Original Article

Comparison of the Effect on Oral Discomfort of Two Positioning Techniques with Lingual Brackets

Ariane Hohoff, DDS[a]; Thomas Stamm, DDS[a]; Ulrike Ehmer, DDS, PhD[b]

Abstract: Using a standardized questionnaire, 41 patients (12 men, 29 women; mean age 31.5 ± 12.1 years) were interviewed prospectively on their subjective oral comfort, various oral functions, and professional qualification before indirect application of lingual brackets (T0), within 24 h of application (T1), and three months later (±1 week) (T2). In 22 of the 41 patients, the brackets were positioned with the Bonding with Equalized Specific Thickness (BEST) technique (BEST group) and in 19 patients by the Transfer Optimized Positioning (TOP) method (TOP group). Despite positive adaptation, the patients in both groups still reported a significant deficiency in tongue space at T2 as well as significantly more frequent lesions to the tongue. The BEST group was affected significantly more often by these problems than the TOP group. At T2, the tongue position was also rated as changed significantly more often in the BEST group than in the TOP group. Although the BEST positioning technique leads to greater impairments in oral comfort than the TOP technique, it offers the orthodontist the advantage of less bending input. In both techniques, there is a need for detailed briefing of patients about the extent and duration of impairments induced by lingual brackets. (*Angle Orthod* 2004;74:226–233.)

Key Words: Esthetic appliances; BEST system; TOP system; Discomfort; Speech

INTRODUCTION

Because indirect bonding ensures a more exact outcome in general, indirect bracket positioning in a professional laboratory process is an essential prerequisite for the success of an economically efficient lingual treatment concept.[1–10] Examples of currently used professional positioning methods based on *Torque Angulation Reference Guide* (TARG)[11] by Ormco (Ormco, Amersfoort, Netherlands) are the Bonding with Equalized Specific Thickness (BEST) system[6,11–14] and Transfer Optimized Positioning (TOP) system.[10,15]

In the BEST system, the brackets are bonded from canine to canine at a uniform distance from the labial surface, with the tooth with the greatest distance between labial surface and slot specifying the general positioning thickness of the six anterior teeth.[9,13–17] This makes for a symmetric anterior curvature without first-order bends and thus simplifies archwire fabrication. However, the appliance projects further into the tongue space than when positioning with the TOP system (Figure 1A,B). With the TOP system, all brackets are positioned as close as possible to the tooth. The differences in tooth thickness, therefore, have to be compensated by means of first-order bends in the archwire (Figure 1A,B).[10,15,18]

Depending on the positioning technique applied, there are thus marked differences in the thickness of the appliance and in the number of first-order bends, especially in the anterior region, even when the same bracket system is used. This might result in different effects on oral comfort; on biting, chewing, and swallowing functions; and on phonation in the second articulation zone.[19–21]

The working hypothesis for the present prospective evaluation, therefore, was that even if the same bracket type is used, the BEST and the TOP positioning techniques affect oral comfort and performance to varying extents.

MATERIALS AND METHODS

Forty-one patients (12 men, 29 women; mean age 31.5 ± 12.1 years) were enrolled in this prospective longitudinal study. Exclusion criteria were cleft lip, cleft palate or velar cleft, dialects, a history of speech or hearing defects, and previous elocution training or speech therapy. All probands were treated with Ormco 7th Generation lingual brackets (Ormco, Glendora, Calif). Positioning on the model had

