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Is the relationship of maxillary molar roots to the floor of the maxillary sinus associated with antral pseudocysts? A retrospective study using cone beam computed tomography

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Objective. The aim of this study was to examine the relationship between molar root positions and antral pseudocysts (APs).
Study Design. The retrospective study included 160 patients. Vertical relationships of the molar roots and the maxillary sinus floor were divided into 4 categories. Root relationships were compared for the presence and dimensions of APs overlying teeth. The root relationships and the presence of APs were also compared for differences in gender, right versus left side, and age groups.
Results. APs were significantly more likely to occur in areas where 1 root extended through the sinus floor from the first molar (P = .004) or second molar (P = .014) and where more than 1 root of the first molar extended through the floor (P = .002). The extension of roots into the sinus was associated with a 9.900 to 25.300 times increase in APs compared with areas with no root contact. The height and width of APs were significantly greater in areas of root penetration into the sinus but gender, side, and age had no effect on the distribution of these root relationships.
Conclusions. Root apices that transmit occlusal force to the Schneiderian membrane might induce the formation of APs and increase the dimensions of the lesions. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:574−582)

The antral pseudocyst (AP) is a pathologic entity that is formed in the maxillary sinus by accumulation of serous exudate, caused by obstruction of ducts of the seromucous glands. The exudate is surrounded by connective tissue that lacks an epithelial lining.[1-3] It is typically self-limiting, is dome-shaped or rounded, and has a relatively radiopaque appearance isodense with soft tissue.[2,4-10] APs are mostly localized on the floor of the sinus (69.7%)[11] and less commonly in the lateral or medial walls or the roof of the sinus.[4,5,12]

The prevalence of APs has been reported to range from 1.4% to 9.6% based on examination of panoramic radiographs,[1,2,4,12,13] but the prevalence can be higher when the 3-dimensional images of cone beam computed tomography (CBCT) or computed tomography (CT) are examined.[14]

Although the exact cause of APs remains controversial, the lesions are often asymptomatic and have been suggested to be associated with adjacent periapical or periodontal disease, allergic reactions, trauma, smoking, changes in air temperature, humidity, and upper respiratory infection.[5,15-17] Moreover, although there are numerous studies reporting the prevalence of APs, few investigations have addressed the relationship between the lesions and anatomic factors or the possible dental origin of APs.[12,14,18,19] Recent research by de Carvalho et al. reported a significant relationship between the presence of APs and greater height of the maxillary sinus ostium.[20] In a 2004 study, Kwak et al. first described the topographic relationship of the root apices of maxillary molars to the maxillary sinus floor by using coronal CT images.[21] This anatomic relationship was believed to provide a crucial pathway in the spread of pulpal infections to the maxillary sinus, as reported in other studies.[22-24] It is unclear, however, to what extent the roots of the posterior teeth extending into the sinus floor may facilitate fluid accumulation in the Schneiderian membrane.[1,5,13] In addition, APs may occur in edentulous as well as dentate patients.[25] Some research has shown that dental infection may cause maxillary sinus abnormalities (antral pseudocyst, sinus polyp, and mucosal thickening), but a possible relationship between the roots of healthy teeth perforating the sinus floor and the development of AP has not yet been elucidated.[17]

In cases of APs associated with the roots of healthy posterior teeth, the question arises as to whether the masticatory forces transmitted to the sinus membrane through these roots can be a triggering factor in the development of the lesions. The present study was designed to investigate the relationship between the roots of the molar teeth and APs by examining with the use of CBCT the following parameters: selection of cases based on radiographic criteria for APs, the relationship of roots to the sinus floor at the site of the lesion, AP size (height,

Statement of Clinical Relevance

The occlusal forces transmitted to the maxillary sinus membrane *via* the roots of the healthy molar teeth might be considered to play a role in the formation and dimensions of antral pseudocysts.

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width, and depth), and the distribution of types of root relationship by gender, location on the right versus left side , and age groups of the patients. The null hypotheses of the study stated that there were no significant differences between the root relationships with the sinus and the frequency of AP formation or the dimensions of the lesions, and no significant differences between the root relationships and patient gender, the side where the lesions occurred, or age.

