Original Article

Post-treatment Stability in Angle Class III Cases: Treatment Modality-based Comparison

Jun Yoshizumi and Kenji Sueishi

*Department of Orthodontics, Tokyo Dental College,
1-2-2 Masago, Mihama-ku, Chiba 261-8502, Japan*

Received 29 September, 2015/Accepted for publication 10 November, 2015

Abstract

The purpose of this study was to compare post-treatment stability in Angle Class III cases grouped by treatment modality into extraction, non-extraction, or surgical. Twenty-seven Angle Class III patients (9 men, 18 women) were selected from among the records of qualified retention cases treated at the Department of Orthodontics, Tokyo Dental College. The patients were divided into the following groups: Group 1, extraction ($n=10$); Group 2, non-extraction ($n=9$); and Group 3, surgery ($n=8$). Lateral cephalograms, panoramic X-rays, and study casts were obtained at baseline (T0), after active treatment (T1), and after retention (T2). The ABO Model Grading System (ABO) and Gottlieb's Grading Analysis (GGA) were used as indices of occlusion, and the scores at each stage and differences in scores at T1 and T2 ($|T1-T2|$), defined as post-retention stability, recorded. Little's Irregularity Index (IRI) from the study casts and the ANB from lateral cephalograms at T0, T1, and T2 were also recorded to assess post-treatment stability from a different perspective. The Kruskal-Wallis test was performed for statistical comparisons. Mean ranking according to the ABO and Kruskal-Wallis test at T1, T2, and $|T1-T2|$ was lowest in Group 1 and highest in Group 3, and the mean amount of change in the ABO score after active treatment was also the same. This suggests that post-treatment stability is highest in non-extraction cases and lowest in surgical cases. This result correlated with change in the ANB from T0 to T1. This indicates that amount of change in the ANB affects post-treatment stability and that relapse will tend to be greater in surgical cases. However, the amount of change in IRI after active treatment was highest in Group 2 and lowest in Group 3, suggesting that relapse of the lower incisors is greatest in non-extraction cases.

Key words: Angle Class III—Treatment stability—Treatment modality—Retention

Introduction

Post-treatment stability of occlusion is crucial to the success of orthodontic treatment, and many researchers have attempted to identify which primary factors are key to

achieving this after active treatment. Retention is usually understood as being stability resulting from periodontal and gingival reorganization together with neuromuscular adaptation. Riedel, however, has suggested rather that it represents the holding of the teeth in

Table 1 Mean age of patients at each stage

	Overall	Group 1	Group 2	Group 3
T0	19y0m	15y10m	15y8m	26y8m
T1	22y0m	19y4m	18y0m	29y10m
T2	27y6m	25y1m	22y5m	33y10m
Retention	5y7m	5y11m	7y1m	3y10m

an ideal position in terms of esthetics and functionality¹⁷⁾.

Inter-canine and inter-molar width have been reported to decrease during the post-retention period, particularly if expanded during treatment^{1,2,9,19)}. Moreover, it is generally agreed that the pre-treatment arch form should be maintained during orthodontic treatment, as it has a natural tendency to relapse to this shape anyway^{12,16)}. Post-treatment stability is also affected by the treatment modality employed. Little's Irregularity Index (IRI) generally shows a greater increase where no extraction is involved^{11,14)}.

However, the majority of these earlier studies have focused on Angle Class II cases, and there have been very few reports on post-treatment stability in patients with Angle Class III^{10,18)}. Therefore, the purpose of this study was to assess post-treatment stability in Angle Class III cases grouped by treatment modality into extraction, non-extraction, or surgery.

