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Prevalence and Distribution of Periapical Lesions Submitted for Histopathologic Analysis by Endodontists

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

by

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Abstract

PREVALENCE AND DISTRIBUTION OF PERIAPICAL LESIONS SUBMITTED FOR HISTOPATHOLOGIC ANALYSIS BY ENDODONTISTS

By Claire Siegel Gerhard, DDS

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The current understanding of the distribution and frequency of periapical pathoses include biopsies submitted by all specialists and general dentists. As a result, they do not accurately reflect the distribution seen by endodontists. This retrospective chart review aims to determine the prevalence of periapical pathoses and associated demographics from biopsies submitted by endodontists over 30 years. All biopsy reports submitted to the Virginia Commonwealth University Oral Pathology Diagnostic Service from January 1, 1983 to December 31, 2012 were reviewed. Only reports submitted by verified endodontists and those with a periapical location were included. The following data was recorded from each report: submission date, referring endodontist, sex, age, race, biopsy location, tooth number, and histologic diagnosis. Results were calculated using chi-square and logistic regression analysis (significance $p<0.05$). Meeting the inclusion criteria were 9,777 biopsy reports for an overall distribution of 24.11% radicular cysts, 73.54% periapical granulomas, 1.66% scars, and 0.70% other pathoses. Findings include a

significant association between sex, location, and diagnosis. An association with race, age, or location (left/right) was not seen. Significantly more radicular cysts were seen in males and in the anterior maxilla. Conversely, significantly more periapical granulomas were seen in females and in the posterior quadrants. Significantly more other diagnoses were found in the anterior mandible and more scars in the anterior maxilla. Overall, approximately ¾ of biopsies submitted for evaluation by endodontists are diagnosed as periapical granulomas and ¼ as radicular cysts. Other pathoses and scars make up less than 3% of diagnoses.

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Introduction

The current standard of care for all dentists and specialists is to submit all non-healing periapical lesions obtained during surgery for biopsy. The biopsies are processed and examined by pathologists to determine the histologic diagnosis so that further treatment recommendations, if any, can be made. Past research has shown that the overwhelming majority of these lesions are benign or of inflammatory origin. These studies claim the incidence of cysts ranges from 6-55% and granulomas ranged from 45-94% (1-13).

In1954, Priebe, Lazansky and Wuehrmann performed a histologic analysis of 101 teeth with radiographic evidence of periapical pathosis to determine the degree of correlation between radiographic and microscopic diagnosis. They found that 55 cases (54.5%) had evidence of epithelium in the lumen, consistent with a diagnosis of cyst. Conversely, 45.4% of cases lacked epithelium and were diagnosed as granuloma or abscess. They also concluded that the chance of accurately interpreting cystic formation based on the radiographic appearance alone is poor (13%) (1).

Sommer also attempted to correlate radiographic appearance of non-healing periapical radiolucencies to histologic diagnosis in 1954. While he was unsuccessful in identifying any correlation, he found that 83% of the 170 biopsies were granulomas, 6.4% were cysts and 9.6% were other diagnoses (3).

Two years later in 1956, Bauman and Rossman analyzed 121 teeth with periapical radiolucencies by histologic sectioning. They found that only 26% of biopsies were cystic lesions and further confirmed that diagnostic certainty can only be attained through microscopic analysis (4).

Then in 1958, Wais defined several preoperative factors that increased the likelihood of predicting the histologic diagnosis. He predicted that the lesion was of cystic origin if the radiographic appearance was larger than 8mm, consisted of a pathologic area with a radiolucent central zone, and appeared to be an area of rarefaction limited by a continuous radiopaque border. Fifty non-vital anterior teeth fitting the above description were selected from 426 of his cases and were submitted for biopsy following apical surgery. He found that 64% of lesions were granulomas, 26% were cysts and 10% were other diagnoses. He then submitted a second set of 50 anterior teeth with periapical radiolucencies for histologic analysis following apical surgery. These teeth were selected at random and did not meet the specified criteria for cysts. The incidence of periapical granulomas in this group was 84%, followed by 14% cysts, and 2% other diagnoses. He concluded that although the incidence of cysts increased from 14% to 26% when controlling for preoperative risk factors, the diagnosis could not be accurately predicted from the radiographic appearance alone (2).

Several years later in 1964, Patterson found the distribution of diagnoses to be 84% granuloma, 14% cyst, and 2% other diagnoses in a retrospective chart review of 501 biopsy reports (8).

In 1966, Bhaskar attempted to find a more accurate distribution of diagnoses by increasing his sample size to 2308 teeth. He found 48% of biopsies to be dental granulomas, 42% radicular cysts, 3.7% residual cysts, 2.5% apical scars, 1.2% cementomas, 1.1% abscesses, 1.0% foreign body reactions, 0.4% cholesteatomas, and 0.1% giant cell lesions. He also found that granulomas were found three times more often in the maxilla and cysts were ten times more commonly located in the maxilla than mandible. Although no sex predilection was seen with granulomas, cysts were found two times more often in males than females (5).

In 1976, Block performed a histopathologic, histobacteriologic, and radiographic study of 230 periapical endodontic surgical specimens. He identified 169 cases as granulomas (94%) and 14 as cysts (6%). Sixty-one of the cases were defined as granulomas with epithelium (20%) (10).

In 1990, Spatafore obtained biopsy reports of 1659 specimens and determined 52% of the lesions were granulomas, 42% cysts, 2% periapical scars, and 4% other disorders. Other disorders included actinomycosis, cementoma, traumatic bone cyst, nasopalatine duct cyst, central ossifying fibroma, central giant cell lesion (CGCL), keratocystic odontogenic tumor (KOT), lymphoma, compound odontoma, condensing osteitis, chronic osteomyelitis and foreign body reaction. The most common location for lesions was the maxillary anterior, followed by maxillary posterior, mandibular posterior, and finally the mandibular anterior jaw. This was true for all age ranges except 60 to 69 where lesions were most commonly located in the maxillary posterior. More granulomas were detected in all areas except in the mandibular posterior where cysts were more common (12).

Other research indicates that the incidence of other disorders may be much higher. In a study by Koivisto, the frequency of KOT in 9,723 non-healing radiolucent jaw lesions was 8.8%, CGCL was 1.3%, ameloblastoma was 1.2%, and metastatic lesions were <1%. He found 40% of lesions were granulomas and 33% were cysts. The majority of granulomas and cysts were found in the anterior maxilla (>36% in each category). KOTs, CGCLs, ameloblastomas, and metastatic lesions were located predominately in the posterior mandible. The occurrence of apical cysts, ameloblastomas, KOTs, and metastatic lesions were seen slightly more in men, at 56%, 54%, 55%, and 68%. The occurrence of CGCLs was seen slightly more in women at 56%, whereas apical granulomas were equally present in men and women (13).

Recently, studies have attempted to determine a differential diagnosis of cysts versus granulomas by cone-beam computed tomography (CBCT). Guo and Simon evaluated the reliability and accuracy of CBCT imaging against the histopathologic diagnosis for the differential diagnosis of periapical cysts from granulomas. All 36 periapical lesions were first imaged using CBCT scans before apicoectomy surgeries were conducted and biopsies were sent for histopathological examination. The CBCT scan were evaluated for the presence of six radiologic characteristics of a cyst (i.e., location, periphery, shape, internal structure, effects on surrounding structure, and perforation of the cortical plate). They found that CBCT images can provide a 76% accurate diagnosis if the lesion had greater or equal to four radiologic characteristics of a cyst (14). However, these results should be interpreted with caution given the small sample size and high rates of false negatives.