MATERIALS AND METHODS

All procedures involving human participants in the present study were performed in accordance with the ethical standards of the institutional research committee (Izmir Katip Celebi University Ethics Committee, No. 229) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Study patients

Greater than 1700 CBCT images that had been acquired for radiographic diagnosis and treatment planning at the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Izmir Katip Celebi University between January 2014 and December 2018 were examined for the presence of APs. Images were obtained with a NewTom 5 G CBCT device (QR s.r.l., Verona, Italy). Exposure parameters were set at 110 kVp and 1 to 20 mA, with a 15 × 12 cm field of view, and a voxel size of 0.2 mm^3.

The diagnostic criteria for APs were developed on the basis of published literature.[11] Lesions that appeared as faintly radiopaque, dome-shaped, or sessile soft tissue elevations on the intact floor of the maxillary sinus were included in the study (Figure 1). The inclusion and exclusion criteria are listed in Table I.

Identification of antral pseudocysts

Examination of all CBCT scans was performed by 2 oral and maxillofacial surgeons with 6 and 8 years of experience, respectively, in CBCT and also in maxillofacial pathology, particularly in maxillary sinus diseases. The observers individually evaluated all images and decided which sinuses had APs. In case of disagreement, consensus was reached through discussion. On radiologic examination, cases in which a soft tissue density mass could not be distinguished from dome-shaped radiopacities or lesions that occupied the inferior portion of sinus volume and extended from the medial to the lateral wall were excluded from the study.

APs were detected in 193 of 1700 CBCT images, but 33 images were excluded from the study because of the presence of sinusitis (n = 1); odontogenic infection (n = 6); presence of maxillary posterior implants (n = 3); impacted third molars (n = 7); and inadequate scan quality (n = 16). In total, 160 CBCT images were included, each with 1 lesion interpreted as an AP. The power of 160 CBCT images with APs was determined to be 0.83, the effect size was 0.30, and the level of significance was established at $\alpha = 0.05$.

Classification of the relationship between the roots of the maxillary molars and the maxillary sinus floor at the site of the APs

The topographic relationship of the apices of the maxillary molar roots with the maxillary sinus floor was analyzed on coronal images, and the specific teeth involved at the site of the APs were documented. Selection of CBCT images and the classification of molar root topography were performed individually by the same 2 observers. The vertical relationships of the buccal and palatal roots of the molars and the maxillary sinus floor were divided into 4 categories:

Type 1: Root apices are not in contact with the osseous floor of the maxillary sinus.

Type 2: Root apices are in contact with the osseous floor of the maxillary sinus.

Type 3: One root apex protrudes into the curving cortical border of the sinus and the AP.

Type 4: Two or more apices protrude into the curving cortical border of the sinus and the AP (Figure 2).

After reaching consensus on the relationship between the roots and the inferior portion of the sinus floor, the observers used these data for statistical analysis.

Measurements of the antral pseudocysts

Measurements of the height, width, and depth of the APs were performed in the multiplanar reconstructions

Fig. 1. Multiplanar reconstructions of a cone beam computed tomography (CBCT) scan revealing an antral pseudocyst (AP). **(A)** Coronal reconstruction. **(B)** Axial reconstruction. **(C)** Sagittal reconstruction.

Table I. Inclusion and exclusion criteria for cone beam computed tomography (CBCT) scans depicting antral pseudocysts (APs)

Inclusion criteria	Exclusion criteria
Patients older than 18 years of age	Inadequate scan quality (low resolution, artifacts)
At least 1 molar	Pathologic entities in the maxillary region (e.g., cysts, tumors)
Complete visualization of the maxillary sinus, including the ostiomeatal complex	Maxillofacial trauma
Presence of APs in the maxillary sinus	Impacted maxillary teeth
	Odontogenic or periodontal infection related to the maxillary molars
	Presence of one or more maxillary posterior implants
	Previous maxillary sinus operation (e.g., sinus lift)