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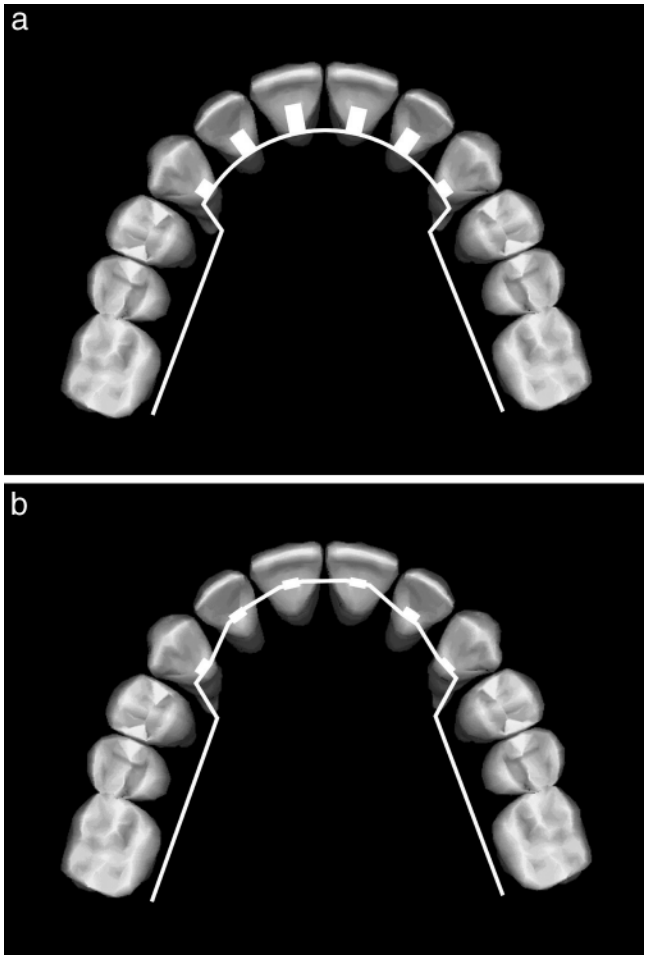

FIGURE 1. (a) Schematic illustration of the BEST technique. (b) Schematic illustration of the TOP technique.

been executed with Phase II (Reliance Orthodontic Products, Itasca, Ill). After intraoral sandblasting and enamel etching,[22] the brackets were fixed intraorally with a bonding agent (Maximum Cure, Reliance). This was done indirectly with a tray.

Using a standardized questionnaire, the patients were evaluated for education, subjective oral comfort, speech, and mastication at the following time points: directly before placement of the lingual brackets (T0), within 24 hours thereafter (T1), and three months (±1 week) later (T2). Each question (see Results) had five possible answers: ''No, not at all'' (rating = 1); ''Slightly'' (rating = 2); ''Yes, with reserve'' (rating = 3); ''Yes, indeed, I can confirm this without reserve'' (rating = 4); and ''No evaluation possible'' (rating = ''omitted'').

Of the 41 patients, 22 had the brackets positioned by the BEST system (BEST group, five men, 17 women; mean age 33.7 ± 10.7 years). These patients had lingual brackets in only the upper arch at T1 and T2 and were native speakers of standard French. For the remaining 19 patients, the TOP positioning system was used (TOP group, seven men, 12 women; mean age 38.9 ± 13.4 years). These patients were native speakers of standard German and had lingual brackets in only the upper arch at T1. At T2, nine of the 19 patients of the TOP group had lingual brackets in the lower arch also.

Statistics

Statistical analysis was based on SPSS 11.0 for Windows (SPSS, Chicago, Ill). The Wilcoxon signed rank test for related samples was used to evaluate changes between T0, T1, and T2 in the BEST group and in the TOP group. The chi-square test was used to detect any interdependencies between the different test parameters at T0, T1, and T2 in each of the two groups. The number of fields was adapted to the number of probands by combining possible answers 1 and 2 and possible answers 3 and 4, respectively, into one possible answer for this test, providing a four-field test for each two parameters.

The Mann-Whitney *U*-test for independent samples was applied to check for any differences at the respective time points between the BEST and the TOP groups. $P \leq .05$ was defined as significant and $P \leq .001$ as highly significant.

RESULTS

Patients

The collective total comprised 14.7% schoolchildren, 34.1% academics, and 34.1% nonacademics. No information on their profession was available for 17.1% of the probands. The BEST and the TOP groups did not differ with respect to sex, age, and education.

Subjective oral comfort

Answers to the question, ''Have you a sense of your tongue space being restricted?'' The patients in both groups reported a highly significant restriction of the tongue space from T0 to T1 (Figure 2; Table 1). The intergroup difference was not significant. Although a significant improvement was reported in the BEST group and a highly significant improvement in the TOP group from T1 to T2 (though with no significant intergroup difference), the tongue space was still significantly restricted in both groups at T2 in relation to T0. The BEST group was affected significantly more often by this restriction at T2 than the TOP group.