Similar CBCT studies found conflicting results. According to Rosenberg, only a weak agreement (51-65%) could be found between CBCT and histologic diagnosis after analysis of 46 cases (15). Overall, further research is needed to determine the accuracy of differential diagnosis of cysts versus granulomas by CBCT. At this point in time only histologic evaluation is suitable for determining an accurate diagnosis.

Most of the current understanding of the distribution or frequency of periapical pathoses comes from research pooled from biopsy reports submitted to a single or multiple pathology labs over a specific period of time. These reports include biopsies submitted by all specialties and general dentists and do not accurately reflect the distribution seen by a single specialty. As a result, biopsy composition statistics may be inaccurate for a single specialty. To date, research has not been collected from biopsy reports submitted solely by endodontists. Further research is

needed to provide an accurate understanding of the distribution of periapical pathoses associated with endodontically treated teeth.

Materials and Methods

The purpose of this retrospective study was to review biopsy reports submitted by endodontic specialists to the Oral Pathology Diagnostic Service at Virginia Commonwealth University over a 30-year period. The specimens were received fixed in 10% neutral buffered formalin and processed routinely for paraffin embedding and sectioning at 5um. All sections were stained with hematoxylin and eosin. The specimens were received with a pathology consultation request for clinicians to record the following pertinent information: 1) surgeon's name, address, and telephone number; 2) patient's address, sex, race, and age; 3) radiographic findings; 4) location, duration and appearance of lesion; 5) pertinent medical or dental history; and 6) differential diagnosis based on clinical appearance.

This study was approved by the Virginia Commonwealth University Institutional Review Board (VCU IRB: HM15360). All biopsy reports included in this study were submitted to the Oral Pathology Diagnostic service from January 1, 1983 to December 31, 2012. Records from 2011 to 2012 were available through the electronic PathLogix Database and those from 1983 through 2010 were available in another electronic database. Reports were examined for location of lesion and referring specialty. Only reports submitted by licensed endodontists in the United States and those with a periapical location were included in this study. All specialist credentials were verified through the American Association of Endodontists. Table 8 in the Appendix, lists all of the 145 endodontists identified for inclusion in the study. Biopsies submitted by non-endodontists and lesions not associated with a tooth were excluded. All included biopsy locations and their descriptions are listed in Table 9 in the Appendix. Table 12 in the Appendix lists all of the biopsy locations that were included and excluded in this study. Any implausible diagnoses

were also excluded from the sample. Table 11 in the Appendix lists all of the diagnoses excluded from this study and Table 13 lists the included diagnoses.

There were 9,777 biopsy reports that fulfilled the inclusion criteria. The following data was recorded from each report: biopsy date, birth date of the patient, sex of the patient, race of the patient, referring endodontist, location of biopsy specimen, gross description of the biopsy specimen, and histologic diagnosis. Age was calculated from the biopsy date and the patient's birth date. In some instances, the birth date was apparently unknown. There were 690 cases where age calculated to zero. In cases where the birthdate and biopsy date were the same, or where the calculated age was less than 10 and the birthdate was "01/01" in the same year as the biopsy date, age was recorded as missing.

The biopsy location was further identified as to tooth number, tooth type, arch, left/right, and anterior/posterior based on the location code or gross description. Table 10 in the Appendix shows tooth number and associated location fields. In those cases where the location was identified as "0=Not supplied" or "1001=Listed below" the tooth number may have been identified in the gross description field. In instances were two teeth were identified in the gross description field (i.e., "#24 and #25") the numerically lower tooth was used. In those cases where a range of 3 or more teeth were identified in the gross description field (i.e., "#2-4") the middle tooth was used for identification.

The data was described using sample size and percentages. Association between locations and diagnoses was tested using chi-square or logistic regression analysis. All analyses were done using SAS software (JMP pro, version 10, SAS Institute, Inc., Cary NC). Significance was declared at alpha<0.05.

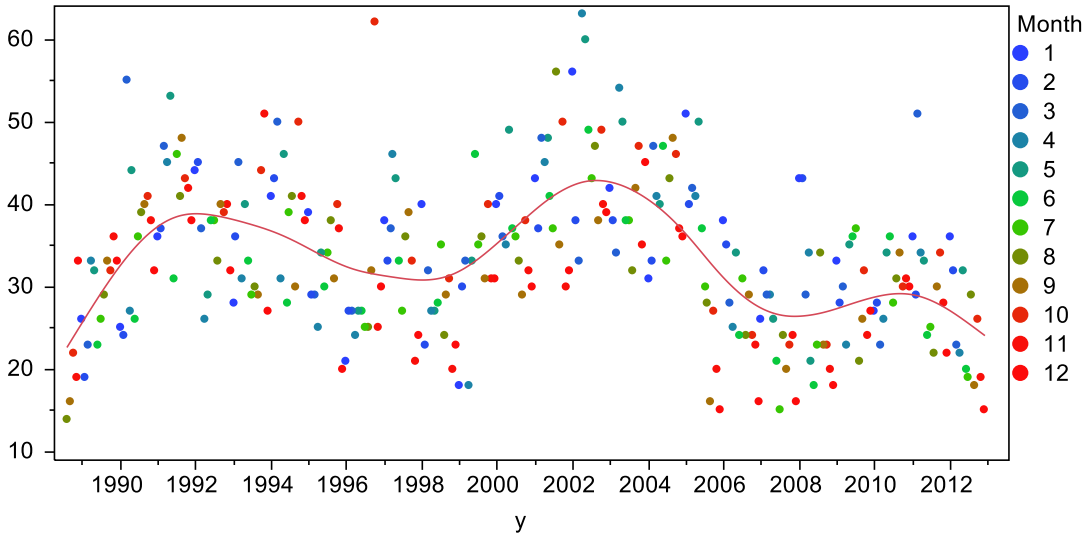
Results

The presentation of results is organized into three sections. In the first section, a description of the sample is presented. Associations between characteristics and the histological diagnoses are presented using bivariate analyses. In the final section, multiple logistic regressions were used to combine all of the significant findings into one summary result.

Description of the sample

A total of 9,777 biopsy samples met the inclusion and exclusion criteria. The number of samples per month from August 1988 to December 2012 is shown in Figure 1.

Figure 1. Number of Biopsy Samples per Month



The sample demographics are shown in Table 1. Fifty-four percent of samples were from females and 46% were from males (Table 1). Eighty-seven percent of the samples came from individuals identified as Caucasian. The mean age was 48.5 years (SD = 15.6years) and ages ranged from less than one year to 96 years.

Table 1. Demographic Characteristics

Characteristic	N	Percent
Sex		
F	5305	54.3
M	4472	45.7
Race/ethnicity		
Asian	146	1.7
Black	505	5.9
Caucasian	7629	88.6
Hispanic	273	3.2
American Indian	2	0.0
Other	58	0.7
(Unknown)	1170	

The location of each of the biopsy samples by each of the location characteristics is shown in Table 2. The maxillary to mandibular ratio was approximately 3 to 1. There were an equal number of samples from the left and right side. Thirty-seven percent of the samples were from incisors, 6% from canines, 23% from premolars, and 34% from molars.