Materials and Methods

A total of 27 patients with Angle Class III including 9 men and 18 women were selected from medical records of retention cases at the Department of Orthodontics, Tokyo Dental College over the past 30 yr. The patients were classified into 3 groups: Group 1, extraction ($n=10$); Group 2, non-extraction ($n=9$); and Group 3, surgical ($n=8$). Generally, the treatment modality employed depended on the degree of skeletal discrepancy, incisor and molar movement required, and crowding. Orthognathic surgery was applied in patients

where skeletal discrepancy was marked, while extraction was applied in those where crowding necessitated tooth movement. The average retention period was 5 yr 11 mo in Group 1 (± 3.76 yr), 7 yr 1 mo in Group 2 (± 3.20 yr), and 3 yr 10 mo in Group 3 (± 1.97 yr). Lateral cephalograms, panoramic X-rays, and study casts were collected at baseline (T0), after active treatment (T1), and after retention (T2). The mean age of the patients was 19 yr (± 6.90 yr) at T0, 22 yr (± 7.02 yr) at T1, and 27 yr 6 mo (± 6.91 yr) at T2 (Table 1). There was a marked difference in mean age in Group 3 at T0 in comparison with the other groups as the appropriate age for orthognathic surgery is after skeletal growth has been completed (Table 1).

In assessing post-treatment stability, the ABO Model Grading System (ABO) and Gottlieb's Grading Analysis (GGA) were used as indices of occlusion (Tables 2 and 3), and the score at each stage and differences in the scores between T1 and T2 ($|T1-T2|$), defined as post-retention stability, were recorded. The Kruskal-Wallis test was used for statistical comparisons. Little's IRI from the study casts and the ANB from the lateral cephalograms at T0, T1, and T2 were also recorded to evaluate post-treatment stability from a different perspective. The study protocol was approved by the Ethics Committee of Tokyo Dental College (Approval no.626).

Results

The median (minimum value–maximum value) ABO scores at T1 and T2 were 32 (20–58) and 26.5 (16–63) in Group 1, 21

Table 2 Evaluation criteria in ABO grading system

ABO evaluation criteria	
① Alignment	⑤ Occlusal contacts
② Marginal ridges	⑥ Occlusal relationships
③ Buccolingual inclination	⑦ Interproximal contacts
④ Overjet	⑧ Root angulation

Model grading system established by American Board of Orthodontics to evaluate final dental casts and panoramic radiographs; contains 8 criteria. Total score of less than 20 considered desirable.

Table 3 Evaluation criteria in Gottlieb's grading analysis

GGA evaluation criteria	
① Class I Molar	⑥ Midline
② Class I Cuspid	⑦ Rotation
③ Interdigitation	⑧ Crowding and Spacing
④ Overbite	⑨ Arch Form
⑤ Overjet	⑩ Torque and Parallelism

Gottlieb EL. has advocated 10 criteria to evaluate occlusion. Evaluation compares pre- and post-treatment scores, and is represented as percentage. Score of over 85% regarded as "good"; 75–85% as "satisfactory"; 65–75% as "mediocre"; 50–65% as "poor"; and under 50% as "unsatisfactory".

Fig. 1 Box plot of mean ABO score at T1

Median (minimum value–maximum value) ABO scores at T1 were 32 (20–58) in Group 1, 21 (10–31) in Group 2, and 31 (14–60) in Group 3. Statistically significant difference was observed between three groups ($p=0.033$).

Fig. 2 Box plot of mean ABO score at T2

Median (minimum value–maximum value) ABO scores at T2 were 26.5 (16–63) in Group 1, 21 (7–49) in Group 2, and 38 (24–45) in Group 3. Statistically significant difference was observed between three groups ($p=0.050$).

(10–31) and 21 (7–49) in Group 2, and 31 (14–60) and 38 (24–45) in Group 3, respectively (Figs. 1 and 2); whereas the median

(minimum value–maximum value) change in scores $|T1-T2|$ was 4.5 (0–17) in Group 1, 3 (0–19) in Group 2, and 10 (1–20) in Group

Fig. 3 Box plot of mean ABO score at |T1-T2| (Stability)

Median (minimum value–maximum value) change in ABO scores |T1-T2| was 4.5 (0–17) in Group 1, 3 (0–19) in Group 2, and 10 (1–20) in Group 3. No statistically significant difference was observed between three groups ($p=0.063$).

