ORIGINAL ARTICLE

Comparison of 2 modifications of the Twin-block appliance in matched Class II samples

Nicola Ann Parkin, BDS, MMedSci, FDS RCS(Eng), M Orth RCS(Eng),[a] Helen Fiona McKeown, BDS, MMedSci, FDS RCS(Ed), M Orth RCS(Eng),[b] and Paul Jonathan Sandler, BDS(Hons), MSc, FDS RCPS(Glas), M Orth RCS(Eng)[c]
Chesterfield, United Kingdom

The purpose of this study was to compare the skeletal and dental changes contributing to Class II correction with 2 modifications of the Twin-block appliance: Twin-block appliances that use a labial bow (TB1) and Twin-block appliances that incorporate high-pull headgear and torquing spurs on the maxillary central incisors (TB2). After pretreatment equivalence was established, a total of 36 consecutively treated patients with the TB1 modification were compared with 27 patients treated with the TB2 modification. Both samples were treated in the same hospital department and the same technician made all the appliances. The cephalostat, digitizing package, and statistical methods were common to both groups. The results demonstrated that the addition of headgear to the appliance resulted in effective vertical and sagittal control of the maxillary complex and thus maximized the Class II skeletal correction in the TB2 sample. Use of the torquing springs resulted in less retroclination of the maxillary incisors in the TB2 sample when compared with the TB1 sample; however, this difference did not reach the level of statistical significance. (Am J Orthod Dentofacial Orthop 2001;119:572-7)

Several studies have shown that a Twin-block appliance is a very effective tool in the correction of Class II maloclusions.[1-3] The effectiveness of the Twin-block appliance is probably related to its reduced demand on patient tolerance as compared with some other functional appliances, which results in a higher rate of patient acceptance. Illing et al[3] showed the appliance to be advantageous in terms of its rapidity of correction, compared with Bass and bionator appliances.

Lund and Sandler[1] investigated the Twin-block appliance in a prospective controlled study and, like many other authors, concluded that Class II correction was achieved primarily by dentoalveolar changes. These changes included distalization of the maxillary buccal teeth, mesial movement of the mandibular buccal segments, an average retroclination of the maxillary incisors by 10.8°, and proclination of the mandibular incisors by 7.9°. A small but significant reduction in the ANB angle occurred, due mainly to an increase in the SNB angle. No significant anteroposterior restraint of maxillary growth was demonstrated. Failure to control vertical development of the maxilla led to an increase in lower face height in the Twin-block group compared with the control group.

Mills and McCulloch[2] compared a modification of the Twin-block appliance with an untreated control group. The control group was taken from the Burlington Growth Centre studies and was not equivalent to the treatment group at the start of the study. Nevertheless, their results demonstrated that skeletal effects accounted for 50% of the correction. The dentoalveolar changes again included proclination of the mandibular incisors and retroclination of the maxillary incisors, although to a lesser extent than reported previously, probably because of the absence of a labial bow. Of the skeletal changes achieved, the majority of mandibular growth was expressed vertically. This increase in vertical dimension, often due to a backward rotation of the mandible, does not improve the facial profile and has been found to be the primary expression of mandibular skeletal change in other functional appliances.[4,5]

With Class II cases, the most desirable goal of correction is to stimulate forward mandibular growth. Many authors have recommended combining functional appliances with high-pull headgear as a means of controlling vertical and sagittal growth of the maxilla while allowing the mandible to auto-rotate and increase its forward displacement.[6-9] Teuscher[6] used a combination of an activator appliance with anteriorly placed high-pull headgear to act on the maxillary dentition as a whole. He argued that the headgear maintained the

From the Chesterfield Royal Hospital, Derbyshire, England.
[a]Registrar in Orthodontics.
[b]Registrar in Orthodontics.
[c]Consultant Orthodontist.
Reprint requests to: Jonathan Sandler, Chesterfield and North Derbyshire, Royal Hospital NHS Trust, Calow, Chesterfield, Derbyshire S44 5BL, UK; e-mail, JonSandler@aol.com.
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palatal plane and prevented the posterior rotation of the maxillary, occlusal, and mandibular planes, as well as the concomitant increase in the lower anterior face height. In short, the headgear helps avoid an adverse clockwise response during treatment.