Table 2. Biopsy location by Arch, Side, Tooth Type, and Anterior/Posterior and Tooth Number

Location	N	Percent
Arch		
Mandibular	2191	24.2
Maxillary	6868	75.8
(Unknown)	724	
Side		
Left	4483	50.0
Right	4486	50.0
(Unknown)	814	
Tooth Type		
Incisor	3285	37.0
Canine	500	5.6
Premolar	2043	23.0
Molar	3054	34.4
(Unknown)	901	
Anterior/Posterior		
Anterior	3868	43.1
Posterior	5097	56.9
(Unknown)	818	
Tooth number		
1	3	0.0

Location	N	Percent
2	101	1.1
3	809	9.1
4	506	5.7
5	350	3.9
6	202	2.3
7	742	8.4
8	688	7.7
9	770	8.7
10	629	7.1
11	181	2.0
12	333	3.7
13	497	5.6
14	837	9.4
15	98	1.1
16	3	0.0
17	6	0.1
18	72	0.8
19	528	5.9
20	80	0.9
21	85	1.0
22	62	0.7
23	101	1.1
24	153	1.7
25	132	1.5
26	70	0.8
27	55	0.6
28	102	1.1
29	90	1.0
30	530	6.0
31	64	0.7
32	3	0.0
(Unknown)	901	

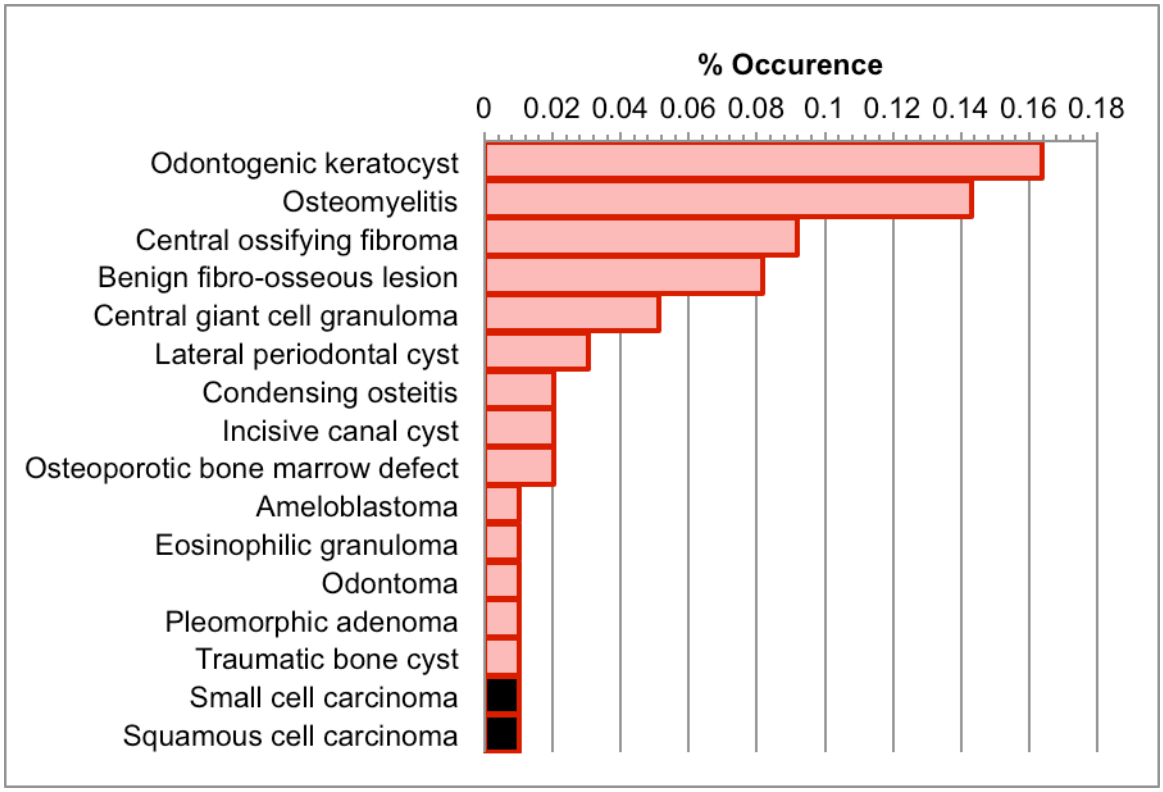
Table 3 shows the prevalence of diagnoses in the sample. Diagnosed as periapical granulomas were 7,190 of the samples (73.5%), 2,357 as radicular cyst (24.1%), 162 as scar (1.7%), and 68 as other diagnosis (0.7%). The composition of rare diagnoses encompassing the "Other" diagnosis group is shown in Figure 2. Other diagnoses included odontogenic keratocyst (OKC), osteomyelitis, benign fibro-osseous lesion, central ossifying fibroma, central giant cell granuloma (CGCG), lateral periodontal cyst, condensing osteitis, incisive canal cyst,

osteoporotic bone marrow defect, ameloblastoma, eosiniphillic granuloma, odontoma, pleomorphic adenoma, traumatic bone cyst, small cell carcinoma, and squamous cell carcinoma (Figure 2). OKCs were seen more frequently than the other diagnoses in this group (0.16% of the sample). Two of the 68 other diagnoses were determined to be malignancies (small cell carcinoma and squamous cell carcinoma) (Table 3). The prevalence of malignancies in the total sample was 0.02%. Conversely, 99.98% of samples were benign.

Table 3. Diagnoses

Diagnosis	N	Percent
Periapical Granuloma	7190	73.540
Radicular Cyst	2357	24.108
Scar	162	1.657
Other (malignancy)	68 (2)	0.696

Figure 2. Prevalence of "Other" Diagnoses in the Entire Sample



Preliminary Analyses

Table 4 describes the relationship between diagnosis and demographic characteristics. Each demographic was analyzed to determine whether there was a potential association within the four categories of histological diagnosis. There was a statistically significant association between sex and diagnosis (chi-square = 24.4, p <0.0001, Table 4). There was no association with race/ethnicity (chi-square = 14.0, df = 15, p = 0.5247, Figure 4 and Figure 4), and no association with age (chi-square = 25.7, df =243, p = 0.3674,Table 4 and Figure 5).

Table 4. Relationships between Demographic Characteristics and Diagnosis

	Percentage					
Demographics	Cyst	Periapical Granuloma	Other	Scar	Total	*p* value
Sex						
F	22.15	75.36	0.75	1.73	5304	<0.0001
M	26.41	71.39	0.63	1.57	4471	
Race						
Asian	27.40	70.55	0.68	1.37	146	0.5247
Black	21.19	75.45	1.58	1.78	505	
Caucasian	24.07	73.74	0.59	1.60	7629	
Hispanic	24.18	73.63	0.37	1.83	273	
American Indian	50.00	50.00	0.00	0.00	2	
Age Decade						
10	23.41	75.00	0.79	0.79	252	0.3674
20	26.58	71.45	0.39	1.58	760	
30	25.36	72.48	0.60	1.56	1668	
40	24.28	73.18	0.69	1.85	2166	
50	23.32	73.65	1.01	2.02	1985	
60	22.12	75.78	0.58	1.52	1379	
70	22.17	76.06	1.03	0.73	681	
80	27.12	71.75	0.56	0.56	177	
90	26.09	73.91	0.00	0.00	23	

The mosaic plot seen in Figure 3 shows the distribution of the four diagnoses separately for each sex on the left, and overall on the right. The right hand figure is thus an illustration of the null hypothesis. The proportion of radicular cysts are seen in green, periapical granulomas are seen in yellow, the blue portion shows the small proportion of other diagnoses, and the red

portion shows the proportion of scars. The proportion of periapical granulomas was larger in females than in males (75% vs. 71%, Figure 3). Correspondingly, the proportion of radicular cyst diagnoses is larger in males than in females (26% vs. 22%, Figure 3). There was no apparent difference between the proportion of scars or other diagnoses and sex.

