Original Article

Rapid Canine Distalization through Segmental Alveolar Distraction Osteogenesis

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ABSTRACT

Objective: The objectives of this study were to achieve rapid canine distalization by segmental alveolar distraction method in first premolar extraction cases, to examine the changes in the periodontal tissues surrounding canines, to evaluate the displacement of the canine and first molar teeth, to assess the effects of the procedure on the pulpal vitality of the canines, and to determine the amount of root resorption in retracted canines.

Materials and Methods: The sample of the study consisted of 20 teeth in eight patients (four females and four males, mean age 18.5 years). Pre- and posttreatment dental casts, panoramic radiographs, and standard periapical radiographs were taken from all patients. An electrical vitality test was applied before and after the distraction procedure and during the follow-up period (6 months after the completion of the procedure). In addition, six periodontal indices were used to examine the health of the periodontal tissues.

Results: The distraction procedure was completed in 12 to 28 days (mean 14.65 $\pm$ 3.49). The anchorage loss ranged from 0 to 3 mm (mean 1.2 $\pm$ 0.83). The distal displacement of the canines ranged from 3 to 8 mm (mean 5.35 $\pm$ 1.22). The canines showed a mean of 9.1° distal tipping, whereas there was no statistically significant change in the axial inclinations of first molars after distraction.

Conclusion: We believe that rapid canine distalization by segmental distraction osteogenesis will become a routine protocol and a popular method among orthodontic applications.

KEY WORDS: Distraction osteogenesis; Canine distalization

INTRODUCTION

Distraction osteogenesis is a method of inducing new bone formation by applying mechanical strains on the preexisting bone. The formation of new bone is achieved through stretching of the callus in the osteotomy or corticotomy gap with distraction devices. It is suggested that the formation of the new bone in the osteotomy or corticotomy site with a width of approximately 1 mm per day can be achieved by this method.[1]

This procedure was used as early as 1905 by Codivilla[2] and later popularized by the clinical and research studies of Ilizarov[3–5] and Ilizarov et al.[6] In 1992, distraction osteogenesis was first applied to the human mandible by McCarthy et al,[7] and since then it has been applied to all the bones of the craniofacial skeleton, including the midface and maxilla. Liou and Huang[8,9] first applied this concept to orthodontic tooth movement and performed rapid canine retraction through distraction. Liou et al[10] investigated rapid orthodontic tooth movement into newly distracted bone after mandibular distraction osteogenesis in a canine model and found that rapid orthodontic tooth movement is a form of distraction osteogenesis of the periodontal ligament.

In a more recent study, Sayın et al[11] investigated the clinical validation of the original technique of Liou and Huang and found that this procedure reduced the treatment time. Kişnişci et al[12] and Iseri et al[13] used a different technique for rapid canine distalization by

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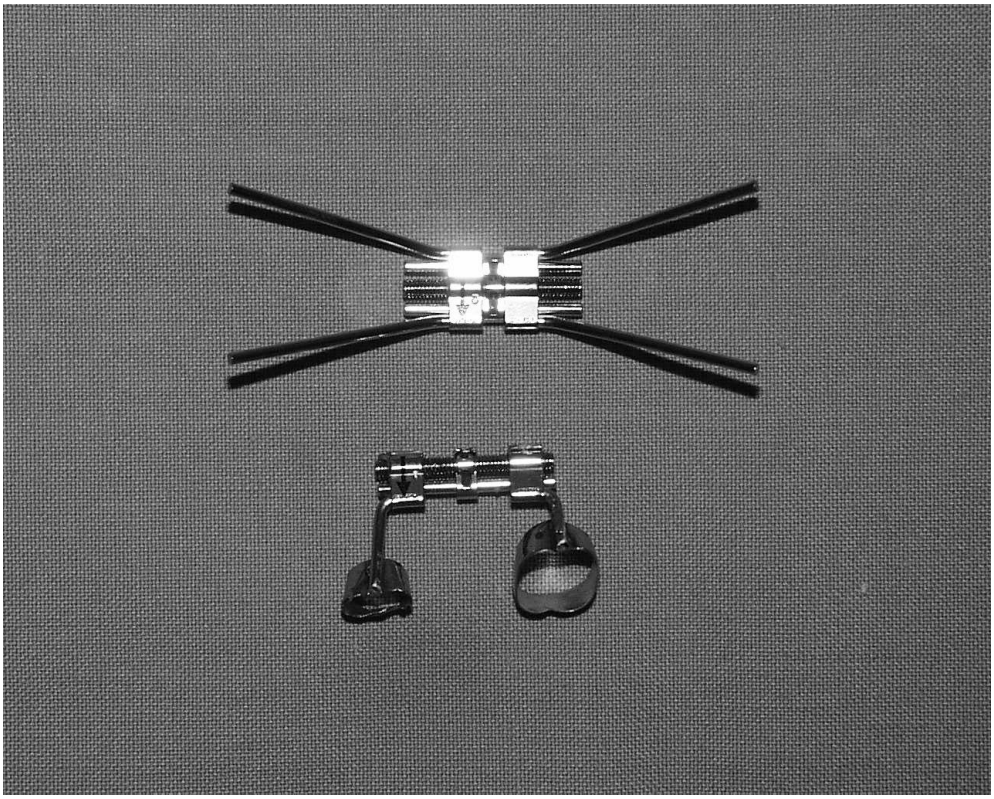

Figure 1. Distraction device used in the study.

performing osteotomies surrounding the canines and achieved rapid movement of the canines in the dentoalveolar segment, in compliance with the principles of distraction osteogenesis.