Current literature shows various responses to the addition of headgear to functional appliances. Lagerstrom et al[7] investigated the effects of headgear-activator combinations and found that the maxillary occlusal plane often remained unchanged during treatment. This finding was in contrast to reports on activator therapy without headgear, which resulted in the maxilla rotating in an unfavorable downward and backward direction.[10] Lagerstrom et al[7] also found that mean mandibular growth was in an anterior direction—not in a vertical direction, as was demonstrated in other activator studies.[11] Weislander[12] looked at the effects of treatment in a group of patients in the mixed dentition with headgear and the Herbst appliance and found a larger skeletal effect than that found in the study carried out by Pancherz[13] with patients in the permanent dentition treated with the Herbst appliance without headgear. The increased skeletal effects may have been due to the additional effect of headgear, although the outcome may have been influenced by the age difference between the 2 groups. Pancherz[14] looked at Class II correction in Herbst and Bass therapy, the latter being combined with a high-force high-pull headgear. Although Bass treatment seemed to have a somewhat greater influence on maxillary and mandibular jaw-base position, no statistically significant differences existed between the 2 appliance groups. Illing et al,[3] in their comparison of Twin-block appliances, bionators, and Bass appliances, found that the greatest restraint in forward movement of A-point was in the Twin-block group. Mandibular length increased most in the group treated with bionators and the least in the group treated with Bass appliances, the only appliance that incorporates headgear. The Bass group did, however, show the smallest amount of increase in lower face height, and it was felt that headgear was more effective at limiting the vertical rather than the anterior development of the maxilla.

The aim of this study was to enhance the skeletal effects of the Twin-block appliance in the hope that dentoalveolar effects would make less of a contribution to the correction of the malocclusion. The effects of Twin-block appliances with a labial bow (TB1) were compared with the effects of Twin-block appliances combined with high-pull headgear and torquing springs positioned on the maxillary central incisors (TB2). Torquing springs were used to prevent unwanted retroclination of the upper labial segment. High-pull headgear directed at the center of resistance of the maxilla was used in an attempt to control the vertical position of the maxilla. As reported by Drage and Hunt[15] and Keeling et al,[16] the skeletal contribution to overjet reduction is the most stable, whereas the dentoalveolar effects show an increased tendency to relapse. It was therefore appropriate to try to maximize the former and minimize the latter.

Ideally, comparison of the 2 treatment modalities should have been made by means of a randomized clinical trial; however, this would have presented a variety of practical problems. The results of the effects of the TB1 appliance have already been published.[1] In this study, steps have been taken to control and minimize any attendant problems associated with comparing records at different time periods. A deliberate attempt was made not to select patients on the basis of treatment success. Furthermore, in both samples, pretreatment equivalence was checked by using independent *t* tests.

MATERIAL AND METHODS

The patient population was the same for both TB1 and TB2 groups. The patients included in the study were consecutively chosen from the functional appliance waiting list. The following inclusion criteria were used for both groups.

- 10 to 14 years of age with all first premolars fully erupted
- White
- Class II skeletal pattern with an ANB greater than 5°
- Class II Division 1 incisor relationship
- Overjet greater than 6 mm

The TB1 group comprised 36 patients consecutively treated between 1994 and 1996. Of the next 49 patients taken from the waiting list, 22 were unsuitable; 17 did not satisfy the inclusion criteria, 3 failed to comply within the first 2 months of treatment, and 2 had radiographs of inadequate diagnostic quality. This resulted in 27 patients being included in the TB2 sample (12 males and 15 females). These patients were treated between 1997 and 1999. Treatment for both groups was carried out under the instruction of a single consultant (P.J.S).

Both appliances studied were modifications of the Clark Twin-block and were worn full time. They had Adams clasps on maxillary and mandibular first molars and first premolars, and ball-ended clasps on the lower labial segment to maximize retention. The steep inclined planes were constructed at 70° to the occlusal plane. The upper block contained a midline expansion screw that was turned 1 turn per week. Jaw registration was taken with approximately 7 to 8 mm of protrusion and the teeth 6 to 7 mm apart in the buccal segments. Reactivation of both appliances was carried out as required. The

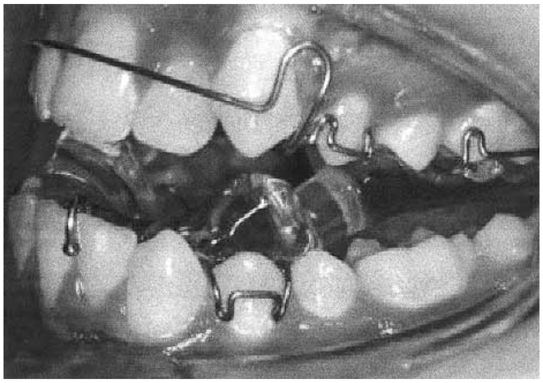

Fig 1. TB1 appliance; modifications include Adams cribs, ball clasps, and labial bow.