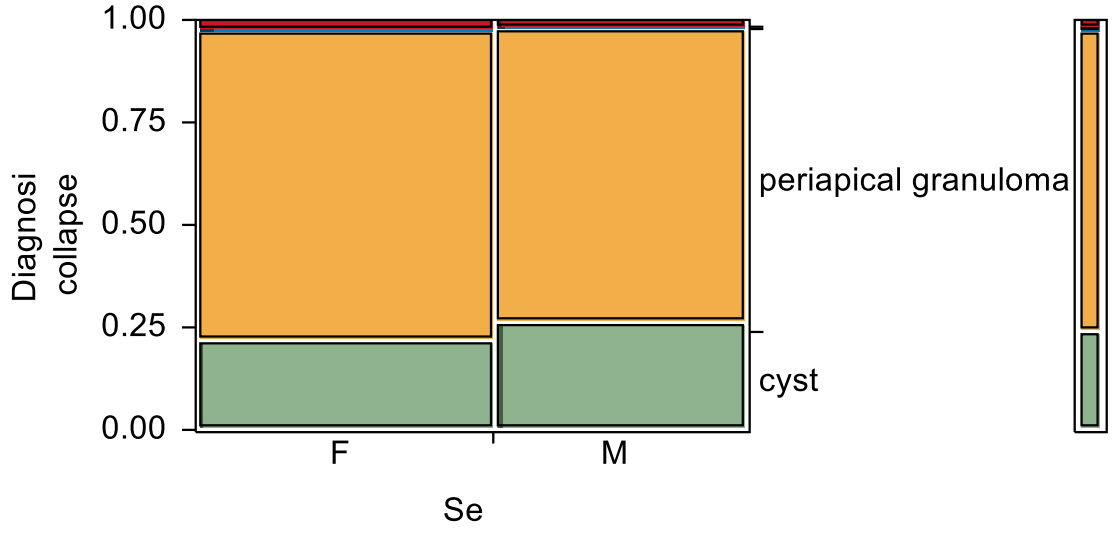


Figure 3. Bivariate Relationship between Sex and Diagnosis

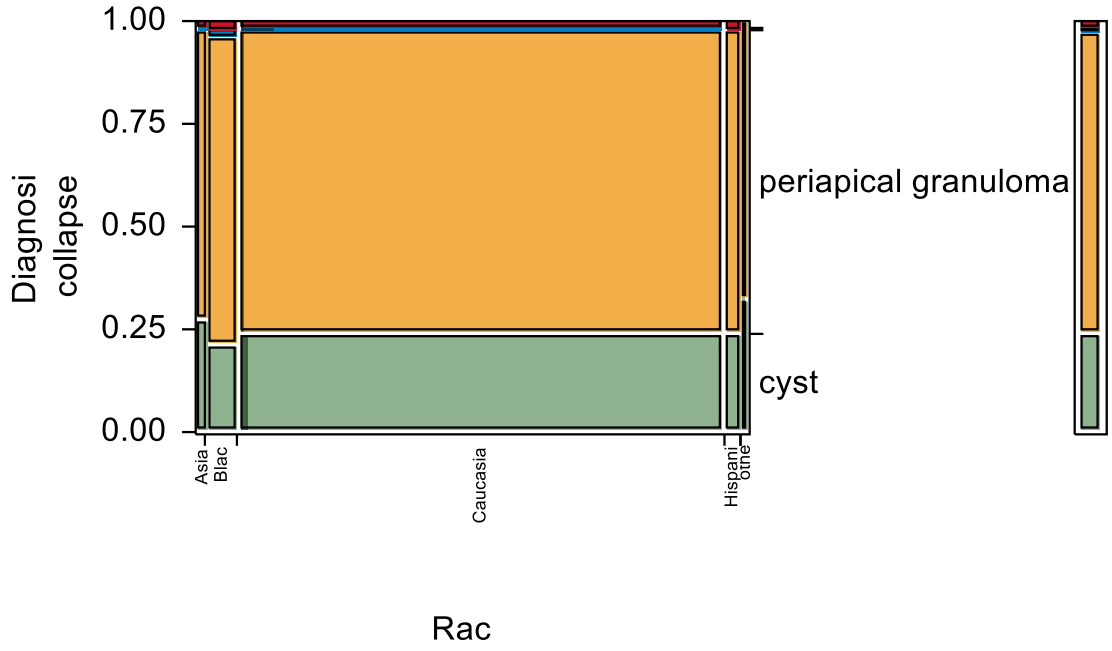


Figure 4. Bivariate Relationship between Race and Diagnosis

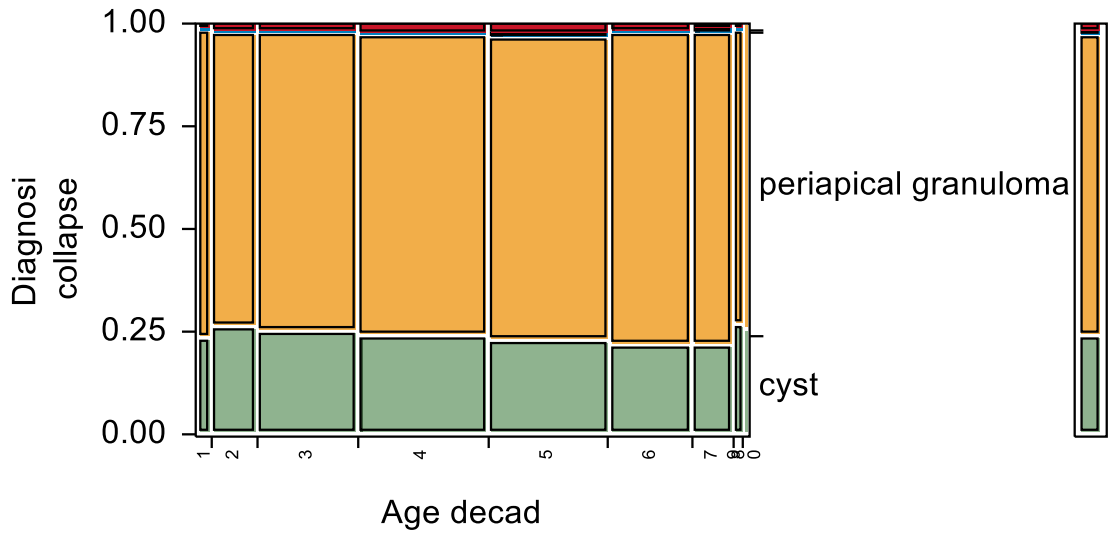


Figure 5. Bivariate Relationship between Age Decade and Diagnosis

Table 5 shows the relationship between tooth location and diagnosis. There was a significant difference in the diagnosis percentages depending upon arch (chi-square = 11.6, df = 3, $p = 0.0090$, Table 5 and Figure 6). The chi-square analysis indicated that there were more other diagnoses in the mandible than in the maxilla (1% vs. 0.5%). There was no left/right difference (chi-square = 1.15, df = 3, $p = 0.7648$, Table 5 and Figure 7).

There was a significant difference in the diagnosis percentages depending upon the four tooth types (chi-square = 49.9, df = 9, $p < 0.0001$, Table 5 and Figure 8). The chi-square analysis indicated that there were more scars adjacent to incisors than premolars (2.4% vs. 0.9%). There were more other diagnoses in the canines (1.6%). There were more radicular cysts and fewer periapical granulomas in incisors than the other three tooth types. This pattern within diagnoses can also be seen in the anterior posterior difference (chi-square = 32.9, df = 3, $p < 0.0001$, Figure 9).