Fig. 2. Vertical relationship of the molar roots with the maxillary sinus at the site of the antral pseudocyst (AP). **(A)** Type 1: Root apices are not in contact with the osseous floor of the maxillary sinus. **(B)** Type 2: Root apices are in contact with the osseous floor of the maxillary sinus. **(C)** Type 3: One root apex protrudes into the curving cortical border of the sinus and the AP. **(D)** Type 4: Two or more apices protrude into the curving cortical border of the sinus and the AP.

according to their longest dimensions (Figure 3). All measurements were performed individually by the 2 observers. The measurements used in statistical analysis were determined by averaging the measurements made by the observers.

AP height was defined as the maximum measurement of the lesion in the superoinferior dimension, width as the maximum measurement in the mediolateral dimension, and depth as the maximum measurement in the anteroposterior dimension.

Distribution of types of root relationship by gender, side, and age groups

The numbers of each type of root relationship with the maxillary sinus were stratified by gender, side, and age groups. Patients were divided into 3 age groups: group A (18−35 years); group B (36−50 years); and group C (> 50 years).

Statistical analysis

The following parameters were analyzed: (1) distribution of the root relationships (types 1−4) according to the specific teeth (first molar, second molar, and third molar) at the sites of the APs; (2) multiple comparisons of the root relationship types according to the height, width, and depth of the APs; (3) distribution of the types of root relationship according to gender; (4) distribution of the types of root relationship according to side (right and left maxillary sinuses); and (5)

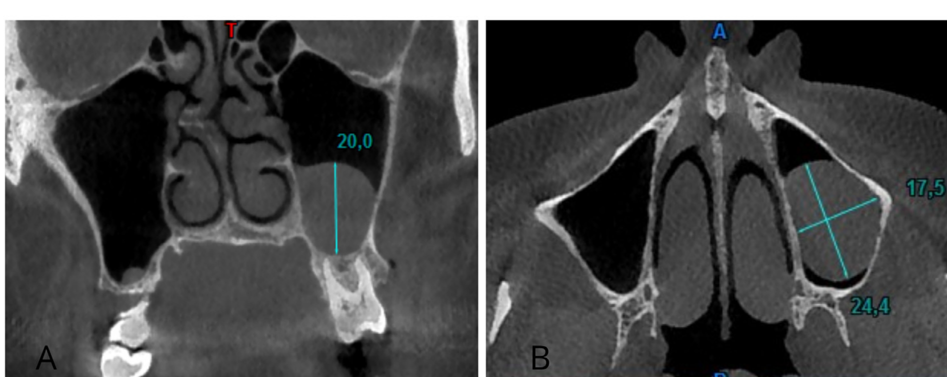

Fig. 3. Measurements of the dimensions of antral pseudocysts (APs). **(A)** Measurement of AP height in the superoinferior dimension. **(B)** Measurement of AP width (in the mediolateral dimension) and depth (in the anteroposterior dimension). All measurements were made in millimeters.

distribution of the types of root relationship according to age groups.

The Shapiro-Wilk test was performed to determine the normality of the continuous data (dimensions of the lesions). The data were not distributed normally. Therefore, continuous data were analyzed by using the Kruskal-Wallis H test. Correlations between nonnormally distributed continuous variables were evaluated by using the Spearman correlation coefficient. Categorical variables (types of root relationship and the specific teeth involved, gender, lesion side, and age groups) were compared by using the χ^2 test. The Bonferroni correction was used in the post hoc analysis of this test. Logistic regression analysis was performed on categorical data to evaluate the significance of differences between the occurrence of APs in sites with types 2, 3, and 4 molar root relationship compared with type 1. This analysis was also done for data on comparisons of types of root relationships with gender, lesion side, and age groups.