Fig 2. TB2 appliance; modifications include torquing spurs and flying headgear tubes.

TB1 appliance had Adams clasps and ball clasps for retention, as well as a labial bow (Fig 1). The TB2 appliance had torquing spurs to the maxillary central incisors, flying headgear tubes situated next to the maxillary second premolars, and high-pull headgear, 400 g per side, worn 120 hours per week (Fig 2).

The patients had pretreatment and posttreatment lateral cephalograms, all of which were taken on the same machine. Treatment was considered finished when there was a full reduction in overjet and overbite and sagittal correction of the posterior occlusion. A single operator (N.A.P.) randomly digitized the pretreatment and posttreatment lateral cephalograms. The radiographs were then redigitized 2 weeks later to determine intraexaminer agreement. Good intraexaminer agreement was demonstrated, and therefore the first set of figures obtained were used for the statistical analysis. The analysis was composed of linear and angular measurements (Figs 3-5).

Statistical analysis was undertaken with the Statistical Package for the Social Sciences for Windows software (SPSS, Chicago, Ill). Intraoperator error agreement was assessed with Bland and Altman's method of limits of agreement.[17] Pretreatment equivalence was determined between the 2 treatment groups by using an independent sample *t* test to ensure that both groups came from a population with the same mean. Descriptive statistics (means and SDs) were calculated for all measurements. Between-means differences for initial and final facial form, treatment change, and differences between the changes of the 2 samples were analyzed by means of paired *t* tests.

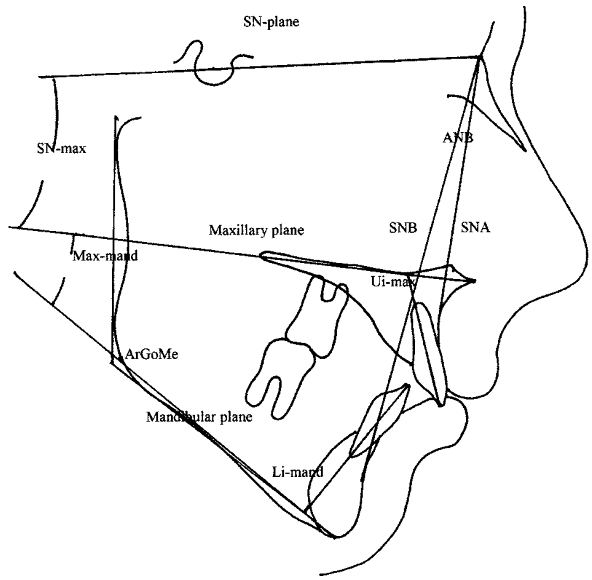

Fig 3. Angular measurements.

RESULTS

The error study was performed with the 2 sets of cephalometric data. Both systematic and random error were assessed by using Bland and Altman's method of limits of agreement.[17] First, the mean and SD of the differences between the pairs of measurements were calculated. The mean difference represented the bias or systematic error between the 2 sets of measurements. For intraoperator agreement, no bias was expected and therefore was assumed to be equal to 0; however, this assumption was checked on each occasion. The SD of the differences in the mean difference represented the random error. The mean difference and the SD of the differences were used to construct a range of agreement, within which we expected 95% of the differences to occur (ie, 95% limits = ± 1.96 × SD [differences about 0]).

