Vertical changes in Class I malocclusion between 2 different extraction patterns

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ABSTRACT

الأهداف: مقارنة التغيرات العمودية التي ظهرت على مرضى الصنف الأول بعد المعالجة التقويمية بأنماط القلع المختلفة.

الطريقة: لقد تم الحصول على سجلات 47 مريضًا تم قلع الضواحك العلوية الأولى والضواحك السفلية الثانية (5/4، المجموعة A) و46 مريضًا تم قلع الضواحك الأربعة الأولى (4/4، المجموعة B) وذلك بقسم التقويم، مستشفى الصين الغربي، تشنغدو، سيتشوان، الصين خلال الفترة من أبريل 2008م حتى يوليو 2012م. وتم أخذ صور أشعة سيفالومترية جانبية مصوَّرة قبل المعالجة وبعدها، واختيرت القياسات السيفالومترية الجانبية منها 8 قياسات هيكل عظمي و10 قياسات أسنان من أجل تقييم التغييرات العمودية. وتمت مقارنة التغيرات في القياسات الناتجة عن المعالجة التقويمية في كل مجموعة من خلال اختبار تي؛ ومقارنة التغيرات بين المجموعتين من خلال اختبار تي المستقل.

النتائج: قبل المعالجة، أظهر أفراد العينة في المجموعة A زاوية ANB وبروز وتغطية أكبر مما في المجموعة B. وبعد المعالجة، أظهرت كلا المجموعتين تغييرات عمودية كبيرة بعد المعالجة التقويمية بدون اختلافات ملحوظة بين المجموعتين.

خاتمة: لم يظهر هنالك أي اختلافات في التغيير العمودي بين نمطين القلع الاثنين.

Objectives: To compare vertical changes occurring in Class I patients after orthodontic treatment with different extraction patterns in a retrospective study.

Methods: Records of 47 patients with extraction of maxillary first premolars and mandibular second premolars (4/5, Group A) and 46 patients with extraction of fourth first premolars (4/4, Group B) were obtained in the Orthodontic Department, West China Hospital of Stomatology, Chengdu, Sichuan, China from April 2008 to July 2012. Pretreatment and posttreatment cephalograms were digitized, 8 skeletal and 10 dental cephalometric measurements were selected to evaluate vertical changes. Changes of measurements resulting from orthodontic treatment in each group were compared by paired t-test; changes between 2 groups were compared by Independent t-test.

Results: Before treatment, subjects in Group A showed larger angle formed by the intersection of NA and NB lines, overjet, and overbite than those in Group B. After treatment, both groups showed significant vertical changes after orthodontic treatment without remarkable differences between groups.

Conclusion: No differences of vertical change were found between the 2 extraction patterns. The hypothesized wedge effects due to mesial movement of posterior teeth might be balanced by the extrusion of posterior teeth as well as the residual growth potentials.

Saudi Med J 2013; Vol. 34 (3): 302-306

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Received 27th October 2012. Accepted 21st January 2013.

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Extractions in orthodontic treatment to relieve crowding have been widely accepted.[1] Premolars are the most commonly extracted teeth for their location between the anterior and posterior segments.[2] As for Class I malocclusions, most orthodontists would choose the extraction patterns of either first or second premolars, depending on the degree of crowding and the patients' profiles.[3-5] Balanced maxillary and mandibular molar movement would be wanted to maintain the Class I molar relationship. However, differences exist

in teeth movement of maxilla and mandible. Because of thinner cortical bone and richer blood circulation, periodontal reconstruction could be more favorable for teeth movement in maxilla.[6,7] In other word, if no extra anchorage enhancement was taken into treatment, maxillary molar would be more easily to move forward, resulting in Class II molar relationship. To prevent this consequence, Class II elastics would be introduced to retract the maxillary incisors and prevent more mesial movement of molars. However, the adverse effects of long-term Class II elastics should never be underestimated, such as the extrusion of lower molars, exceeding retrusion of maxillary incisors.[8-10] The position and inclination of incisors influenced the fullness of the lips and aesthetics of profiles.[11] To avoid the over retraction of anterior teeth which would result in 'flattening effect' on the facial profile, some scholars proposed that when mandibular premolar extractions were necessary, it was frequently better and safer to extract the mandibular second rather than the first premolar if little change of mandibular incisor position was desired.[12] Moreover, there is a controversy regarding the effect of premolar extraction on the vertical height of face.[13] It has been suggested that if the molars are moved forward without extrusion to the extraction spaces, by the principle of 'wedge effect', the mandible would show a counterclockwise rotation, resulting in vertical dimension decrease. Studies have shown that molars would move mesially more with extraction of the second premolar than the first premolar. Theoretically, the more distance molars move forward, the more obvious the counterclockwise rotation would appear. And this rotation would be viewed as beneficial to improve the commonly convex facial profile especially for yellow people. Therefore, we assumed that extraction of mandibular second premolars would be more beneficial to maintain Class I molar relationship even no Class II elastics were used in treatment. Besides, more forward movement would be favorable for counterclockwise rotation of mandible to improve convex facial profile of yellow race. In addition, retraction of mandibular incisors would be less when extracting more posterior teeth, which would be beneficial for the maintenance of full facial profile. To validate this hypothesis, this study was designed to compare the differences of 2 extraction patterns in the treatment of Class I malocclusions with mild or moderate crowding.