Table 5. Relationship between Tooth Location and Diagnosis

	Percentage					
Location	Radicular Cyst	Periapical Granuloma	Other	Scar	Total	*p* value
Arch						
Mandibular	22.73	74.62	1.19	1.46	2191	0.0090
Maxillary	24.04	73.70	0.52	1.73	6868	
Left Right						
Left	23.91	73.63	0.71	1.74	4483	0.7648
Right	23.52	74.30	0.58	1.60	4486	
Tooth Type						
Incisor	26.06	71.05	0.49	2.40	3285	<0.0001
Canine	21.00	75.40	1.60	2.00	500	
Premolar	21.39	76.90	0.78	0.93	2043	
Molar	22.59	75.54	0.52	1.34	3054	
Sextant						
Anterior	25.34	71.64	0.70	2.33	3868	<0.0001
Posterior	22.11	76.08	0.63	1.18	5097	

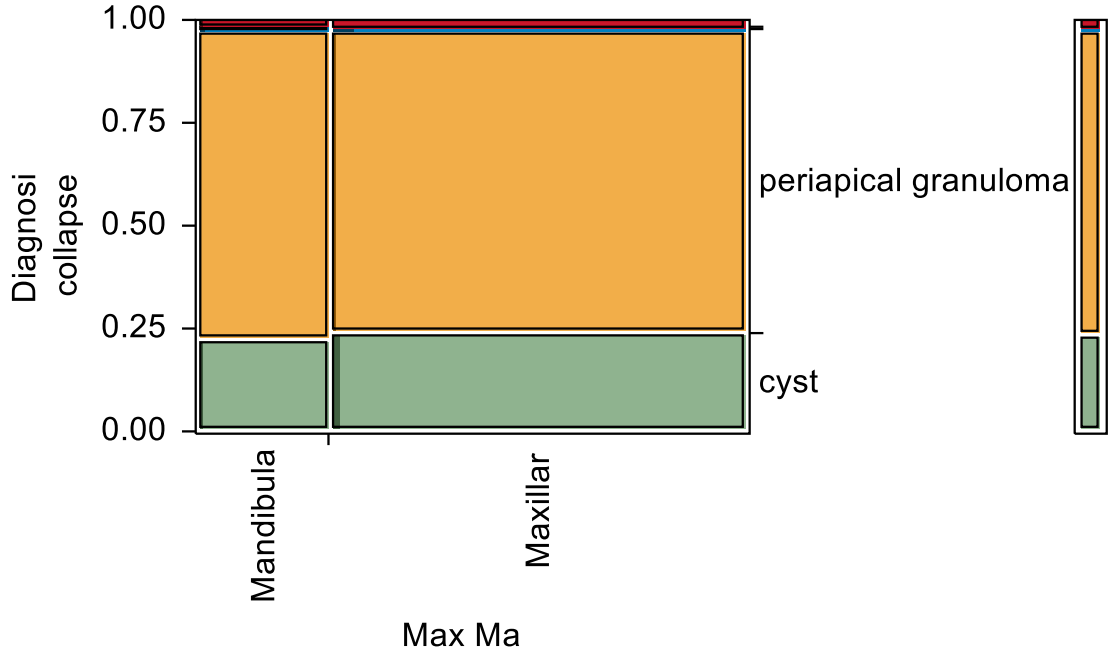


Figure 6. Bivariate Relationship between Arch and Diagnosis

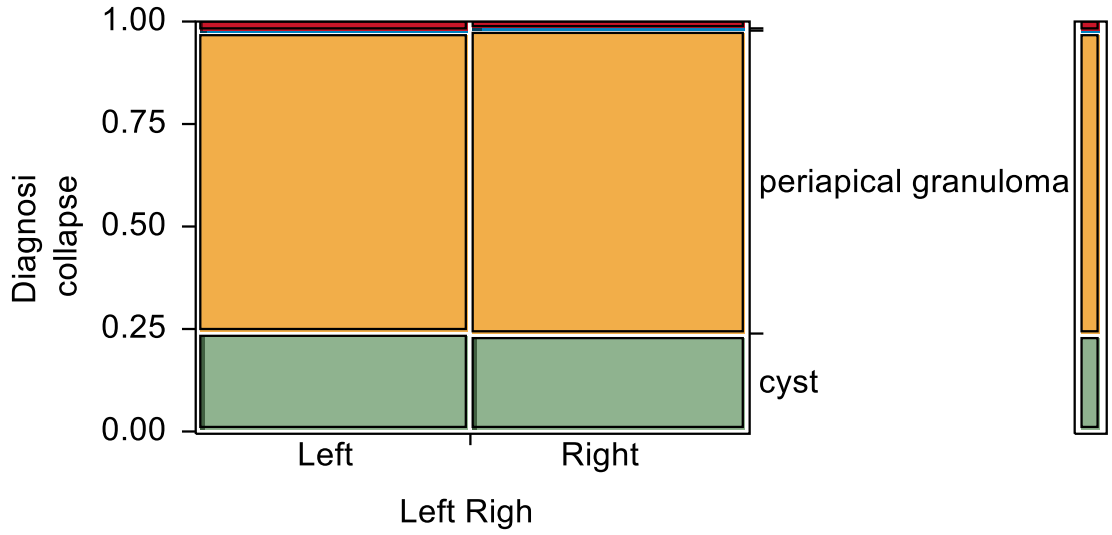


Figure 7. Bivariate Relationship between Side and Diagnosis

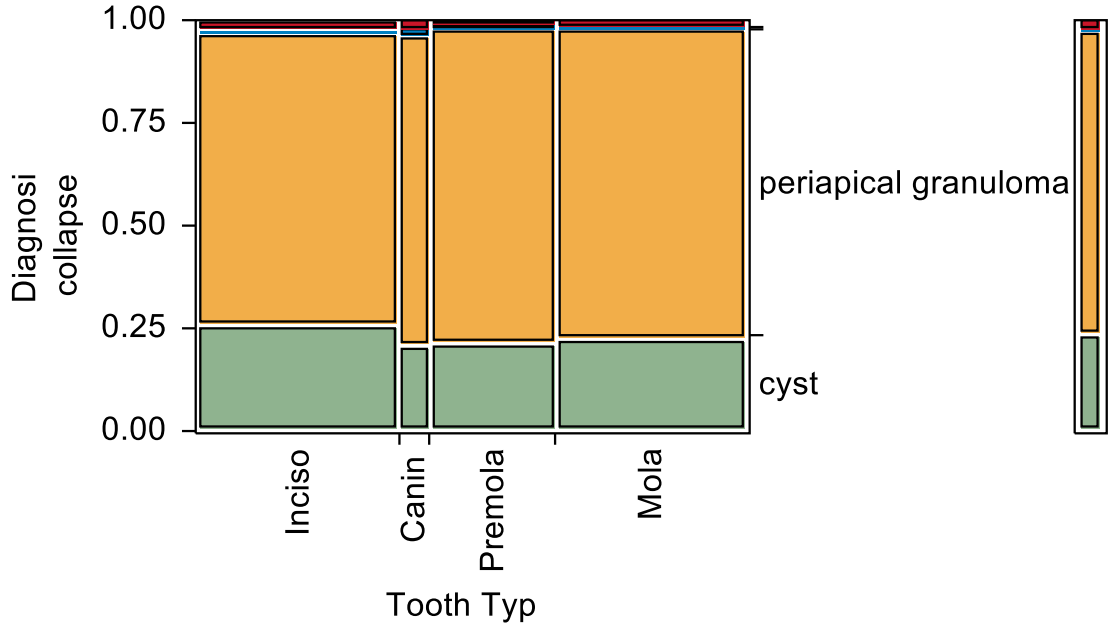


Figure 8. Bivariate Relationship between Tooth Type and Diagnosis

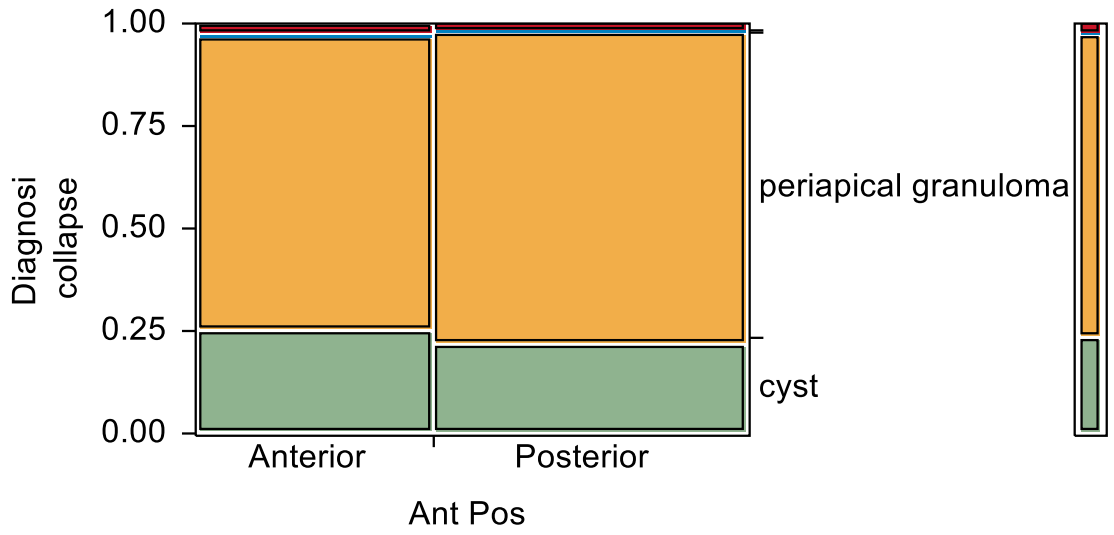


Figure 9. Bivariate Relationship between Sextant and Diagnosis

Additionally, there was a significant change in diagnostic groups across the 24 years that samples were diagnosed at the VCU pathology service (chi-square = 123, df = 72, $p < .0002$, Figure 10). No pattern was noted in this change.

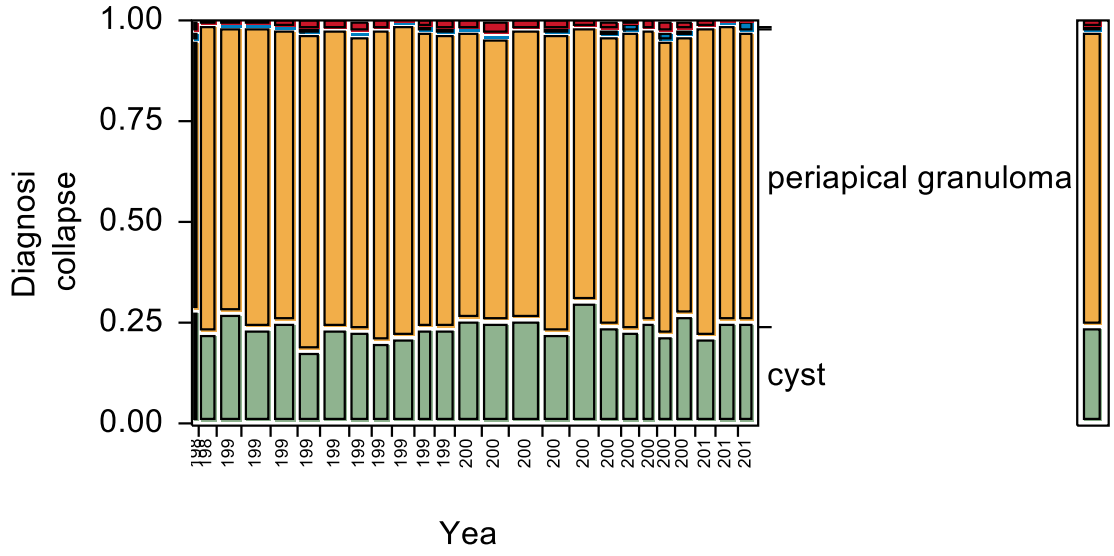


Figure 10. Bivariate Relationship between Year and Diagnosis

Final Analyses

All of the previous analyses were considered one variable at a time. This was done in order to screen the characteristics to determine which should be included in the subsequent

definitive analysis. Factors with significant bivariate relationships (Sex, Arch, Location (Anterior/Posterior), and Tooth Type) were included in a multiple logistic regression to determine which of the above factors contributed to differences in the diagnoses percentages after adjusting for all the other factors. The factors included in the model were: Sex and Quadrant (anterior maxilla, anterior mandible, posterior maxilla, posterior mandible). The logistic regression compared the odds of radicular cyst versus periapical granuloma, other diagnoses versus periapical granuloma, and scar versus periapical granuloma. Periapical granuloma was chosen as the reference group since it had the largest prevalence.

