Original Article

Initial Effects of the Tongue Crib on Tongue Movements During Deglutition:
A Cine-Magnetic Resonance Imaging Study

M. Özgür Sayın[a]; Erol Akın[b]; Şeniz Karaçay[c]; Nail Bulakbaşı[d]

Abstract: The objective of this study was to investigate the initial effects of a tongue crib on tongue movements during deglutition by using real time balanced turbo field echo (B-TFE) Cine-MR imaging. A total of 21 patients were evaluated in this study. The open-bite group (OBG) consisted of 11 patients (seven girls, four boys) who had a mean age of 11.09 $\pm$ 2.02 years and a mean overbite of -5.14 ± 1.83 mm. These patients were evaluated initially (T1) and while wearing a tongue crib (T2). A total of 10 patients (five girls, five boys) with a mean age of 14.5 $\pm$ 2.6 years and with a mean overbite of 1.6 $\pm$ 0.5 mm served as controls (CG), and only initial records were obtained from these patients. T2 was compared with T1 and CG. T1 was also compared with CG. We evaluated deglutition during three stages matching oral (1), pharyngeal (2), and esophageal (3) stages. Our results indicated that the tongue's tip positioned more posteriorly when the crib was in place (T2) compared with both T1 and CG; the anterior portion of the tongue's dorsum was at a lower position in T2 compared with both T1 and CG at stage 3; the midportion of the tongue's dorsum was at a lower position in T2 than in T1 and CG at stages 1 and 2. To compensate for the posterior position of the tongue's tip (caused by the tongue crib), adaptive changes occurred in the anterior and midportions of the dorsum of the tongue. (*Angle Orthod* 2006;76:400–405.)

Key Words: Deglutition; Magnetic resonance imaging; Open bite; Swallowing; Tongue; Tongue crib

INTRODUCTION

The treatment of anterior open bite is one of the most troubling problems for the orthodontist. Several treatment modalities have been used to correct anterior open bites by preventing the placement of the tongue tip between the anterior teeth. The tongue crib is a removable appliance that is designed to modify tongue behavior or to break habits, or both.[1] However, there has been a controversy about its effectiveness in closing the open bites. Some authors[1–6] have reported that cribs are a successful treatment tool, whereas others[7–9] have reported the opposite. The main reason for this controversy may be the individual variations in the adaptive capability of the tongue to the new environment created by the appliance.

In orthodontics, appliances such as tongue cribs often are applied with only consideration for the tongue tip position and the tongue's function during deglutition is often overlooked.[10] It has been reported that tongue thrust swallowing was a physiologic adaptation to achieve anterior seal in patients with anterior open bite.[7,10–14] Proffit[14] suggested that correcting the tooth positions in open-bite patients should cause a change in swallowing patterns. If the anterior seal function of the tongue is prevented by restraining its forward movement with a tongue crib, the alterations in the

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Accepted: May 2005. Submitted: March 2005.

swallowing pattern should be investigated. In an early study, Cleall[11] observed the tongue movements of patients wearing a palatal crib during deglutition using cinefluorography. He reported that the palatal crib forced the tongue to function in a more posterior and higher position. However, he presented no statistical data to substantiate this statement.

The use of cineradiography in such studies is questionable because of radiation exposure. Recently, dynamic magnetic resonance imaging (MRI), a new noninvasive method, has become available to evaluate swallowing function.[15–17] It has been reported that, compared with videofluorography, high-speed kinetic MRI provides direct soft-tissue imaging in the absence of radiation exposure with comparable near real-time temporal resolution.[16] In a previous study,[18] tongue movements in subjects with anterior dental open bite were evaluated during deglutition by real time balanced turbo field echo (B-TFE) Cine-MR imaging.

By using the same technique, this study aims to evaluate the initial effects of tongue crib on tongue movements in patients with anterior open bite and to determine whether or not the tongue movements in these patients are changed to normal by the presence of a tongue crib during deglutition.

