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# The variable anchorage straight wire technique compared with the straight wire technique in deep overbite correction

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SUMMARY The aim of this retrospective study was to compare the treatment results and the number of required treatment appointments between the variable anchorage straight wire technique (VAST) and the straight wire (SW) technique. The subjects were 53 Caucasian patients of both sexes (25 males and 28 females, mean age 13.5 years at the start of treatment), with an overjet ≥ 4 mm and an overbite ≥ 3 mm. The patients were divided into four groups, VAST ($n$ = 31) or SW ($n$ = 22), extraction or non-extraction, and were treated by the same orthodontist. Variables from two lateral cephalograms obtained before and at the completion of active treatment, and the number of scheduled appointments were compared between the two techniques.

The main difference between the two techniques was the bracket design. With the VAST, the bracket allowed both tipping and parallel movements with the possibility to combine double archwires. Due to the influence of the Begg technique, no extra-oral traction was needed in the VAST groups and Class II elastics were used at the start of treatment.

Both techniques seemed to produce equal treatment results. However, in this study, it was shown that in deep overbite correction, the VAST required fewer scheduled appointments than the SW technique.

## Introduction

Efforts have been made during the last few decades to explain the potential benefits of several techniques of orthodontic treatment and remodel them into a philosophy called 'the combination technique' (Thompson, 1981; Hocevar, 1985; Kesling, 1989). The combination of the Begg and the straight wire (SW) technique was improved by a second generation of combination brackets developed by Thompson (1988). The variable anchorage straight wire technique (VAST), used in this study, was a further development (Thompson, 1995) and the idea was to improve the possibilities to adapt and vary the intra-arch anchorage need of the individual patient.

The VAST takes advantage of the favourable characteristics of the Begg technique, such as rapid alignment, maximum retraction of the incisors and bite opening by utilizing the gingival or occlusal wing slot, which gives a single-point contact and tipping movements of the teeth. Using uprighting springs on the canines and/or rectangular archwires as sectionals in the anterior or posterior region enhance the anchorage. Therefore, the use of extra-oral anchorage may not be necessary.

The VAST consists of four phases with varying demands on the anchorage. Each phase has its clearly defined goals that should ideally be reached before the next phase begins. Phase 1: Organization: Alignment of the anterior teeth and bite opening are achieved in this early stage by using round wires with anchorage bends that are ligated into the wing slots. Normal transversal molar and sagittal canine relationships should also be obtained (Figure 1a). Phase 2: Consolidation: Correction of the molar relationship is established and residual extraction spaces are closed while maintaining the results from the previous phase. Phase 3: Co-ordination: Uprighting and paralleling of roots together with anterior root torque are obtained while maintaining the results from phases 1 and 2 (Figure 1b). In this phase, two archwires (tandem arches) are used simultaneously in each dental arch. The rectangular superelastic NiTi archwire in the pre-adjusted slot is responsible for uprighting and torque, while the round stainless steel archwire with introduced V-bends is ligated in the wing slots to maintain the results achieved from previous phases. Phase 4: Harmonization: Finishing and individualizing the arch forms with consideration for functional and aesthetic aspects.

The aim of this retrospective study was to compare the treatment results by cephalometric analysis between two groups of patients treated with the VAST and the SW technique and the number of required treatment appointments during the active treatment phase between the two groups.

## Subjects

The subjects were 53 Caucasian patients, 25 males and 28 females, with Angle Class I, Class II division 1 or Class II division 2 relationships who received treatment

**Figure 1** The variable anchorage straight wire technique (VAST). (a) Phase 1. Archwires are ligated in the gingival slot with a single-point contact. Class II elastics are used from the beginning. (b) Phase 3. Tandem arches are used simultaneously. The rectangular archwire is responsible for uprighting and torque, while the round archwire with introduced V-bends, together with Class II elastics, maintain the results achieved from phases 1 and 2.

