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口腔正畸 MIA 技术对青少年安氏Ⅱ类错(牙合)畸形患者龈沟液 MMP-2 表达水平的影响 *

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摘要 目的:探讨口腔正畸微螺钉种植体支抗(Microscrew implant anchor,MIA)技术对青少年安氏Ⅱ类错(牙合)畸形患者对龈沟液基质金属蛋白酶(Matrix metalloproteinase,MMP)-2 表达水平的影响。**方法:**2016 年 1 月 1 日至 2019 年 12 月 31 日选择在本院诊治的青少年安氏Ⅱ类错(牙合)畸形患者 86 例,根据治疗方法把患者分为 MIA 组与对照组,各 43 例,对照组给予头帽口外弓支抗技术结合直丝弓矫治器治疗,MIA 组给予 MIA 技术结合直丝弓矫治器治疗,检测龈沟液 MMP-2 表达水平变化情况。**结果:**MIA 组正畸后 6 个月的总有效率为 97.7 %, 显著高于对照组的 81.4 %(P<0.05)。两组正畸后 6 个月的 SNA 角、OB 与 OJ 值低于正畸前,MIA 组低于对照组(P<0.05),两组正畸前后 SNB 角在组内与组间对比差异都无统计学意义(P>0.05)。两组正畸后 6 个月的龈沟液 MMP-2 值低于正畸前,MIA 组低于对照组(P<0.05)。**结论:**口腔正畸 MIA 技术在青少年安氏Ⅱ类错(牙合)畸形患者的应用能抑制龈沟液 MMP-2 的表达,有利于改善患者的头颅与牙齿的 X 线指标,从而促进提高治疗效果。

关键词:口腔正畸;微螺钉种植体支抗;青少年安氏Ⅱ类错(牙合)畸形;基质金属蛋白酶 -2
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Effect of Orthodontic MIA Technique on Expression of MMP-2 in Gingival Crevicular Fluid in Adolescents with Class Ⅱ Malocclusion*

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ABSTRACT Objective: To explore the effect of orthodontic microscrew implant anchor (MIA) technique on the expression of matrix metalloproteinase (MMP)-2 in gingival crevicular fluid in adolescents with Class Ⅱ malocclusion. **Methods:** A total of 86 patients with adolescent Class II malocclusion, who were diagnosed and treated in Lianyungang Hospital from January 1, 2016 to December 31, 2019, were selected and were randomly divided into MIA group (n=43) and contorl group (n=43). The control group was given head-gear external arch anchorage technique combined with straight wire appliance treatment, and the MIA group was given MIA technique combined with straight wire appliance treatment. The changes of gingival crevicular fluid MMP-2 expression level were detected. **Results:** Six months after orthodontics, the total effective rate (97.7 %) in the MIA group was significantly higher than that (81.4 %) in the control group (P<0.05); the SNA angle, OB and OJ values of the two groups were lower than before orthodontics, and the MIA group was lower than the control group (P<0.05). There was no statistically significant difference in the SNB angle values before and after orthodontics within and between two groups (P>0.05). The MMP-2 values of gingival crevicular fluid in the two groups 6 months after orthodontics were lower than before orthodontics, and the MIA group was lower than the control group (P<0.05). **Conclusion:** The application of orthodontic MIA technology in adolescents with Class Ⅱ malocclusion could inhibit the expression of MMP-2 in gingival crevicular fluid, which was beneficial to improving the X-ray indicators of the patient's head and teeth, thereby increase treatment effectiveness.

Key words: Orthodontics; Microscrew implant anchorage; Juvenile Class Ⅱ malocclusion; Matrix metalloproteinase-2
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前言