Answers to the question, ''Have you noticed pressure sores, reddening, or lesions on your tongue?'' The patients in both groups reported a highly significant increase in pressure sores, reddening, or lesions of the tongue at T1 in comparison with T0, without any significant intergroup difference being recorded (Figure 3; Table 1).

Although a significant improvement in this phenomenon from T1 to T2 was reported in the BEST group and a highly significant improvement in the TOP group (though with no

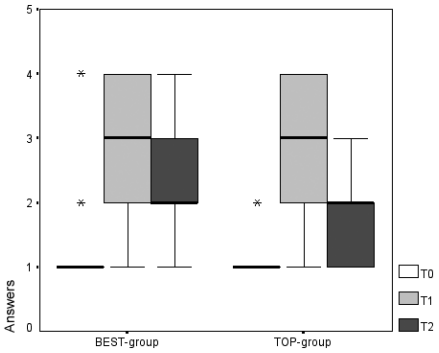

FIGURE 2. Answers to the question, ''Have you a sense of your tongue space being restricted?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1week) after start of therapy. * indicates extreme values.

significant intergroup difference), the frequency of lesions was still highly significantly greater in the BEST group and significantly greater in the TOP group at T2 than at T0. At T2, the BEST group was affected significantly more often by pressure sores, reddening, or lesions of the tongue than the TOP group.

Answers to the question, ''Is your tongue position changed?'' At T0, there was no significant intergroup difference in the answer to this question (Figure 4; Table 1). From T0 to T1, a highly significant change in tongue position was reported in the BEST group, whereas no significant changes were recorded in the TOP group. At T1, the tongue position was reported to have changed highly significantly more often in the BEST group than in the TOP group. No significant improvements occurred from T1 to T2 in either group. In comparison with T0, the tongue position in the BEST group was still highly significantly changed at T2, whereas no significant changes were reported in the TOP group. A changed tongue position was reported highly significantly more often in the BEST group than in the TOP group.

Speech

Answers to the question, ''Do you feel that your articulation has changed?'' At T0, there were no significant intergroup differences in the answer to this question (Figure 5—subjective evaluation of speech; Table 1). From T0 to T1, the patients in both groups reported a highly significant change in their articulation (with no significant intergroup difference at T1). From T1 to T2, the articulation improved significantly in the BEST group and highly significantly in the TOP group. At T2, the articulation in both groups was still highly significantly poorer than at T0, with the patients in the BEST group giving their articulation a significantly poorer rating than those in the TOP group.

Answers to the question, ''Has a change in your articulation been noticed in your social environment?'' From T0 to T1, a highly significant change in articulation was noticed in the social environments of both groups (Figure 6—semiobjective rating of articulation; Table 1). From T1 to T2, a highly significant improvement was reported in both groups. At T2, in comparison with T0, however, the articulation was still rated as highly significantly changed in the BEST group and as significantly changed in the TOP group. At no time was a significant intergroup difference recorded.

Answers to the question, ''Do you avoid specific types of conversation (eg, on the phone?)'' At T0, no significant intergroup difference was recorded (Figure 7—conversation behavior; Table 1). From T0 to T1, the conversation pattern deteriorated highly significantly in the BEST group, but no significant changes were registered in the TOP group. At T1, the number of patients avoiding specific types of conversation was significantly greater in the BEST group than in the TOP group. Although a significant improvement was registered in the BEST group from T1 to T2, conversations were still avoided significantly more often at T2 than at T0 in that group. No significant changes were recorded in the TOP group. At T2, there were no significant intergroup differences.

Eating

Answers to the question, ''Do you have difficulty in chewing?'' In both groups, mastication deteriorated highly significantly from T0 to T1 (Figure 8; Table 1). However, it improved significantly in the BEST group and highly significantly in the TOP group from T1 to T2. In both groups, mastication was still highly significantly poorer at T2 than at T0. At none of the registration times were any significant intergroup differences recorded.

Answers to the question, ''Do you have difficulty in biting?'' The biting function deteriorated highly significantly from T0 to T1 in both groups (Figure 9; Table 1). From T1 to T2, no significant improvement was recorded in the BEST group; a significant improvement was recorded in the TOP group. At T2, the biting function was highly significantly poorer in both groups than at baseline (T0). At none of the registration times were any significant intergroup differences recorded.