Interobserver agreement was analyzed by using the Cohen kappa (κ) test by comparing the observers' original individual interpretations of categorical parameters (before consensus) regarding identification of AP lesions and root relationship type. The observers' calculations of AP size were not compared with the Cohen κ coefficient test because this test is designed for categorical evaluations and not quantitative data. The κ test for interobserver agreement was interpreted as poor agreement for κ values less than 0.40; moderate agreement for 0.40 to 0.59; good agreement for 0.60 to 0.79; and excellent agreement for 0.80 to 1.00.[26] A P value of less than .05 was considered significant.

RESULTS

The distribution of types 1, 2, 3, and 4 root relationships among the specific molars is presented in Table II. Penetration of the molar roots into the antral space (types 3 and 4) was detected in 50 (31.2%); 24 (15%); and 4 (2.5%) of the first, second, and third molars, respectively (see Table II). A significant difference was found among the 4 types of root relationship and the specific molars ($P \leq .001$). Types 3 and 4 were mostly seen in the first molars. The number of third molars was significantly different from the numbers of first and second molars in type 1 ($P < .001$). No significant differences were detected between molars in types 2 and 4. When the relationship between molars in type 3 cases was analyzed, there was a significant difference between the first (29.9%) and third molars (3.7%) (see Table II).

In the logistic regression analysis (Table III), no significant difference in AP number was found between type 1 and type 2 in any of the molars ($P > .05$), but significant differences were discovered between type 1 and type 3 in the first and second molars ($P = .004$ and $P = .014$, respectively). The incidence of the type 3 root relationship in the first and second molars was 25.300 and 15.889 times higher, respectively, than in type 1. A significant difference was found between type 1 and type 4 in the first molars ($P = .002$); the incidence of a type 4 relationship in the first molars was 9.900 times higher compared with that of type 1. Although there was no significant difference between type 1 and type 4 in the second molars ($P = .058$), the incidence of type 4 in the second molars was 4.481 times greater compared with that of type 1. However, no significant difference was discovered between type 1 and types 2, 3, and 4 in the third molars.

Data regarding the comparisons of root relationship types with the sizes of the APs are presented in Table IV. The AP height was statistically greater in the type 2 root relationship than in type 1 ($P = .049$) and in type 3 than in type 2 ($P = .032$). The greatest average AP height occurred when the roots were in the type 3 relationship to the sinus.

Table II. Relationship between the roots of the maxillary molars and the maxillary sinus floor (types 1−4) by specific molar tooth (post hoc test results)

			Molar teeth			*Total*
			First molar	*Second molar*	*Third molar*	
Relationship between root apex and AP	Type 1	Count	10^a	9^a	11^b	30
		n %	13%	16.1%	40.7%	18.8%
	Type 2	Count	17^a	23^a	12^a	52
		n %	22.1%	41.1%	44.4%	32.5%
	Type 3	Count	23^a	$13^{a,b}$	1^b	37
		n %	29.9%	23.2%	3.7%	23.1%
	Type 4	Count	27^a	11^a	3^a	41
		n %	35.1%	19.6%	11.1%	25.6%
Total		Count	77	56	27	160
		n %	100%	100%	100%	100%

Different superscript letters denote significant differences among the molars for each type of root relationship at the 0.05 level (χ^2 test, $P \leq .001$). In the post hoc analysis of χ^2 tests, the Bonferroni correction was used to reduce the alpha error of the test.

Table III. Logistic regression analysis of the relationship between the specific molars and the types of root relationship with the sinus

Relationship between root apex and antral pseudocysts (AP)[a]		*B*	*Standard error*	*Wald*	*Degrees of freedom (df)*	*Significance*	*Exp(B)*	*95% confidence interval for Exp(B)*	
								Lower bound	*Upper bound*
Type 2	Intercept	0.087	0.417	0.043	1	.835			
	[First molars]	0.444	0.577	0.591	1	.442	1.558	0.503	4.830
	[Second molars]	0.851	.573	2.204	1	.138	2.343	0.761	7.208
	[Third molars]	0[b]	–	–	0	–	–	–	–
Type 3	Intercept	−2.398	1.044	5.271	1	0.022	–	–	–
	[First molars]	3.231	1.111	8.456	1	0.004	**25.300**[c]	2.867	223.270
	[Second molar teeth]	2.766	1.131	5.980	1	0.014	**15.889**[d]	1.732	145.788
	[Third molars]	0[b]	–	–	0	–	–	–	–
Type 4	Intercept	−1.299	0.651	3.979	1	0.046	–	–	–
	[First molars]	2.293	0.749	9.364	1	0.002	**9.900**[e]	2.280	42.988
	[Second molars]	1.500	0.791	3.593	1	0.058	**4.481**[f]	0.950	21.137
	[Third molars]	0[b]	–	–	0	–	–	–	–