Table 4 Kruskal-Wallis test in ABO and GGA at T1, T2 and |T1-T2|

	T1 (ABO)	T2 (ABO)	T1-T2 (ABO)	T1 (GGA)	T2 (GGA)	T1-T2 (GGA)
Chi-square	6.794	5.989	5.54	1.131	2.559	0.854
Degree of freedom	2	2	2	2	2	2
p-value	0.033	0.05	0.063	0.568	0.278	0.652

3 (Fig. 3). Statistically significant differences were observed in ABO scores between the three groups at T1 ($p=0.033$) and T2 ($p=0.050$), but not in post-retention stability |T1-T2| ($p=0.063$; Table 4). Moreover, the mean ranking according to the Kruskal-Wallis test at T1 was Group 2<Group 3<Group 1, while at T2 or |T1-T2| it was Group 2<Group 1<Group 3. This suggests that occlusion after active treatment was the most stable in Group 2 and the least stable in Group 3 (Table 5). Moreover, the percentage of actual improvement in ABO scores for |T1-T2| was 50% in Group 1, 33% in Group 2, and 37.5% in Group 3 (Fig. 4).

On the other hand, no significant difference was observed in the GGA scores between the three groups at T1, T2, or |T1-T2| ($p=0.568$, 0.278, and 0.652, respectively; Table 4). The median scores (minimum value–maximum value) of GGA at T1 and T2 were

Table 5 Mean ranking according to Kruskal-Wallis test in each group at T1, T2 and |T1-T2|

Group	N (Mean rank)
T1	
Group 1	10 (17.45)
Group 2	9 (8.44)
Group 3	8 (15.94)
Total	27
T2	
Group 1	10 (15.35)
Group 2	9 (8.94)
Group 3	8 (18)
Total	27
T1-T2 (Stability)	
Group 1	10 (13.05)
Group 2	9 (10.39)
Group 3	8 (19.25)
Total	27

Table 6 Median score of ABO and GGA in each group at T1 and T2

	Group 1		Group 2		Group 3	
	T1	T2	T1	T2	T1	T2
ABO	32 (20–58)	26.5 (16–63)	21 (10–31)	21 (7–49)	31 (14–60)	38 (24–45)
GGA	85 (72–88)	80 (64–92)	85 (76–96)	82 (52–92)	86.3 (76–96)	88 (74–97)

Fig. 4 Percentage of improvement and deterioration in ABO out of all [T1–T2]

50% of patients in Group 1 showed improvement in ABO score after retention, whereas 33% in Group 2 and 37.5% in Group 3 showed improvement.

Fig. 6 Amount of change in ANB in each group
Greatest skeletal improvement was achieved in Group 3, and greatest skeletal relapse also was observed in Group 3, which was same amount as in Group 2.

Fig. 5 Amount of change in Irregularity Index in each group

IRI decreased from T0 to T1, and increased from T1 to T2 in all groups. Greatest improvement in IRI by active treatment was achieved in Group 1, and greatest relapse of anterior crowding after retention was observed in Group 2.

85 (72–88) and 80 (64–92) in Group 1, 85 (76–96) and 82 (52–92) in Group 2, and 86.3 (76–96), and 88 (74–97) in Group 3, respectively (Table 6).

The IRI decreased from T0 to T1, and

increased from T1 to T2 in all groups. The mean decrease in IRI from T0 to T1 was 4.2 mm in Group 1, 1.4 mm in Group 2, and 1.5 mm in Group 3. The mean increase in IRI from T1 to T2 was 0.8 mm in Group 1, 1.4 mm in Group 2, and 0.2 mm in Group 3 (Fig. 5). Therefore, the greatest improvement in IRI by active treatment was achieved in Group 1, and the greatest relapse of anterior crowding after retention was observed in Group 2. No significant difference was observed in IRI between each group at T0 ($p=0.071$) and T1 ($p=0.629$); a significant difference was observed, however, at T2 ($p=0.025$).

At T0, the ANB was $-1.7^\circ (\pm 2.04^\circ)$ in Group 1, $-2.2^\circ (\pm 1.46^\circ)$ in Group 2, and $-2.6^\circ (\pm 1.95^\circ)$ in Group 3. Change in ANB from T0 to T1 was $+1.4^\circ (\pm 0.82^\circ)$ in Group 1, $+0.8^\circ (\pm 0.97^\circ)$ in Group 2, and $+3.5^\circ (\pm 1.63^\circ)$ in Group 3; and that from T1 to T2 was $-0.1^\circ (\pm 0.90^\circ)$ in Group 1, $-0.5^\circ (\pm 0.73^\circ)$ in Group 2, and $-0.5^\circ (\pm 0.66^\circ)$ in Group 3 (Fig. 6). No significant difference

was observed between each group at T0, T1, and T2 ($p=0.521$, 0.164 , and 0.118 , respectively). This suggests that the greatest skeletal improvement was achieved in Group 3, which also showed the greatest relapse.