Answers to the question, ''Do you have difficulty in swallowing liquids?'' In neither group did the swallowing function change significantly during the study period, nor were significant intergroup differences registered at any time (Figure 10; Table 1).

Interdependencies between individual parameters

In the TOP group, interdependencies were recorded between individual parameters (Table 2) in that the majority of patients rated the changes that had occurred since application of the brackets as minor. In the BEST group, the interdependencies between the individual parameters were

TABLE 1. Comparison of Answers Given by the BEST Group and by the TOP Group at the Different Registration Time points[a]

Question/ Timepoint	BEST Group (n = 22) Possible Answer (%) 1	2	3	4	Mean	SD	*P* Value ≤	TOP Group (n = 19) Possible Answer (%) 1	2	3	4
1 T0	86.4	9.1	0.0	4.5	1.2	0.7	T0 vs T1: .000	94.7	5.3	0.0	0.0
1 T1	9.1	36.4	22.7	31.8	2.8	1.0	T1 vs T2: .024	5.3	31.6	15.8	47.4
1 T2	18.2	45.4	18.2	18.2	2.4	1.0	T2 vs T0: .002	47.4	42.1	10.5	0.0
2 T0	95.5	4.5	0.0	0.0	1.1	0.2	T0 vs T1: .000	100.0	0.0	0.0	0.0
2 T1	4.5	31.8	9.1	54.5	3.1	1.0	T1 vs T2: .002	5.3	26.3	31.6	36.8
2 T2	22.7	54.5	9.1	13.6	2.1	0.9	T2 vs T0: .000	57.9	31.6	5.3	5.3
3 T0	100.0	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .000	100.0	0.0	0.0	0.0
3 T1	9.1	36.4	27.3	27.3	2.7	1.0	T1 vs T2: NS	78.9	15.3	5.3	0.0
3 T2	9.1	50.0	22.7	18.2	2.5	0.9	T2 vs T0: .000	84.2	15.8	0.0	0.0
4 T0	100.0	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .000	100.0	0.0	0.0	0.0
4 T1	0.0	18.2	22.7	59.1	3.4	0.8	T1 vs T2: .002	0.0	15.8	26.3	57.9
4 T2	9.1	40.9	27.3	22.7	2.6	1.0	T2 vs T0: .000	31.6	47.4	15.8	5.3
5 T0	90.9	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .000	100.0	0.0	0.0	0.0
5 T1	4.5	27.3	22.7	45.5	3.1	1.0	T1 vs T2: .001	10.5	26.3	10.5	52.6
5 T2	27.3	54.5	9.1	9.1	2.0	0.9	T2 vs T0: .001	63.2	21.1	10.5	5.3
6 T0	95.5	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .001	100.0	0.0	0.0	0.0
6 T1	40.9	22.7	13.6	22.7	2.2	1.2	T1 vs T2: .003	84.2	10.5	0.0	5.3
6 T2	77.3	18.2	4.5	0.0	1.3	0.6	T2 vs T0: .034	94.7	5.3	0.0	0.0
7 T0	95.5	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .000	100.0	0.0	0.0	0.0
7 T1	18.2	18.2	22.7	40.9	2.9	1.2	T1 vs T2: .024	5.3	26.3	21.1	47.4
7 T2	27.3	31.8	22.7	18.2	2.3	1.1	T2 vs T0: .001	31.6	42.1	26.3	0.0
8 T0	90.9	0.0	0.0	0.0	1.0	0.0	T0 vs T1: .001	100.0	0.0	0.0	0.0
8 T1	18.2	13.6	18.2	36.4	2.8	1.2	T1 vs T2: NS	21.1	5.3	31.6	42.1
8 T2	22.7	18.2	13.6	31.8	2.6	1.3	T2 vs T0: .001	26.3	42.1	21.1	10.5
9 T0	90.9	4.5	0.0	0.0	1.1	0.2	T0 vs T1: NS	100.0	0.0	0.0	0.0
9 T1	77.3	18.2	4.5	0.0	1.3	0.6	T1 vs T2: NS	94.7	5.3	0.0	0.0
9 T2	86.4	13.6	0.0	0.0	1.1	0.4	T2 vs T0: NS	100.0	0.0	0.0	0.0

