Face convexity changes in class II malocclusion patients after Twin-block appliance therapy★

Liu Ya-fei[1], Cui Li-juan[2], Zuo Yan-ping[1], Liu Xue-cong[3], Liu Xin[4]

Abstract

BACKGROUND: Twin-block appliance has been confirmed to efficiently change hard tissue and the profile of soft tissue. Whether a linear relationship exists between soft tissue and hard tissue changes remains unclear.

OBJECTIVE: To evaluate the face convexity changes of soft and hard tissues after Twin-block appliance therapy and compare with controls.

METHODS: Thirty-one class II division 1 malocclusion subjects with hand-wrist radiographs in FG-G stage were selected. Among the 31 patients, 17 received Twin-block appliance therapy, serving as experimental group, and the remaining 14 subjects abandoned treatment, serving as control group. Cephalometric radiographs of each included subject were taken prior to and after treatment or observation. Face convexity of soft and hard tissues, as well as the face convexity changes, was compared between the experimental and control groups. Linear regression equation was employed to analyze the linear association between soft- and hard-tissue changes. Regression equations of experimental and control groups were compared.

RESULTS AND CONCLUSION: Prior to and after Twin-block appliance therapy, a significant correlation existed between the position changes of superior and inferior alveolar sockets relative to the nose and mandible, and the position changes of upper and lower lip pits relative to the nose and mandible, *i.e.*, there was a linear correlation between A–E change and Ss–E change, and between B–E change and Si–E change. The largest Pearson's correlation coefficient (0.839) appeared between Si–E change and B–E change, indicating the best correlativity between these two changes. Statistical analysis revealed that the linear equations of face convexity changes of soft and hard tissues after Twin-block appliance therapy were Si–E = 0.745 B-E, Ss–E = 0.276 A–E. These linear equations would be helpful to explain mandible growth and face convexity change after Twin-block appliance therapy and predict the prognosis of face convexity change.

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Received: 2009-12-07
Accepted: 2010-01-15
(20091221006/GW)

Liu YF, Cui LJ, Zuo YP, Liu XC, Liu X. Face convexity changes in class II malocclusion patients after Twin-block appliance therapy. Zhongguo Zuzhi Gongcheng Yanjiu yu Linchuang Kangfu. 2010;14(17): 3217-3221.

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INTRODUCTION

Twin-block appliance is a functional appliance that was developed by Clark[1] in 1982 to redeem the drawbacks of activator. The appliance can be wearable during the whole day and is mainly used for treatment of class II, division 1 malocclusions. Twin-block appliance has been confirmed to alter dentofacial soft and hard tissues of patients with class II, division 1 malocclusions but much controversial exits[2-4]. This appliance has been also shown to gradually alter the craniofacial structure of patients with class II, division 1 malocclusions. Zuo *et al*[5-6] reported that following guiding mandibular protraction, Twin-block appliance promoted the growth and rebuilding of mandibular body and mandible ascending ramus and the bone deposition of inferior alveolar region. Remmer *et al*[7-9] reported that Twin-block appliance could obviously improve the soft tissue profile of class II division 1 malocclusion patients. Following Twin-block appliance therapy, UL-Eline and LL-Eline were reduced, but nasolabial angle and mentolabial sulcus angle were increased. Therefore, Twin-block appliance can effectively change the profiles of hard and soft tissues. Whether a linear relationship exists between soft tissue and hard tissue changes remains unclear. This study took sensitive, visualized aesthetic plane as reference plane, analyzed the face convexity changes of soft and hard tissues prior to and after Twin-block appliance therapy, and compared with controls, hopefully further understanding the mechanisms by which Twin-block appliance cause the face convexity changes of soft and hard tissues.

SUBJECTS AND METHODS

Design

A non-randomized, concurrent, comparative observation.

Time and setting

This study was performed at the Department of Orthodontics, Stomatological Hospital of Hebei Medical University between August 1999 and February 2007.