MATERIALS AND METHODS

A total of 21 patients were evaluated in this study. After the proposed study was approved by the appropriate institutional review board, 11 patients (seven girls, four boys; mean age: 11.09 $\pm$ 2.02 years) who had an anterior open bite of at least 2 mm (mean overbite: -5.14 ± 1.83 mm) measured between the incisal edges of the most erupted upper and lower central incisors and were planned for tongue crib therapy were included in the open-bite group (OBG). Ten patients (five girls, five boys; mean age of 14.5 $\pm$ 2.6 years) with a mean overbite of 1.6 $\pm$ 0.5 mm served as controls (CG). In each group, two subjects had an Angle Class II malocclusion, and the others had an Angle Class I malocclusion.

Patients in the OBG were evaluated at two sessions. T1 was the initial examination, and T2 was the second examination while patients were wearing a tongue crib. An acrylic tongue crib with a smooth spur and with no metal clasps was constructed for each patient in the OBG. Tongue cribs were made completely of acrylic because metal clasps cause distortions during magnetic resonance imaging (Figure 1). Patients in the OBG were instructed to wear this appliance at least 18 hours a day for 2 weeks to ensure adaptation before the second examination. To increase the stability of the appliance, the upper lateral incisors and canines were covered with the acrylic. The spur of the appliance was positioned just behind the upper incisors. It neither touched the teeth nor disturbed the occlusion. After 2 weeks, the patients in the OBG were recalled for the second examination while wearing the appliance (T2). Only initial records were obtained from the patients in CG.

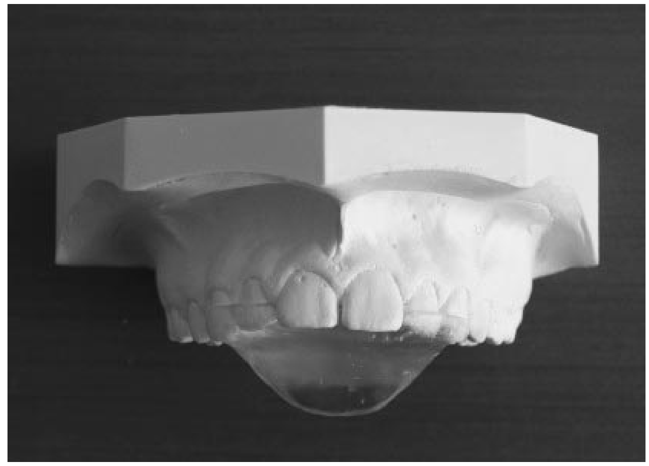

FIGURE 1. Acrylic tongue crib.

All subjects were examined in a supine position. The examination used a 1.5-Tesla superconducting MR scanner (The New Intera Nova, Philips Medical Systems, Best, The Netherlands) with a standard quadrature head coil, with version 9 software release. The system was equipped with magnetic field gradients capable of a maximum strength of 33 mT/m and maximum slew rate of 160 T/m/s. To increase the signal intensity of the oropharynx and to observe the soft-tissue motion during bolus propulsion,[15] we used a water bolus. Subjects were instructed to take 10 mL of water with a syringe just before imaging. The B-TFE images (500/10 ms, TR/TE, one excitation) were obtained in midsagittal plane using 50° flip angle, 10-mm slice thickness, autoshim, 350 $\times$ 350–mm field of view, and 256 $\times$ 256–matrix size during swallowing of water. The midsagittal plane is defined as the section, which is parallel to the interhemispheric fissure, and was determined on the scout images. A total of 100 dynamic scans were obtained in 11 seconds. Acquired cine images were then transferred to a system workstation (Easy Vision R4, Philips Medical Systems), and the image analysis and cine display were performed off-line on a workstation. Selected cine images were transferred by an image capture program of the vendor on a one by one image basis.

For each patient, images matching the following three stages of deglutition were determined by four specialists. One image was chosen for each stage and printed out on a radiograph.