[a] T = Time point; T0 = before placement of lingual brackets; T1 = within 24 h thereafter; T2 = 3 months (±1 week) after start of therapy; NS = not significant ($P > .05$). Possible answers: 1 = No, not at all, (Value = 1); 2 = Slightly, (Value = 2); 3 = Yes, with reserve, (Value = 3); 4 = Yes, indeed, I can confirm this without reserve, (Value = 4); 5 = No evaluation possible, (Value = missing). Question 1 = ''Have you a sense of your tongue space being restricted?'' Question 2 = ''Have you noticed pressure sores, reddening, or lesions on your tongue?'' Question 3 = ''Has your tongue position changed?'' Question 4 = ''Do you feel that your articulation has changed?'' Question 5 = ''Has a change in your articulation been noticed in your social environment?'' Question 6 = ''Do you avoid specific types of conversation (e.g. on the phone)?'' Question 7 = ''Do you have difficulty in chewing?'' Question 8 = ''Do you have difficulty in biting?'' Question 9 = ''Do you have difficulty in swallowing liquids?''

less consistent: the proportion of patients rating the changes in the course of orthodontic therapy as minor or as fairly severe was approximately the same. The exceptions were the parameters ''subjectively rated articulation'' and ''swallowing function'' at T1, with the majority of patients rating the changes induced by the lingual brackets as severe.

DISCUSSION

Patients

The patient collective investigated in this study was typical of lingually treated orthodontic patients with respect to age and sex. The majority of patients were women aged less than 40 years.[23–26]

Although the patients in the two groups did not differ significantly with respect to age, sex, and professional status, there were disparities between the two samples. The patients in the BEST group were charged a higher fee for the therapy than those in the TOP group, which may imply higher demands on therapeutic comfort. An investigation of the interdependencies between various parameters and a comparison of the standard deviations revealed a more heterogeneous distribution of the possible answers in the BEST group. This may be an expression of that phenomenon, but it may also be merely an indicator of a somewhat greater heterogeneity of the BEST group compared with the TOP group.

However, the patients in the BEST group did not give significantly more negative answers to all the investigated parameters than the probands in the TOP group, but only to some, ie, oral comfort (T2), speech as evaluated subjectively (T2), and conversation behavior (T1). The potential influence of higher expectations induced by financial dif-

TABLE 1. Continued

TOP Group (n = 19)			*P* Value BEST Group vs TOP Group ≤
Mean	SD	*P* Value ≤	
1.1	0.2	T0 vs T1: .000	NS
3.1	1.0	T1 vs T2: .000	NS
1.6	0.7	T2 vs T0: .005	.015
1.0	0.0	T0 vs T1: .000	NS
3.0	1.0	T1 vs T2: .000	NS
1.6	0.9	T2 vs T0: .008	.029
1.0	0.0	T0 vs T1: NS	NS
1.3	0.6	T1 vs T2: NS	.000
1.2	0.4	T2 vs T0: NS	.000
1.0	0.0	T0 vs T1: .000	NS
3.5	0.8	T1 vs T2: .000	NS
2.0	0.9	T2 vs T0: .001	.022
1.0	0.0	T0 vs T1: .000	NS
3.1	1.1	T1 vs T2: .001	NS
1.6	0.9	T2 vs T0: .016	NS
1.0	0.0	T0 vs T1: NS	NS
1.3	0.7	T1 vs T2: NS	.005
1.1	0.3	T2 vs T0: NS	NS
1.0	0.0	T0 vs T1: .000	NS
3.1	1.0	T1 vs T2: .001	NS
2.0	0.8	T2 vs T0: .001	NS
1.0	0.0	T0 vs T1: .000	NS
3.0	1.2	T1 vs T2: .004	NS
2.2	1.0	T2 vs T0: .001	NS
1.0	0.0	T0 vs T1: NS	NS
1.1	0.3	T1 vs T2: NS	NS
1.0	0.0	T2 vs T0: NS	NS

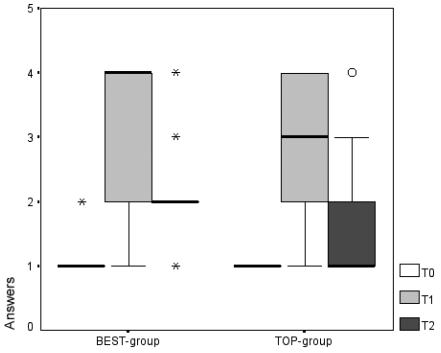

FIGURE 3. Answers to the question, ''Have you noticed pressure sores, reddening, or lesions on your tongue?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1week) after start of therapy. ∗ indicates extreme values; ○ indicates outliers.

ferences on the overall outcome is therefore considered unlikely.

