*European Journal of Orthodontics* 33 (2011) 354–358
*doi:10.1093/ejo/cjq082*
*Advance Access Publication 18 October 2010*



# Treatment effects of the R-appliance and twin block in Class II division 1 malocclusion

Abdolreza Jamilian*, Rahman Showkatbakhsh** and Shabnam Sheikholeslam Amiri*
Departments of Orthodontics, Universities of *Islamic Azad University and **Shahid Beheshti, Tehran, Iran

*Correspondence to:* Professor Abdolreza Jamilian, No. 2713, Jam Tower, Valiasr Street, Tehran 1966843133, Iran.
E-mail: info@jamilian.net

SUMMARY The purpose of this study was to compare the effects of a differently designed functional appliance (the R-appliance) with a twin-block (TB)-treated group.

Thirty patients (18 girls and 12 boys) with a mean age of 10.5 ± 0.7 years were treated with the R-appliance for 16.2 ± 0.3 months and 25 (11 boys and 14 girls) with a mean age of 11.2 ± 1.3 years with a TB for 16.1 ± 1.4 months (control). All had a Class II division 1 malocclusion due to mandibular deficiency. Lateral cephalograms obtained at the beginning ($T_1$) and end ($T_2$) of the study were analysed.

Paired *t*-tests showed that SNB significantly increased in both groups. The incisor mandibular plane angle (IMPA) was reduced in the R-appliance group by 1.9 ± 4.9 degrees ($P < 0.04$) but increased by 0.5 ± 5.1 degrees ($P < 0.6$) in the TB group. SNA in the R-appliance group showed an increase of 0.2 ± 1.8 degrees ($P < 0.5$), while it was decreased by 0.2 ± 1.3 degrees ($P < 0.3$) in the TB group.

Both treatment modalities were successful in moving the mandible forward. However, with the R-appliance, this was achieved without retroclination of the lower incisors.

## Introduction

Class II division 1 malocclusions due to mandibular deficiency have been extensively studied regarding the skeletal and dental characteristics and method of treatment (McNamara, 1981). Different removable functional appliances have been used to treat this malocclusion (Clark, 1988; Ghafari *et al.*, 1988; Tulloch *et al.*, 1997; Ehmer *et al.*, 1999; Wheeler *et al.*, 2002; O'Brien *et al.*, 2003). Past studies that have described positive effects with the various functional appliances have focused on the skeletal and dental structures (Bishara and Ziaja, 1989; Mills, 1991; Petrovic *et al.*, 1991; Morris, 1995; Aelbers and Dermaut, 1996; Barton and Cook, 1997; McSheny and Bradley, 2000; McDonagh *et al.*, 2001; Chen *et al.*, 2002; Jacobs and Sawaengkit, 2002; Shen *et al.*, 2005). The twin-block (TB) appliance first introduced by Clark (1988) is one of the most popular appliances used for treating Class II division 1 malocclusions associated with mandibular retrusion (Morris *et al.*, 1998; Singh and Clark, 2003). However, the TB has been shown to have an inhibiting effect on growth of the maxilla (Clark, 2002). In general, functional appliances restrict growth of the maxilla (Kerr *et al.*, 1989; Perillo *et al.*, 1996; Toth and McNamara, 1999; Trenouth, 2000; Pangrazio-Kulbersh *et al.*, 2003; Hägglund *et al.*, 2008). Labial tipping of the lower incisors is evident in TB therapy (Clark, 2002) as well as with other types of functional appliances (Pancherz, 1982; Vargervik and Harvold, 1985). Restriction of the maxilla and proclination of the lower incisors are the main disadvantages of most functional appliances.

To avoid these side-effects, the R-appliance was designed (Jamilian *et al.*, 2009). The aim of this study was to evaluate dentoskeletal changes achieved with the R-appliance in comparison with the TB in the treatment of Class II division 1 patients, in the late mixed dentition.

## Subjects and methods

This retrospective study consisted of 55 patients who were randomly assigned to two groups using a standard random number table. All subjects gave informed written consent and all met the following inclusion criteria:

1. ANB >4 degrees, SNB <78 degrees, overjet ≥5 mm at the start of treatment.
2. No syndromic or medically compromised patients.
3. No previous surgical intervention.
4. No use of other appliances before or during the period of functional treatment.
5. A normal mandibular growth pattern: neither horizontal nor vertical.
6. No skeletal asymmetry.