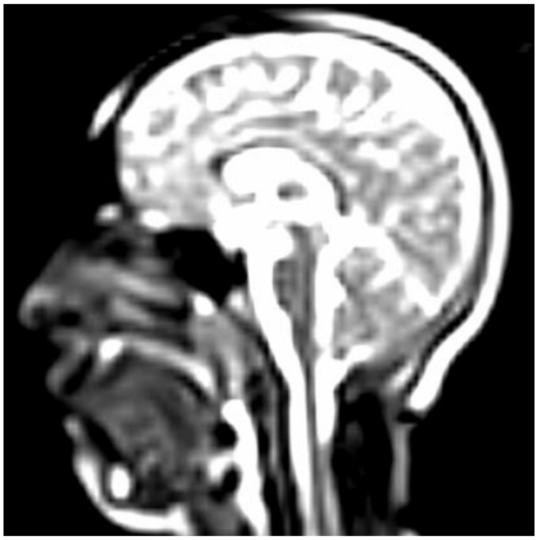

FIGURE 2. Image of a patient in the open-bite group without tongue crib (T1). Note that the tongue's tip is between the incisors.

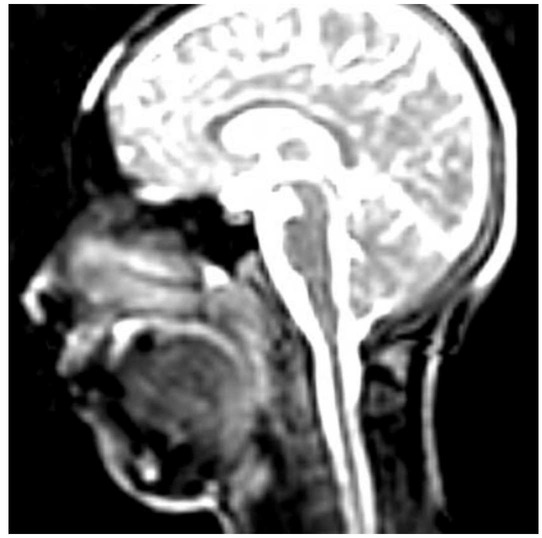

FIGURE 3. Image of the same patient with tongue crib (T2). Note that the tongue's tip is positioned more posteriorly.

- Stage 1: loss of contact of the dorsum of the tongue with soft palate (oral stage).
- Stage 2: passage of the bolus head across the posterior/inferior margin of the ramus of the mandible (pharyngeal stage).
- Stage 3: passage of the bolus head through the opening of the esophagus (esophageal stage).

Figure 2 shows an image of a patient in the OBG without the tongue crib (T1). Figure 3 shows an image of the same patient with a tongue crib (T2). To evaluate tongue motions in the three stages of deglutition, the method defined by Fujiki et al[10] was used because this method enables an investigation of not only the tip but also the dorsal surface of the tongue (Figure 4; Table 1). Only the AP-E/AP-PP measurement was not used in this study because the tongue tip did not contact the palatal mucosa because of the crib. All mea-

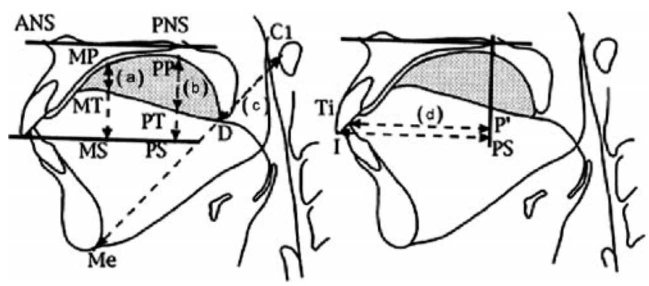

FIGURE 4. Linear measurements by MRI. (a) The anterior portion of the tongue's dorsum, MP-MT/MP-MS. (b) The midportion of the tongue's dorsum, PP-PT/PP-PS. (c) The posterior portion of the tongue's dorsum, C1-D/C1-Me. (d) The tongue's tip, P′-Ti/PS-I. MP-MT, MP-MS, PP-PT, PP-PS, C1-D, C1-Me, and PS-I are straight distances. P′-Ti is the shortest distance from the line crossing at a right angle to the palatal plane through PNS to Ti (from Fujiki et al.[10]).