a. The reference category is type 1.
b. This parameter is set to zero because it is redundant.
c: $P = .004$
d; $P = .014$
e: $P = .002$
f: $P = .058$

Table IV. Multiple comparisons of the types of root relationship according to the height, width, and depth of antral pseudocysts (APs)

Dependent variable	*(I) Relationship between root apex and AP*	*(J) Relationship between root apex and AP*	*Mean difference (I−J)*	*Standard Error*	*P value*	*95% confidence interval*	
						Lower bound	*Upper bound*
Height (mm)	Type 1	Type 2	−3.48400	26.64358	**.049**	−72.6758	65.7078
		Type 3	−38.92035	28.55117	.524	−113.0660	35.2253
		Type 4	.20515	27.92059	1.000	−72.3029	72.7132
	Type 2	Type 1	3.48400	26.64358	**.049**	−65.7078	72.6758
		Type 3	−35.43635	24.99427	**.032**	−100.3449	29.4722
		Type 4	3.68915	24.27146	.999	−59.3423	66.7206
	Type 3	Type 1	38.92035	28.55117	.524	−35.2253	113.0660
		Type 2	35.43635	24.99427	**.032**	−29.4722	100.3449
		Type 4	39.12550	26.35133	.449	−29.3073	107.5583
	Type 4	Type 1	−.20515	27.92059	1.000	−72.7132	72.3029
		Type 2	−3.68915	24.27146	.999	−66.7206	59.3423
		Type 3	−39.12550	26.35133	.449	−107.5583	29.3073
Width (mm)	Type 1	Type 2	−1.68969	2.37932	**.015**	−7.8686	4.4893
		Type 3	4.75503	2.54967	.247	−1.8663	11.3764
		Type 4	2.08507	2.49336	.837	−4.3900	8.5602
	Type 2	Type 1	1.68969	2.37932	**.015**	−4.4893	7.8686
		Type 3	6.44472*	2.23203	**<.001**	0.6483	12.2412
		Type 4	3.77477	2.16748	**.045**	−1.8541	9.4036
	Type 3	Type 1	−4.75503	2.54967	.247	−11.3764	1.8663
		Type 2	−6.44472*	2.23203	**<.001**	−12.2412	−0.6483
		Type 4	−2.66995	2.35322	.669	−8.7811	3.4412
	Type 4	Type 1	−2.08507	2.49336	.837	−8.5602	4.3900
		Type 2	−3.77477	2.16748	**.045**	−9.4036	1.8541
		Type 3	2.66995	2.35322	.669	−3.4412	8.7811
Depth (mm)	Type 1	Type 2	−.44471	1.19690	.982	−3.5530	2.6636
		Type 3	.66623	1.28259	.954	−2.6646	3.9970
		Type 4	−.66469	1.25426	.952	−3.9219	2.5925
	Type 2	Type 1	.44471	1.19690	.982	−2.6636	3.5530
		Type 3	1.11093	1.12280	.756	−1.8049	4.0268
		Type 4	−.21999	1.09033	.997	−3.0515	2.6115
	Type 3	Type 1	−.66623	1.28259	.954	−3.9970	2.6646
		Type 2	−1.11093	1.12280	.756	−4.0268	1.8049
		Type 4	−1.33092	1.18377	.675	−4.4051	1.7433
	Type 4	Type 1	.66469	1.25426	.952	−2.5925	3.9219
		Type 2	.21999	1.09033	.997	−2.6115	3.0515
		Type 3	1.33092	1.18377	.675	−1.7433	4.4051

*The mean difference is significant at the $P = .05$ level.