The patients had different mother tongues. This entails the risk of causing different responses due to different tongue positions used with different languages. However,

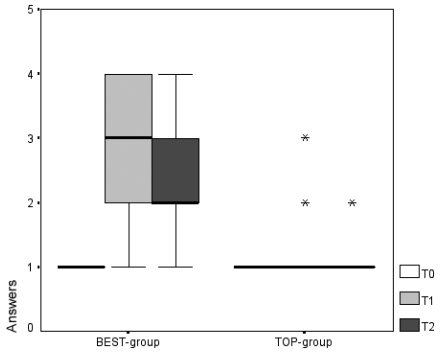

FIGURE 4. Answers to the question, ''Is your tongue position changed?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy. ∗ indicates extreme values.

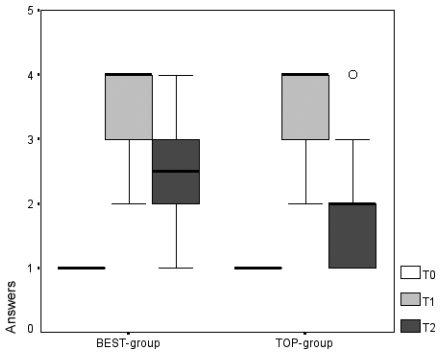

FIGURE 5. Answers to the question, ''Do you feel that your articulation has changed?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy. ○ indicates outliers.

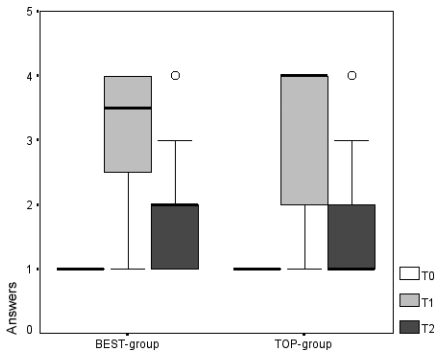

FIGURE 6. Answers to the question, ''Has a change in your articulation been noticed in your social environment?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy. ○ indicates outliers.

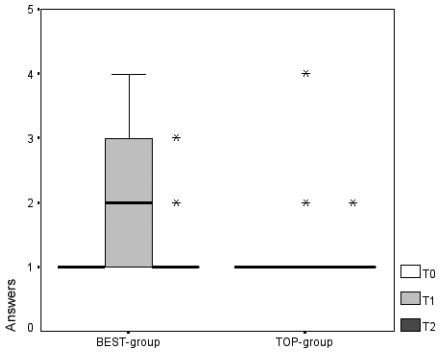

FIGURE 7. Answers to the question, ''Do you avoid specific types of conversation (eg, on the phone)?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy. * indicates extreme values.

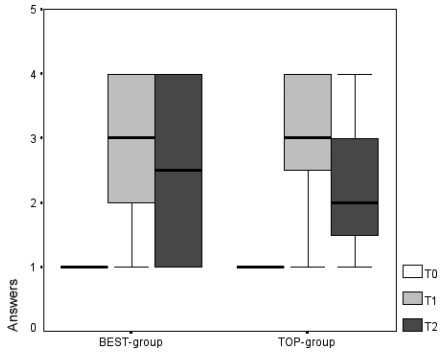

FIGURE 9. Answers to the question, ''Do you have difficulty in biting?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy.

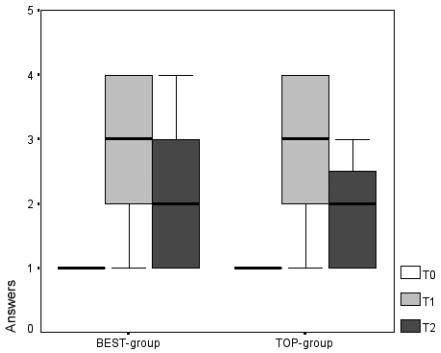

FIGURE 8. Answers to the question, ''Do you have difficulty in chewing?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy.