Disclosure. This study was funded by the Sichuan Provincial Science Supporting Program (Grant No. 2009SZ0159).

Methods. *Data collection.* Sample subjects were selected from April 2008 to July 2012. All patients were treated by one experienced practitioner (J. Wang) in the Department of Orthodontics, West China Hospital of Stomatology, Chengdu, Sichuan, by using the fixed appliance (straight wire technique, 0.022 slot). The inclusion criteria are (1) Angle Class I molar relationship before and after orthodontic treatment and (2) completed pubertal growth spurt. The exclusion criteria are (1) skeletal discrepancy, such as prognathism or retrognathism of maxilla or mandible and (2) any congenitally missing teeth. During treatment, no adjunctive appliance such as headgears or microimplants were used as anchorage enhancement. Space closure was carried on 0.019×0.025 inches stainless steel archwire (3M, USA) using Nickel-Titanium closing spring (Shinye, Hangzhou, China). Space in the dental arch was completely closed at the end of treatment and Class I incisor and molar relationships were achieved at the end of treatment. Class II elastics were used in both groups when necessary. Records of 93 patients were included with the criterion of Class I malocclusion before and after treatment. Patients who had first maxillary and second mandibular premolars extracted were grouped into Group A (47 patient with 21 male and 26 female); while patients with the extraction of the fourth first premolars were sorted as Group B (46 with 24 male and 22 female).

This study was approved by the local ethic committee, and informed patient consent was received from all study participants. And all steps of study conform to the Helsinki principles.

Cephalometric assessment. The pretreatment and posttreatment cephalometrics were traced and digitized by one operator with the same magnification. For both groups, pretreatment and posttreatment cephalometric values were calculated by Winceph program (RISE, Sentai, Japan). The pterygomaxillary line (PM) plane (Se-Ptm) was chosen as the vertical reference line for it was less influenced by growth development.[14] Eight skeletal and 10 dental measurements were selected to evaluate vertical changes.

Skeletal measurements are shown in **Figure 1**. 1) SNA (Angle formed by the intersection of SN and NA lines); 2) SNB (Angle formed by the intersection of SN and NB lines); 3) ANB (Angle formed by the intersection of NA and NB lines); 4) MP/SN (degree); 5) Me to ANS (mm); 6) ANS-Me to N-Me ratio (%); 7) S-Go (mm); 8) S-Go to N-Me ratio (%)

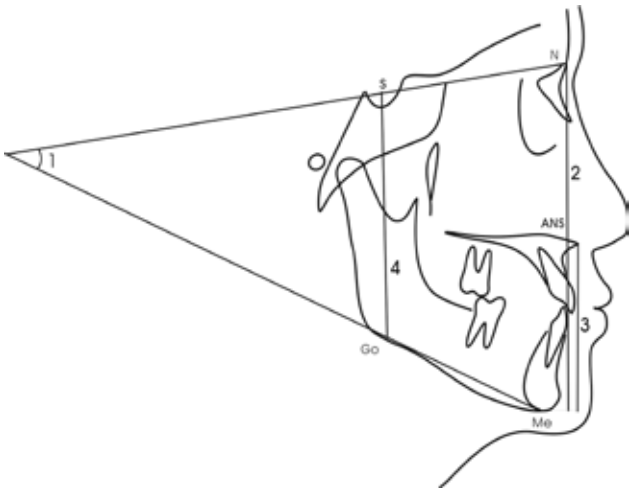

Figure 1 - Reference points and skeletal measurements used in cephalometric analysis: N - nasion, S - sella, Go - gonion, ANS - anterior nasion spine, Me - menton, MP - mandibular plane. 1. SN/MP (degrees), 2. N-Me (anterior facial height, mm) 3. ANS-Me (lower facial height, mm), 4. S-Go (posterior facial height, mm)