between 1985 and 1995. The mean age of the patients was 13.5 years [standard deviation (SD)= 1.7] at the start and 15.5 years (SD = 1.7) at the end of treatment. Thirty-one patients were treated with the VAST, 16 non-extraction and 15 with extractions. Twenty-two patients were treated with the conventional SW technique, eight non-extraction and 14 with extractions. Most of the subjects had a post-normal molar relationship (≥ half cusp) except for one patient in the VAST group and three in the SW group who had normal relationships. First or second premolars in the upper and/or lower dental arch were selected for extraction depending on the individual case. Extra-oral traction was used in approximately 75 per cent of all subjects treated with the SW technique. The criteria to participate in the study were complete records and radiographs before and after treatment, an overjet ≥ 4 mm and an overbite ≥ 3 mm, as measured on the study casts (Table 1). All patients had been treated to normal occlusion in a community specialist clinic by the same experienced orthodontist and the filed records were consecutively selected by staff members other than the attending clinician.

This research was approved by the ethical committee of Huddinge University Hospital.

## Methods

The combination bracket used in the VAST is called Spectrum 411 (Lancer Orthodontics, California, USA), and is designed to have four slots: pre-adjusted, vertical, and gingival and occlusal wings (Figure 2). Skeletal and dento-basal variables from two lateral cephalograms taken within 1 year before (mean = 0.6, SD = 0.4) and at completion of the active treatment were used for measuring the treatment effects. The landmarks were based on points on the lateral skull radiographs defined by Björk (1947) and Solow (1966). The cephalometric analysis was performed according to the method of Pancherz (1982). In addition the following variables were included: overjet, ANB, and ML/NL (Figure 3).

The cephalometric measurements were performed with the aid of a computer program (Dentofacial Planner 7.02, Dentofacial Software Inc., Toronto, Ontario, Canada) by the same examiner. All measurements were corrected according to the same magnification factor (10.3 per cent). The numbers of scheduled appointments and emergency visits for each technique were also calculated and compared. There was no information in the records about the chairside time.

**Table 1** Number of patients and mean values for overjet (OJ), overbite (OB), age before and after treatment, treatment time, number of scheduled visits and emergency visits for the variable anchorage straight wire technique (VAST) and the straight wire (SW) technique.

| | *n* | Males (*n*) | Females (*n*) | Mean OJ (mm) | Mean OB (mm) | Mean age at start of treatment (years) | Mean age at end of treatment (years) | Mean treatment time (months) | Mean number of scheduled visits | Mean number of emergency visits |
|---|---|---|---|---|---|---|---|---|---|---|
| VAST | | | | | | | | | | |
| Non-extraction | 16 | 8 | 8 | 8.6 | 4.9 | 12.5 | 14.8 | 20 | 15 | 1.2 |
| Extraction | 15 | 8 | 7 | 8.0 | 4.7 | 13.0 | 15.5 | 20 | 16 | 1.3 |
| SW | | | | | | | | | | |
| Non-extraction | 8 | 4 | 4 | 7.4 | 6.6 | 12.6 | 15.1 | 24 | 19 | 1.6 |
| Extraction | 14 | 5 | 9 | 7.4 | 4.7 | 13.7 | 17.0 | 30 | 23 | 1.9 |

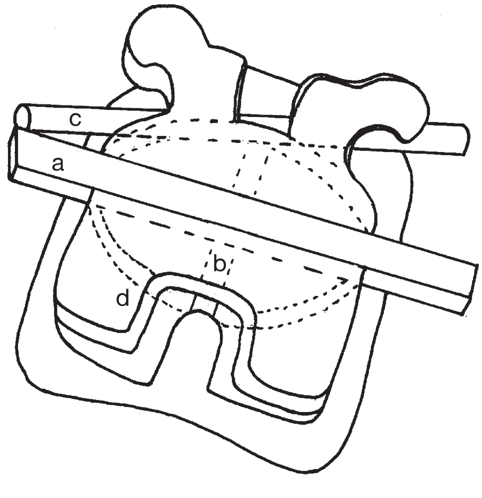


**Figure 2** The combination bracket used in the variable anchorage straight wire technique (VAST) is designed to have four slots: (a) pre-adjusted, (b) vertical, (c) gingival wing and (d) occlusal wing.