In terms of AP width, average measurements were significantly greater in the type 2 root relationship than in type 1 ($P = .015$); in type 3 compared with type 2 ($P \leq .001$); and in type 4 than in type 2 ($P = .045$). AP width was significantly greater in type 3 and type 4 than in type 1 and type 2. However, no significant differences were found among the types with regard to AP depth ($P \geq .675$) (see Table IV).

The study included 160 patients (89 males and 71 females; mean age 34.67 years; mean age of males 34.11 years; mean age of females 35.11 years) (Table V). There were no significant differences in the distribution of root relationship types between males and females ($P = .542$).

In total, 79 APs (49.4%) were located in the right maxillary sinus and 81 (50.6%) in the left maxillary sinus. No significant differences among the root relationship types were discovered between APs in the right maxillary sinuses versus those in the left maxillary sinuses ($P = .073$) (Table VI). There was a significant difference between the types of root relationship and the 3 age groups ($P \leq .001$) (Table VII). When group A was compared with groups B and C in type 1 root relationship cases, a statistically significant difference was detected. In addition, a significant difference was found between group B and group C in type 2 cases ($P < .001$). However, there were no statistically significant differences among the age groups in types 3 and 4 (see Table VII).

The Cohen kappa test showed good-to-excellent interobserver agreement ($\kappa = 0.677-0.836$).[26]

Table V. Distribution of the types of root relationship according to gender

		Relationship between root apex and antral pseudocyst (AP)								
		Type 1		*Type 2*		*Type 3*		*Type 4*		*Total*
		Count	*n*	*Count*	*n %*	*Count*	*n %*	*Count*	*n %*	
Gender	Male	16	18%	33	37.1%	18	20.2%	22	24.7%	89
	Female	14	19.7%	19	26.8%	19	26.8%	19	26.8%	71

Pearson's χ^2 test, $P = .542$.

Table VI. Distribution of the types of root relationship in the right and left maxillary sinuses

		Relationship between root apex and antral pseudocyst (AP)								
		Type 1		*Type 2*		*Type 3*		*Type 4*		*Total*
		Count	*n %*	*Count*	*n %*	*Count*	*n %*	*Count*	*n %*	
Maxillary sinus	Right	11	13.9%	23	29.1%	18	22.8%	27	34.2%	79
	Left	19	23.5%	29	35.8%	19	23.5%	14	17.3%	81

Pearson's χ^2 test, $P = .073$.

DISCUSSION

In the present investigation, we hypothesized that the apices of molars associated with APs have an effect on the formation and sizes of the lesions. To our knowledge, no study reported in the literature has investigated the relationship between molars and APs.

Masticatory forces are transmitted to the sinus membrane via the roots of molars in type 2, 3, and 4, thereby triggering the formation and/or enlargement of APs. In the present study, the incidence of type 3 and type 4 root relationships to the sinus in the first molars was 25.300 and 9.900 times higher, respectively, compared with that of type 1 (see Table III). Similarly, the incidence of type 3 and type 4 in the second molars was 15.889 and 4.481 times greater, respectively, compared with that of type 1 (see Table III). However, no significant difference was found between type 1 and types 2, 3, and 4 in the third molars (see Table III). It is assumed that the root apices of the first and second molars transmit occlusal forces to the Schneiderian membrane. In our study, the numbers of type 3 and type 4 root relationships were 50 (65%) of the 77 first molars included in the study and 24 (42.9%) of the 56 second molars (see Table II). Ye et al. reported that the occlusal force on first molars was greater than on second molars within the same quadrant, which seems to support our hypothesis that occlusal forces trigger AP formation.[27] In our study, although the numbers of type 3 and type 4 root relationships were high in the first and second molars compared with the third molars, there was no statistically significant difference between the first and second molars in types 3 and 4 cases in the post hoc test results (see Table II). These findings suggest that the roots of molars associated with the sinus membrane are at least as effective as the occlusal forces and that the occlusal forces on the first and second molars may trigger AP formation, regardless of the difference between the magnitudes of the occlusal forces transmitted to the sinus membrane through these teeth.