Subjects

Thirty-one class II division 1 malocclusion subjects were included in this study. Seventeen subjects (experimental group) received Twin-block appliance therapy over a course of 14.2 months on average, consisting of 9 males and 8 females, with mean age of 11.7 years. The remaining 14 subjects (control group) abandoned treatment, consisting of 6 males and 8 females, with mean age of 11.7 years. An average of 14.5 months of follow-up was performed. Written informed consent regarding therapeutic procedures was obtained from each patient.

Inclusion criteria: molar distalization, anterior deep overbite > 4 mm, deep overbite Ⅱ-Ⅲ degree, normal upper mandible, retrusive mandible, the included angle of subspinale (A)- nasal point(N)- supramentale(B) ≥ 5°, hand-wrist bone being in the early development stage and development stage, no facial deviation, not receiving orthodontic treatment, and being healthy.

Methods

Experimental group: the modified Twin-block appliance was used for orthodontic treatment[5]. Upper and lower mandibles were motion appliance with 45°distalization at contralateral region (5|5 site). The upper mandible device was composed of an arrowhead clasp (0.8 mm) at 65|56 site, long labial bow extending to proximate 6|6 site, and occlusal pad covering 765|567 tongue tip. The lower mandible device was composed of labial arch appliance of lower mandible anterior teeth with 0.8 mm plastic cement hood and δ clasp curved at 4|4 site (0.8 mm). The lower occlusal pad covered the occlusal surface completely to compensate appropriate arch width and anastomosed with the inclined plane of upper mandible appliance at the site of second bicuspid, thus a 45° inclined plane formed. For patients with inappropriate width, a spiral amplifier was placed in the center of the upper mandible (Figure 1).

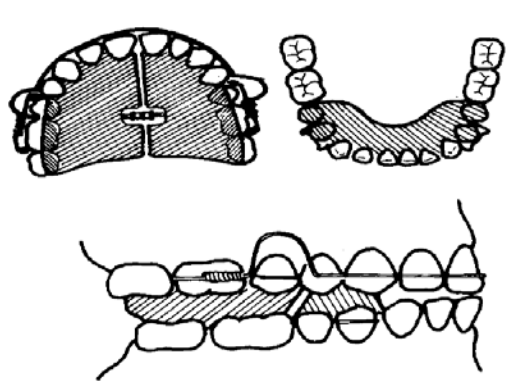
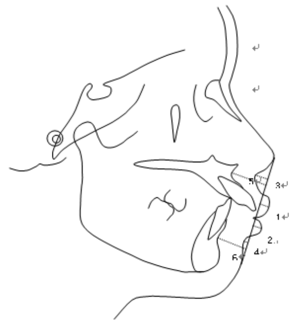


Figure 1 Modified Twin-block appliance

Based on three methods mentioned by Burstone[10], cephalometric radiographs in the central occlusion were taken through the use of X-ray video camera(CRNEX3+CXPH, Finland; magnification 1.35) prior to treatment, prior to and after observation. Each cephalometric radiograph was depicted using transparent vegetable parchment for location and measurements. Each landmark was designated twice, and another location and measurement was performed if the measurement angle or value between twice measurements was over 1° or 0.5 mm. The third measurement value was compared with the first two, and the abnormal one was abandoned, then the mean measurement value was obtained. This study used the aesthetic plane proposed by Ricketts[11], *i.e.*, “line E” as reference plane. Two pairs of measurement landmarks of soft and hard tissues (A: subspinale; Ss: superior labial sulcus; B: supramentale; Si: mentolabial sulcus) and two landmarks of soft tissue. The distances of landmarks of soft and hard tissue to line E were measured prior to and after treatment (observation). The distance difference (A–E, B–E, Ss–E, Si–E) between prior to and after Twin-block appliance therapy could reflect the treatment efficiency of Twin-block treatment. The cephalometric landmarks are shown in Figure 2 and cephalometric measurements are shown in Figure 3.