MATERIALS AND METHODS

The sample of the study consisted of 20 teeth in eight patients (four females and four males, mean age 18.5 years) whose orthodontic treatments were planned to be carried out with the extraction of either all first premolars or the upper or lower first premolars. All patients were selected from those who were referred to the Dentistry Faculty of Selcuk University, Department of Orthodontics. Written informed consent was obtained from all patients who participated in the study, and the approval for the study was granted by the Ethical Committee of Selcuk University.

Distractor Construction

After the selection of bands for canines and first molars, an impression was taken, the bands were transferred into the impression material, and a study cast was obtained. The distraction device consisted of a conventional hyrax screw and canine and first molar bands soldered on the arms of the screw (Figure 1).

Distraction Protocol

The distraction procedure was initiated after 3 days of a latency period after surgery. The distraction device was activated twice a day at a rate of 0.5 mm/d. The distraction time ranged between 12 and 28 days (mean 14.65 $\pm$ 3.49). After the completion of the distraction procedure, a consolidation period started and lasted 1 week, and then the treatment was continued with conventional fixed appliances.

Flap Design

Crevicular incisions were made extending from the distal interdental papilla of the first molar to the distal interdental papilla of the lateral incisor on the corresponding side. In addition, a vertical releasing incision beginning mesial to the distal interdental papilla of the lateral incisor at the vestibule was made. A mucoperiosteal flap was elevated 6 mm above the canine and first premolar to allow for the planned osteotomy.

Osteotomy

The first premolar was extracted after the flap preparation, and the buccal wall of the extraction socket was removed with osteotomes. An osteotomy line was determined between the buccal root apex of the first

Figure 2. Dissection and osteotomies performed at the vestibule.

premolar and canine apex on the panoramic radiograph, taking magnification into consideration. A reference point was formed 5 mm above the canine apex in the alveolar bone with a round bur, and new reference points were constructed mesial and distal to the initial reference point coronally (Figure 2).

To gain minimal space in the osteotomy line, all reference points were connected with a microreciprocal bone saw. The palatal wall of the extraction socket of the first premolar was ground, and the depth of the extraction socket of the first premolar was increased with a round bur to allow for the sliding of the distracted dentoalveolar segment. The osteotomy depth was increased with interdental osteotomes. Afterwards, the osteotomy procedure was continued by advancing through the extraction socket of the first premolar with osteotomes with curved tips and then completed by a final osteotomy extending coronally from the apical region of the canine on the palatal side.

Model Analysis

To evaluate the amount of canine movement and posterior anchorage loss, alginate impressions were taken on all eight patients and poured in hard stone. A total of sixteen study casts were obtained. The posterior anchorage loss and the amount of canine movement in the anteroposterior direction were assessed by determining the location of maxillary raphe by using two predetermined reference points as described by Haas and Cisneros[14] and Hoggan and Sadowsky.[15] The mandibular midline was marked on the study models by transferring the maxillary raphe on these models as described by Alavi et al.[16]

The maxillary (R1) and mandibular (R2) reference planes were formed by plotting tangents to the interdental contact points of the upper and lower central incisors (R1 and R2 were constructed to intersect Rp vertically). The perpendicular distances from the cusp tips of the upper and lower canines and the mesiobuccal cusp tip of the first molars to the reference line were measured (Figure 3).

A transparent grid was used to measure the amount of canine and molar movements in the model analysis.