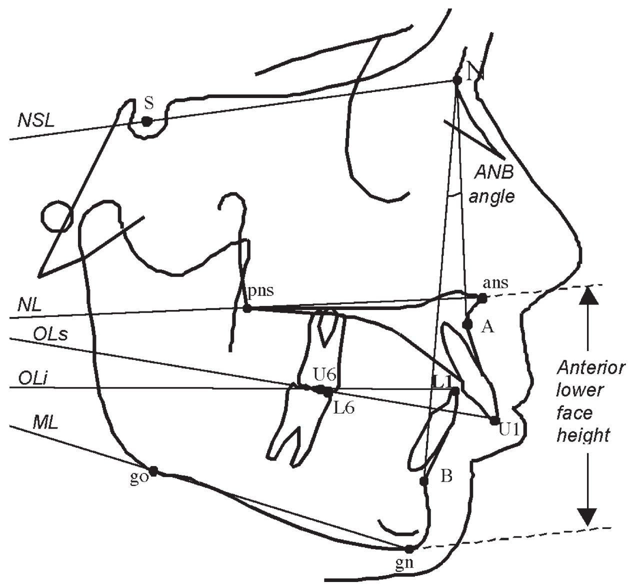


**Figure 3** Reference points and lines on the lateral skull radiographs and variables used in the cephalometric analysis.

Basal variables: ANB, the angle of the sagittal relationship between the jaws; ML/NSL, mandibular plane angle (mandibular line to nasion sella line); NL/NSL, maxillary plane angle (nasal line to nasion sella line); ML/NL, intermaxillary plane angle (mandibular line to nasal line); Ant LFH, anterior lower face height (the distance of ans–gn perpendicular to nasion sella line);

Dento-basal variables: U1/NL, inclination of the long axis of the maxillary central incisor (U1) to nasal line; U1–NL, the position of the maxillary central incisor (the distance of U1 to perpendicular to nasal line); L1/ML, inclination of the long axis of the mandibular central incisor (L1) to mandibular line; L1–ML, the position of the mandibular central incisor (the distance of L1 perpendicular to mandibular line); U6–NL, the position of the maxillary first molar [the distance of the tip of the mesio-buccal cusp of the maxillary permanent first molar (U6) perpendicular to nasal line]; L6–ML, the position of the mandibular first molar [the distance of the tip of the mesio-buccal cusp of the mandibular permanent first molar (L6) perpendicular to mandibular line]; Ols/NSL, maxillary occlusal plane angle [the angle between a line through U6–U1 (Ols) and nasion sella line]; Oli/NSL, mandibular occlusal plane angle [the angle between a line through L6–L1 (Oli) and nasion sella line];

Dental variables: OJ, overjet [the distance of the projection of U1–L1 perpendicular to upper occlusal plane (Ols)]; OB, overbite [the distance of L1 perpendicular to upper occlusal plane (Ols)].

*Statistical methods*

All cephalometric variables before treatment were tested for any significant differences between the groups at the 5 per cent level when selecting the cases.

The registrations were made directly on the lateral cephalograms and data were subsequently analysed using conventional statistical methods, i.e. arithmetic means, SD, standard error of the mean and normality test (Smirnov–Kolmogorov). Paired and unpaired Student's *t*-tests were executed for a comparison of values between the cephalograms within and between the groups, respectively. The intra-observer method error ($S_i$) was calculated using the formula

$$S_i = \pm \div(\Sigma d^2/2n)$$

where $d$ is the difference between the first and second measurements and $n$ is the number of double registrations (Dahlberg, 1940). Fifteen radiographs were randomly selected and measured twice by the same observer with an interval of 1 month. The values varied between 0.41 and 1.15 degrees for the angular (minimum ML/NSL, maximum Oli/NSL) and 0.23 and 0.56 mm for the linear (minimum overjet, maximum anterior lower face height) measurements.

