偿过程中的牙槽骨安全边界、正颌术后气道适应性变化及术后稳定性仍是临床难点[3-4]。本文报道1例伴咽气道偏窄及下前牙牙槽骨薄的成人骨性Ⅱ类高角错𬌗畸形患者，应用正畸—正颌联合治疗取得了良好疗效，为该类病例的临床诊治提供参考。

1　资料和方法

本研究为单例回顾性病例报告，已获得吉林大学白求恩口腔医院伦理委员会审核（批号：SJDKQ2026063），病历资料及照片的使用均已获得患者的书面知情同意。本报告严格遵循Case Report Guideline（CARE指南）[5]进行报告。

1.1　病历资料

患者，男性，23岁，于2019年7月因牙列不齐、下颌后缩及侧貌改善诉求到吉林大学白求恩口腔医院正畸科就诊。患者一般情况良好，未曾接受牙科正畸治疗。既往存在张口呼吸习惯，夜间打鼾并偶有憋醒，否认外伤史，否认其他口腔不良习惯。家族史中其父亲存在下颌后缩表现。

专科检查：正面观，面部左右基本对称，面下1/3长，唇闭合紧张，最大微笑时可见轻度露龈；侧面观为凸面型，下颌后缩，颏部发育不足，鼻唇角109°，颏唇沟浅，颏肌紧张（图1a）。

口内检查示：恒牙列，口腔卫生状况欠佳，牙颈部可见软垢堆积及白垩色脱矿斑；上中线较面中线左偏1.7 mm，下中线较面中线右偏0.5 mm；上下前牙唇倾，前牙覆𬌗浅，局部小开𬌗，Ⅱ°深覆盖，

双侧尖牙远中关系，双侧磨牙远中关系；37见修复体（图1b）；双侧颞下颌关节开闭口运动未见明显异常，右侧偶发弹响伴疼痛，左侧无弹响及疼痛；双侧关节区无摩擦音，耳屏前无压痛。

模型分析：上颌牙弓拥挤度为2.3 mm，下颌牙弓拥挤度为5.1 mm；以双侧恒尖牙牙尖顶间的直线距离作为前牙段宽度，以双侧第一恒磨牙中央窝间的直线距离作为后牙段宽度。上颌前、后牙段宽度分别为35.1 mm和47.8 mm，下颌分别为26.6 mm和44.1 mm，结合上下颌模型匹配及后牙横向咬合关系，提示上颌牙弓横向宽度相对不足；下颌Spee曲线深约1.8 mm；Bolton前牙比为80.03%，全牙比为93.84%，均偏高，提示下颌牙量相对偏大，同时12、22牙冠宽度相对较小（图1c）。

影像学检查：曲面体层片示：双侧髁突形态欠对称，18牙可见，28、38、48近中阻生，37冠部及根管内见高密度影，远中根高密度影欠连续，根尖区未见明显异常，16、26牙根近上颌窦底（图1d）；头颅侧位片示：骨性Ⅱ类错𬌗畸形，呈高角骨面型，下颌后缩，颏部发育不足，上下前牙牙轴唇倾，气道偏窄（图1e）；头颅正位片示：双侧下颌升支长度大致相等，颏部略右偏（图1f）；锥形束CT（cone beam CT，CBCT）示：上下前牙唇、舌侧牙槽骨较薄（图1g）；右侧髁突表面骨皮质模糊、欠连续，左侧髁突骨皮质连续性尚可；双侧髁突位置偏前，关节后间隙较窄（图1h）。基于CBCT的咽气道三维重建及测量显示，其总体积为17.6 cm^3，最小横截面积为161.0 mm^2（图1i）。