青少年安氏Ⅱ类错(牙合)畸形是常见的错(牙合)畸形，在临床上主要表现为下(牙合)后缩、开唇露齿、上(牙合)前突、腭盖高拱、上下牙弓狭窄、下前牙代偿性唇倾[1,2]。该病可严重影响青春期患者的颜面部美观，也会影响患者的生活质量[3]。该病治疗的原则是引导下(牙合)骨发育协调、解决上下牙弓宽度不调、解除下(牙合)骨发育的阻碍因素并达到软组织容貌的协调[4,5]。若采取拔牙矫治会容易导致双(牙合)后缩，不利于上下(牙合)骨和软组织的发育[6]。现代研究表明良好的支抗控制对于安氏Ⅱ类错(牙合)畸形可达到稳定的咬合，也可协调改善患者的侧貌[7]。其中微螺钉种植体支抗(Microscrew implant anchor，MIA)系统是正畸领域研究的趋势，正畸 MIA 技术治疗移动前牙能够改变上唇形态[8,9]。而与传统口外弓支抗相比，MIA 技术减少了操作时间，减轻了患者痛苦，能够利用拔牙间隙充分使前牙内收，具有很好的支抗控制效果，也具有足够稳固性、持续稳定输出、精确正畸等优点[10,11]。在错(牙合)畸形的正畸治疗中，容易导致菌斑积累并且难以清除，导致牙龈组织肿胀与发生炎症。基质金属蛋白酶(Matrix metalloproteinase，MMP)-2 也就是明胶酶 A，可作为降解胶原纤维和降解细胞外基质的重要酶类，对牙周组织的破坏起着至关重要的作用[12,13]。本文具体探讨了口腔正畸 MIA 技术对青少年安氏Ⅱ类错(牙合)畸形患者对龈沟液 MMP-2 表达水平的影响，以明确 MIA 技术的应用效果与机制。现总结报道如下。

1 资料与方法

1.1 研究对象

2016 年 1 月 1 日到 2019 年 12 月 31 日选择在本院诊治的青少年安氏Ⅱ类错(牙合)畸形患者 86 例作为研究对象。纳入标准：年龄 11~18 岁；符合安氏Ⅱ类错(牙合)畸形的诊断标准；首次接受正畸治疗；磨牙和尖牙为远中关系；前牙覆盖 >5 mm，覆(牙合)Ⅱ-Ⅲ度，前牙开唇露齿；本院伦理委员会批准了此次研究；口腔和牙周健康状况良好；具有正畸治疗的指征；均取得患者知情同意。排除标准：合并系统性疾病、传染病者；过敏体质患者；既往接受过矫治治疗未成功者；患者依从性差、交流障碍者。

根据随机信封抽签原则把患者分为 MIA 组与对照组各 43 例，两组患者的前牙覆盖厚度、性别、年龄、矢状骨面型、体重、身高等对比差异无统计学意义(P>0.05)，见表 1。

表 1 两组一般资料对比

Table 1 Comparison of general data between two groups

Groups	n	Front tooth cover thickness(mm)	Gender (M/F)	Age (years)	Sagittal plane type(Ⅰ/Ⅱ/Ⅲ)	Weight(kg)	Height(cm)
MIA group	43	9.04±0.25	18/15	15.02±1.57	16/14/13	43.87±2.48	156.98±8.22
Control group	43	9.11±0.33	17/16	14.87±2.01	17/13/13	44.09±3.12	157.02±9.18

1.2 正畸方法

对照组：给予头帽口外弓支抗技术结合直丝弓矫治器治疗。头戴口外弓支抗，于上(牙合)第一、二磨牙带环，将尖牙向远中牵引并连接第二磨牙带环，内收前牙，定期加压直至拔牙间隙关闭。

MIA 组：给予 MIA 技术结合直丝弓矫治器治疗。将自攻种植体(螺钉直径 1.6 mm、骨内钉长 9 mm、上(牙合)钉长 11 mm)植入于两侧第一磨牙与第二前磨牙间的颊侧牙龈，连接植入体，内收前牙，拉定期加压直至拔牙间隙关闭，取出植入体。

1.3 观察指标

(1)在正畸后 6 个月进行总体疗效标准：显效：咬合正常，各测量指标正常；有效：咬合及各测量指标改善；无效：上述指标无改善甚或恶化。总有效率 =(显效 + 有效)/ 总例数×100.0 %。(2)在正畸前、正畸后 6 个月进行头颅定位侧位 X 线扫描，对患者软硬组织进行定点测量，记录 SNA 角(鼻根点至上齿槽座点连线与前颅底平面所构成)与 SNB 角(鼻根点至下齿槽座点连线与前颅底平面所构成)。(3)取上述的 X 线头影测量数据，计算覆(牙合)(OB)、前牙覆盖(OJ)值。上述所有 X 线片的定点与测量均在相同条件下完成，测量三次求平均值。(4)在正畸前、正畸后 6 个月采集患者的龈沟液 1 mL 左右，加入磷酸盐缓冲液 200 μL 混合，3000 r/min 左右 4 ℃离心 10 min，取上清液，采用酶联免疫法检测检测 MMP-2 含量。