TABLE 1. Reference Points and Planes Used in the Study (From Fujiki et al[10])

Landmark	Definition
ANS	The most anterior point of the maxilla at level of the palate
PNS	The most posterior point on the bony hard palate
Me	The lowest point on symphyseal outline of the chin
I	The edge point of the maxillary incisor
C1	The front most point of the atlas
MP	The point at which the line crossing at right angle to the palatal plane (through ANS and PNS) through the middle point between ANS and PNS intersects the palatal mucosa
MT	The point at which the line crossing at right angle to the palatal plane through the middle point between ANS and PNS intersects dorsum of the tongue
MS	The point at which the line crossing at a right angle to the palatal plane through middle point between ANS and PNS intersects the standard plane (passing the edge of the maxillary incisor and parallel to the palatal plane)
PP	The point at which the line crossing at a right angle to the palatal plane through PNS intersects palatal mucosa
PT	The point at which the line crossing at a right angle to the palatal plane through PNS intersects the dorsum of the tongue
PS	The point at which the line crossing at right angle to the palatal plane through PNS intersects the standard plane
D	The point at which the line through Me and C1 intersects the dorsum of the tongue

TABLE 2. Descriptive Statistics of all Measurements for Each Stage in OBG(T1), OBG(T2), and CG[a]

		OBG(T1)		OBG(T2)		CG	
		Mean	SD	Mean	SD	Mean	SD
MP-MT/MP-MS	Stage 1	0.58	0.23	0.68	0.21	0.56	0.16
	Stage 2	0.70	0.34	0.54	0.32	0.67	0.19
	Stage 3	0.34	0.21	0.66	0.23	0.39	0.23
PP-PT/PP-PS	Stage 1	0.28	0.04	0.56	0.19	0.28	0.08
	Stage 2	0.23	0.04	0.49	0.24	0.19	0.03
	Stage 3	0.35	0.09	0.44	0.19	0.37	0.25
C1-D/C1-Me	Stage 1	0.22	0.05	0.23	0.07	0.23	0.08
	Stage 2	0.22	0.04	0.24	0.08	0.19	0.03
	Stage 3	0.24	0.07	0.23	0.06	0.24	0.05
P′-Ti/PS-I	Stage 1	1.13	0.14	0.78	0.10	0.98	0.10
	Stage 2	1.21	0.29	0.74	0.09	0.80	0.09
	Stage 3	1.09	0.13	0.75	0.11	0.92	0.18

[a] OBG indicates open-bite group; CG, controls.

TABLE 3. Comparison of the Measurements Between OBG(T1), OBG(T2), and CG for each stage[a]

		OBG(T1)-OBG(T2)			CG-OBG(T1)			CG-OBG(T2)		
	Stage	Z	*P*	Significance	Z	*P*	Significance	Z	*P*	Significance
MP-MT/MP-MS	1	−0.978	.328	NS	−0.141	.918	NS	−1.656	.099	NS
	2	−1.245	.213	NS	−0.986	.349	NS	−1.128	.282	NS
	3	−2.395	.017	*	−0.282	.809	NS	−2.537	.010	*
PP-PT/PP-PS	1	−2.701	.007	**	−0.424	.705	NS	−3.100	.001	**
	2	−2.667	.008	**	−2.378	.016	*	−3.207	.001	**
	3	−1.274	.203	NS	−0.458	.654	NS	−1.127	.282	NS
C1-D/C1-Me	1	−0.663	.507	NS	−0.211	.863	NS	−0.141	.918	NS
	2	−0.889	.374	NS	−1.904	.061	NS	−1.690	.099	NS
	3	−0.089	.929	NS	−0.493	.654	NS	−0.634	.557	NS
P′-Ti/PS-I	1	−2.934	.003	**	−2.219	.024	*	−3.029	.002	**
	2	−2.934	.003	**	−3.521	.000	***	−0.211	.863	NS
	3	−2.934	.003	**	−2.043	.043	*	−2.253	.024	*