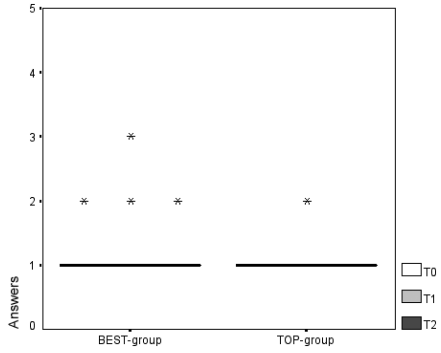

FIGURE 10. Answers to the question, ''Do you have difficulty in swallowing liquids?'' Possible answers: 1 = ''No, not at all''; 2 = ''Slightly''; 3 = ''Yes, with reserve''; 4 = ''Yes, indeed, I can confirm this without reserve''; ''No evaluation possible'' = missing value. T0 = before placement of lingual brackets; T1 = within 24 hours thereafter; T2 = three months (±1 week) after start of therapy. * indicates extreme values.

TABLE 2. Interdependencies Between Different Parameters at Registration Time points: BEST group vs TOP group[a]

T	Questions	Parameter + Parameter		BEST Group χ^2 *P* Value ≤	TOP Group χ^2 *P* Value ≤
1	4 + 9	Speech, subjective	Swallowing	.030	NS
1	6 + 7	Conversation behavior	Chewing	.007	NS
2	1 + 8	Tongue space restriction	Biting	.009	NS
2	2 + 8	Lesions to tongue	Biting	.013	NS
1	3 + 6	Tongue position	Conversation behavior	NS	.000
2	1 + 4	Tongue space restriction	Articulation, subjective	NS	.004
2	1 + 5	Tongue space restriction	Articulation, semiobjective	NS	.001
2	2 + 7	Lesions to tongue	Difficulty in chewing	NS	.012

[a] T0 = before placement of lingual brackets; T1 = within 24 h thereafter; T2 = 3 months (±1 week) after start of therapy; NS = not significant ($P > .05$). Question 1 = ''Have you a sense of your tongue space being restricted?'' Question 2 = ''Have you noticed pressure sores, reddening, or lesions on your tongue?'' Question 3 = ''Has your tongue position changed?'' Question 4 = ''Do you feel that your articulation has changed?'' Question 5 = ''Has a change in your articulation been noticed in your social environment?'' Question 6 = ''Do you avoid specific types of conversation (e.g. on the phone)?'' Question 7 = ''Do you have difficulty in chewing?'' Question 8 = ''Do you have difficulty in biting?'' Question 9 = ''Do you have difficulty in swallowing liquids?''

the groups did not differ with respect to all the speech-related parameters: for speech as assessed semiobjectively (T1, T2) and conversation behavior (T2), no significant intergroup differences were found. A potential influence of the different mother tongues on the overall outcome with respect to the intergroup comparison of all the speech-related parameters of the study is therefore considered unlikely.

At T2, approximately 50% of the patients in the TOP group had lingual brackets in the lower arch too, whereas all the patients in the BEST group had lingual brackets in the upper arch only. This disparity between the TOP group and the BEST group gives rise to two possible hypotheses: (1) the additional brackets in the lower arch had no influence on the answers given by the TOP collective and thus no influence on the comparison between the answers given by the TOP group vs those given by the BEST group, and (2) the additional brackets in the lower arch had an influence on the answers given by the TOP group, ie, the ratings by the TOP group would have been different (presumably more positive, indicating fewer restrictions) if the TOP group had had no lingual brackets in the lower arch.

Interest in the present study, however, was focused not so much on the individual results of the respective groups but rather on the intergroup comparison. Despite the additional lingual brackets in the lower arch, the TOP group recorded significantly better results than the BEST group with respect to oral comfort and subjectively rated articulation. The possibility that the TOP group might have recorded even better results (fewer restrictions) without lingual brackets in the lower arch would therefore be irrelevant in terms of these intergroup comparisons.