1.4 统计方法

应用 SPSS 19.00，计量资料采用均数±标准差表示(对比为配对 t 检验与独立样本 t 检验等)，计数数据采用百分比表示(对比 χ^2 检验)，P<0.05 为差异有统计学意义。

2 结果

2.1 总有效率对比

MIA 组正畸后 6 个月的总有效率为 97.7 %，显著高于对照组的 81.4 %(P<0.05)，见表 2。

表 2 两组总有效率对比(例，%)

Table 2 Comparison of total effective rate between two groups (n, %)

Groups	n	Effect	Effective	Invalid	Total efficiency
MIA group	43	39	3	1	42(97.7)*
Control group	43	23	12	8	35(81.4)

Note: * P<0.05 compared with the control group.

2.2 SNA 角与 SNB 角变化对比

两组正畸后 6 个月的 SNA 角低于正畸前，MIA 组低于对照组，对比差异都有统计学意义(P<0.05)，两组正畸前后 SNB 角在组内与组间对比差异都无统计学意义(P>0.05)，见表 3。

表 3 两组正畸前后 SNA 角与 SNB 角变化对比(°，$\bar{x}\pm s$)

Table 3 Comparison of SNA angle and SNB angle changes before and after orthodontics between two groups (°, $\bar{x}\pm s$)

Groups	n	SNA angle		SNB angle	
		Before orthodontic	6 months after orthodontic	Before orthodontic	6 months after orthodontic
MIA group	43	81.95±2.18	80.77±1.23#*	76.02±1.47	76.10±0.85
Control group	43	82.09±1.47	81.32±1.47#	76.09±1.22	76.02±0.87

Note: Compared with before treatment, #P <0.05; Compared with the control group, * P<0.05.

2.3 OB 与 OJ 值变化对比

两组正畸后 6 个月的 OB 与 OJ 值都低于治疗前，MIA 组低于对照组，对比差异都有统计学意义(P<0.05)，见表 4。

表 4 两组正畸前后 OB 与 OJ 值变化对比(mm，$\bar{x}\pm s$)

Table 4 Comparison of changes in OB and OJ values before and after orthodontics between two groups (mm, $\bar{x}\pm s$)

Groups	n	OB		OJ	
		Before orthodontic	6 months after orthodontic	Before orthodontic	6 months after orthodontic
MIA group	43	6.63± 0.56	2.17±0.28#*	9.02±0.24	2.65±0.14#*
Control group	43	6.64± 0.32	3.26±0.72#	9.00±0.33	3.98±0.44#

2.4 MMP-2 变化对比

两组正畸后 6 个月的龈沟液 MMP-2 值低于正畸前，MIA 组低于对照组，对比差异都有统计学意义(P<0.05)，见表 5。

表 5 两组正畸前后龈沟液 MMP-2 值变化对比(pg/mL，$\bar{x}\pm s$)

Table 5 Comparison of changes in gingival crevicular fluid MMP-2 values between two groups before and after orthodontics (pg/mL, $\bar{x}\pm s$)

Groups	n	Before orthodontic	6 months after orthodontic
MIA group	43	109.33±21.74	51.98±5.18#*
Control group	43	110.77±17.82	87.87±6.22#