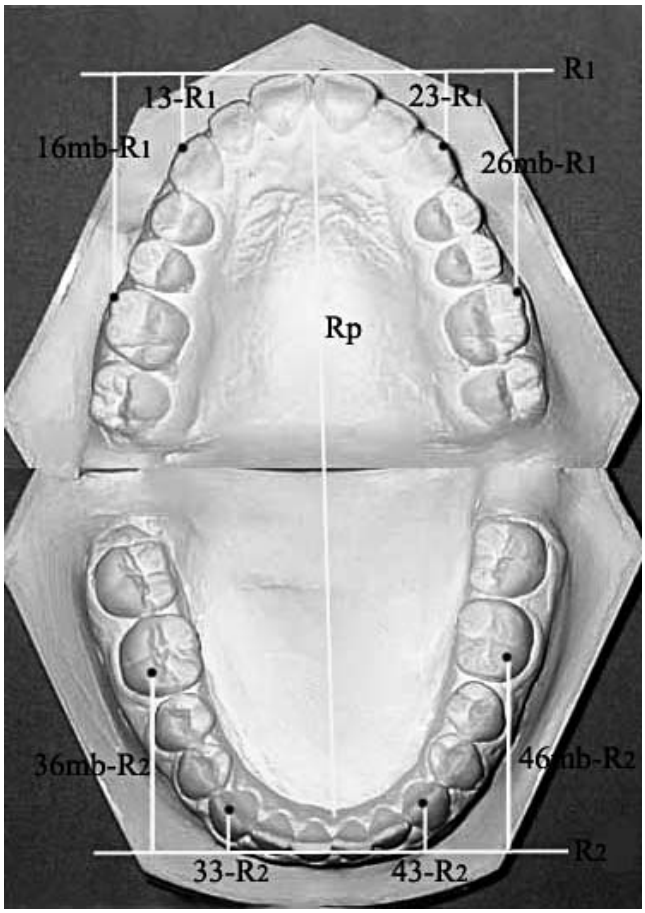

Figure 3. Reference points and lines used for the measurements performed on the study casts. 13-R1 indicates the perpendicular distance from the cusp tip of the upper right canine to line R1; 23-R1, the perpendicular distance from the cusp tip of upper left canine to line R1; 33-R2, the perpendicular distance from the cusp tip of lower right canine to line R2; 43-R2, the perpendicular distance from the cusp tip of lower left canine to line R2; 16mb-R1, the perpendicular distance between the mesiobuccal cusp tip of the upper right first molar and line R1; 26mb-R1, the perpendicular distance between the mesiobuccal cusp tip of the upper left first molar and line R1; 36mb-R2, the perpendicular distance between the mesiobuccal cusp tip of the lower right first molar and line R2; and 46mb-R2, the perpendicular distance between the mesiobuccal cusp tip of the lower left first molar and line R2.

To evaluate the data obtained from the model analysis, descriptive statistical methods were used.

Panoramic Radiographic Analysis

The changes that occurred during the rapid canine distalization were assessed by examining the panoramic radiographs taken before and after the distraction. All panoramic radiographs were taken with the same orthopantomograph (Planmeca-PM 2002 CC Proline, Helsinki, Finland) with each patient's lips in the resting position, the Frankfurt horizontal plane parallel to the floor, and the jaws in centric relation.

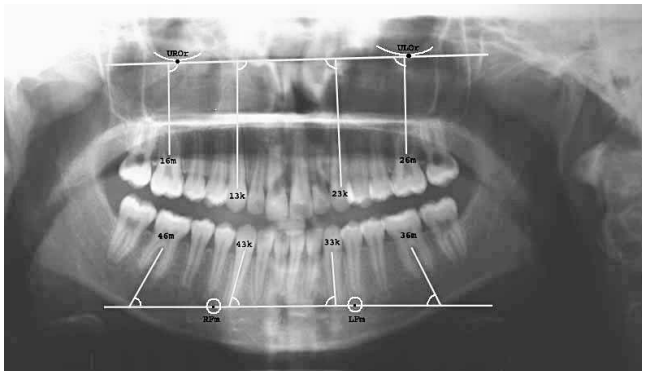

Figure 4. Reference points and lines used in the panoramic radiographic analysis. UROr indicates the most inferior and lateral point of upper right orbit; ULOr, the most inferior and lateral point of upper left orbit; RFm, the midpoint of right mental foramen; LFm, the midpoint of left mental foramen; UROr-ULOr, line connecting UROr to ULOr; RFm-LFm, line connecting RFm to LFm; 13k;23k;33k;43k, the lines representing the mesiodistal angulations of teeth 13, 23, 33, and 43, respectively; and 16m;26m;36m;46m, the lines representing the mesiodistal angulations of teeth 16, 26, 36, and 46, respectively.

TABLE 1. Duration of Distraction

Patient	Tooth	Distraction Time, d
1	13	12
	23	12
2	33	15
	43	13
3	13	28
	23	18
4	13	15
	23	17
	33	14
	43	12
5	13	13
	23	13
6	13	14
	23	14
7	33	14
	43	14
8	13	13
	23	13
	33	15
	43	14
n		20
Minimum		12
Maximum		28
Mean		14.65
Standard deviation		3.49

To analyze the panoramic radiographs, four reference points were determined as described by Ursi et al[17] and two reference planes were formed by using these points (Figure 4). Additional planes were constructed by connecting the coronal and apical points of root canals of the canines.

Apical and coronal points of the palatal root canal in the upper first molars were used in constructing the

TABLE 2. Posterior Anchorage Loss and Distal Displacement of Canines

Patient	Tooth	Movement, mm	Tooth	Anchorage Loss, mm
1	13	7	16	1
	23	5	26	1
2	13	6	16	1
	23	6	26	0
3	33	4	36	1
	43	3	46	1
4	13	7	16	1
	23	6	26	2
	33	4	36	3
	43	5	46	3
5	13	8	16	1
	23	6	26	1
6	13	5	16	1
	23	5	26	1
7	33	4	36	2
	43	4	46	0
8	13	6	16	1
	23	6	26	0
	33	5	36	1
	43	5	46	2
n		20		20
Minimum		3		0
Maximum		8		3
Mean		5.35		1.2
Standard deviation		1.22		0.834

TABLE 3. Angular Changes in Canines and First Molars After Distraction

		Angular Change, °			Angular Change, °	
Patient	Tooth	Before Distraction	After Distraction	Tooth	Before Distraction	After Distraction
1	13	88	104	16	98	90
	23	85	90	26	96	92
2	13	90	100	16	92	89
	23	87	102	26	86	81
3	33	85	74	36	69	60
	43	96	96	46	76	66
4	13	89	96	16	93	93
	23	89	80	26	99	86
	33	51	90	36	73	72
	43	61	83	46	65	66
5	13	82	98	16	78	70
	23	90	95	26	76	72
6	13	70	80	16	95	92
	23	75	90	26	91	86
7	33	91	80	36	89	80
	43	82	82	46	86	76
8	13	78	85	16	83	82
	23	99	90	26	95	83
	33	69	98	36	73	72
	43	55	81	46	78	78