In the logistic regression both sex ($p = 0.0002$, Table 6) and quadrant ($p < 0.0001$, Table 6) had significant associations. There were significantly more radicular cysts in males (26.41%) versus females (22.15%, Table 7). Conversely, there were more periapical granulomas in females (75.36%) versus males (71.39%, Table 7) ($p <0.0001$, Table 6). A sex difference was not seen in scars or other diagnoses.

The posterior maxilla was chosen as the reference group for the comparisons between quadrants. There were significantly more other diagnoses found in the anterior mandible (p=0.014, Table 6). Additionally, scars were more frequently located in the anterior maxilla (p=0.0004, Table 6). There were significantly more radicular cysts diagnosed in the anterior maxilla as well (p=0.0074, Table 6). No significant associations were seen in the posterior mandible or posterior maxilla. All associations can be seen in Figure 11.

Table 6. Multiple Logistic Regression Results

		p-values			
Source		Overall	Cyst	Other	Scar
Sex		0.0002	<0.0001	0.5205	0.7756
Arch	Quad[Anterior Mandibular]	<0.0001	0.4391	0.0140	0.7361
	Quad[Anterior Maxillary]		0.0074	0.1368	0.0004
	Quad[Posterior Mandibular]		0.0640	0.2959	0.3411

The description of percentages in each quadrant appears in Table 7.

Table 7. Percentage Diagnoses by Tooth Quadrant and Sex

	Percentage				
Quadrant	Cyst	Periapical Granuloma	Other	Scar	Total
			Females		
Anterior Mandibular	21.55	73.74	2.36	2.36	297
Anterior Maxillary	24.51	72.55	0.41	2.53	1701
Posterior Mandibular	20.94	76.43	1.14	1.49	874
Posterior Maxillary	19.49	78.91	0.55	1.05	1996
(Unknown)	27.98	69.04	1.15	1.83	436
Overall, females	22.15	75.36	0.75	1.73	5304
			Males		
Anterior Mandibular	27.39	70.96	0.66	0.99	303
Anterior Maxillary	26.55	70.39	0.70	2.36	1567
Posterior Mandibular	22.59	75.36	0.87	1.17	686
Posterior Maxillary	25.96	72.55	0.32	1.17	1541
(Unknown)	33.96	63.90	1.07	1.07	374
Overall, males	26.41	71.39	0.63	1.57	4471