## Results

In order to find patients who were morphologically similar before treatment with the VAST and SW technique, all variables from the pre-treatment cephalograms were tested for significant differences between the two techniques. The mean values of the basal, dento-basal and dental variables were comparable except for overbite in the non-extraction groups ($P < 0.001$).

Lower anterior face height (LAFH) was the only basal variable that increased significantly after treatment with both techniques. However, the difference was not significant.

In the VAST non-extraction group, the upper incisors were retroclined and extruded, the lower incisors proclined and the upper and lower molars extruded after treatment. Subsequently, the angle between the upper and lower occlusal planes and the skull base increased. However, in the SW non-extraction group, both the upper and lower incisors were proclined, the upper and lower molars extruded and subsequently the angle between the skull base and the upper occlusal plane decreased while the angle to the lower occlusal plane increased. When comparing the two techniques, significant differences ($P < 0.05$) were found for the inclination and position of the upper incisors and the upper and lower occlusal plane angles (Table 2).

In the extraction groups, the results showed less significant differences between the VAST and SW technique. With both techniques, the upper incisors were retroclined, the lower incisors proclined and the upper and lower molars extruded. As a consequence, both the upper and lower occlusal plane angles to the skull base increased (Table 3).

In all four groups, overjet and overbite significantly decreased after treatment. When comparing the two techniques, overjet decreased significantly more in the VAST extraction group compared with the SW group ($P < 0.05$).

The average treatment time was 20 months (SD = 0.4) with the VAST and 27 months (SD = 0.8) with the SW technique. The number of scheduled appointments for the two techniques was fewer with the VAST (mean = 15.5) than with the SW (mean = 21) (Table 1). There was no difference in the number of emergency visits between the two techniques.

## Discussion

This retrospective study is one of the first attempts to cephalometrically compare the treatment results between the VAST combination and conventional SW technique. It also compared the duration of active treatment time and the number of scheduled appointments. It should be remembered that retrospective investigations often suffer from difficulties of finding reliable clinical material that can be statistically compared. In this study, the mean values for all variables were comparable before treatment except for overbite in the non-extraction groups. The material originated from filed records in a community specialist clinic where several techniques were practised simultaneously. In order to find subjects treated with the VAST or SW technique, the time period for finding treatment records had to be prolonged to 10 years.

The total sample of patients in the study was 53, divided into four subgroups, as the treatment strategy differed between extraction and non-extraction cases with the two techniques. The different number of subjects in the groups made it necessary to evaluate the results with caution.

In this study, the same experienced orthodontist treated all the patients. According to Livieratos and Johnston (1995), there is a risk of proficiency bias if a limited number of clinicians generate the records of a retrospective study and the results may depend on the skill of the clinician rather than the general worth of the treatment. However, one single operator has the advantage of achieving an unbiased treatment result where different techniques have been used.

**Table 2** Mean values and standard deviation (SD) for the changes in cephalometric variables pre- and post-treatment among patients treated with non-extraction with the variable anchorage straight wire technique (VAST) or the straight wire (SW) technique. Mean differences, standard error (SE), and levels of significance using Student's *t*-test, paired and unpaired, were calculated within and between the two techniques, respectively.