TABLE 4. Gingival Sulcus Depths Measured Before and After the Distraction and 6 mo After the Completion of Distraction

		Gingival Sulcus Depth (Buccal)								
		Mesial, mm			Midbuccal, mm			Distal, mm		
Patient		Before	After	6 mo After	Before	After	6 mo After	Before	After	6 mo After
1	13	2	2	2	1	1	2	2	2	2
	23	2	2	2	1	1	2	2	2	2
2	33	2	2	2	1	2	2	2	2	2
	43	2	2	2	1	1	2	2	2	2
3	13	2	2	3	2	2	2	2	2	3
	23	2	2	2	1	2	2	2	2	3
4	13	4	4	3	2	2	2	3	3	3
	23	2	2	3	2	2	2	3	3	3
	33	3	2	2	1	2	2	2	2	2
	43	2	2	3	1	2	2	2	2	3
5	13	2	2	2	1	1	2	2	2	2
	23	2	2	2	1	1	2	2	2	2
6	13	2	2	2	1	1	2	2	2	2
	23	2	2	2	2	2	3	2	2	3
7	33	2	2	2	1	1	2	2	2	2
	43	2	2	2	1	1	1	2	2	2
8	13	1	1	2	1	1	2	1	2	2
	23	1	2	2	1	1	2	1	1	1
	33	2	2	2	1	1	2	2	2	3
	43	2	2	2	1	1	2	1	1	2
Mean		2.05	2.05	2.2	1.2	1.4	2	1.95	2	2.3
Standard deviation		0.6	0.5	0.41	0.41	0.5	0.3	0.51	0.45	0.57

reference planes, and the bifurcation point of the lower first molars was used for the same purpose. A total of eight angular measurements were made with these points and planes.

The axial inclinations of the canines and molars were measured on the panoramic radiographs taken before and after the distraction, and the data obtained were analyzed by Mann-Whitney *U*-test.

Periodontal Surveys

The evaluation of periodontal tissues surrounding distracted canines was performed on three different occasions (before the distraction, soon after the completion of the distraction, and 6 months after the completion of the procedure) with the indices proposed by Löe and Silness[18] and Silness and Löe.[19] A Friedman test was used for the statistical analysis of the data.

Vitality

An electrical vitality test was performed before and after the distraction procedure and 6 months after the completion of the procedure with an electronic pulp tester (Parkell Inc, Farmingdale, NY). The probe of the pulp tester was placed on the occlusal or incisal one-third of the buccal enamel surface of the tooth, and the current was increased gradually. Each patient was observed for signs of pain, and then the corresponding number on the scale was registered. The number obtained from the suspected tooth was compared with the numbers obtained from the intact teeth. Each suspected tooth was tested twice, and then the arithmetic mean of the test results was calculated and registered in the patient's chart.

Periapical Radiographs

To evaluate the amount of root resorption, periapical radiographs were taken from all canines on three different occasions (before the distraction, soon after the completion of the distraction, and 6 months after the completion of the procedure) with the same periapical x-ray machine (CCX Digital Type 70, Trophy Radiologie, Paris, France). All radiographs were taken by parallel long cone technique. A film holder mounted on the lateral incisor and second premolar was fabricated on the study casts with cold-curing orthodontic acrylic resin. In this way, the periapical radiographs taken before and after the rapid canine distraction were standardized. An effort was made to maintain a minimum distance between the tooth and film and to position the film parallel to the long axis of the tooth. The films were mounted on the film holder, and the film holder was placed in the mouth. Afterwards, the x-ray tube was attached to the film holder with a connector.

The x-ray tube and the patient's face were separat-

TABLE 4. Extended

Gingival Sulcus Depth (Lingual)								
Mesial, mm			Midlingual, mm			Distal, mm		
Before	After	6 mo After	Before	After	6 mo After	Before	After	6 mo After
2	2	2	1	1	1	2	2	2
2	2	2	1	1	2	2	2	2
2	2	2	2	1	1	2	2	2
2	2	2	2	2	1	2	2	2
2	3	3	1	2	3	2	2	3
2	2	2	1	2	2	2	3	2
3	3	3	3	3	3	3	3	5
3	3	5	2	2	2	3	3	2
2	2	2	2	2	2	3	2	4
2	2	2	2	2	2	2	2	2
2	2	2	1	1	1	2	2	2
2	2	2	1	1	1	2	2	2
2	2	2	1	1	2	2	2	2
2	2	2	2	2	2	3	3	3
2	2	2	1	2	2	2	2	3
1	1	2	2	2	2	2	2	2
2	2	2	1	1	2	2	2	2
2	2	2	2	2	2	2	2	2
3	3	3	2	3	3	3	3	3
2	2	2	3	3	3	2	2	2
2.1	2.1	2.3	1.65	1.8	1.95	2.25	2.25	2.45
0.44	0.48	0.73	0.67	0.69	0.68	0.44	0.44	0.82