诊断：骨性Ⅱ类；高角；安氏Ⅱ类Ⅰ分类；毛氏$Ⅱ^2$+$Ⅰ^1$分类。

1.2　矫治方案

矫治目标：纠正上下颌骨三维向不调；排齐与整平上下牙列，建立前牙正常覆𬌗覆盖及个别正常𬌗；优化面部侧貌轮廓；改善咽气道形态。

矫治计划：①嘱患者进行口腔卫生宣教及牙周维护，并行唇肌功能训练；②经牙体牙髓科会诊37无临床症状，根尖区无阴影；38近中阻生，牙根形成不足1/3，根尖孔未闭合，根冠比失衡；患者选择保留37，定期复查，若出现症状则行根管再治疗和全冠修复；③经颞下颌关节科会诊，先行保守观察与行为管理，加强随访监测，在充分告知风险后启动正畸治疗；④针对Bolton牙量比例不调，与患者充分沟通下前牙邻面去釉及12、22修复性增宽等处理方案。患者因担心邻面去釉后可能出现牙齿敏感，且不愿接受12、22修复性增宽，故未行直接牙量校正，拟通过后续正畸调整对残余牙量不调进行代偿。⑤制定两种矫治方案。方案一：正畸—正颌联合治疗。术前正畸减数14、24、34、44、18、28、38、48，排齐与整平牙列，去除牙性代偿，匹配上下颌牙弓宽度，去除颌间干扰；正颌手术行上颌Le Fort Ⅰ型截骨术、双侧下颌支矢状劈开术（bilateral sagittal split osteotomy，BSSO）及颏成形术；术后正畸精细调整，建立稳定咬合关系；保持。方案二：正畸掩饰治疗。减数14、24、35、45，解除牙列拥挤，排齐整平牙列，恢复前牙正常覆𬌗覆盖及尖牙、磨牙中性关系，必要时配合颏成形手术改善侧貌。患者对面型改善要求较高，并希望兼顾气道问题，最终选择方案一，即正畸—正颌联合治疗。

1.3　矫治过程

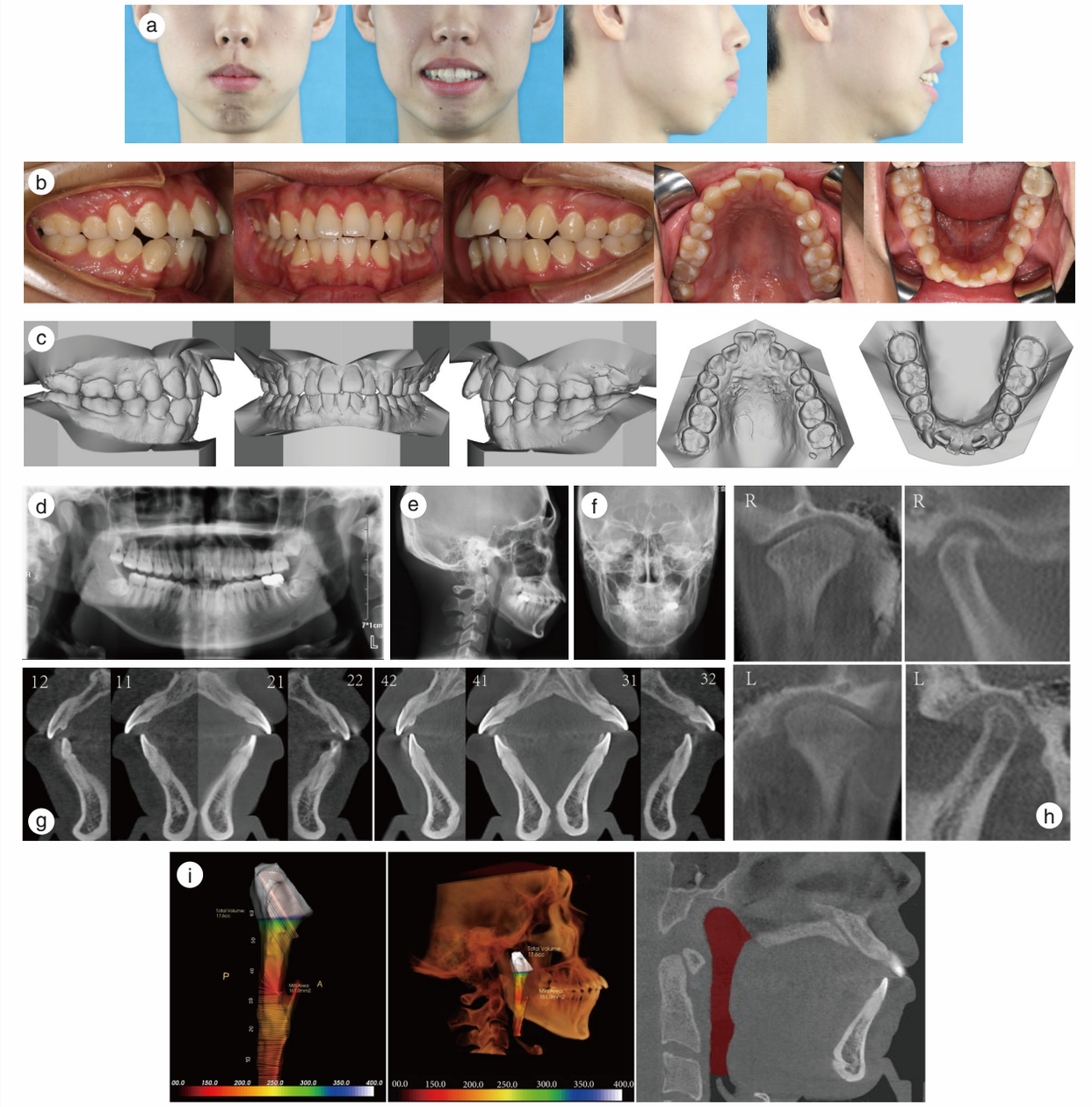
1.3.1　术前正畸　拔牙后全口粘接陶瓷直丝弓自锁托槽，依次使用镍钛弓丝排齐并整平上下颌牙列（图2a），同时通过阶段性牙列模型匹配上下颌牙弓宽度，并逐步去除颌间干扰，此阶段治疗时长为5个月。随后于下颌双侧第二前磨牙与第一磨牙间颊侧牙槽骨植入微种植体支抗钉（直径1.5 mm，长度8 mm），上下颌使用0.019英寸×0.025英寸不锈钢方丝作为主弓丝，并于下颌设置长度为9 mm的牵引钩，采用低摩擦滑动法关闭上下颌拔牙间隙并进行前牙内收及去代偿，牵引力为每侧150～200 g（图2b），此阶段治疗时长为5个月。在此基础上继续关闭剩余间隙，并进一步加强前牙牙根位置及转矩控制，协调上下颌牙弓，为正颌手术建立良好的牙列及咬合条件（图3），此阶段治疗时长为12个月。