| | VAST non-extraction (*n* = 16) | | | | | | SW non-extraction (*n* = 8) | | | | | | VAST–SW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-treatment | | Post-treatment | | | | Pre-treatment | | Post-treatment | | | | Difference | |
| | Mean | SD | Mean | SD | Mean difference | SE | Mean | SD | Mean | SD | Mean difference | SE | Mean difference | Significance |
| ANB | 4.9 | 1.3 | 4.5 | 1.5 | –0.4 | 0.4 | 5.0 | 2.1 | 3.9 | 3.0 | –1.1 | 0.5 | 0.7 | ns |
| ML/NSL | 28.4 | 5.0 | 28.6 | 5.4 | 0.2 | 0.5 | 30.4 | 5.9 | 30.0 | 6.5 | –0.4 | 0.7 | 0.6 | ns |
| NL/NSL | 6.6 | 2.7 | 6.7 | 2.8 | 0.1 | 0.2 | 7.2 | 1.9 | 7.1 | 1.9 | –0.1 | 0.3 | 0.2 | ns |
| ML/NL | 21.9 | 4.8 | 21.8 | 5.1 | –0.1 | 0.4 | 23.2 | 5.2 | 23.0 | 6.8 | –0.2 | 0.9 | –0.3 | ns |
| Ant LFH | 64.0 | 4.7 | 68.2 | 6.1 | 4.2*** | 0.9 | 66.4 | 5.1 | 69.7 | 7.4 | 3.3* | 1.4 | 0.9 | ns |
| U1/NL | 112.3 | 11.3 | 110.1 | 6.2 | –2.2 | 2.9 | 105.4 | 10.2 | 114.2 | 8.2 | 8.7 | 4.0 | –6.5 | * |
| U1–NL | 29.1 | 2.6 | 31.3 | 2.5 | 2.2*** | 0.5 | 30.5 | 3.5 | 30.7 | 4.0 | 0.2 | 0.6 | 2.0 | * |
| L1/ML | 96.4 | 6.4 | 113.3 | 5.9 | 16.9*** | 1.3 | 96.1 | 8.3 | 108.8 | 6.8 | 12.7*** | 1.4 | 4.2 | ns |
| L1–ML | 40.9 | 2.8 | 39.7 | 4.3 | –1.2 | 0.6 | 43.2 | 3.4 | 42.6 | 4.1 | –0.6 | 0.7 | –0.6 | ns |
| U6–NL | 21.7 | 1.8 | 22.7 | 1.8 | 1.0*** | 0.2 | 21.2 | 2.1 | 22.1 | 2.2 | 0.9 | 0.4 | 0.1 | ns |
| L6–ML | 30.3 | 1.9 | 34.1 | 2.6 | 3.8*** | 0.4 | 31.9 | 3.5 | 35.0 | 3.7 | 3.1** | 0.8 | 0.7 | ns |
| Ols/NSL | 18.5 | 4.0 | 20.7 | 3.8 | 2.2 ** | 0.8 | 22.4 | 4.2 | 21.0 | 4.8 | –1.4 | 1.2 | 0.8 | * |
| Oli/NSL | 7.1 | 3.8 | 18.0 | 4.0 | 10.9*** | 0.8 | 7.9 | 6.0 | 15.3 | 4.0 | 7.4** | 1.6 | 3.5 | * |
| OJ | 8.6 | 2.6 | 2.9 | 1.3 | –5.7*** | 0.8 | 7.4 | 2.3 | 3.5 | 0.7 | –3.9** | 0.8 | –1.8 | ns |
| OB | 4.9 | 1.3 | 0.9 | 1.1 | –4.0*** | 0.4 | 6.6 | 1.1 | 2.0 | 0.7 | –4.6*** | 0.5 | 0.6 | ns |

ns, not significant; $^*P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

**Table 3** Mean values and standard deviation (SD) for the changes in cephalometric variables pre- and post-treatment among patients treated with extractions with the variable anchorage straight wire technique (VAST) or the straight wire (SW) technique. Mean differences, standard error (SE) and levels of significance using Student's *t*-test, paired and unpaired, were calculated within and between the two techniques, respectively.