TABLE 6. Results Obtained From Vitality Tests

		Vitality		
Patient	Tooth	Before Distraction	After Distraction	6 mo After Completion of Distraction
1	13	6	0	0
	23	5	0	0
2	33	4	0	0
	43	4	0	5
3	13	5	0	0
	23	4	0	0
4	13	8	0	0
	23	7	0	4.5
	33	10	0	7.5
	43	5	0	0
5	13	6	0	5.5
	23	6.5	0	0
6	33	7	0	0
	43	8	0	0
7	13	5	0	5
	23	5	0	0
8	13	9	0	6
	23	6	0	0
	33	7	0	6.5
	43	5	0	0

TABLE 5. Results Obtained From Periodontal Indices

	Indices														
	Gingival Index			Plaque Index			Gingival Recession, mm			Gingival Recession Width, mm			Keratinized Gingiva, mm		
Patient	Before	After	6 mo After	Before	After	6 mo After	Before	After	6 mo After	Before	After	6 mo After	Before	After	6 mo After
1	1	1	2	1	1	2	0	0	0	0	0	0	5	5	5
	1	1	2	1	1	2	0	0	0	0	0	0	4	4	4
2	2	2	2	1	1	2	0	0	1	0	0	3	0	0	0
	2	2	2	1	1	2	0	2	0	0	3	0	1	1	1
3	1	2	2	1	2	2	0	0	0	0	0	0	3	3	3
	1	2	2	1	2	2	0	0	0	0	0	0	4	4	4
4	2	2	2	2	2	1	0	0	0	0	0	0	5	5	5
	2	2	2	2	2	1	0	0	0	0	0	0	5	5	5
	2	2	2	2	2	2	0	0	0	0	0	0	3	3	3
	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2
5	1	2	2	1	2	2	0	0	0	0	0	0	3	3	3
	1	1	2	1	2	2	0	0	0	0	0	0	4	4	4
6	2	2	2	2	2	2	0	0	0	0	0	1	1	1	1
	1	2	2	1	2	1	0	0	0	0	0	0	3	3	3
7	2	2	2	1	2	2	0	0	0	0	0	0	2	2	2
	2	2	2	1	2	2	0	0	0	0	2	0	5	5	5
8	1	2	2	2	2	1	0	0	0	0	0	0	5	5	5
	1	2	2	2	2	2	0	0	0	0	0	0	4	4	4
	1	2	2	1	1	2	0	1	0	0	0	0	5	5	5
	1	1	2	1	1	2	0	0	0	0	0	0	3	3	3
Mean							0	0.15	0.05	0	0.25	0.2	3.35	3.35	3.35
Standard deviation							0	0.48	0.22	0	0.78	0.69	1.53	1.53	1.53

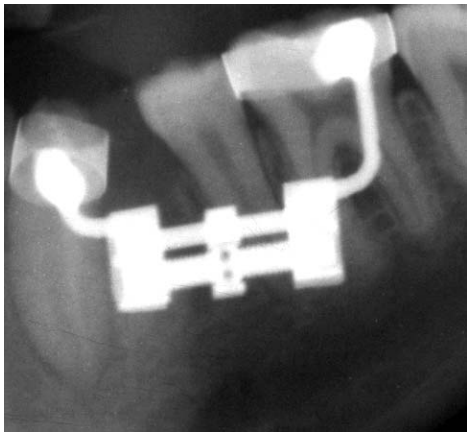

Figure 5. Radiograph taken from distraction site before distraction.

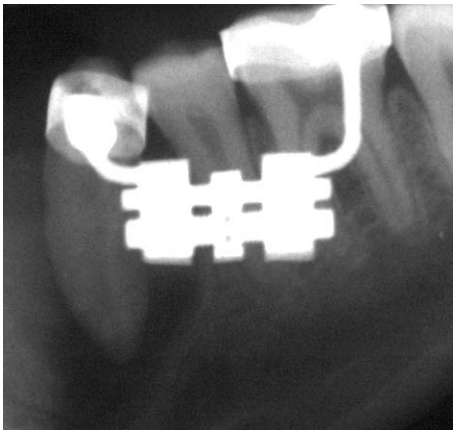

Figure 6. Radiograph taken from distraction site after distraction.

ed by a 2-cm distance, and attention was paid to sending the central x-ray beam perpendicular to both the film and the long axis of the tooth. The exposure time was 0.8 second. Four experienced orthodontists and one endodontist evaluated all the periapical radiographs, and the arithmetic means of the results were calculated. To evaluate the amount of apical and lateral root resorption, the scale described by Liou and Huang[8] was used.

RESULTS

The duration of distraction is shown in Table 1. The distraction procedure was completed in 12 to 28 days (mean 14.65 $\pm$ 3.49). The posterior anchorage loss and distal displacement of canines are shown in Table 2. The anchorage loss ranged from 0 to 3 mm (mean 1.2 $\pm$ 0.834). The distal displacement of the canines ranged from 3 to 8 mm (mean 5.35 $\pm$ 1.22).

The results of the panoramic radiographic analysis (Table 3) indicated that there was a statistically significant difference in the axial inclinations of the distracted canines, whereas there was no statistically significant difference in the axial inclinations of the first molars after the completion of distraction ($P < .05$).

The findings obtained from the periodontal surveys (Table 4) revealed that the gingival sulcus depths measured in the first to sixth months showed a statistically significant difference ($P < .05$). The results obtained from the periodontal indices are shown in Table 5. There was no statistically significant difference among the results of periodontal indices.