1.3.2　正颌手术　上颌Le Fort Ⅰ型截骨术，整体前移4 mm，上移3 mm，逆时针旋转5°；双侧下颌支矢状骨劈开术前徙下颌骨，结合颏成形手术。

1.3.3　术后正畸　进一步调整前牙转矩、轴倾及咬合关系，对残余牙量不调进行代偿。整个治疗过程患者依从性良好，未出现支抗钉松动或软组织炎症。此阶段治疗时长为12个月。

2　治疗结果

治疗后患者骨性Ⅱ类颌面关系及侧貌改善，下颌与颏部形态协调，颏肌紧张缓解（图4a）。上、下牙列整齐，中线基本一致，前牙覆𬌗覆盖正常，双侧尖牙及磨牙中性关系，牙弓协调（图4b）。曲面体层片显示牙根平行度良好（图4c）。头颅侧位

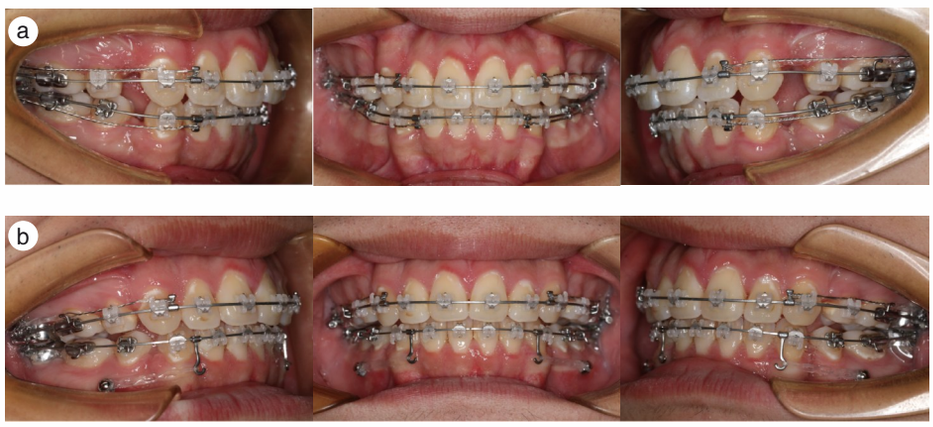


Patient, male, 23 years old. a: convex profile, mandibular retrusion, deficient chin projection, lip strain, and mild gingival display; b: increased overjet, bilateral Class Ⅱ canine/molar relationships, maxillary arch constriction, and crowding; c: digital dental models; d: condylar asymmetry and mesioangular impaction of teeth 28, 38, and 48 on a panoramic radiograph; e: skeletal Class Ⅱ relationship, mandibular retrusion, incisor proclination, and relatively narrow pharyngeal airway on a lateral cephalogram; f: slight rightward chin deviation on posteroanterior cephalogram; g: cone beam computed tomography (CBCT) images showing thin anterior alveolar bone around the tooth roots; h: CBCT images of the temporomandibular joints showing cortical irregularity of the right condyle with relatively intact left condylar cortex; i: CBCT-based pharyngeal airway reconstruction showing a total volume of 17.6 cm^3 and a minimum cross-sectional area of 161.0 mm^2