Table I demonstrates the limits of agreement for both the linear and angular measurements. For example, with regard to the linear measurement A-horizon-

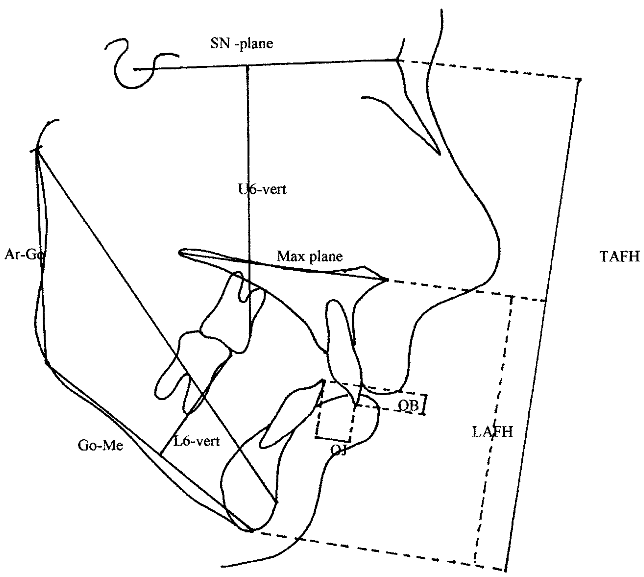

Fig 4. Linear measurements.

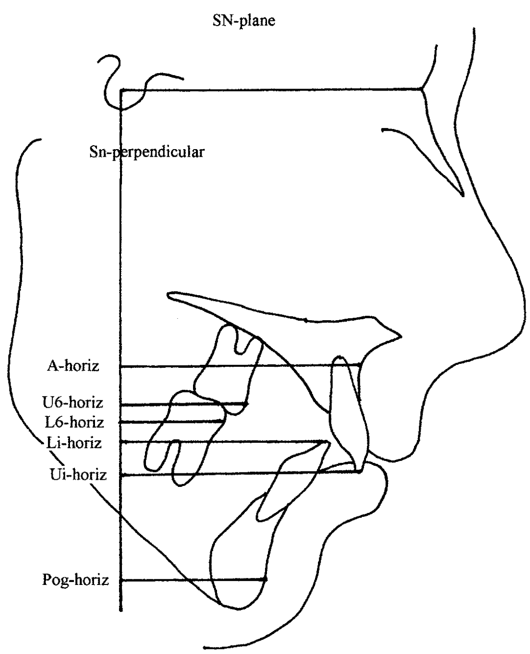

Fig 5. Linear measurements recorded from cephalometric landmark to sella-nasion perpendicular.

tal, we expected 95% of the measurements to be ± 1.01 mm, and, for the angular measurement SNA, we expected 95% of the measurements to be ± 1.4°.

Pretreament equivalence between the TB1 and TB2 groups was obtained for all results (Table II).

The results of the effects of the 2 appliances are presented in Table III. The differences between pretreatment and posttreatment are shown for both groups, and the results have been expressed as a rate of change per year. The net effects, that is, the differences between the 2 groups, are also presented. After comparison of the means for each variable between the 2 groups, the significance levels were modified according to the Bonferroni method.

Table I. Error study for the cephalometric analysis (n = 27)

Variable	*Limits of agreement*	*SD of differences near 0*
Linear (mm)		
A-horiz	±1.01	0.51
Ui-horiz	±0.88	0.44
Li-horiz	±1.31	0.66
U6-horiz	±1.21	0.6
L6-horiz	±1.51	0.75
Pog-horiz	±1.55	0.77
Ar-Pog	±1.06	0.53
Ar-Go	±0.6	0.3
Go-Me	±0.47	0.23
U6-vert	±0.88	0.44
L6-vert	±1.91	0.95
OJ	±0.76	0.38
OB	±0.7	0.35
TAFH	±0.96	0.48
LFH/TAFH%	±0.01	0
Angular (°)		
SNA	±1.4	0.7
SNB	±1.17	0.59
ANB	±0.63	0.31
Ui-Max	±1.76	0.88
Li-Mand	±1.39	0.7
SN-Max	±0.74	0.37
Sn-Mand	±0.98	0.49
Max-Mand	±1	0.5
Ar-Go-Me	±1.51	0.76

DISCUSSION

The intention of this study was to compare 2 modifications of the Twin-block appliance and evaluate their skeletal and dental effects. Random allocation of patients into the 2 different treatment groups and the control group at the outset would have been preferable; however, in this single-center study, this would have significantly reduced the sample size. The advantage of patient selection from a single unit means that the entire group was under the supervision of a single consultant (P.J.S.), which consequently reduces interoperator discrepancies.