It was observed that all the teeth in the study sample were vital before the distraction. However, none of the teeth reacted positively to the vitality test after the distraction procedure. Seven of the 20 teeth were vital according to the results obtained from the electrical vitality test that was performed 6 months after the completion of the distraction procedure, and there was no clinical sign of discoloration or pulpal pain in any tooth (Table 6).

The results of the assessments regarding root resorption are shown in Table 7. It was observed that the amount of root resorption that occurred during distraction was insignificant.

The radiographs taken from the distraction site on three different occasions (before and after distraction and after the completion of fixed appliance therapy) are shown in Figures 5 through 7. The pretreatment and posttreatment photographs of a patient are shown in Figures 8 through 11.

DISCUSSION

During the past decade, rapid canine distalization by distraction osteogenesis has gained significant importance because it reduces the time needed for canine distalization.[8–13]

No extra- or intraoral appliance was utilized for enhancing anchorage throughout the whole study. The posterior anchorage unit was formed merely by the second premolars and first molars. The results of the

Figure 7. Radiograph taken from distraction site after the completion of fixed appliance therapy.

Figure 8. Pretreatment photographs of a patient.

model analysis revealed that first molars moved a mean of 1.2 mm mesially and the canines moved a mean of 5.35 mm distally. The distalization time ranged from 12 to 28 days (mean 14.65 days). The reason for this variation in time needed for distalization might have been the resistance of the osteotomized bone fragments against the desired movement.

The results regarding the anchorage loss were greater than those of previous studies. However, this loss can be considered insignificant clinically. The results concerning the amount of canine displacement were consistent with those of the previous studies, whereas the amount of time required for distalization was less than that mentioned in the previous studies. The reason for this is thought to be the surgical planning and the rigidity of the distraction device.

The results of the panoramic radiographic analysis indicated distal tipping and displacement of the canines and mesial displacement and tipping of the first molars. These results were consistent with those of Liou and Huang[8] but not consistent with those of Sayın et al.[11] Sayın et al[11] reported tipping of the canines, posterior anchorage loss, and mesial tipping of the molars.

Previous investigations regarding rapid canine distraction and distalization by Liou and Huang,[8] Sayın et al,[11] and Kişnişci et al[12] stated that there was no significant change in the periodontal tissues. The findings obtained from the periodontal indices showed that there was a statistically significant increase in gingival sulcus depth, particularly in the midbuccal and distobuccal aspects of the canine. However, this change in the gingival sulcus depth can be considered insignificant clinically, for it is believed that the reason for this increase might have been the impingement of the canine bands into the gingival sulcus. There were no statistically significant differences between the pre- and postprocedure results of the other gingival indices.

Liou and Huang[8] reported that 9 of 26 teeth reacted positively to the electrical vitality test that was per-

TABLE 7. The Evaluation of Root Resorption After the Distraction

		Researcher 1		Researcher 2		Researcher 3		Researcher 4		Researcher 5	
Patient	Tooth	Apical	Lateral	Apical	Lateral	Apical	Lateral	Apical	Lateral	Apical	Lateral
1	13	0	0	0	1	0	0	0	0	0	0
	23	1	0	1	0	0	0	1	0	0	1
2	33	0	0	1	1	1	1	1	1	0	1
	43	0	0	1	0	0	0	0	1	0	1
3	13	0	0	0	0	0	0	0	2	1	0
	23	0	0	0	0	1	0	1	1	1	0
4	13	1	0	1	0	0	1	0	0	1	0
	23	1	0	1	0	1	1	0	1	1	0
	33	1	0	0	1	1	1	1	1	0	2
	43	1	0	0	1	1	1	1	0	0	0
5	13	0	0	0	1	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	1	2
6	13	0	0	1	1	0	0	0	0	0	1
	23	0	0	1	0	0	0	0	0	0	0
7	33	0	0	0	0	0	0	0	0	0	0
	43	1	1	0	0	1	1	1	1	1	1
8	13	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	1	1	0	0
	33	0	0	0	0	1	1	0	0	0	0
	43	1	1	0	0	1	0	1	1	1	1