[a] OBG indicates open-bite group; CG, controls; and NS, not significant.
* $P < .05$; ** $P < .01$; *** $P < .001$.

surements were performed by one author to avoid interobserver variability. Measurements of all patients were repeated one month later, and the method error was determined by Dahlberg's formula, $ME = \sqrt{d^2/2n}$, where n is the number of subjects and d is the difference between the two measurements of a pair. The method error did not exceed 0.178 mm.

Descriptive statistics were calculated for all the measurements used in this study. Tongue movements of patients in the OBG at T1 and T2 were compared by Wilcoxon signed rank test. T1 of the OBG and T2 of the OBG were compared with CG by Mann-Whitney *U*-test.

RESULTS

In this study, T2-weighted images were obtained, and water-brightening sequences were used. Consequently, liquids composed of unbounded protons appeared hyperintense (white), and soft tissues and teeth composed of bounded protons appeared hypointense (black).

A dynamic MRI investigation of our sample revealed that all patients with or without tongue cribs swallowed the water efficiently without aspiration. The water bolus appeared as a high-intensity image and was clearly observed at all stages of swallowing. The use of a water bolus is essential in identifying the stages of deglutition.

Descriptive statistics of all measurements for each stage for the OBG (T1 and T2) and CG are shown in Table 2. Comparisons of the measurements between the OBG (T1), OBG (T2), and CG for each stage are shown in Table 3. Figure 5 represents the differences between T1 and T2 in the OBG at stages 1, 2, and 3.

Compared with T1, the tongue's tip (P′-Ti/PS-I) was positioned more posteriorly when the crib was in place (T2) at all stages of deglutition ($P < .01$). It was also determined that the tongue's tip was positioned more

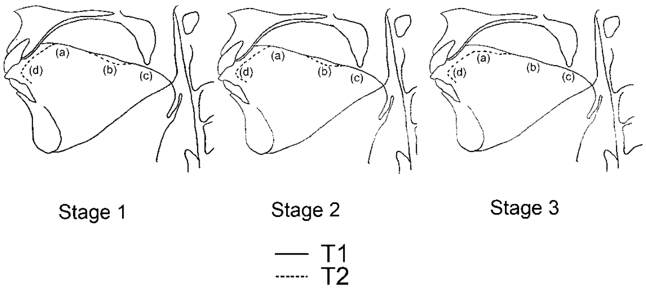

FIGURE 5. Schematic representation of the differences determined in tongue's tip and dorsum between T1 and T2 at stages 1, 2, and 3.

posteriorly in T2 than in CG at stages 1 ($P < .01$) and 3 ($P < .05$). However, no significant differences were found in the tongue's tip position between T2 and CG at stage 2. The tongue's tip was also positioned more posteriorly in CG than in T1 at stages 1 ($P < .05$), 2 ($P < .001$), and 3 ($P < .05$). The anterior portion of the tongue's dorsum (MP-MT/MP-MS) was at a lower position in T2 compared with both T1 ($P < .05$) and CG ($P < .05$) at stage 3. However, no significant differences were found in the anterior portion of the tongue's dorsum between T1 and CG at any of the stages.

The midportion of the tongue's dorsum (PP-PT/PP-PS) was at a lower position at T2 than at T1 and CG at stages 1 and 2 ($P < .01$). The midportion was also at a lower position in T1 than in CG at stage 2 ($P < .05$). No significant differences were determined in the midportion between the groups at any other stages. The posterior portion of the tongue's dorsum (C1-D/C1-Me) showed no significant differences between T1, T2, and CG at any of the stages.