| | VAST extraction ($n$ = 15) | | | | | | SW extraction ($n$ = 14) | | | | | | VAST–SW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-treatment | | Post-treatment | | | | Pre-treatment | | Post-treatment | | | | Difference | |
| | Mean | SD | Mean | SD | Mean difference | SE | Mean | SD | Mean | SD | Mean difference | SE | Mean difference | Significance |
| ANB | 5.0 | 1.5 | 3.9 | 2.1 | –1.1 | 0.5 | 5.0 | 2.0 | 4.3 | 1.6 | –0.7 | 0.4 | 0.6 | ns |
| ML/NSL | 32.8 | 4.3 | 33.7 | 4.8 | 0.9 | 0.6 | 31.2 | 6.0 | 31.1 | 6.2 | –0.1 | 0.6 | 1.0 | ns |
| NL/NSL | 7.9 | 2.3 | 8.3 | 1.9 | 0.4 | 0.4 | 6.8 | 3.4 | 7.4 | 3.1 | 0.6 | 0.4 | –0.2 | ns |
| ML/NL | 24.9 | 4.3 | 25.1 | 5.2 | 0.2 | 0.5 | 24.4 | 4.9 | 23.7 | 5.0 | –0.7 | 0.4 | 0.9 | ns |
| Ant LFH | 63.6 | 5.3 | 68.7 | 5.4 | 5.1*** | 0.8 | 64.6 | 5.8 | 67.9 | 6.5 | 3.3** | 1.0 | 1.8 | ns |
| U1/NL | 112.5 | 6.8 | 108.9 | 7.5 | –3.6 | 2.4 | 114.2 | 8.6 | 111.7 | 5.8 | –2.5 | 2.8 | –1.1 | ns |
| U1–NL | 29.0 | 2.4 | 30.2 | 3.0 | 1.2** | 0.3 | 29.7 | 3.5 | 30.2 | 4 | 0.5 | 0.6 | 0.7 | ns |
| L1/ML | 99.0 | 8.0 | 107.0 | 8.6 | 8.0** | 2.2 | 99.5 | 8.4 | 104.1 | 7.6 | 4.6* | 1.8 | 3.4 | ns |
| L1–ML | 41.6 | 2.8 | 41.9 | 3.2 | 0.3 | 0.5 | 42.9 | 4.2 | 41.9 | 4.7 | –1.0 | 0.6 | 1.3 | ns |
| U6–NL | 21.1 | 1.8 | 23.4 | 2.0 | 2.3*** | 0.3 | 22.2 | 2.5 | 24.0 | 3.0 | 1.8** | 0.6 | –1.5 | ns |
| L6–ML | 30.1 | 3.0 | 34.9 | 2.9 | 4.8*** | 0.2 | 31.3 | 3.6 | 34.9 | 4.7 | 3.6*** | 0.7 | 1.2 | ns |
| Ols/NSL | 20.6 | 2.7 | 22.3 | 3.3 | 1.7 | 0.9 | 19.1 | 4.3 | 20.5 | 4.0 | 1.4 | 1.3 | 0.3 | ns |
| Oli/NSL | 9.5 | 4.5 | 17.3 | 3.0 | 7.8*** | 1.1 | 7.9 | 3.8 | 14.3 | 4.3 | 6.4*** | 1.0 | 1.4 | ns |
| OJ | 8.0 | 1.0 | 2.8 | 1.2 | –5.2*** | 0.4 | 7.4 | 2.0 | 3.7 | 1.3 | – 3.7*** | 0.6 | –1.5 | * |
| OB | 4.7 | 1.4 | 1.3 | 1.1 | –3.4*** | 0.4 | 4.7 | 1.2 | 1.3 | 0.9 | – 3.4*** | 0.4 | 0.0 | ns |

ns, not significant; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

The results of this study showed no significant differences after treatment in the basal variables except for LAFH, which increased with both techniques. This indicated that the increase in LAFH with both techniques was dento-alveolar due to alveolar growth and/or further eruption of the molars resulting in a change in the mandibular plane in a parallel, inferior direction. Consequently, there was no change in the mandibular plane angle. This is consistent with the findings of Adenwalla and Kronman (1985), but is in contrast to a previous investigation by Nelson *et al.* (1999), where the pure Begg technique was practised.