Discussion

The purpose of this study was to investigate change in post-treatment stability depending on treatment modality. Mean ranking according to the Kruskal-Wallis test at T1, T2, and $|T1-T2|$ was lowest in non-extraction cases and highest in surgical cases, and the mean amount of change in the ABO scores after active treatment also showed the same result. This suggests that post-treatment stability is highest in non-extraction cases and lowest in surgical cases. This result may be explained by the fact that the average ANB at T0 was the lowest and amount of change in ANB from T0 to T1 largest in the surgical group, as surgical setback occurred in all these cases. However, the average ANB was better and amount of change in ANB smaller in the non-extraction group. Jakobsone *et al.*⁽⁸⁾ reported that skeletal relapse of the mandible increased with greater surgical setback, which implies that amount of change in the ANB affects post-treatment stability. They also noted that relapse tends to occur more often in surgical than non-surgical cases when there is an unfavorable ANB at baseline. This suggests that extra attention should be paid to functional stability after active treatment in surgical cases.

Moreover, the mean ABO scores improved from T1 to T2 in the extraction group, indicating that occlusal contact had increased as a result of occlusal force after removal of the appliance^(7,13). Dinçer *et al.*⁽⁵⁾ and Razdolsky *et al.*⁽¹⁵⁾ reported that the number of contacts in centric occlusion increased during the retention period. Cordua *et al.*⁽⁴⁾ reported that whereas ABO scores improved after active treatment compared with at initiation, occlusal contacts did not. These findings suggest that occlusal contacts decrease immediately after active treatment, but then increase

throughout the retention period by settling. In the present study, some cases were recorded as unstable, even if the scores showed an actual improvement after years of retention, as post-retention stability was defined as the difference in absolute ABO scores between T1 and T2. In fact, a change in ABO scores was observed in some 50% of the patients in the extraction group. These were referred to as unstable, even though an actual improvement was observed after retention. The values in the surgical and non-extraction groups were 37.5 and 33%, respectively, clearly showing a greater relative change in post-retention ABO scores in the extraction and surgical groups. However, at the same time, greater improvement was observed in occlusal contacts and inter-digitation than in the non-extraction group.

The GGA revealed no significant differences between T1, T2, and $|T1-T2|$ in the three groups. The GGA score evaluates occlusion based on the initial record and assesses improvement from initial occlusion, which was achieved here by comparing occlusion from T0 to T1 and T0 to T2. The ABO score evaluates occlusion at one point in time, enabling comparison of occlusion in any way. Therefore, we believe that the GGA is not a suitable index of occlusion for evaluation of post-treatment stability because it is always based on the initial record.

The amount of change in IRI after active treatment was largest in the non-extraction group and smallest in the surgical group, indicating that the former exhibited the greatest relapse of lower incisors. This may have been due to differences in the volume of the oral cavity after treatment. After treatment, extraction and surgical cases have less oral cavity volume than non-extraction cases, and thus they tend to have more forward tongue pressure to support lower incisors, preventing relapse. According to Erdinc *et al.*⁽⁶⁾, lower incisors tended to incline labially in extraction cases and lingually in non-extraction cases after retention, suggesting that over time mandibular anterior crowding could also vary with treatment modality.

Bjork³⁾ also reported that anterior rotation of the mandible by growth influences lower incisors to incline lingually due to the presence of upper incisors, indicating that mandibular anterior crowding may increase with growth. In the present study, the mean age at T1 in the non-extraction group was 18yr (± 5.09 yr), whereas in the surgical group it was 29yr 10mo (± 5.87 yr). This indicates the presence of residual growth in the non-extraction group, which may also have affected the IRI results.