DISCUSSION

Although a controversy exists in the literature whether tongue thrusting is a cause or a result of anterior open bite, most authors agree that patients with anterior open bite place their tongue forward during deglutition.[10–14,18–21] It has been reported that placing the tongue between the separated anterior teeth was a necessary adaptation to form an anterior seal.[7,10–14] Therefore, it is reasonable to expect alterations in tongue movements during deglutition if the tongue's anterior seal function is prevented by an appliance such as a tongue crib.

Several techniques have been used to evaluate tongue movements during deglutition. These techniques have various disadvantages. The use of cineradiography or videofluoroscopy is questionable because of radiation exposure. Ultrasonography is a noninvasive method, but it cannot be used to examine the pharynx or larynx because of skeletal interference.

New developments in MRI techniques have made it possible to provide dynamic images. Cine-MRI, or kinetic MRI, produces a series of anatomic images with periodic motion and has advantages in being noninvasive and providing clear dynamic images of oral, pharyngeal, and deep tissue structures.[15–17] However, it has limited utility as a diagnostic tool for deglutition studies under physiologic conditions because the examination is performed while subjects are in a supine position.[16] It was reported that changing head position changes pharyngeal dimensions and the direction of food flow.[22] However, because all the subjects were in a supine position during examinations, comparison of the selected groups is convenient by this technique.[18] By using ''Real Time Balanced Turbo Field Echo (B-TFE) Cine-MRI,'' the current study was designed to evaluate the initial effects of the tongue crib on swallowing patterns rather than to investigate its treatment effects or its ability to retrain the tongue.

In our study, all patients, with or without tongue cribs, swallowed the water efficiently without aspiration. Therefore, we suggest that the tongue and other structures participating in deglutition immediately adapt to changes in the local environment created by the tongue crib and propel the bolus while protecting the airway patency. Similarly, Cleall[11] suggested that the glossopharyngeal structures at rest and during swallowing adapted well to the changes in sensory stimuli afforded by the insertion of the tongue crib. Without measuring the tongue positions, Cuozzo and Bowman[23] suggested that the tongue tip should be displaced posteriorly and inferiorly to accommodate the tongue crib. Cleall[11] also reported that the tongue crib restricted the forward movement of the tongue and influenced the tongue tip to function more posteriorly during deglutition.

In accordance with these authors, in the current study, the tongue tip was positioned more posteriorly when the crib was in place (T2) compared with T1 at all stages of deglutition. It was also determined that the tongue tip was positioned more posteriorly in T2 than in CG at stages 1 and 3. Because the crib was behind the upper incisors, this was an expected finding. On the other hand, no significant differences were found in the tongue's tip position between T2 and CG at stage 2. This was also another expected finding because the tongue tip moved posteriorly from stage 1 to stage 2 in CG, as reported in the previous study.[18] It was determined that to compensate for the posterior position of the tongue tip (caused by the tongue crib), adaptive changes occurred in the anterior and midportions of the tongue's dorsum, but it was interesting to find no significant adaptive changes in the posterior portion of the tongue's dorsum. The anterior portion of the tongue's dorsum was at a lower position in T2 compared with both T1 and CG at stage 3. The midportion of the tongue's dorsum was at a lower position in T2 than in T1 and CG at stages 1 and 2. At stage 1 (oral stage), tongue movement is the most critical element to move the bolus from the oral cavity to the anterior faucial arches, where the reflexive swallow is initiated.[22,24]

Therefore, we suggest that midportion of the tongue's dorsum was lowered at stage 1 to facilitate bolus propulsion when the tongue crib was in place. Pharyngeal (stage 2) and esophageal (stage 3) stages are involuntary and under reflexive control.[22,24] Airway protection is maintained during the involuntary stages.[23,24] Tongue movements also contribute airway protection.[22,24] Hence, we suggest that at the midportion (at stage 2) and anterior portion, (at stage 3) the tongue's dorsum was lowered to facilitate airway protection when the crib was in place.