The question remaining is to what extent the parameters ''semiobjective rating of articulation,'' ''conversation pattern,'' and ''eating'' would have differed if the TOP group had had no lingual brackets in the lower arch. With respect to the influence of lingual brackets in the lower arch on semiobjectively rated articulation and conversation pattern, there are no published investigations directly comparable with the present study. Miyawaki et al[25] in a retrospective study of patients with upper and lower lingual brackets significantly reported more problems in /s/ and /t/ sound formation than were found in patients with lingual brackets in the upper and buccal brackets in the lower arch. However, the outlined methodology fails to report what questions the patients were asked. According to Fillion,[27] ''speech is not altered by lower lingual brackets''; however, the term ''speech'' is not further defined. No definitive answer can thus be given to the question of whether significantly better results would have been recorded for semiobjectively rated articulation and for conversation pattern in the TOP group without lower lingual brackets in comparison with the BEST group.

According to Miyawaki et al,[25] there are no significant differences with respect to difficulty in chewing between patients with both upper and lower lingual brackets compared with patients with upper lingual brackets only. Therefore, the question of whether the additional lower lingual brackets in the TOP group had any influence on the comparison of the two positioning techniques with respect to ''eating'' can be answered in the negative.

Subjective oral comfort

The working hypothesis can be confirmed for this parameter: after a three-month adaptation period, the BEST positioning technique leads to more severe impairments in subjective oral comfort than the TOP positioning technique. The adaptation periods in the present study are longer than those reported by Fritz et al[26] and by Fillion.[27] On the one hand, this may be due to the possible answers being more detailed, but on the other hand it may be due to the prospective nature of our own study.

Despite the discomfort associated with the lingual technique, various studies report a dropout rate approaching zero[27,28]; this is certainly to be seen in the light of the outstanding esthetic preconditions of the lingual technique,[29] which offer adequate compensation for the discomfort.[8] Recent studies confirm that even color-matched buccal brackets were regarded by the vast majority of patients as offering no alternative to the lingual technique.[26,30]

Speech

According to the results, the working hypotheses can be confirmed only for the parameter ''speech as evaluated subjectively'' (T2) and ''conversation behavior'' (T1). However, as stated above, the findings have to be interpreted with care because of the different mother tongues and the additional lower brackets in ca. 50% of the patients in the TOP group.

The fact that the patients in the BEST group gave their articulation a significantly poorer rating at T2 than those in the TOP group (a phenomenon not verified in the semiobjective rating of articulation by other persons) may, like the more restricted conversation pattern compared with the TOP group (T1), be an indication of the possibly higher expectations or more critical attitude in the BEST collective, as stated above under ''Patients.''

The good conformity in the rating of the articulation by the patients themselves in both collectives as compared with the rating by other persons confirms that the changes perceived by the patients in both groups were not an outcome of excessive attention being paid to speech-related changes but had indeed occurred. Prospective studies report good conformity between subjective, semiobjective, and objective computerized methods of sonagraphy and auditive analysis with reference to /s/-articulation[21] but not to vowel formation.[28] As the latter involves no contact with the teeth, no changes are to be expected a priori. As in the study by Sinclair et al,[31] no correlations could be estab-

lished in the present study between lesions on the tongue and speech impairments.

Whereas oral comfort is reported in various retrospective studies to be the most strongly affected parameter,[25–27,31] articulation was rated subjectively by the patients enrolled in the present study as being the most affected by changes. Muir[8] too expressed the opinion that speech was the greater problem associated with the lingual technique and that problems in articulation might persist for up to three months. The results of the present study correspond with those of Årtun,[32] who diagnosed speech impairment in 70% of patients with lingual brackets over a period of three months or more.

Eating

The working hypothesis for the parameter ''eating'' had to be rejected. The percentage of patients with moderate to severe eating problems in both collectives in the present study is comparable with that reported by Miyawaki et al[25] and Sinclair et al[31] but is well above that reported by Fritz et al[26] and Fillion.[27] This might be due to the patients having been interviewed at different timepoints and to the variations in, or absence of, possible ratings for the complaints.

CONCLUSIONS

Although the BEST technique leads to greater impairments in oral comfort than the TOP positioning technique, the BEST technique offers the orthodontist the advantage of harmoniously shaped archwires, which can be bent more easily by hand.

In both techniques, there is a need for detailed briefing of patients about the extent and duration of impairments induced by lingual brackets.

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