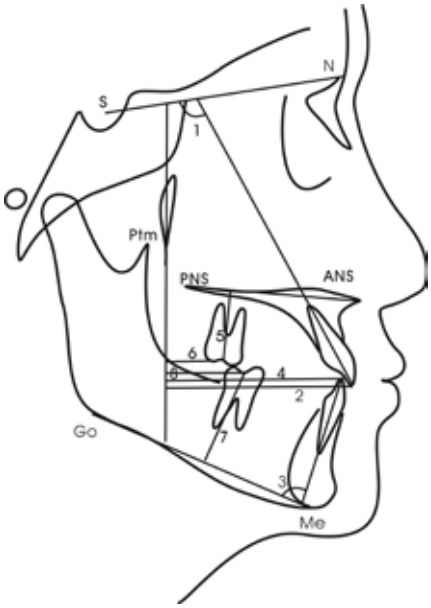

Figure 2 - Reference points and dental measurements used in cephalometric analysis: N - nasion, S - sella, Go - gonion, ANS - anterior nasion spine, Me - menton, PNS - posterior nasion spine, U1 - upper central incisor, L1 - lower central incisor, U6 - upper first molar, L6 - lower first molar, Ptm - pterygomaxillay fissure, PP plane- palatal plane, MP, mandibular plane, PM - pterygomaxillary plane, 1. U1 to SN (degrees); 2. U1 to PM plane (mm); 3. L1 to MP (degrees); 4. L1 to PM plane (mm); 5. U6 to PP plane (mm); 6. U6 to PM plane (mm); 7. L6 to MP (mm); 8. L6 to PM plane (mm).

Dental measurements are shown in **Figure 2**). 1) U1 to SN (degree); 2) U1 to PM plane (mm); 3) L1 to mandibular plane (degree); 4) L1 to PM plane (mm); 5) U6 to PP plane (mm); 6) U6 to PM plane (mm); 7) L6 to mandibular plane (mm); 8) L6 to PM plane (mm); 9) Overjet; 10) Overbite.

Statistical analysis. Statistical analysis was performed by the SPSS System (version v.17.0, SPSS Inc., Chicago, IL, USA). Values were expressed as Means±SD or as percentages. Changes of measurements resulting from orthodontic treatment in each group were compared by paired t-test; changes between 2 groups were compared by Independent t-test. The comparison of Class II elastics usage was conducted by Pearson's Chi-square test. The limit of statistical significance was set at $p<0.05$. To evaluate the tracing and measurement error, records of 30 patients were selected at random and experimental procedures were repeated. Analysis of variance (ANOVA) was conducted, and the results of comparison showed no significant differences between the first and second sets of measurements at the 95% confidence level.

Results. Differences between the 2 groups before and after treatment were compared and listed in **Tables 1 & 2.** The comparison of changes after treatment between the 2 groups were listed in **Table 3.** The statistical analysis of Class II elastics usage during treatment in each group were listed in **Table 4.** Before treatment, the 2 groups were comparable except for 3 variables. The ANB, overbite and overjet in Group A were larger than those in Group B ($p<0.05$; **Table 1**), whereas no significant differences between the 2 groups were found after treatment ($p>0.05$; **Table 1**). After treatment, both skeletal and dental measurements showed no significant changes between the 2 groups, including ANB, overjet and overbite, which showed significant difference between the 2 groups before treatment ($p>0.05$, **Table 2**). However, the initial-final difference caused by treatment showed significant differences between the 2 groups. The MP/SN increased slightly in Group A while decreased significantly in Group B. The difference was significant between the 2 groups. ($p<0.05$, **Table 3**). The ANB changes significantly in Group A ($p<0.05$) (**Table 3**), while no changes in Group B. Facial height increased after treatment in both groups ($p<0.001$) except the ratio of posterior to total facial height in Group A ($p<0.05$). The initial-final difference between the 2 groups shows that the changes of ANB, MP/SN as well as overbite were significant ($p<0.05$) (**Table 3**). The usage of Class II elastics was used in both

Table 1 - Comparison of skeletal and dental measurements of study samples of Group A and Group B before orthodontic treatment.