Conclusion

Post-treatment stability in Angle Class III cases depends on the treatment modality employed. Greatest stability is achieved in non-extraction cases, while it is poorest in surgical cases.

References

- 1) Amott RD (1962) A serial study of dental arch measurements on orthodontic subjects: 55 cases at least 4 years postretention [MSD Thesis], Northwestern University Dental School, Chicago.
- 2) Arnold MI (1963) A study of the changes of the mandibular intercanine and intermolar widths during orthodontic treatment and following postretention period of five or more years [MSD Thesis], University of Washington, Seattle.
- 3) Bjork A (1969) Prediction of mandibular growth rotation. *Am J Orthod* 55:585–599.
- 4) Cordua T, Ursini R, Giuliani L, Deli R (2009) The excellence challenge in orthodontics: clinical use of an objective grading system for orthodontic cases. *Prog Orthod* 10:4–15.
- 5) Dinçer M, Meral O, Tümer N (2003) The investigation of occlusal contacts during the retention period. *Angle Orthod* 73:640–646.
- 6) Erdinc AE, Nanda RS, İşıksal E (2006) Relapse of anterior crowding in patients treated with extraction and nonextraction of premolars. *Am J Orthod Dentofacial Orthop* 129:775–784.
- 7) He SZ, Li S, Gao XH, An WW (2010) A preliminary study on the occlusal contact changes during retention in adolescent patients. *Zhonghua Kou Qiang Yi Xue Za Zhi* 45:556–559.
- 8) Jakobsone G, Stenvik A, Sandvik L, Espeland L (2011) Three-year follow-up of bimaxillary surgery to correct skeletal Class III malocclusion: stability and risk factors for relapse. *Am J Orthod Dentofacial Orthop* 139:80–89.
- 9) Kahl-Nieke B, Fischbach H, Schwarze CW (1995) Post-retention crowding and incisor irregularity: a long-term follow-up evaluation of stability and relapse. *Br J Orthod* 22:249–257.
- 10) Li X, Deng M, Yuan X (2015) Stability of the anterior teeth and hard tissue of skeletal class III malocclusion after orthodontic surgery: systematic review. *Hua Xi Kou Qiang Yi Xue Za Zhi* 33:267–271. (in Chinese)
- 11) Luppapornlarp S, Johnston LE (1993) The effects of premolar extraction: a long-term comparison of outcomes in “clear cut” extraction and non-extraction Class II patients. *Angle Orthod* 63:257–272.
- 12) McCauley DR (1944) The cuspid and its function in retention. *Am J Orthod Oral Surg* 30:196–205.
- 13) Morton S, Pancherz H (2009) Changes in functional occlusion during the postorthodontic retention period: a prospective longitudinal clinical study. *Am J Orthod Dentofacial Orthop* 135:310–315.
- 14) Paquette DE, Beattie JR, Johnston LE Jr (1992) A long-term comparison of nonextraction and premolar extraction edgewise therapy in “borderline” Class II patients. *Am J Orthod Dentofacial Orthop* 102:1–14.
- 15) Razdolsky Y, Sadowsky C, BeGole EA (1989) Occlusal contacts following orthodontic treatment: a follow-up study. *Angle Orthod* 59:181–185.
- 16) Riedel RA (1960) A review of the retention problem. *Angle Orthod* 30:179–199.
- 17) Riedel RA (1969) Chapter 9 Retention, *Current Orthodontic Concepts and Techniques*, Graber TM, Swain BF, 1st ed., pp.875–918, WB Saunders, Philadelphia.
- 18) Troy BA, Shanker S, Fields HW, Vig K, Johnston W (2009) Comparison of incisor inclination in patients with Class III malocclusion treated with orthognathic surgery or orthodontic camouflage. *Am J Orthod Dentofacial Orthop* 135:146.e1–146.e9.
- 19) Welch KN (1956) A study of treatment and postretention dimensional changes in mandibular dental arches [MSD Thesis]. University of Washington, Seattle.

Correspondence:

Dr. Jun Yoshizumi
Department of Orthodontics,
Tokyo Dental College,
1-2-2 Masago, Mihama-ku,
Chiba 261-8502, Japan
E-mail: yoshizumijun@tdc.ac.jp