It is claimed that with the VAST, the reduction in overbite originates from the Begg technique. Thompson (1979) stated that both maxillary and mandibular incisor intrusion and lower molar extrusion account for bite opening and that the net result gives a flattened occlusal plane angle in the Begg technique. In a prospective cephalometric study of Class II correction using a non-extraction Begg technique, Reddy *et al.* (2000) found that significant mandibular incisor intrusion and proclination, together with extrusion of the lower molars, contributed to overbite correction. However, the reduction in overbite with the VAST in this study seemed to be obtained by extrusion of both the upper and lower first molars and by proclination of the lower anterior teeth.

Despite the frequent use of cervical headgear in the SW technique, extrusion of the lower molars and proclination of the lower incisors were the major responsible factors for the overbite reduction. No significant differences were found in intrusion of the lower incisors, but they were significantly proclined in all four groups and predominantly with non-extraction treatment. According to Bennett and McLaughlin (1990), the reduction in overbite with the SW technique occurs by a combination of extrusion and/or uprighting of posterior teeth and intrusion of anterior teeth.

In this study, subjects with Class I, Class II division 1 or Class II division 2 relationships were pooled together. The reduction in overjet occurred differently with the two techniques. The influence of Begg in the VAST was obvious in the non-extraction groups, where it was found that the upper incisors retroclined and significantly extruded, whereas in the SW non-extraction group the upper incisors proclined. One explanation could be the effect of V-bends in the VAST, resulting in distalization of both molars, together with the whole dental arch.

Proclination of the lower incisors and the influence of the sagittal component of Class II elastics contributed to a reduction in overjet in all four groups. However, the reduction was greater in the VAST extraction group compared with the SW group. During the initial phase of VAST treatment, the upper incisors were tipped distally to an edge-to-edge relationship using Class II elastics. Reddy *et al.* (2000) suggested that the vertical effect of Class II elastics counteracts the effect of anchor bends and increases extrusion of the upper incisors. On the other hand, Xu *et al.* (1992) claimed that the effect of Class II elastics in reducing the intrusion of upper incisors generated by anchor bends in the upper archwire was less than expected and that the position of the hooks for intermaxillary elastics in the upper archwire had a greater influence than the force exerted by the elastics themselves.

There was a significant difference in active treatment time between the VAST and SW technique. One of the main differences was the elimination of extra-oral anchorage with the VAST, while in the SW groups the frequency was 75 per cent. According to McLaughlin and Bennett (1991), reinforcement of anchorage is often needed in the SW technique and the dependence of patient co-operation to obtain the optimal effect of the extra-oral traction may prolong the active treatment time. Another factor that might have contributed to the shorter treatment period with the VAST was the treatment strategy that demanded bonding of both arches at the first appointment for initiation of Class II elastics from the beginning of treatment.

The influence of the materials used, e.g. archwires and the design of brackets, cannot be ignored, especially when explaining the difference in the number of appointments. The duration between appointments was on average 2 weeks longer with the VAST than with the SW technique. By utilizing the Begg effect of round wires, anchor bends and Class II elastics early in treatment, there was less strain on anchorage with the VAST. Therefore, it was possible to minimize the stress from friction between bracket and wire by using the one-point contact of the gingival or occlusal wing slot.

The VAST offered a greater flexibility in certain cases when reinforcement of anchorage was needed. Rectangular wires, utilized as sectionals, in the pre-adjusted slot or uprighting springs in the vertical bracket slot on the canines could be used temporarily. Thus, the VAST gave a possibility to alter the anchorage resistance in specific areas of the appliance at any desired point during the treatment by changing slot and archwire dimensions.

As the efficiency of a technique is important socio-economically, variables such as the number of appointments and total chairside and treatment time have a great impact on the decision to choose a particular technique.

## Conclusion

1. Both the VAST and the SW technique seemed to produce equal treatment results.
2. In the hands of one experienced orthodontist, the VAST required no extra-oral traction and fewer scheduled appointments than the SW technique.

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