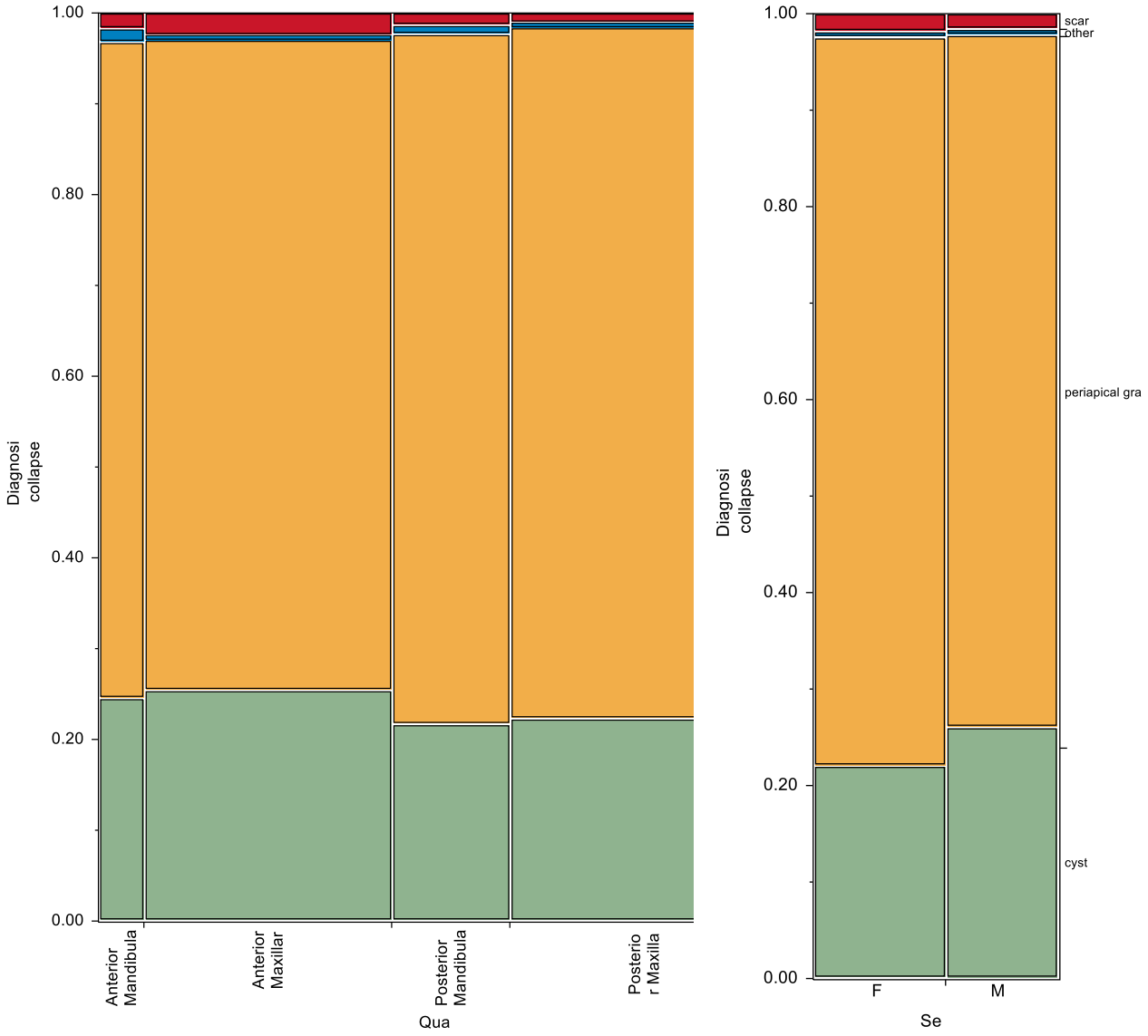


Figure 11. Proportion of Each Diagnosis by Tooth Quadrant and Sex

Discussion

Overall, the most frequent periapical diagnosis obtained from periapical biopsies submitted by endodontists following apical surgery was granuloma followed by cyst, scar, and other diagnoses at 73.5%, 24.1%, 1.6%, and 0.07% respectively. The prevalence of periapical granulomas in previous literature ranged from 40% to 94% (1-13). Additionally, the prevalence of cysts ranged from 6% to 54.5% (1-13). Although the prevalence of diagnoses differed among studies, majority of previous research agreed with the present study and found a higher prevalence of periapical granulomas compared to cysts. Only Priebe disagreed with this distribution, citing a larger ratio of radicular cysts to periapical granulomas (45.5% versus 54.5%).

The discrepancy seen in cyst and periapical granuloma prevalence may be due to differing criteria for cyst diagnosis between oral pathologists. For instance, the histologic properties necessary to make a diagnosis of cyst differ historically. Currently, a diagnosis of cyst is made if stratified squamous epithelium is noted in the biopsy specimen (16). However, previous pathologists may have only made a diagnosis of cyst if the entire sample was encapsulated by epithelium. As a result, those specimens that would have been diagnosed as radicular cyst today were instead diagnosed as periapical granuloma. Evidence of this practice was documented in Block's study where 61 of the cases were defined as granulomas with epithelium and not as cysts (10).

The present study found a higher rate of cysts in men and granulomas in females. The relationship seen between males and cysts was also seen by Kovisto. However, Kovisto found

that granulomas were equally present in men and women. Spatafore did not find a relationship between diagnosis and sex.

In the present study, cysts were more commonly diagnosed in the maxilla and anterior quadrant, whereas more granulomas were diagnosed in the mandible and posterior quadrant. Spatafore or Kovisto did not see this relationship. Instead, Spatafore found more cysts in the posterior mandible than other quadrants. Kovisto found an equal presence of granulomas and cysts in the anterior maxilla.

The distribution of scars found in the present study was consistent with previous research by Spatafore and Bhaskar, at 1.6%, 2.0% and 2.5% respectively (5,12).

Other diagnoses obtained in the present study included odontogenic keratocyst (OKC), osteomyelitis, central ossifying fibroma, benign fibro-osseous lesion, central giant cell granuloma, condensing osteitis, ameloblastoma, eosinophilic granuloma, incisive canal cyst, lateral periodontal cyst, pleomorphic adenoma, odontoma, osteoporotic bone marrow defect, squamous cell carcinoma, small cell carcinoma, and traumatic bone cyst for an overall prevalence of 0.70%. However, Spatafore, Bhaskar, and Koivisto found higher percentages of other diagnoses than the current study. For instance, Koivisto determined his sample consisted of 26.5% other diagnoses with the majority being keratocystic odontogenic tumor (KOT) at 8.8% (13). Koivisto used the term KOT instead of OKC due to its reclassification by the World Health Organization from cyst to tumor (17). However, the new terminology was not used in this study because all oral pathologists did not recognize the change. The present study also diagnosed more OKCs than other diagnoses, however, the prevalence was much lower at 0.16%. Similarly, Spatafore identified 4% of the total sample as other diagnoses and 7.5% as other diagnoses in Bhaskar's study (5,12). The discrepancy between other diagnoses could be attributed to the prior

inclusion of samples from other specialties and general dentists. In addition, the high frequency of other diagnoses in Koivisto's study may be due to the large sample size of 9,723 biopsy reports. Furthermore, Koivisto did not indicate the source of his biopsies, possibly introducing bias into his results.

The results indicated that the vast majority of periapical biopsies were benign (99.98%) and the relative risk of obtaining a malignancy (small cell carcinoma or squamous cell carcinoma) was 0.02%. Similarly, 0.66% of periapical lesions submitted for biopsy required additional monitoring or treatment after removal. These findings aid in allaying patients' fears when the differential diagnoses were discussed. Although the likelihood of obtaining a biopsy result requiring additional monitoring was very small, this important clinical finding should not be overlooked considering the possible severe pathologic implications.

The limitations of the present study include errors in database records. These errors could have occurred when biopsy reports were improperly labeled. Evidence of these errors was seen when calculating the age of the patient. There were several cases where age calculated to zero because the birth date of the patient was recorded as the same date the biopsy sample was submitted. Additionally, error could have occurred when collecting data. All biopsy reports were filtered electronically for provider before subsequently filtering for location and diagnosis simultaneously. As a result, many excluded samples were unable to be traced to the origin of exclusion. Furthermore, there was a relatively small number of samples associated with mandibular teeth (24%) compared to those associated with maxillary teeth (76%). The large ratio of maxillary to mandibular samples may have contributed to an inability to find statistical significance between locations for all diagnoses. Lastly, racial bias existed in the sample. Eighty-

nine percent of biopsy results used in this study were from Caucasian individuals. Therefore, the results may not accurately reflect a more diverse patient population.