Thirty patients (18 girls and 12 boys) were treated with the R-appliance (Figure 1). Their mean age was 10.5 ± 0.7 years, and the average treatment time was 16.2 ± 0.3 months. The patients were instructed to wear the appliances full-time except for eating, contact sports, and tooth brushing.

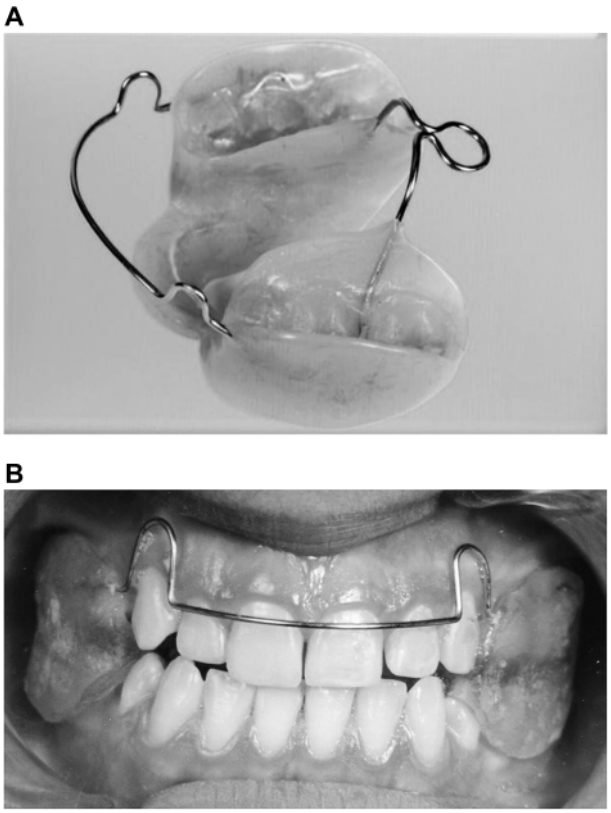


**Figure 1** (A) The R-appliance and (B) *in situ*.

The R-appliance is a tooth- and tissue-borne appliance. It consists of buccal and lingual shields, which are connected to each other through the occlusal clearance during bite construction. These shields are extended to the distal of the first permanent molars and cover the buccal and lingual regions and the depth of the vestibule. The lingual shield was fabricated with minimal undercut relief to allow the appliance to settle more easily. The left and right lower lingual shields were connected and reinforced with a heavy archwire (1 mm diameter) to withstand muscular activity loading. The heavy wire, which acts as a tongue bow, was positioned posteriorly to connect the right and left acrylic parts on the palatal aspect in order to reinforce the appliance. The labial bow was constructed of 0.7 mm stainless steel wire extending from canine to canine with vertical loops in the canine region. In this group, the construction bites were taken with the upper and lower anterior teeth in an edge-to-edge occlusion with 2–3 mm posterior clearance. Lateral cephalograms of the R-appliance group were taken in centric occlusion at the start ($T_1$) and completion ($T_2$) of functional treatment.

The TB group consisted of 25 patients (11 boys and 14 girls) with a mean age of 11.2 ± 1.3 years, treated with the TB (Clark, 1988) incorporating an upper labial bow. The treatment time was 16.1 ± 1.4 months. The patients were instructed to wear the TB block full-time except for eating, contact sports, and tooth brushing. None of the subjects dropped out during the study. Lateral cephalograms of the TB group were taken at $T_1$ and after 16 months of observation ($T_2$).

SNA, SNB, ANB, overjet, 1 to SN (angle between the long axis of the upper central incisor and anterior cranial base), incisor mandibular plane angle (IMPA; angle between the long axis of the lower central incisor and mandibular plane), and the Jarabak index (the ratio between posterior and anterior face heights; S–Go/N–Me) were measured on all radiographs.

Both groups were treated by one practitioner in a private orthodontic office. All measurements were carried out twice by two individuals. The reliability of the measurements was determined by randomly selecting 10 cephalograms at the beginning and end of the treatment from each group. They were traced twice by the same trained dentists on two separate occasions after a 1 month interval. Paired *t*-tests showed no statistically significant differences between the two measurements. The correlation analyses between the first and second measurements consistently showed coefficients greater than 0.90.

Data were tested for normality and appropriate statistical test were applied (Table 1). Paired *t*-tests were used for intragroup evaluation and a *t*-test for intergroup evaluation. Statistical significance was set at $P < 0.05$. The magnification factor of the cephalograms was standardized at 8 per cent. The Statistical Package for Social Sciences, Version 16 (SPSS Inc., Chicago, Illinois, USA), was used to analyse the data.