Figure 1　Initial diagnosis data of a typical case: adult skeletal Class Ⅱ malocclusion (July 2019)

图1　成人骨性Ⅱ类错𬌗畸形典型病例的初诊资料(2019年7月)

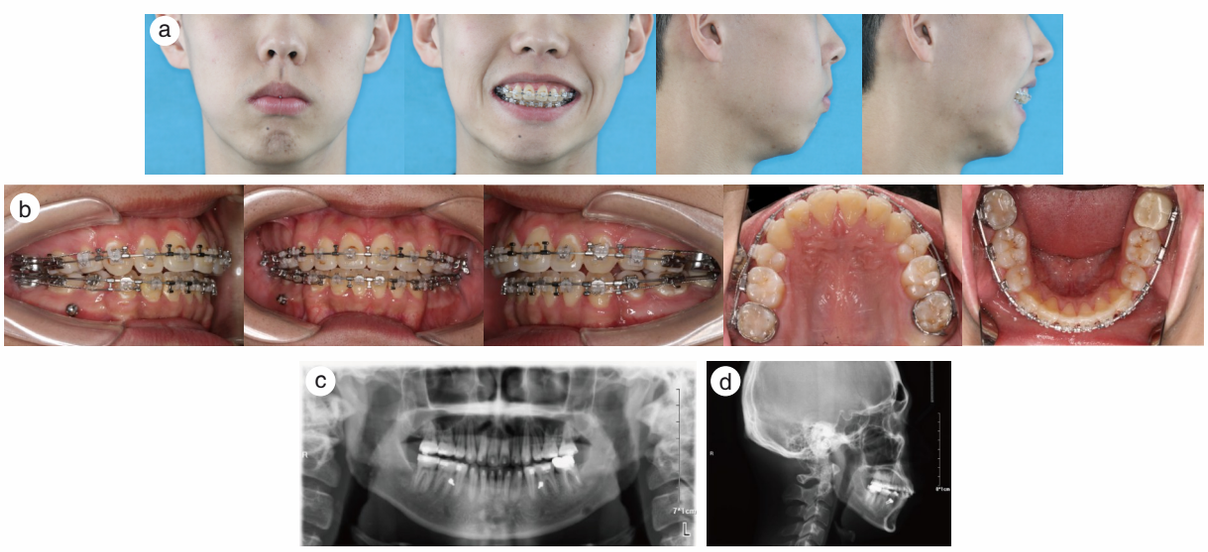
片显示颌骨矢状向、垂直向关系及软组织侧貌改善(图4d);正位片显示颅颌面总体对称(图4e)。CBCT检查显示,治疗后前牙牙根位于牙槽骨范围内,未见明显骨开窗或骨开裂,部分上下前牙牙根长度较治疗前缩短并伴根尖圆钝(图4f);髁突与关节窝空间关系有所改变,右侧髁突表面骨皮质



a: at 5 months, initial alignment and leveling (photography time: January 2020); b: at 10 months, mandibular anterior retraction with mini-screw anchorage and long power arms (photography time: June 2020)

Figure 2　Presurgical orthodontic treatment of a typical case: combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion

图2　成人骨性Ⅱ类错殆畸形正畸—正颌联合治疗典型病例正颌术前的正畸过程



a: facial appearance; b: dental decompensation with increased presurgical overjet; c: aligned dentitions and root parallelism on a panoramic radiograph; d: incisor decompensation on a lateral cephalogram