Variables	Group A		Group B		*P*-value
	Mean	SD	Mean	SD	
Age (years)	12.52	1.22	12.96	1.31	0.135
Crowding (mm)	3.83	2.17	4.18	2.35	0.119
SNA°	80.83	2.83	81.14	3.28	0.395
SNB°	77.17	2.86	78.23	3.18	0.174
ANB°	3.73	0.72	2.94	0.84	0.012*
MP/SN	33.42	2.27	32.89	2.51	0.346
ANS'-Me'	58.62	4.13	54.23	3.39	0.433
S'-Go'	69.08	3.71	68.18	4.14	0.817
ANS'-Me'/N'-Me'	53.44	1.67	54.33	1.19	0.239
S'-Go'/N'-Me'	64.24	1.64	64.67	2.71	0.427
U1/SN	108.99	2.60	109.05	5.87	0.089
U1-PM	53.61	3.35	52.55	3.63	0.075
L1/MP	101.38	5.01	98.51	3.49	0.089
L1-PM	48.83	3.08	48.13	2.18	0.355
U6-PP	18.87	1.55	18.15	1.98	0.519
U6-PM	18.73	2.60	19.13	2.56	0.681
L6-MP	27.57	2.42	26.63	2.19	0.527
L6-PM	19.08	2.44	18.83	2.19	0.076
Overjet	5.22	0.92	4.83	1.01	0.017*
Overbite	4.68	1.81	3.92	1.14	0.031*

*$p<0.05$. SNA - angle formed by the intersection of SN and NA lines, SNB - angle formed by the intersection of SN and NB lines, ANB - angle formed by the intersection of NA and NB lines, MP - mandibular plane, SN - sella-nasion, ANS - anterior nasion spine, Me - menton, S - sella, Go - gonion, U1 - upper central incisor, PM plane - peterygomaxillary plane, L1 - lower central incisor, PP plane - palatal plane, U6 - upper first molar, L6 - lower first molar.

Table 2 - Comparison of skeletal and dental measurements between Group A and Group B after orthodontic treatment.

Variables	Group A		Group B		*P*-value
	Mean	SD	Mean	SD	
SNA°	80.37	2.86	81.41	3.61	0.255
SNB°	77.57	2.68	78.45	3.19	0.181
ANB°	2.97	0.58	2.75	1.24	0.491
MP/SN	33.72	2.92	32.71	2.99	0.273
ANS'-Me'	60.03	3.75	59.94	2.74	0.951
S'-Go'	71.63	4.61	72.56	4.42	0.571
ANS'-Me'/N'-Me'	54.24	1.25	54.28	1.36	0.393
S'-Go'/N'-Me'	64.72	2.44	65.69	2.91	0.217
U1/SN	103.39	3.74	104.51	3.61	0.427
U1-PM	50.48	2.59	49.24	2.98	0.196
L1/MP	96.48	6.03	94.13	3.19	0.174
L1-PM	47.18	2.69	47.03	2.35	0.880
U6-PP	21.13	1.54	20.74	1.88	0.365
U6-PM	22.99	2.33	22.96	2.62	0.781
L6-MP	30.02	2.17	29.08	2.22	0.627
L6-PM	23.63	2.79	22.91	2.49	0.315
Overjet	4.16	0.58	4.04	0.62	0.079
Overbite	3.85	0.97	3.39	0.94	0.819

SNA - angle formed by the intersection of SN and NA lines, SNB - angle formed by the intersection of SN and NB lines, ANB - angle formed by the intersection of NA and NB lines, MP - mandibular plane, SN - sella-nasion, ANS - anterior nasion spine, Me - menton, S - sella, Go - gonion, U1 - upper central incisor, PM plane - peterygomaxillary plane, L1 - lower central incisor, PP plane - palatal plane, U6 - upper first molar, L6 - lower first molar

Table 3 - Comparison of the changes caused by orthodontic treatment between Group A and Group B.