1: labrale superius; 2: labrale inferius; 3: superior labial sulcus; 4: mentolabial sulcus; 5: subspinale; 6: supramentale

Figure 2 Hard-soft tissue cephalometric landmarks



1: labrale superius–E; 2: labrale inferius–E; 3: superior labial sulcus–E; 4: mentolabial sulcus–E; 5: subspinale -E; 6: supramentale -E

Figure 3 Cephalometric measurements of distance from soft-hard tissue landmarks to line E

Main outcome measures

Distance from soft-hard tissue landmarks to line E (A–E, B–E, Ss–E, Si–E) prior to and after treatments.

Design, enforcement and evaluation

The corresponding author and the first and second authors were responsible for experimental design and data evaluation. All authors participated in experimental procedure enforcement. The major participants had middle- or high-rank professional titles and had many years of professional experience. Blind method evaluation was employed.

Statistical analysis

Data regarding A–E, B–E, Ss–E, and Si–E prior to and after treatments, as well as prior to and after natural growth, were input into Excel database to obtain the responding changes of each index after treatment, as well as after natural growth, compared with prior to, as well as prior to natural growth. Linear correlation regression analysis of these data was performed using SPSS 13.0 software. Statistical processing was performed by the second author.

RESULTS

Quantitative analysis of participants

All initial 31 class II division 1 malocclusion subjects were included in the final analysis, with no loss. Intention-to-treat analysis was done.

Comparison of baseline data regarding age and gender between experimental and control groups

According to sample characteristics, paired χ^2 test of two correlation samples was performed. Results revealed that there were no significant differences in age and gender between experimental and control groups (Table 1).

Table 1 Comparison of gender between experimental and control groups

Group	*n*	Mean (yr)	Standard deviation (yr)	Significance
Experimental	17	11.69	1.45	0.180
Control	14	11.34	1.68	0.180

Group	Male	Female	Significance	*P*
Experimental	9	8	0.158	—
Control	6	8	0.158	—

Correlations of soft and hard tissue measurement changes after Twin-block appliance therapy (Table 2)

Table 2 Correlations of soft and hard tissue measurement changes after Twin-block appliance therapy (n = 17)

Item	Ss–E		Si–E	
	Pearson's correlation coefficient	*P*	Pearson's correlation coefficient	*P*
A–E	0.505	< 0.05	0.741	< 0.01
B–E	0.629	< 0.01	0.839	< 0.01

A: landmark subspinale; B: landmark supramentale; Ss: labrale superius; Si: labrale inferius; E: line E. Significant linear correlations existed between A–E change and Ss–E change, and between B–E change and Si–E change (P < 0.05). The largest Pearson's correlation coefficient (0.839) appeared between Si–E change and B–E change

Correlations of soft and hard tissue measurement change after natural growth (Table 3).

Table 3 Correlations of soft and hard tissue measurement changes prior to and after observation in the control group (n = 14)

Item	Ss–E		Si–E	
	Pearson's correlation coefficient	*P*	Pearson's correlation coefficient	*P*
A-E	0.471	> 0.05	0.125	> 0.05
B-E	0.454	> 0.05	0.555	> 0.05

A: landmark subspinale; B: landmark supramentale; Ss: labrale superius; Si: labrale inferius; E: line E. There were no significant linear correlations between A–E change and Ss–E change, and between B–E change and Si–E change (P > 0.05)

Linear regression equation of soft and hard tissue changes after Twin-block appliance therapy (Tables 4–7).

Table 4 F test for soft-tissue landmark (B–E) as dependent variables and hard-tissue landmark (Si–E) as independent variables in a linear regression equation of the experimental group

Model	*n*	*F*	Significance	*P*
B–E	17	34.842	0.000	< 0.001

B: landmark supramentale; E: line E; Si: labrale inferius

Table 5 Linear regression equation for dependent variable (B–E)

Model	*B*	*t*	Significance	*P*
B–E	0.745	5.903	0.000	< 0.01

B: landmark supramentale; E: line E

Table 6 F test for soft-tissue landmark (A–E) as dependent variables and hard-tissue landmark (Ss–E) as independent variables in a linear regression equation

Model	*n*	*F*	Significance	*P*
A–E	17	8.667	0.010	< 0.01

A: landmark subspinale; E: line E; Ss: labrale superius

Table 7 Linear regression equations for dependent variable (A–E)

Model	*B*	*t*	Significance	*P*
A–E	0.276	2.944	0.010	< 0.01

Two linear regression equations were established taking A–E and B–E changes as the independent variables and Ss–E and Si–E changes as dependent variables. SPSS software analysis yielded equations Si–E = 0.745 B–E and Ss–E = 0.276 A–E. Analysis of variance revealed that regression equations had statistical significance (F_1 = 34.842, P_1 = 0.0001; F_2 = 8.667, P_2 = 0.010).