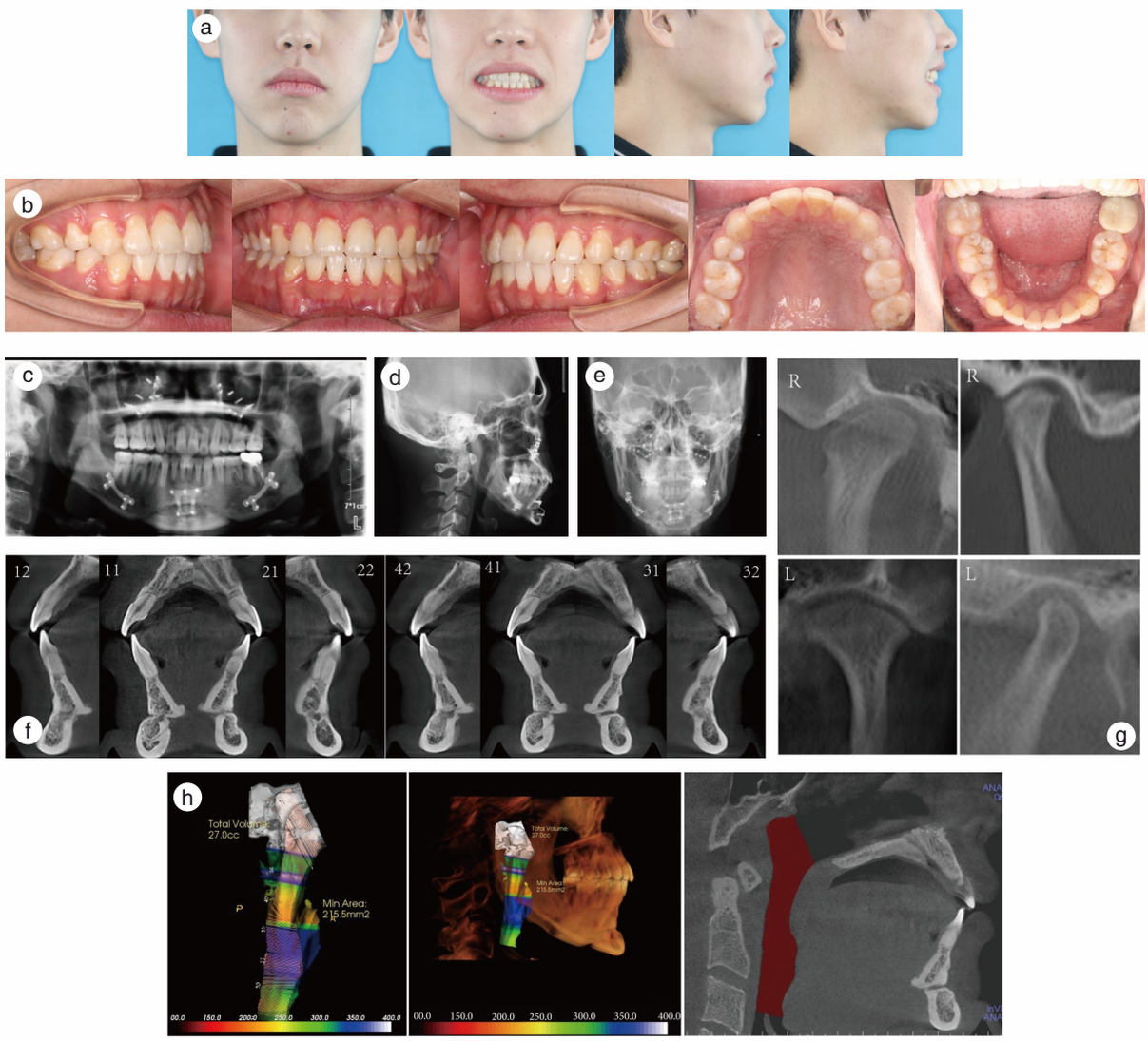
Figure 3　Clinical and radiographic records after completion of presurgical preparation in a typical case of combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion (June 2021)

图3　成人骨性Ⅱ类错殆畸形正畸—正颌联合治疗典型病例正颌术前准备完成时的临床和影像学资料(2021年6月)

轮廓较治疗前清晰、连续(图4g)。治疗后咽气道总体积及最小横截面积均增加,咽气道形态改善(图4h)。患者自述右侧颞下颌关节疼痛、弹响等症状较治疗前缓解。患者对治疗后面部外观及咬合关系总体满意,自述夜间打鼾及偶发憋醒较治疗前缓解。所有阶段治疗中均未发生不良并发症。

颅颌面三维模型重叠显示,上、下颌骨前移并逆时针旋转(图5a);头影描迹重叠分析进一步显示术前正畸去代偿及治疗前后颌骨、牙齿位置变化(图5b)。头影测量数据显示,治疗后ANB由7.6°减至5.6°,MP-SN减小,Z角增大(表1)。