Variables	Group A		Group B		*P*-value
	Mean	SD	Mean	SD	
SNA°	-0.46†	1.38	0.27	1.49	0.098
SNB°	0.40	1.02	0.22	1.39	0.742
ANB°	-0.77†	0.83	-0.19†	0.78	0.019*
MP/SN	0.30	1.55	-0.18†	1.51	0.017*
ANS'-Me'	1.41	2.67	5.74	1.96	0.624
S'-Go'	2.56	3.30	4.38	3.14	0.384
ANS'-Me'/N'-Me'	0.76	0.92	-0.06†	0.70	0.506
S'-Go'/N'-Me'	0.46	1.24	1.03	1.42	0.148
U1/SN	-5.61†	4.32	-4.54†	7.61	0.544
U1-PM	-3.13†	1.99	-3.31†	3.42	0.299
L1/MP	-4.91†	4.81	-4.37†	3.62	0.216
L1-PM	-1.65†	1.73	-1.07†	1.50	0.584
U6-PP	2.27	1.39	2.55	1.35	0.737
U6-PM	4.26	1.62	3.83	1.55	0.471
L6-MP	2.45	1.17	2.44	1.61	0.984
L6-PM	4.55	1.70	4.08	1.63	0.323
Overjet	-1.06†	0.85	-0.79†	1.11	0.061
Overbite	-0.83	1.71	-0.53	1.49	0.014*

†the minus value means the values before treatment is larger than those after treatment. *$p<0.05$. SNA - angle formed by the intersection of SN and NA lines, SNB - angle formed by the intersection of SN and NB lines, ANB - angle formed by the intersection of NA and NB lines, MP - mandibular plane, SN - sella-nasion, ANS - anterior nasion spine, Me - menton, S - sella, Go - gonion, U1 - upper central incisor, PM plane - peterygomaxillary plane, L1 - lower central incisor, PP plane - palatal plane, U6 - upper first molar, L6 - lower first molar.

Table 4 - Comparison of usage of Class II elastics between Group A and Group B.

Variables	Group A	Group B	P value
Usage of Class II elastics (%)	31.91	67.39	0.003†
Mean duration (month)	2.36	3.73	0.037*

*$p<0.05$; †$p<0.01$

groups when necessary. But the percentage of usage was different. Fifteen out of 47 patients in Group A adopted Class II elastics to facilitate the teeth movement whereas the percentage in Group B was significantly higher than that in Group A. The duration of Class II elastics were 2.3 months in average in Group A compared to 3.7 months in Group B and the difference was significant ($p<0.05$) (**Table 4**).

Discussion. According to the concept of 'wedge effect', extraction of the second premolar would allow more mesial movement of molars, thus greater decrease of facial vertical dimension (FVD) would be expected, as well as counterclockwise rotation of mandible.[15-19] However, in our study, significant increases were found of skeletal linear measurements after orthodontic treatment in both groups. According to previous studies, the increase of anterior lower facial height can be influenced significantly by residual vertical growth of the patients, as well as extrusion of molars by treatment mechanics.[20-23] In present study, the age of the subjects included ranged from 11 to 16 years, indicating growth potential of mandible in both groups. Although MP/SN decreased significantly in Group B, this less than one degree decrease could be easily neglected in clinical practice. According to the formula propose by Staggers,[24] the MP/SN angle could be maintained if the extrusion and mesial movement of molars could be balanced in a certain proportion.[24] The L6-MP showed significant increase in both groups after treatment in our study, which might compensate the loss of vertical dimension resulting of molar mesial movement. In another word, the wedge effect of mesial molar movement might be nullified due to the extrusion of L6. As our research was a retrospective study, therapeutic measurements beneficial to each patient would be adopted during treatment when necessary. Class II elastics were adopted to facilitate teeth movement for patients in both groups when necessary. The percentage of Class II elastics' usage in Group A was much lower than that in Group B, as well as the duration of usage. Adoption of Class II elastics brought no obvious adverse effects in both groups however, decreased demands for patients' cooperation as well as time of wearing elastics would

be preferred by orthodontists and patients. Further research would explore deeper correlation of vertical changes with the duration and magnitude of force of the Class II mechanics applied. Although ANB is different in the beginning of treatment between two groups, the value of ANB in all subjects participated in this study are within the normal range except that its mean value was higher in Group A than that in Group B. In Class I patients, the higher or lower ANB value might be one of the effect that influencing the doctors' choice of extraction pattern. However, this is one of the speculations we put forward from limited data. Further study would conduct to substantiate this study.

Study limitations. This study is a retrospective research, in which the limited number of study sample could be collected as well as information during treatment. Therefore, results might be improved if it would be a prospective study in which we could control strictly the affecting factors.

In conclusion, no significant vertical changes occurred after orthodontic treatment with 2 different extraction patterns; the hypothesized wedge effects due to mesial movement of posterior teeth might be balanced by the extrusion of posterior teeth as well as the residual growth potentials. The chance of Class II elastics usage was lower in 4/5 extraction pattern, as well as the duration of the elastics usage.

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