DISCUSSION

The profile of class II division 1 malocclusion subjects primarily differ from that of normal subjects in the lower third part. Twin-block appliance can promote craniofacial growth and mandibular development by altering maxillofacial muscle environment and coordinate the profile by adjusting naso-labiomental relationship. Through the use of finite element scanning, Singh *et al*[12] found that Twin-block appliance can cause the adaptable changes of condylar cartilage and the bone deposition of mandibular region. Li[13] reported that following Twin-block appliance treatment, UL-ELine and LL-ELine were reduced in patients with class II division 1 malocclusion. Twin-block has been confirmed to greatly reduce the incoordination of upper and lower mandible in the sagittal plane and alter upper lip convexity and mentolabial sulcus. But the mechanism regarding Twin-block appliance improves soft tissue profile by promoting the growth improvement of craniofacial bone remains unclear. This study used mathematical techniques to analyze the face convexity changes of soft and hard tissues prior to and after Twin-block appliance threapy, evaluated the relationship between soft and hard tissue changes, and preliminarily investigated the mechanisms underlying Twin-block appliance improves soft tissue profile.

Sagittal relationship of lip has been presently used to evaluate face profile. The international reference plane commonly used primarily includes "line E" proposed by Ricketts, "line S" proposed by Steiner[14], "line B" proposed by Burston[15], and "line H" proposed by Holdaway[16]. Among numerous measurements, which method yields better sensitivity and consistency to lip positions and which method is more suitable for clinical application should be confirmed. Luo *et al*[17] studied the sensitivity and consistency of "line E", " line B", and "line H" in Chinese Han population and concluded that "line E" had better consistency and sensitivity in assessing profile lip and easier use in clinical diagnosis. For this reason, this study used aesthetic plane (*i.e.*, "line E") as reference plane to directly observe the position of profile lip.

The present study measured the distances of soft-hard tissue landmarks to line E (A–E, B–E, Ss–E, Si–E). A-E and B-E reflect the sagittal relationship of hard tissue upper and lower mandible and aesthetic plane; Ss–E and Si–E reflect the sagittal relationship of soft tissue upper and lower lip pits and aesthetic plane. Because "line E" is a direct-viewing reference plane for assessing face convexity, so above-mentioned four indices were selected to represent soft and hard tissue items closely related to face convexity and to evaluate the relationships between the nose, lip, mandible, and upper and lower lip pits of soft tissue and subspinale and supramentale of hard tissue.

More and more scholars used linear analysis to study the soft and hard tissue changes prior to and after orthodontic treatment. Lin *et al*[18] studied the soft and hard tissue correlations in adolescents with unilateral complete chilopalatognathus and found significant correlation between maxillofacial soft tissue and corresponding hard tissue indices. Leng *et al*[19] studied the soft and hard tissue correlations in patients with class III malocclusion and found that the morphological change of lower third soft tissue was consistent with hard tissue change.

Prior studies compared the treatment efficacy of functional appliance with natural growth in class II malocclusion and found that functional appliance therapy could greatly change craniofacial soft and hard tissue relationship. The present study investigated the soft and hard tissue changes in the lower third profile prior to and after Twin-block appliance therapy and analyzed the correlation of soft and hard tissue changes using SPSS 13.0 software (bivariate statistics). Results revealed that prior to and after Twin-block appliance therapy, a significant correlation existed between the position changes of superior and inferior alveolar sockets relative to nose and mandible, and the position changes of upper and lower lip pits relative to nose and mandible, *i.e.*, there was a linear correlation between A–E change and Ss–E change, and between B–E change and Si–E change. The largest Pearson's correlation coefficient (0.839) appeared between Si–E change and B–E change, indicating the best correlativity between these two changes. Two linear regression equations were established taking A–E and B–E changes as the independent variables and Ss–E and Si–E changes as dependent variables. Analysis of variance revealed that regression equations had statistical significance (F_1 = 34.842, P_1 = 0.0001; F_2 = 8.667, P_2 =0.010).