Third molars are generally not in centric occlusion and, therefore, are often not functional. They may not transmit forces to the Schneiderian membrane in types 2, 3, and 4 root relationships with APs.[27] In our study, the numbers of type 3 and type 4 relationships in the third molars were 1 (3.7%) and 3 (11.1%), respectively, of the 27 third molars (see Table II). The numbers of types 3 and 4 were lower than type 1 and type 2 (11 and 12, respectively) as listed in Table II. In type 1 cases, the post hoc test results revealed that the proportion of third molars was significantly greater than the first and second molars (see Table II). This difference may have occurred because the third molar roots generally do not protrude into the maxillary sinus (see Table II). These findings confirm our hypothesis by indicating that the absence of occlusal forces in these teeth is accompanied by decrease in AP formation.

In our study, AP height was significantly greater in the type 2 root relationship than in type 1 ($P = .049$) and significantly greater in type 3 than in type 2 ($P = .032$). Similarly, AP width was significantly larger in type 3 and type 4 compared with type 1 and type 2 ($P \leq .045$). These results support the hypothesis that the root apices protruding into APs increase the height and width of the lesions. However, no significant difference was found between the types of root relationship and depth of AP ($P \geq .675$) (see Table IV).

No significant differences were found in the distribution of root relationships among the AP lesions when comparing males and females ($P = .542$) or when comparing the right and left maxillary sinuses ($P = .073$) (see Tables V and VI). Within the limitations of the

Table VII. Distribution of the types of root relationship according to patient age groups

			Patient age groups (years)			*Total*
			A (18−35)	*B (36−50)*	*C (>50)*	
Relationship between root apex and antral pseudocyst (AP)	Type 1	Count	7[a]	14[b]	9[b]	30
		n %	7.4%	42.4%	28.1%	18.8%
	Type 2	Count	29[a,b]	7[b]	16[a]	52
		n %	30.5%	21.2%	50%	32.5%
	Type 3	Count	28[a]	6[a]	3[a]	37
		n %	29.5%	18.2%	9.4%	23.1%
	Type 4	Count	31[a]	6[a]	4[a]	41
		n %	32.6%	18.2%	12.5%	25.6%
Total		Count	95	33	32	160
		n %	100%	100%	100%	100%

Different superscript letters denote significant differences among the age groups for each type of root relationship at the $P = .05$ level (χ^2 test, $P \leq .001$; post hoc test results).

present study, it was determined that patient gender and the side of the AP had no effect on the distribution of root relationship types.

When comparing root relationships with age groups, the number of molars in the type 1 relationship was significantly smaller in the youngest age group (A) than in the older patients (B and C). Among teeth in the type 2 classification, the number of molars in the middle age group (B) was significantly lower than in the oldest group (C). However, when considering the types of root relationships that are significantly more likely to be associated with APs (types 3 and 4), there were no significant differences among the 3 age groups. In the present study, the number of AP-associated type 3 and 4 cases did not increase significantly in older patients compared with younger patients. It appears that the length of time during which occlusal forces are transmitted into the sinus, as indicated by advanced age, does not by itself contribute to the development of APs. A combination of many factors, including age, hypertrophic or atrophic masticatory muscles, and stress, might have an effect on the magnitude and continuity of occlusal forces (see Table VII).

Our study had several limitations. First, although upper respiratory syndromes are considered strong factors in the etiology of AP,[7] patients with clinically suspected sinus and/or upper respiratory conditions (particularly with allergic etiology) could not be included in the study because of the retrospective nature of the research.

CONCLUSIONS

The results of our study indicate that the root apices that transmit occlusal forces to the Schneiderian membrane (types 3 and 4) may cause obstruction of the ducts of the seromucinous glands, thereby inducing the formation of APs and increasing their dimensions.

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