In general, as with other studies designed to evaluate growth modification, large between-patient variation exists and thus the overall mean changes observed are small.

Table II. Pretreatment equivalence, TB1 (n = 36) and TB2 (n = 27)

Variable	*TB1 Mean start*	*TB1 (SD)*	*TB2 Mean start*	*TB2 (SD)*	*Signif-cance P*	*Bonfer-roni*
Linear (mm)						
A-horiz	58.68	4.4	59.21	5.17	.662	1
Ui-horiz	60.06	5.45	61.59	6.72	.322	1
Li-horiz	52.39	5.49	53.36	6.53	.525	1
U6-horiz	31.67	4.38	32.85	5.04	.325	1
L6-horiz	28.65	5.23	29.58	5.76	.506	1
Pog-horiz	42.77	7.77	43.45	8.86	.747	1
Ar-Pog	93.33	4.62	94.32	4.66	.405	1
Ar-Go	40.44	3.67	39.01	4.7	.18	1
Go-Me	62.4	3.97	65.33	3.58	.004	0.088
U6-vert	17.91	2	17.58	3.86	.661	1
L6-vert	24.61	2.31	24.28	1.66	.531	1
OJ	8.17	1.91	8.75	2.1	.258	1
OB	4.53	2.31	5.13	2.45	.324	1
TAFH	107.45	6.88	107.35	6.31	.953	1
LFH/TAFH%	0.55	0.02	0.55	0.02	1	1
Angular (°)						
SNA	81.96	3.85	82.18	4	.826	1
SNB	75.3	3.58	75.78	4.03	.62	1
ANB	6.66	2.04	6.4	1.31	.565	1
Ui-Max	112.64	6.67	113.46	8.02	.66	1
Li-Mand	94.65	7.15	93.06	6.84	.377	1
Sn-Max	5.6	2.4	7.24	6.39	.162	1
Sn-Mand	35.19	6.64	34.91	5.99	.864	1
Max-Mand	29.59	6.74	28.72	4.91	.573	1
Ar-Go-Me	128.61	6.13	128.77	6.09	.918	1

Table III. Comparison of the mean changes between TB1 and TB2

Variable	*Mean difference TB2*	*(SD)*	*Mean difference TB1*	*(SD)*	*Difference between TB2 and TB1*
Linear (mm)					
A-horiz	–0.9	1.1	0.6	1.9	–1.5**
Ui-horiz	–3.8 NS	2.2	–2.9	3.1	–0.9
Li-horiz	5.3 NS	2.9	4.4	3.4	0.9
U6-horiz	–3.0	3.0	–0.7	2.7	–2.3*
L6-horiz	4.6 NS	3.0	4.7	4.4	–0.1
Pog-horiz	3.1 NS	3.1	2.3	3.9	0.8
Ar-Pog	7.4	3.6	5.1	2.3	2.3*
Ar-Go	5.3 NS	4.2	4	2.9	1.3
Go-Me	2.6 NS	2.0	1.9	2.2	0.7
U6-vert	–0.1 NS	3.6	0.2	1.7	–0.3
L6-vert	1.1 NS	1.8	1.6	1.8	–0.5
OJ	–9.6 NS	4.1	–7.8	3.8	–1.8
OB	–6.5 NS	4.4	–5	2.8	–1.5
TAFH	6.2 NS	3.0	4.9	2.6	1.3
Angular(°)					
LFH/TAFH%	0.0	0.0	1.5	1	–1.5***
SNA	–1.4	1.1	–0.1	1.6	–1.3**
SNB	2.4 NS	1.7	1.9	2	0.5
ANB	–3.8	2.0	–2	1.9	–1.8**
Ui-Max	–6.9 NS	6.3	–11	7.6	4.1
Li-Mand	6.4 NS	6.3	8.2	7.1	1.8
Sn-Max	–1.0 NS	9.9	0	1.7	–1
Sn-Mand	0.7 NS	1.9	0.1	2.7	0.6
Max-Mand	0.3 NS	3.4	0.2	3.3	0.1
A-Go-Me	1.7 NS	3.5	1.4	2.8	0.3

*.05 < *P* < .10, "slight evidence" of significance; ***P* < .05, significant; ****P* < .01, highly significant; *NS,* not significant.