## Results

Paired *t*-tests showed that the SNB in the R-appliance group increased by 2.2 ± 1.6 degrees ($P < 0.001$), while ANB and overjet significantly decreased. The changes in SNA and the Jarabak index were not significant. IMPA showed a decrease of 1.9 ± 4.9 degrees ($P < 0.04$; Table 2). In the TB group, SNB increased 1.8 ± 1.2 degrees ($P < 0.001$) and ANB and overjet significantly decreased. SNA showed a non-significant decrease. The Jarabak index did not show any significant changes. IMPA was increased by 0.5 ± 5.1 degrees ($P < 0.6$; Table 2).

Intergroup evaluation showed that SNA was increased with the R-appliance but reduced with the TB. However, the difference was not statistically significant. IMPA was decreased in the R-appliance group by 1.9 ± 4.9 degrees, while it increased in the TB group by 0.5 ± 5.1 degrees ($P < 0.08$). SNB showed an increase in both groups but the difference was not statistically significant. 1 to SN was reduced by 9.1 ± 8.7 degrees in the R-appliance group but by 4.7 ± 7.7 degrees in the TB group. The difference between the two groups was not statistically significant (Table 3). Figure 2 shows the pre- and post-treatment images of one patient treated with the R-appliance.

**Table 1** Normality test for the R-appliance and twin block (TB).

| | Group | Pre-treatment | | Post-treatment | |
|---|---|---|---|---|---|
| | | *P* value | | *P* value | |
| | | Kolmogorov–Smirnov | Shapiro–Wilk | Kolmogorov–Smirnov | Shapiro–Wilk |
| SNA | R-appliance | 0.2 | 0.1 | 0.2 | 0.4 |
| | TB | 0.08 | 0.4 | 0.02 | 0.1 |
| SNB | R-appliance | 0.2 | 0.04 | 0.2 | 0.4 |
| | TB | 0.2 | 0.4 | 0.2 | 0.3 |
| ANB | R-appliance | 0.02 | 0.1 | 0.004 | 0.01 |
| | TB | 0.2 | 0.1 | 0.1 | 0.4 |
| 1 to SN | R-appliance | 0.08 | 0.01 | 0.2 | 0.2 |
| | TB | 0.2 | 0.9 | 0.1 | 0.3 |
| IMPA | R-appliance | 0.04 | 0.1 | 0.2 | 10.2 |
| | TB | 0.2 | 0.4 | 0.02 | 0.05 |
| Overjet | R-appliance | 0.2 | 0.6 | 0.02 | 0.07 |
| | TB | 0.04 | 0.09 | 0.006 | 0.04 |
| Jarabak index | R-appliance | 0.2 | 0.5 | 0.2 | 0.03 |
| | TB | 0.2 | 0.5 | 0.2 | 0.4 |

**Table 2** Pre- and post-treatment measurements in the R-appliance and twin block (TB) groups.

| Cephalometric measurements | Groups | Pre-treatment, mean ± SD | Post-treatment, mean ± SD | Changes, mean ± SD | 95% Confidence interval | *P* value |
|---|---|---|---|---|---|---|
| SNA | R-appliance | 79.3 ± 3.4 | 79.5 ± 3.1 | 0.2 ± 1.8 | −0.5 to 0.9 | 0.5 |
| | TB | 79.9 ± 2.1 | 79.7 ± 2.4 | −0.2 ± 1.3 | −0.8 to 0.3 | 0.3 |
| SNB | R-appliance | 74.8 ± 3.6 | 76 ± 3.2 | 2.2 ± 1.6 | 1.6 to 2.8 | 0.001* |
| | TB | 73.9 ± 2.8 | 75.7 ± 2.9 | 1.8 ± 1.2 | 1.3 to 2.3 | 0.001* |
| ANB | R-appliance | 6.6 ± 1.8 | 4.7 ± 1.6 | −1.9 ± 1.4 | −2.4 to −1.4 | 0.001* |
| | TB | 6.2 ± 2.1 | 4.2 ± 2.2 | 1.8 ± 1.4 | −2.4 to −1.2 | 0.001* |
| 1 to SN | R-appliance | 106.6 ± 7.4 | 97.5 ± 7.2 | −9.1 ± 8.7 | −12.3 to −5.8 | 0.001* |
| | TB | 104.9 ± 7.7 | 100.2 ± 5.4 | −4.7 ± 7.7 | −7.9 to −1.5 | 0.006* |
| IMPA | R-appliance | 102.7 ± 5.9 | 100.8 ± 6.1 | −1.9 ± 4.9 | −3.8 to −0.1 | 0.04* |
| | TB | 101.3 ± 7.3 | 101.8 ± 6.7 | 0.5 ± 5.1 | −1.6 to 2.6 | 0.6 |
| Overjet | R-appliance | 8.4 ± 2.3 | 3.5 ± 1.5 | −4.5 ± 2.3 | −5.7 to −4 | 0.001* |
| | TB | 7.1 ± 2.1 | 2.8 ± 1.3 | −4.3 ± 2.3 | −5.2 to −3.3 | 0.001* |
| Jarabak index | R-appliance | 62.1 ± 4.3 | 62.2 ± 4.6 | 0.1 ± 2 | −0.7 to 0.8 | 0.9 |
| | TB | 63.5 ± 4.6 | 63.5 ± 5.1 | 0.02 ± 3.2 | −1.3 to 1.4 | 0.9 |