治疗结束后3.5年临床随访显示,患者面部轮廓、牙列排列及咬合关系总体保持稳定(图6)。补充牙周检查示探诊深度(probing depth,PD)为2~3 mm,未见探诊出血及临床附着丧失,牙齿无松动,未见明显牙周炎症表现。



a: improved facial profile and chin morphology; b: aligned dentitions, normal overbite/overjet, and bilateral Class Ⅰ canine/molar relationships; c: favorable root parallelism on a panoramic radiograph; d: improved sagittal and vertical skeletal relationships; e: craniofacial symmetry; f: cone beam computed tomography (CBCT) images showing roots within the alveolar housing without evident fenestration or dehiscence, with shortening and apical blunting of some roots; g: CBCT images of the bilateral temporomandibular joints showing improved cortical continuity of the right condyle; h: CBCT-based pharyngeal airway reconstruction showing a total volume of 27.0 cm^3 and a minimum cross-sectional area of 215.5 mm^2

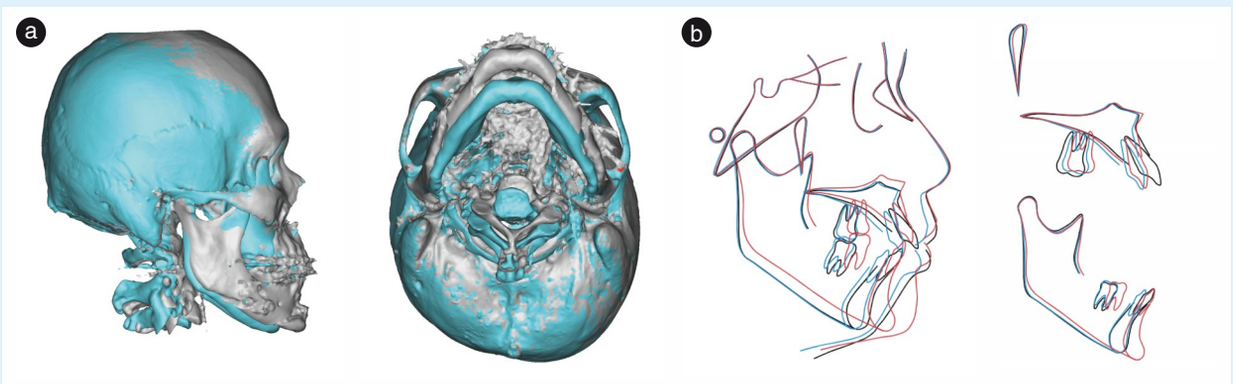
Figure 4　Clinical and radiographic records at the completion of treatment in a typical case of combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion (December 2022)

图4　成人骨性Ⅱ类错殆畸形正畸—正颌联合治疗典型病例治疗结束时的临床及影像学资料(2022年12月)

3　讨　论

对于骨性不调明显、牙性代偿较重且面型改善需求较高的成人骨性Ⅱ类患者,正畸—正颌联合治疗是首要治疗选择[1]。下颌后缩可行BSSO前徙下颌骨;合并上颌骨三维异常时可联合上颌Le Fort Ⅰ型截骨术调整矢状向及垂直向关系[2];颏成形术可改善颏部形态及唇颏关系[6]。

正颌手术后咽气道变化与颌骨移动方式密切相关。单纯BSSO下颌前徙可通过下颌及舌—舌骨复合体前移增加口咽、下咽空间,且部分研究显示该变化在术后1~4年仍可维持[7-8]。双颌手术的气道效应则同时受上、下颌移动方向及幅度影响:下颌前徙联合上颌后退后,总气道容积及舌咽部可增加,但上颌后移可能对鼻咽部产生不利影响[9];下颌前徙联合上颌小幅度位移时,咽气道总体积及最小横截面积增加[10]。对于严重骨性Ⅱ类



a: three-dimensional craniofacial superimposition of pre-treatment (blue) and post-treatment (gray) records; b: cephalometric tracing superimpositions at pre-treatment (black), completion of pre-surgical orthodontic treatment (blue), and post-treatment (red)

Figure 5　Three-dimensional craniofacial model superimposition and cephalometric tracing superimposition before and after treatment in a typical case of combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion

图5　成人骨性Ⅱ类错𬌗畸形正畸—正颌联合治疗典型病例治疗前后颅颌面三维模型及头影描迹重叠分析

表1　成人骨性Ⅱ类错𬌗畸形正畸—正颌联合治疗典型病例不同时间点的头影测量值

Table 1　Cephalometric measurements at different time points of a typical case of combined orthodontic-orthognathic treatment of adult skeletal Class Ⅱ malocclusion　$\bar{x}\pm s$

Measurement index	Pre-treatment	Pre-orthognathic surgery	Post treatment	Normal value
SNA / °	90.7	88.0	93.1	82.8±4.0
SNB / °	83.1	80.5	87.5	80.1±3.9
ANB / °	7.6	7.5	5.6	2.7±2.0
Wits / mm	5.9	0.4	−2.9	0.0±2.0
MP-SN / °	37.2	38.0	35.5	30.4±5.6
GoGn-SN / °	35.0	36.3	34.2	32.9±5.2
NBa-PtGn / °	79.6	79.0	86.5	87.0±4.0
Pg-NB / mm	−3.3	−3.4	1.3	1.0±1.5
U1-L1 / °	104.7	124.0	124.6	125.4±7.9
U1-SN / °	121.6	108.1	111.4	105.7±6.3
U1-NA / mm	8.4	2.8	3.0	5.1±2.4
L1-MP / °	96.6	89.8	88.6	92.6±7.0
L1-NB / mm	12.2	7.1	7.6	6.7±2.1
UL-EP / mm	6.6	2.8	−0.5	2.0±2.0
LL-EP / mm	10.3	7.6	0.8	3.0±3.0
Z-Angle / °	60.4	63.7	78.5	75.0±5.0

S: sella; N: nasion; Ba: basion; A: subspinale; B: supramentale; Go: gonion; Gn: gnathion; Pg: pogonion; Pt: pterygoid point; U1: upper incisor; L1: lower incisor; MP: mandibular plane; SN: S-N plane; GoGn: Go-Gn plane; NBa: N-Ba plane; NA: N-A plane; NB: N-B plane; EP: esthetic plane. SNA, SNB and ANB indicate sagittal skeletal relationships; Wits: AO-BO distance on the functional occlusal plane; MP-SN and GoGn-SN: vertical skeletal relationships; NBa-PtGn: facial axis angle; U1-L1: interincisal angle; U1-SN and L1-MP: incisor inclination; U1-NA and L1-NB: incisor position; UL-EP and LL-EP: lip position relative to EP; Z-angle: Merrifield soft-tissue profile angle

高角患者，Le Fort Ⅰ型截骨上颌上移联合下颌前徙可增加口咽及下咽气道尺寸[11]。上下颌复合体前移并逆时针旋转可增加咽气道容积及最小横截面积[12]；阻塞性睡眠呼吸暂停患者的上下颌前徙术研究显示，咬合平面逆时针旋转有助于增加有效下颌前徙量并改善咽气道形态[13]。本病例上颌前移4 mm、上移3 mm并逆时针旋转5°，联合BSSO下颌前徙，治疗后咽气道总体积由17.6 cm^3增至27.0 cm^3，最小横截面积由161.0 mm^2增至215.5 mm^2。患者自述夜间打鼾、憋醒症状缓解，但因未行多导睡眠监测，尚不能据此判断睡眠呼吸功能的客观改善。正畸掩饰治疗更适用于轻中度骨性不调、牙齿代偿性移动处于牙槽骨安全边界内且侧貌改善要求不高者。对于本病例，掩饰治疗虽可通过拔牙后前牙内收改善覆𬌗覆盖，但难以纠正骨性下颌后缩及凸面型。已有研究显示，成人骨性Ⅱ类高角患者拔牙矫治后，口咽及喉咽部分矢状径可减小[14]，气道横截面可出现前后向压缩[15]，高角拔牙患者的咽气道减小趋势亦可能更为明显[16]；气道变化还可能受垂直向控制及下颌位置变化影响[17-18]。本病例治疗前已存在咽气道偏窄，并伴夜间打鼾及偶发憋醒，因此在选择需较大范围前牙内收的掩饰治疗时，应将潜在气道变化纳入治疗方案评估。

术前正畸的核心在于去除牙齿代偿，协调上下牙弓，为颌骨移动建立稳定、无干扰的术前咬合关系[3]。本病例术前正畸后U1-NA由8.4 mm减至2.8 mm，L1-NB由12.2 mm减至7.1 mm，提示前牙去代偿充分。后牙伸长可能伴随下颌平面角增加及