Dentoalveolar effects

Despite the addition of torquing springs to the maxillary central incisors, they were still retroclined by an average of 6.9°. This value is 4.1° less than that of the TB1 sample, but the difference is not statistically significant. Lagerstrom et al[7] added torquing springs to their headgear-activator appliance and reported a similar average retroclination of 6.6°. Illing et al[5] found significantly less retroclination of the maxillary incisors with the Bass appliance (4.1° ± 8.1°) as compared to the Twin-block appliance (9.1° ± 6.2°). They explained this effect as being due to either the anterior torquing spring preventing excessive palatal tipping of the teeth or to the fact that therapy was incomplete with the Bass sample. Interestingly, Mills and McCulloch[2] found an average retroclination of just 2.5° during treatment with Twin-block appliances without a restraining labial bow.

In the mandibular arch of the TB2 group, there was 6.4° of proclination of the mandibular incisors, as compared to 8.2° in the TB1 group. This difference was also not statistically significant.

There was "slight evidence of significance" with respect to increased distal movement of the maxillary molars in the TB2 sample. Their vertical eruption appears to have been restricted when compared with the TB1 sample.

Skeletal effects

As already mentioned, functional appliance therapy tends to cause tipping of the maxillary plane in a clockwise direction. This occurred to a small degree in the TB1 sample. In the TB2 sample, the maxillary plane appeared to have rotated in an anticlockwise direction as shown by the negative SN-Max value; however, the difference in the SN-Max value between the 2 groups did not reach statistical significance. The headgear tubes in the TB2 appliance were actually situated next to the maxillary second premolars, and perhaps, if the extraoral force vector was positioned more anteriorly, an increased magnitude of anticlockwise rotational change might have been achieved. Teuscher[6] and van Beek[8] paid special attention to the position of the extraoral force vector and suggested that it should be positioned as far forward as possible. If its location is excessively posterior to the center of resistance of the maxilla, it further intensifies the posterior rotating effect of the muscle-induced force vector on the maxilla.

The TB2 group demonstrated restraint in the anteroposterior position of the maxilla. The horizontal linear value of A-horizontal in the TB2 sample was significantly less than that of the TB1 group; this was to be expected because of the added headgear effect and the reduced amount of retroclination of the maxillary incisors. The SNA angle was also significantly reduced in the TB2 sample, despite slight tipping of the maxillary plane in an anticlockwise direction.

The findings suggest an increase in the anterior relocation of pogonion as measured from articulare. This may have been due to growth or repositioning of the mandible. The ANB value was significantly more reduced in the TB2 sample, suggesting that this appliance was more effective in reducing the sagittal Class II discrepancy.

In the TB1 sample, increase in the lower facial height divided by total anterior facial height (LFH/TAFH) ratio was highly significant with respect to the control group, a typical outcome following backward rotation of the mandible. In the TB2 sample, there was no increase in the LAFH/TAFH ratio during treatment, and the difference between the 2 samples was 1.5%, a highly significant change ($P < .01$). This was an expected finding following effective control of the maxillary occlusal plane.

Summary of treatment effects

1. The TB2 sample showed a significant increase in maxillary restraint as compared to the TB1 sample.
2. There was a significantly greater reduction in the ANB angle in the TB2 sample, which suggests that this appliance may be more effective in improving the sagittal intermaxillary relationship.
3. There appeared to be an anterior relocation of the mandible in the TB2 sample. Articulare-pogonion demonstrated an increase in length; however, measurements taken from articulare do not take into account the possibility of the patient posturing anteriorly.
4. The LFH/TAFH ratio increased in the TB1 sample and remained unchanged in the TB2 sample. This was the most significant difference between the 2 groups ($P < .01$).
5. The addition of torquing springs did not totally prevent retroclination of the maxillary incisors in the TB2 sample. However, there did appear to be less retroclination when compared with the TB1 group, although this difference was not statistically significant.

CONCLUSIONS

Both types of the Twin-block appliance were very effective in correcting Class II malocclusions. Dentoalveolar tipping occurred in both groups, although it appeared to occur to a lesser extent in the TB2 sample.

The addition of high-pull headgear to the Twin-block allowed effective vertical and sagittal control of the maxilla and, consequently, there was no increase in the LFH/TAFH ratio in the TB2 sample.

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