*Statistical significance was set at $P < 0.05$.

## Discussion

The findings of this study showed that both the R-appliance and the TB can successfully improve the profile of patients with mandibular deficiency. Both overjet and ANB were reduced while SNB was increased. However, the lower incisors were protruded in the TB group while they were retroclined in the R-appliance group (Table 2). The TB has been shown to restrain maxillary development and cause proclination of the lower incisors (Clark, 2002). Significant forward movement of the mandibular landmarks was the most distinct effect of activator and TB appliances. Additionally, significant proclination of the mandibular incisors at the end of functional appliance use might have contributed to forward movement of the lower lip. In several studies concerning soft tissue profile effects of Class II functional appliances; similar changes have been reported (Bishara and Ziaja, 1989; McDonagh *et al.*, 2001; Cozza *et al.*, 2004; Quintão *et al.*, 2006). In another study, significant dental changes were found with edgewise Herbst treatment, including retraction of the maxillary and proclination of the mandibular (VanLaecken *et al.*, 2006).

The R-appliance improved mandibular deficiency in the anterio-posterior dimension without proclination of the

**Table 3** Comparison of the R-appliance and the twin-block (TB) group measurements.

| Cephalometric measurements | R-appliance, mean ± SD | TB, mean ± SD | *P* value |
|---|---|---|---|
| SNA | 0.2 ± 1.8 | −0.2 ± 1.3 | 0.3 |
| SNB | 2.2 ± 1.6 | 1.8 ± 1.2 | 0.3 |
| ANB | −1.9 ± 1.4 | −1.8 ± 1.4 | 0.8 |
| 1 to SN | −9.1 ± 8.7 | −4.7 ± 7.7 | 0.06 |
| IMPA | −1.9 ± 4.9 | 0.5 ± 5.1 | 0.08 |
| Overjet | −4.9 ± 2.3 | −4.3 ± 2.3 | 0.3 |
| Jarabak index | 0.1 ± 2 | 0.02 ± 3.2 | 0.9 |