At the 3.5-year follow-up. a: generally stable facial profile and lip-chin relationship; b: maintained dental alignment and occlusal relationships

Figure 6　Facial and intraoral photographs at the 3.5-year follow-up in a typical case of combined orthodontic-orthognathic treatment of adult skeletal Class II malocclusion (June 2026)

图6　成人骨性Ⅱ类错殆畸形正畸—正颌联合治疗典型病例治疗后3.5年随访照片及口内照(2026年6月)

咬合平面顺时针旋转[19],而高角骨性Ⅱ类患者术后颌骨位置变化及复发风险可能相对较高[5],因此应重视垂直向控制。本病例治疗早期采用“摇椅”形弓丝整平Spee曲线,使后牙远中直立并限制其伸长;不锈钢方丝阶段增加上颌后牙冠舌向转矩,防止后牙颊倾及腭尖下垂;下颌前牙内收阶段采用微种植体支抗联合长臂牵引钩,轻力滑动并配合根舌向转矩,实现前牙内收,减少单纯冠舌向倾斜移动[20-21]。

前牙去代偿应以牙槽骨安全边界为前提[3,22]。骨性Ⅱ类高角患者下前牙区牙槽骨较薄[23-24],大范围移动及转矩控制可能增加牙槽骨缺损及根尖吸收风险[22,25-26]。对于牙槽骨不足或薄牙周表型的患者,牙周辅助加速成骨正畸(periodontally accelerated osteogenic orthodontics,PAOO)可作为辅助治疗选择[27-28],但牙槽骨较薄并非其绝对指征。本病例结合治疗前牙槽骨条件及计划移动范围,采用微种植体支抗联合长臂牵引钩、轻力滑动及转矩控制,使下前牙去代偿尽量维持于牙槽骨安全边界内,故未预防性采用PAOO。治疗后CBCT显示前牙牙根仍位于牙槽骨范围内,未见明显骨开窗或骨开裂,但部分前牙牙根缩短并伴根尖圆钝,可能与牙齿移动范围、治疗时间及个体易感性有关。随访3.5年时,患者前牙无异常松动,牙周临床状态稳定,后续仍应定期观察牙髓活力、松动度及根尖影像学变化。

正颌术后稳定性受颌骨移动量[29-30]、旋转幅度[31]、髁突定位[32]及适应性改建[33-34]等因素影响。本病例治疗结束时颌骨垂直向和矢状向关系改善,3.5年临床随访显示面部轮廓及咬合关系总体稳定,该随访时点未行头影测量,故未对远期骨性变化进行定量评价。为提高术后稳定性,本病例术前充分去除牙性代偿并协调上下牙弓,减少颌间干扰;术中合理控制颌骨前移量及逆时针旋转幅度;术后采用轻力、短期、间断性颌间牵引精细调整咬合关系。

本病例较完整记录了正畸—正颌联合治疗及随访过程,并结合头影测量和CBCT从颌面形态、咽气道、牙槽骨及颞下颌关节等方面评价疗效。治疗后右侧髁突骨皮质轮廓较治疗前清晰、连续,关节疼痛症状缓解,可能与术后关节负荷重新分布及适应性骨改建有关[33,35]。CBCT主要用于评价骨性结构,关节盘及其他软组织变化仍需结合MRI及后续随访综合判断[36]。本病例牙周支持组织及牙根变化的评价主要依据临床及影像学资料,缺乏多时间点量化随访。作为单病例报告,相关结论应结合病例特征谨慎解释。

综上所述,充分去除牙性代偿、控制垂直向及遵循牙槽骨安全边界,是成人骨性Ⅱ类高角患者正畸—正颌联合治疗获得协调侧貌和稳定咬合的重要基础。

【Author contributions】 Han ZY analyzed the data and wrote the article. Zhou Y revised the article. Guan Y processed the research and revised the article. Xue Q analyzed the data and revised the article. Hu M processed the research and reviewed the article.

【Ethics statement】 This case report was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Hospital of Stomatology, Jilin University (No. SJDKQ2026063). Written informed consent for the publication of the

case details and accompanying images was obtained from the patient.

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【Data availability statement】 The data supporting the findings of this case report are included in the article and its figures. Further inquiries can be directed to the corresponding author upon reasonable request.

【Generative AI statement】 The authors declare that generative AI was not used in the creation of this manuscript.

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