3 讨论

错(牙合)畸形是指由于内外在各种因素等引起的牙齿排列不齐、上下牙弓关系异常，严重者可引起面部畸形、口腔功能障碍[14]。其中安氏Ⅱ类为错(牙合)畸形的主要类型，多发病于青少年，多表现为上下(牙合)骨及牙弓的近、远中关系不调，下牙弓或下(牙合)处于远中位置[15,16]。该病正畸的目的是改善软组织侧貌、促进下(牙合)发育、引导下(牙合)向前、回收上(牙合)切牙、解除牙列拥挤与排齐整平上下牙列[17]。传统的头帽口外弓支抗技术结合直丝弓矫治器治疗具有操作简单、技术成熟等优点，但是由于很多患者的生长发育尚未完成，上述方法的应用容易造成上下(牙合)骨不能充分发育，导致唇部形态娇小与面型不匹配，不利于面型发育[18,19]。本研究显示 MIA 组正畸后 6 个月的总有效率为 97.7 %，显著高于对照组的 81.4 %；两组正畸后 6 个月的 SNA 角低于正畸前，MIA 组低于对照组，两组正畸前后 SNB 角在组内与组间对比无差异，与史建陆[20]等学者的研究类似，通过与传统口外弓支抗(HGA)技术进行比较，回顾性研究微型种植体支抗(MIA)技术结合 MBT 直丝弓矫治器的临床疗效，结果显示 MIA 结合 MBT 技术治疗的效果显著优于传统口外弓支抗结合 MBT 技术，SNA、OJ 均减小。从机制上分析，MIA 技术具有更强的磨牙支抗能力，使牙齿能够通过预定方向排齐，其矢状向机械力可降低牙齿负荷力，符合患者牙齿数据，可缩短治疗后磨牙位移距离[21]。特别是该方法对患者的创伤比较少，能使拔牙间隙充分用于前牙回收，在较短的正畸疗程里让患者获得良好协调侧貌，提高了患者治疗后的美观性[22]。

安氏Ⅱ类错(牙合)畸形通常伴随着上(牙合)前牙唇倾、深覆(牙合)、异常的(牙合)面部肌肉活动，会使得患者的上唇肌肉张力降低[23]。为此正畸的治疗不应该只停留在(牙合)功能和硬组织的改建上，还需要保持患者面部和谐[24]。本研究显示两组正畸后 6 个月的 OB 与 OJ 值都低于治疗前，MIA 组低于对照组。从机制上分析，MIA 技术可通过牵引以及使用多个支抗来移动单个牙齿，其提供的横向机械力要强于正畸矫治所需的负载，可达到绝对的支抗能力[25]。并且 MIA 技术的具有内收力强、骨亲和性好等特点，可直接植入牙槽骨与整体移动上前牙，可达到的骨整合程度更高，从而更有效的改善前牙覆盖及上前牙唇倾斜，显著降低 OB 与 OJ 值[26,27]。

MMPs 家族可作用于细胞外基质和基质膜中的 IV 型胶原，从而直接参与牙周组织的破坏降解过程[28]。其中 MMP-2 为基质金属蛋白酶家族常见一员，又被称为明胶酶 A，分布广

泛，多见于牙龈、牙周膜以及牙槽骨中的破骨细胞、成骨细胞及成纤维细胞等，对成牙骨质细胞及牙本质细胞有一定的破坏作用，而且成牙骨质细胞及牙本质细胞等均参与了牙周组织改建过程，相关研究指出，MMP-2 可降解层黏连蛋白、胶原蛋白等，参与牙周组织破坏[29]。在正畸治疗中，MMP-2 释放增加，提示牙齿移动过程组织吸收及改建较活跃[30]。MMP-2 也能激活肿瘤坏死因子 -α、白细胞介素 -1β 的表达，刺激牙周组织产生大量的氧自由基，导致牙周细胞的代谢紊乱，也可影响组织内免疫细胞及成骨细胞释放炎性介质，从而不利于患者康复[31,32]。本研究显示两组正畸后 6 个月的龈沟液 MMP-2 值低于正畸前，MIA 组低于对照组，孙丽艳[33]等学者也探讨微型种植体支抗正畸对成人安氏Ⅱ类 1 分类错(牙合)畸形患者牙齿咬合力及龈沟液 MMP2，NO 水平的影响，结果显示微型种植体支抗正畸组龈沟液 MMP2 水平显著低于口外弓支抗治疗，与本研究一致。从机制上分析，MIA 技术提供较强的内收力使上切牙和上 (牙合)骨达到较好内收效果，能够改建牙槽基质状况，可明显能改善患者口腔结构，从而有利于抑制 MMP-2 的释放[34-36]。

总之，口腔正畸 MIA 技术在青少年安氏Ⅱ类错(牙合)畸形患者的应用能抑制龈沟液 MMP-2 的表达，有利于改善患者的头颅与牙齿的 X 线指标，从而促进提高治疗效果。不过本研究没有进行随访分析，且没有对成年人的正畸情况进行分析，将在后续研究中深入探讨。

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