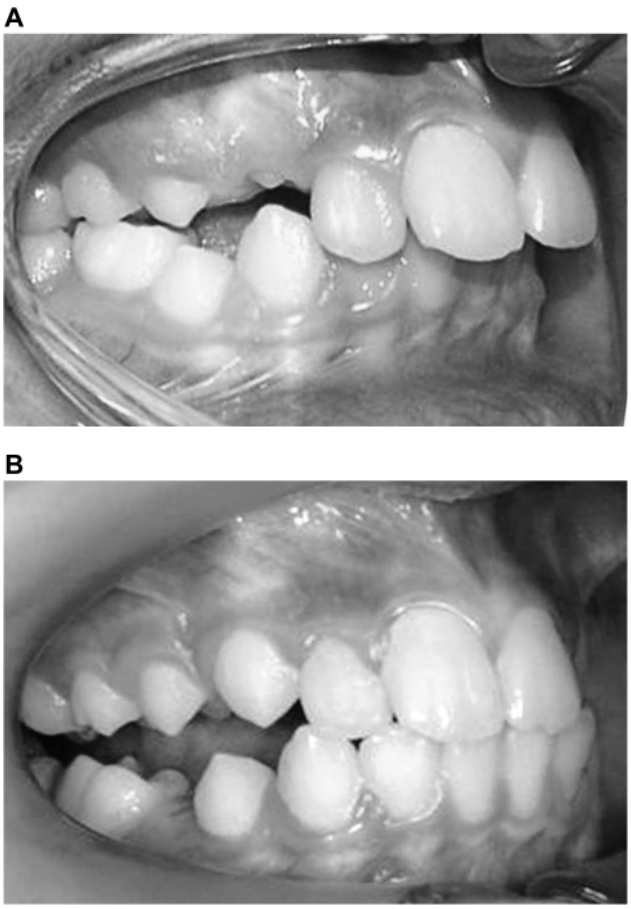


**Figure 2** (A) Pre- and (B) post-treatment photographs of a patient treated with the R-appliance.

lower incisors. However, the upper incisors were retroclined more than in the TB group (Table 3).

In the R-appliance group, in order to avoid potential trauma, all patients were repeatedly instructed to posture the mandible forward. This posturing became habitual as patients naturally adopted a comfortable position. Active mandibular protrusion has been associated with growth and remodelling of the mandible, at least in the short term. Mandibular closure might create excessive retraction forces on the upper anterior teeth, which could be the reason for upper anterior lingualization during treatment. In other words, the retracting force on the upper anterior dentition takes place only at the beginning of mandibular closure. SNA increased in the R-appliance group while it decreased in the TB group (Table 2). In other words, the R-appliance did not affect the maxillary base while it tipped the upper incisors palatally. However, point A would move in a forward position if the palatal tipping is corrected by fixed appliances. In the TB group, the retractor muscles are activated, which will orthopaedically affect the maxilla. TBs have many advantages, which have made them the most popular functional appliance in the UK (Gill *et al.*, 2005). Some advantages have been highlighted by Clark (1997):

1. They can be worn full time due to their smaller size.
2. The absence of lip, cheek, and tongue pads allows of normal function and does not distort the patient's facial appearance during treatment.
3. Good patient compliance is required to achieve neuromuscular adaptation.

## Conclusions

The following conclusions can be drawn based on this study's findings:

1. The R-appliance and TB will result in forward positioning of the mandible in phase 1 of treatment.
2. In the R-appliance group, while the lower incisors retroclined, the difference between the two groups was not statistically significant.

## References

Aelbers C M, Dermaut L R 1996 Orthopedics in orthodontics, part I: fiction or reality—a review of the literature. American Journal of Orthodontics and Dentofacial Orthopedics 110: 513–519

Barton S, Cook P A 1997 Predicting functional appliance treatment outcome in Class II malocclusions—a review. American Journal of Orthodontics and Dentofacial Orthopedics 112: 282–286

Bishara S E, Ziaja R R 1989 Functional appliances: a review. American Journal of Orthodontics and Dentofacial Orthopedics 95: 250–258

Chen J Y, Will L A, Niederman R 2002 Analysis of efficacy of functional appliances on mandibular growth. American Journal of Orthodontics and Dentofacial Orthopedics 122: 470–476

Clark W J 1988 The twin block technique. A functional orthopedic appliance system. American Journal of Orthodontics and Dentofacial Orthopedics 93: 1–18

Clark W J 1997 The twin block technique. In: Graber T M, Rakosi T, Petrovic A G (eds.). Dentofacial orthopedics with functional appliances Mosby Year Book, St Louis, pp. 268–298.

Clark W J 2002 Twin Block functional therapy, 2nd edn. Mosby, St Louis, pp. 343–356.

Cozza P, De Toffol L, Colagrossi S 2004 Dentoskeletal effects and facial profile changes during activator therapy. European Journal of Orthodontics 26: 293–302

Ehmer U, Tulloch C J, Proffit W R, Phillips C 1999 An international comparison of early treatment of Class II/1 cases: skeletal effects of the first phase of a prospective clinical trial. Journal of Orofacial Orthopedics 60: 392–408

Ghafari J, Shofer F S, Jacobsson-Hunt U, Markowitz D L, Laster L L 1988 Headgear versus functional regulator in the early treatment of Class II division 1 malocclusion: a randomized clinical trial. American Journal of Orthodontics and Dentofacial Orthopedics 113: 51–61

Gill D, Sharma A, Naini F, Jones S 2005 The twin block appliance for the correction of Class II malocclusion. Dental Update 32: 158–168