These results indicate that, in patients with anterior open bite, if the anterior seal function of the tongue is prevented by a tongue crib, compensatory changes occur in the anterior and midportions of the tongue's dorsum so as to achieve bolus propulsion and airway protection. It is necessary to investigate whether or not these compensatory functions are maintained after the correction of the anterior open bite. The maintenance of these compensatory tongue functions may affect the stability of treatment. Deglutitive tongue movements in open-bite patients with tongue cribs are also different from those of subjects with normal overbites. Further studies with larger samples are also needed to replicate this study.

CONCLUSIONS

- To compensate for the posterior position of the tongue's tip (caused by tongue crib), adaptive changes occurred in the anterior and midportions of the tongue's dorsum.
- However, no significant adaptive changes were determined in the posterior portion of the tongue's dorsum.
- Deglutitive tongue movements in open-bite patients with tongue cribs are also different from those of subjects with normal overbites.

REFERENCES

1. Huang GJ, Justus R, Kennedy DB, Kokich VG. Stability of anterior openbite treated with crib therapy. *Angle Orthod.* 1990;60:17–24.
2. Haryett RD, Hansen FC, Davidson PO, Sandilands ML. Chronic thumb-sucking: the psychologic effects and the relative effectiveness of various methods of treatment. *Am J Orthod.* 1967;53:569–585.
3. Haryett RD, Hansen FC, Davidson PO. Chronic thumb-sucking. A second report on treatment and its psychological effects. *Am J Orthod.* 1970;57:164–178.
4. Frankel R, Frankel C. A functional approach to treatment of skeletal open bite. *Am J Orthod.* 1983;84:54–68.
5. Erverdi N, Kucukkeles N, Arun T, Biren S. Cephalometric evaluation of crib therapy for cases of mixed dentition (open bite). *J Nihon Univ Sch Dent.* 1992;34:131–136.
6. Villa NL, Cisneros GJ. Changes in the dentition secondary to palatal crib therapy in digit-suckers: a preliminary study. *Pediatr Dent.* 1997;19:323–326.
7. Subtelny JD, Sakuda M. Open-bite: diagnosis and treatment. *Am J Orthod.* 1964;50:37–58.
8. Epker BN, Fish L. Surgical-orthodontic correction of open-bite deformity. *Am J Orthod.* 1977;71:278–299.
9. Cooper JS. A comparison of myofunctional therapy and crib appliance effects with a maturational guidance control group. *Am J Orthod.* 1977;72:333–334.
10. Fujiki T, Takano-Yamamoto T, Noguchi H, Yamashiro T, Guan G, Tanimoto K. A cineradiographic study of deglutitive tongue movement and nasopharyngeal closure in patients with anterior open bite. *Angle Orthod.* 2000;70:284–289.
11. Cleall JF. Deglutition: a study of form and function. *Am J Orthod.* 1965;51:566–591.
12. Subtelny JD. Malocclusions, orthodontic corrections and orofacial muscle adaptation. *Angle Orthod.* 1970;3:170–201.
13. Subtelny JD, Subtelny JD. Oral habits—studies in form, function, and therapy. *Angle Orthod.* 1973;43:349–383.
14. Proffit RW. *Contemporary Orthodontics.* 3rd ed. St Louis, Mo: Mosby; 2000:135–137.
15. Foucart JM, Carpentier P, Pajoni D, Rabischong P, Pharaboz C. Kinetic magnetic resonance imaging analysis of swallowing: a new approach to pharyngeal function. *Surg Radiol Anat.* 1998;20:53–55.
16. Anagnostara A, Stoeckli S, Weber OM, Kollias SS. Evaluation of the anatomical and functional properties of deglutition with various kinetic high-speed MRI sequences. *J Magn Reson Imaging.* 2001;14:194–199.
17. Hartl DM, Albiter M, Kolb F, Luboinski B, Sigal R. Morphologic parameters of normal swallowing events using single-shot fast spin echo dynamic MRI. *Dysphagia.* 2003;18:255–262.
18. Akin E, Sayin MO, Karacay S, Bulakbasi N. Real time balanced turbo field echo (B-TFE) Cine-MRI evaluation of tongue movements during deglutition in subjects with anterior open bite. *Am J Orthod Dentofacial Orthop.* In press.
19. Fujiki T, Inoue M, Miyawaki S, Nagasaki T, Tanimoto K, Takano-Yamamoto T. Relationship between maxillofacial morphology and deglutitive tongue movement in patients with anterior open bite. *Am J Orthod Dentofacial Orthop.* 2004;125:160–167.
20. Cheng CF, Peng CL, Chiou HY, Tsai CY. Dentofacial morphology and tongue function during swallowing. *Am J Orthod Dentofacial Orthop.* 2002;122:491–499.
21. Peng CL, Jost-Brinkmann PG, Yoshida N, Miethke RR, Lin CT. Differential diagnosis between infantile and mature swallowing with ultrasonography. *Eur J Orthod.* 2003;25:451–456.
22. Logemann JA. Upper digestive tract anatomy and physiology. In: Bailey BJ, ed. *Head and Neck Surgery-Otolaryngology.* Vol 1. Philadelphia, Pa: Lippincott Company; 1993:485–491.
23. Cuozzo GS, Bowman DC. Hyoid positioning during deglutition following forced positioning of the tongue. *Am J Orthod.* 1975;68:564–570.
24. Logemann JA. Physiology. In: Cummings CW, Fredrickson JM, Harker LA, Krause CJ, Schuller DE, eds. *Otolaryngology—Head and Neck Surgery.* Vol 3. St Louis, Mo: Mosby-Year Book Inc; 1993:1704– 1709.