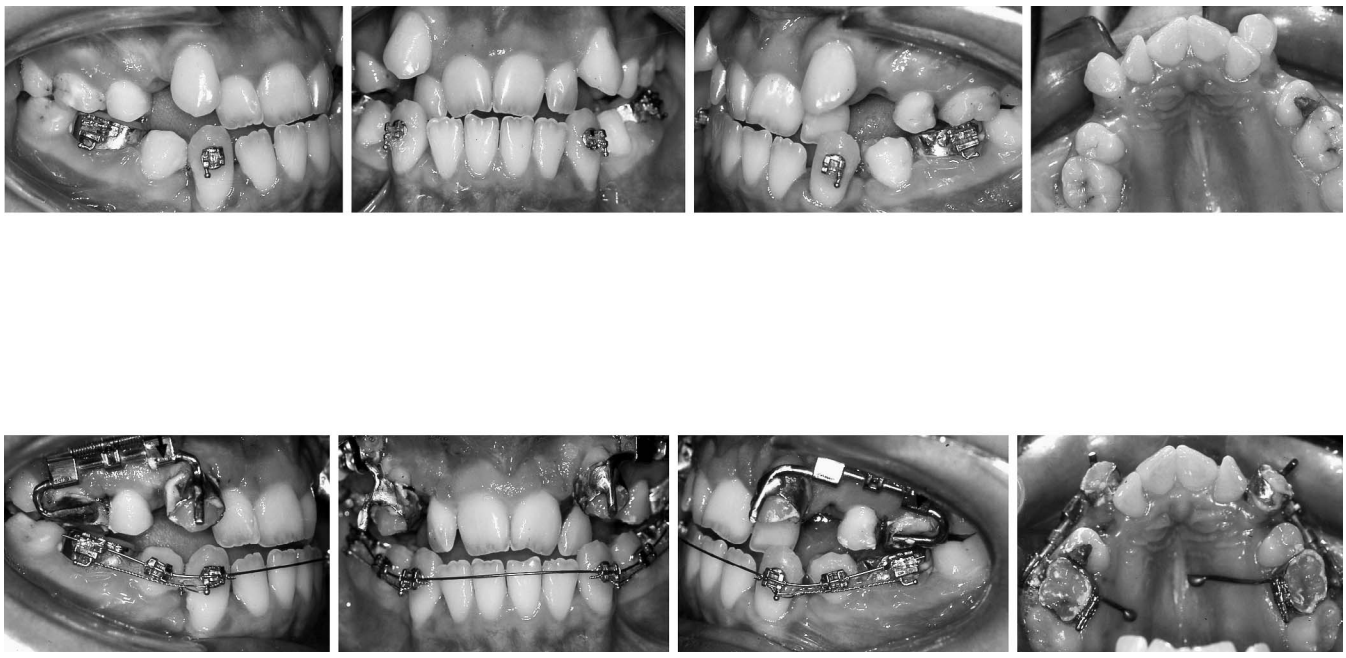

Figure 9. Photographs taken before distraction.

formed after the distraction. Sayın et al[11] did not report pulp vitality in their study.

Kişnişci et al[12] reported that the vitality of the distracted canines was within a normal range. In the present study, 7 of the 20 teeth were found to be vital according to the results obtained from the electrical vitality test that was performed 6 months after completion of the distraction procedure.

Liou and Huang[8] determined a minimal apical and lateral root resorption for both maxillary and mandibular canines and stated that most had no root resorption (score 0) or only lightly blunting of the apex (score 1) after 3 weeks of distraction. They also noted the same findings for lateral surface root resorption, as most of them had no root resorption (score 0) or only a slightly irregular root surface (score 1) after 3 weeks of distraction. The findings of the current study were consistent with those of Liou and Huang.[8]

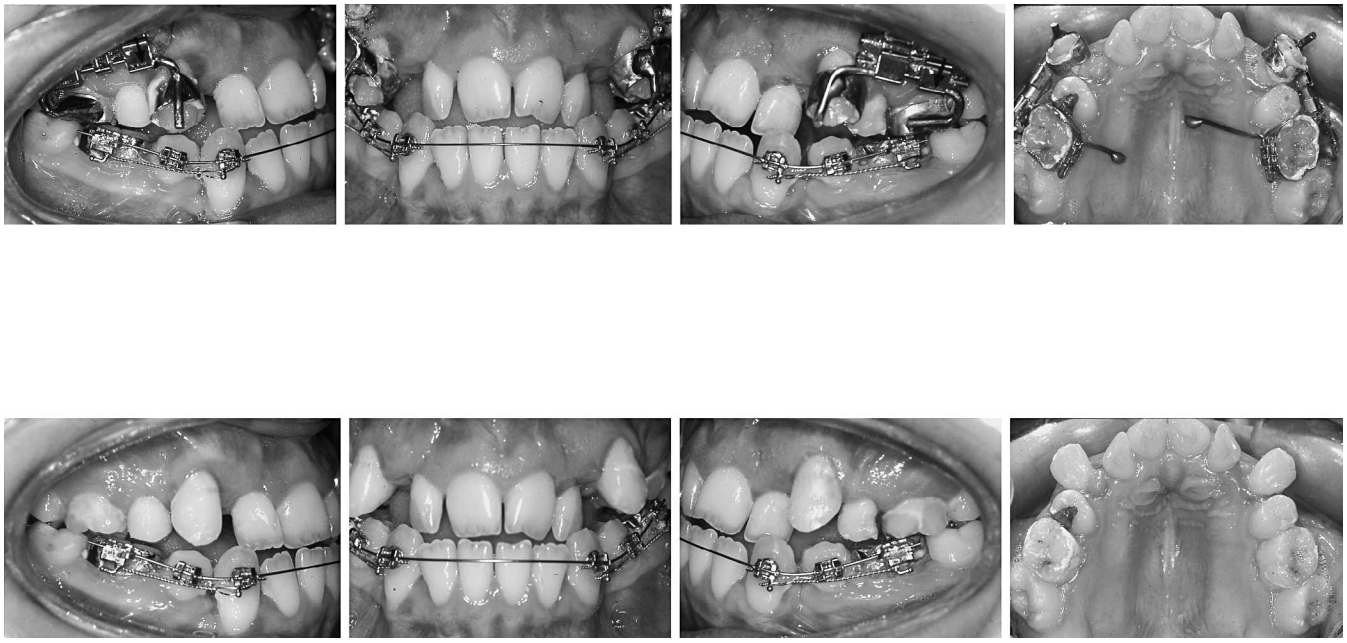

Figure 10. Photographs taken after distraction.