To clarify whether the correlation of soft and hard tissue changes results from Twin-block appliance therapy, a control group was designed in this study and the correlation of soft and hard tissue changes were investigated. Bivariate statistics of resulting data were performed through the use of SPSS software. There were no significant correlations in soft and hard tissue changes prior to and after natural growth (P > 0.05). That is to say, the position changes of superior and inferior alveolar sockets relative to the nose and mandible does not correlate with the position changes of the upper and lower lip pits relative to the nose and mandible in the control group.

Taken together, there was no significant correlation between soft and hard tissue in terms of sagittal face convexity changes after natural growth, but significant correlation existed after Twin-block appliance therapy. Statistical analysis yielded linear equations regarding the face convexity changes of soft and hard tissues: Si–E = 0.745 B–E , Ss–E = 0.276 A–E. These linear equations would be helpful to explain mandible growth and face convexity change after Twin-block appliance therapy and to predict the prognosis of face convexity change after therapy.

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应用 Twin-block 矫治器后Ⅱ类错𬌗患者面型突度软硬组织的改变★

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摘要

背景：国内外研究证实 Twin-block 矫治器不仅能有效地改变硬组织，还能有效地改变软组织侧貌，那么在软硬组织的改变间是否存在一定的关系和规律呢？

目的：评价分析 Twin-block 功能矫治前后面型突度软硬组织的改变，并与自然生长组面型突度的改变进行对比。

方法：选择 Hagg 手腕骨片为 FG-G 期的安氏Ⅱ类 1 分类下颌后缩患者 31 例，其中以接受 Twin-block 功能矫治的Ⅱ类错𬌗患者 17 例作为实验组，以放弃正畸治疗的Ⅱ类错𬌗患者 14 例为对照组，分别在治疗前后拍摄头颅侧位片。比较 Twin-block 功能矫治前后和自然生长前后侧位片面型突度软硬组织的改变。应用无常量的一元线性回归方程，分析软硬组织改变量的线性关系，并对 Twin-block 组和自然生长组的数学回归方程进行对比分析。

结果与结论：发现在 Twin-block 治疗前后，上下齿槽座相对于鼻、颏位置的改变与上下唇凹点相对于鼻、颏位置的改变具有显著相关性，即 A-E 改变量与 Ss-E 改变量、B-E 改变量与 Si-E 改变量，具有线性相关性，其中 Si－E 改变量与 B-E 改变量相关系数 Pearson=0.839 最大，说明二者的相关程度最好。对照组 2 对标志点无线性关系。通过统计分析得到 Twin-block 治疗前后面型突度软硬组织改变量关系的线性方程：Si-E= 0.745 B-E，Ss-E = 0.276 A-E。线性方程不仅有助于解释 Twin-block 矫治促进下颌骨生长的同时，安氏Ⅱ类 1 分类下颌后缩患者的面型突度也随之发生明显的临床观察结果，而且有助于预测 Twin-block 矫治器面型突度的改变。

关键词：Ⅱ类错𬌗；Twin-block 矫治器；软硬组织改变；线性关系；数字化医学

doi:10.3969/j.issn.1673-8225.2010.17.045

中图分类号: R318 文献标识码: B

文章编号: 1673-8225(2010)17-03217-05

刘亚非，崔丽娟，左艳萍，刘学聪，刘昕. 应用 Twin-block 矫治器后Ⅱ类错牙合患者面型突度软硬组织的改变[J].中国组织工程研究与临床康复，2010，14(17):3217-3221.

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(Edited by Song JL/Song LP/Wang L)