Erratum

The Angle Orthodontist **2006;76(3):369–374.**

Microscopic Evaluation of Mandibular Symphyseal Distraction Osteogenesis

Ismet Duran; Sıddık Malkoç; Haluk İşeri; Mustafa Tunalı; Murat Tosun; Hasan Küçükkolbaşı

Please make the following changes:

1. The second paragraph of the ''Patient Population'' section should read, with the addition of the italicized text:

   Patients and their parents were informed about the proposed treatment plan involving the surgical phase as well as the conventional alternative option, and their consent was obtained. A detailed study design was explained to patients and their parents, and only volunteers were included in this study. The *surgical expansion of the mandible with distraction osteogenesis was approved by the Ethics Committee of the School of Dentistry, University of Selçuk. The study design was declared to patients orally and only volunteers were included in the study group.*

2. In the first sentence of the first paragraph of the ''Microscopic Evaluation'' section, the biopsy dimension is given as ''*cm*''; it should be ''*mm.*''
3. In the first sentence of the first paragraph of the ''Surgical Technique'' section, ''*intravenous* sedation'' should be changed to ''*intramuscular* sedation.''

The Angle Orthodontist **2006;76(3):400–405.**

Initial Effects of the Tongue Crib on Tongue Movements During Deglutition: A Cine-Magnetic Resonance Imaging Study

M. Özgür Sayın; Erol Akın; Şeniz Karaçay; Nail Bulakbaşı

The May 2006 issue carried this article and incorrectly listed the matrix size. Please note the change below. In the ''Materials and Methods'' section, please replace the incorrect matrix size.

Correct sentence:

The B-TFE images (shortest TR/TE: 2.1/1.09 ms) were obtained in the midsagittal plane by using 50° flip angle, 10-mm slice thickness, autoshim, 350 $\times$ 350 mm field of view, and *96* $\times$ *96* matrix size during swallowing of water.