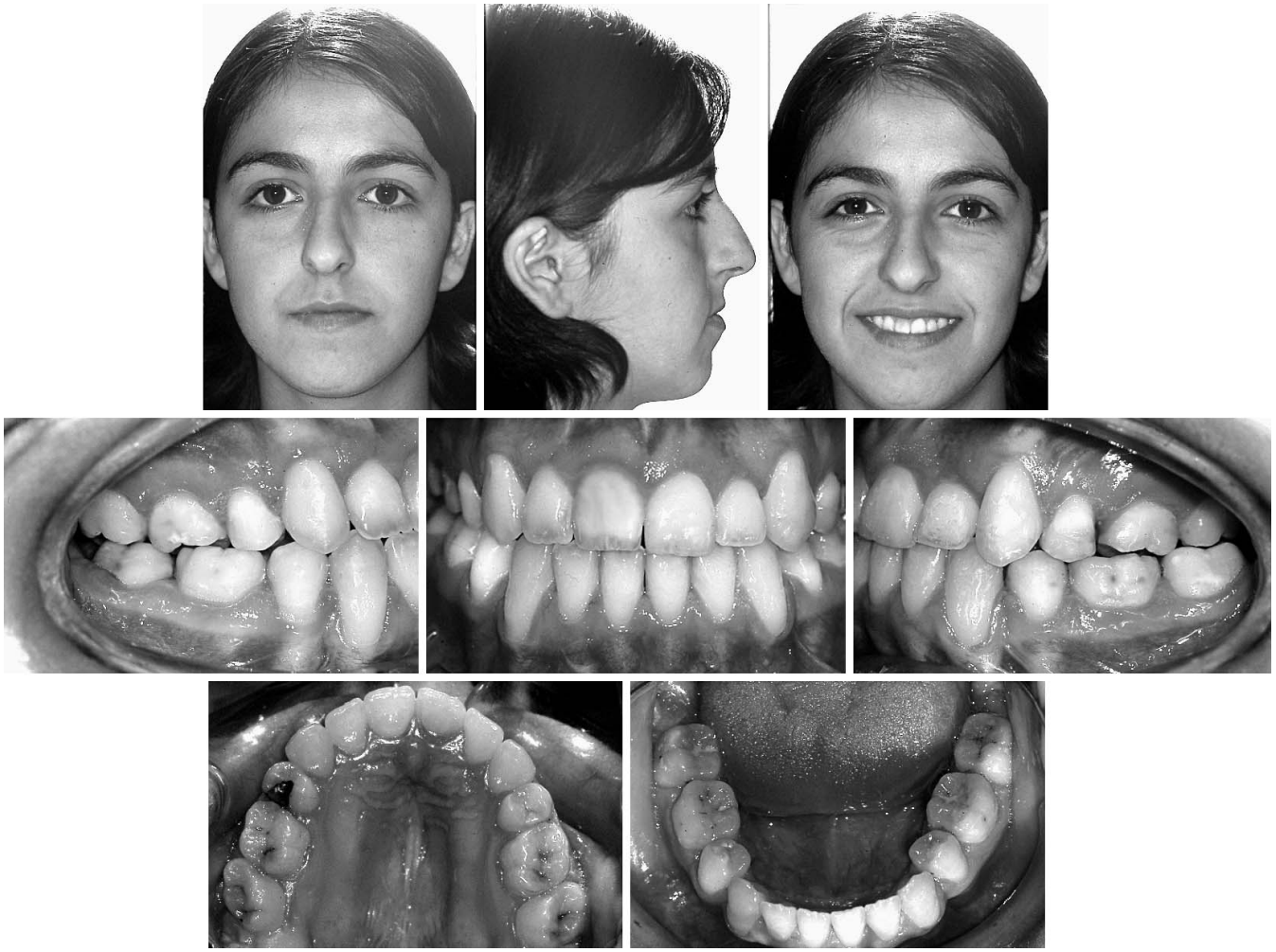

Figure 11. Posttreatment photographs of the same patient.

Sayın et al[11] examined the root resorption, periodontium, pulpal changes, and apposition and deposition of the alveolar bone on the periapical radiographs of canines and first molars taken at weekly intervals and stated that there was no evidence of ankylosis, root resorption, or pathological pulpal changes. Kişnişçi et al[12] found no evidence of complications such as root fracture, root resorption, ankylosis, or soft tissue dehiscence in any patient, and they detected no apical root resorption in any patient at the start or at the end of dentoalveolar distraction.

The results of the radiographic examination revealed no statistically significant difference in the findings regarding root resorption. In addition, the apical and lateral root resorption that occurred during the study was statistically insignificant. This can be explained by the fact that rapid canine distalization was completed in a rather short period of time, which was inadequate for root resorption to occur. However, further investigations concerning the pulpal vitality of the canines distalized through this technique must be performed.

CONCLUSION

a. Rapid canine distalization through segmental alveolar distraction is a clinically efficient method that significantly reduces the overall treatment time without causing any serious discomfort or damage to the patient.

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