Hägglund P, Segerdal S, Forsberg C M 2008 The integrated Herbst appliance treatment effects in a group of adolescent males with Class II malocclusions compared with growth changes in an untreated control group. European Journal of Orthodontics 30: 120–127

Jacobs T, Sawaengkit P 2002 National Institute of Dental and Craniofacial Research efficacy trials of bionator Class II treatment. A review. Angle Orthodontist 72: 571–575

Jamilian A, Showkatbakhsh R, Kamali Z 2009 R-appliance: a different design in functional therapy in Class II division I malocclusion. International Journal of Orthodontics 20: 11–14

Kerr W J, TenHave T R, McNamara J A Jr 1989 A comparison of skeletal and dental changes produced by function regulators (FR-2 and FR-3). European Journal of Orthodontics 11: 235–242

McDonagh S, Moss J P, Goodwin P, Lee R T 2001 A prospective optical surface scanning and cephalometric assessment of the effect of functional appliances on the soft tissues. European Journal of Orthodontics 23: 115–126

McNamara J A Jr 1981 Components of Class II malocclusion in children 8-10 years of age. Angle Orthodontist 51: 177–202

McSheny P F, Bradley H 2000 Class II correction-reducing patient compliance. A review of the available techniques. Journal of Orthodontics 27: 219–225

Mills J R 1991 The effect of functional appliances on the skeletal pattern. British Journal of Orthodontics 18: 267–275

Morris D O 1995 The effects of functional appliances on the soft-tissue facial form. Journal of Dental Research 74: 822 (Abstract)

Morris D O, Illing H M, Lee R T 1998 A prospective evaluation of Bass, Bionator and Twin Block appliances, part II—the soft tissues. European Journal of Orthodontics 20: 663–684

O'Brien K *et al.* 2003 Effectiveness of treatment for Class II malocclusion with the Herbst or twin block appliances: a randomized, controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics 124: 128–137

Pancherz H 1982 The mechanism of Class II correction in Herbst treatment: a cephalometric investigation. American Journal of Orthodontics 82: 104–113

Pangrazio-Kulbersh V, Berger J L, Chermak D S, Kaczynski R, Simon E S, Haerian A 2003 Treatment effects of mandibular anterior repositioning appliances on patients with Class II malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics 123: 286–295

Perillo L, Johnston L E Jr, Ferro A 1996 Permanence of skeletal changes after function regulator (FR-2) treatment of patients with retrusive Class II malocclusions. American Journal of Orthodontics and Dentofacial Orthopedics 109: 132–139

Petrovic A, Stutzmann J, Lavergne J, Shaye R 1991 Is it possible to modulate the growth of the human mandible with a functional appliance? International Journal of Orthodontics 29: 3–8

Quintão C, Helena I, Brunharo V P, Menezes R C, Almeida M A O 2006 Soft tissue facial profile changes following functional appliance therapy. European Journal of Orthodontics 28: 35–41

Shen G, Hägg U, Darendeliler M 2005 Skeletal effects of bite jumping therapy on the mandible-removable vs. fixed functional appliances. Orthodontics and Craniofacial Research 8: 2–10

Singh G D, Clark W J 2003 Soft tissue changes in patients with Class II division 1 malocclusion treated using twin block appliances: finite-element scaling analysis. European Journal of Orthodontics 25: 225–230

Toth L R, McNamara J A Jr 1999 Treatment effects produced by the twin-block appliance and the FR-2 appliance of Fränkel compared with an untreated Class II sample. American Journal of Orthodontics and Dentofacial Orthopedics 116: 597–609

Trenouth M J 2000 Cephalometric evaluation of the twin block appliance in the treatment of Class II division 1 malocclusion with matched normative data. American Journal of Orthodontics and Dentofacial Orthopedics 117: 54–59

Tulloch J F C, Proffit W R, Phillips C 1997 Influences on the outcome of early treatment for Class II malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics 111: 533–542

Vargervik K, Harvold E P 1985 Response to activator treatment in Class II malocclusions. American Journal of Orthodontics 88: 242–251

VanLaecken R, Martin C A, Dischinger T, Razmus T, Ngan P 2006 Treatment effects of the edgewise Herbst appliance: a cephalometric and tomographic investigation. American Journal of Orthodontics and Dentofacial Orthopedics 130: 582–593

Wheeler T T, McGorray S P, Dolce C, Taylor M G, King G J 2002 Effectiveness of early treatment of Class II malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics 121: 9–17