In conclusion, periapical granulomas were most frequently diagnosed from biopsies submitted by endodontists following apical surgery followed by radicular cysts, scars, and other diagnoses. Cysts were more commonly found in males and in the anterior maxilla. Periapical granulomas were more commonly found in females and in the posterior quadrants. Other diagnoses were more commonly found in the anterior mandible. Finally, scars were more commonly found in the anterior maxilla.

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Appendix

Table 8: Selected Endodontists

Endodontist	N	Years	
Al-Ali, Tareq	6	2012	
Alforaih, Fowaz	2	2009	-2010
Aminoshariae, Anita	8	2002	-2003
Ankrum, Matthew	55	2002	-2012
Archer, Richard	109	1993	-2007
Avillion, Jerry	1	1981	-1981
Bailey, Jeffrey	15	1993	-2007
Banach, David	9	1993	-1994
Bangschaefer, K	2	2005	
Barbieri, Steven	40	1988	-1994
Barros, Jose	7	2000	-2002
Baughan, Linda	2	2000	
Beeson, Tom	7	1995	-1996
Begotka, Bruce	11	1995	-1997
Besner, Edward	106	1990	-2006
Bramwell, J. Douglas	2	1998	-2001
Brofsky, Steven	5	2003	-2010
Burns, Donna	34	1990	-2007
Bussey, Kelly	20	1991	-2008
Bussey, William	19	1995	-2011
Buttke, Thomas	9	2003	-2007
Byrne, Ellen	15	1988	-1994
Carson, Katherine	17	2007	-2012
Chapman, Thom	159	1988	-2000
Chau, James	87	2003	-2012
Clark, Paul	4	2006	-2007
Coon, David	78	2007	-2012
Coudron, Jonathan	5	2011	-2012
Davis, Adam	5	2007	-2008
Demayo, Thomas	3	2004	-2005
Desai, Pranav	5	2011	-2012
Dobyns, M	3	1993	-1994
Dodds, R	5	1989	-1991
Dodson, William	74	2000	-2010
Dollard, Wayne	484	1988	-2008
East, Virginia	152	1988	-2000
Ehreth, John	96	1992	-2012
Fabio, Michael	136	1990	-2011
Ferguson, David	2	2003	

Endodontist	N	Years	
Fessenden, Sean	75	2003	-2012
Finkler, Tim	7	2011	-2012
Finkler, Timothy	11	2005	-2011
Forte, Steven	19	1996	-2009
Gambrel, Madelyn	19	2002	-2012
Gelman, Richard	442	1988	-1999
Gerard, Scott	46	1989	-1998
Golian, Timothy	265	1993	-2012
Goodman, Alvin	161	2002	-2012
Grover, Robert	226	1992	-2012
Hadley, David	42	2008	-2012
Hahn, Chin-lo	3	1996	-2005
Harris, Jesse	6	2011	-2012
Hartwell, Gary	27	1988	-1996
Hauser, Mark	65	1990	-2011
Hebertson, Mark	89	1991	-2008
Heffernan, Jim	9	1992	-1993
Helleberg, John	1	1995	
Herring, Carolyn	4	1994	-2001
Hinrichs, Robin	68	1999	-2012
Hunt, Michael	144	1989	-2012
Jenson, Jon	189	2006	-2012
Johnson, Philip	198	1990	-2006
Jordan, Kalisha	4	2011	
Keene, David	1	2005	
Kelly, Ellen Ramos	4	1998	
Kenee, David	6	2011	-2012
Kerr, Mark	145	1998	-2011
Kimpark, Melanie	3	2001	-2002
Kitchens, Gray	41	2005	-2012
Kotler, Lawrence	49	1995	-2012
Kyu, Pye	9	2008	-2009
Lance, James R	5	1988	-1994
Lanier, Leander	152	2003	-2012
Leff, Gary	120	1999	-2012
Levin, Stanley	671	1999	-2011
Lieb, R	250	1988	-1996
Liewehr, Frederick	27	2006	-2009
Martinez, Harold	14	1998	-2012
Mayerchak, Michael	1	2011	
Mayo, Chester	58	1988	-2012
McKearney, Robert	140	1988	-2012
Meares, Anthony	172	1994	-2012
Mello, Kenneth	12	1988	-1990
Merian, Robert	365	1989	-2012

Endodontist	N	Years	
Meza, Fernando	66	2005	-2012
Miller, David W	26	1997	-2006
Monfared, Maryam	9	1995	-1996
Mossler, Margaret	9	1998	-2008
Nelson, Dennis	5	1991	-2002
Newsom, Joel	8	1991	-1992
Nguyen, Tu-quynh	3	2009	-2012
Nielson, Dennis	483	1988	-2005
Oertel, Ellen	2	2004	
O'Keefe, Edward	39	1990	-2012
Osmond, Steve	12	2009	-2010
Osullivan, Sean	11	1998	-1999
Overton, Bruce	120	1993	-2012
Packer, G	34	2011	-2012
Packer, Gardiner	57	2007	-2011
Pagan, A	4	1994	-1995
Pagan, R. David	48	1997	-2012
Paravyan, Suren	1	2011	
Park, Melanie Kim	1	2002	
Patel, Jayesh	15	2001	-2005
Peron, Louis	7	1989	-2003
Piccinino, Michael	323	1993	-2012
Pichardo, Michael	35	2007	-2012
Pollock, Richard	256	1994	-2012
Portell, Frank	13	2004	-2006
Reynolds, Jake	6	2011	-2012
Richards, Robert	1028	1988	-2006
Sacks, Gerald	8	2001	-2002
Sallen, Bruce	71	1999	-2012
Sarao, Manpreet	1	2012	
Sempira, Helen	9	1998	-1999
Setlock, Jason	6	2009	
Shojaei, Mariah	39	2001	-2005
Small, Neil	10	1989	-1990
Smart, Christopher	2	2012	
Smith, Michael	22	2000	-2012
Stanley, James	195	1988	-2012
Stepp, David	46	1992	-1997
Suffridge, Calvin	9	2001	-2002
Thews, Marvin	65	1988	-2012
Thomas, Anthony	3	2002	-2003
Thomas, Katherine	3	2008	-2011
Thorpe, Jeffrey	38	2003	-2012
Trimmer, William, III	9	1988	-1993
Trudeau, Michael	41	2009	-2012

Endodontist	N	Years	
Turner, Ellison P	1	2012	
Turner, Paige	4	2009	-2010
Umstott, Paul T	89	1988	-1999
Vargo, J	10	1991	-1992
Velo, Anthony	83	1990	-1999
Vranas, Ronald	5	2001	-2002
Walker, Thomas	61	1999	-2012
Ward, Fairfield A	1	1997	
Wayment, Nathan	8	2008	-2012
Wheeler, John M	24	1992	-2012
Winick, Michael	39	2011	-2012
Wozniak, David	6	1988	-1990
Wynkoop, Todd	26	1989	-2012
Yang, Allen	46	2004	-2008
Yeung, Priscilla	2	2005	
Yingling, Nicole	9	2000	-2001

Table 9. Included Biopsy Locations

Location	Description	N
0	APEX	2
0	Not supplied	429
1001	Listed below	356
BON	Mandible	2
BON10	Intrabony tooth #10 area	4
BON11	Intrabony tooth #11 area	9
BON12	Intrabony tooth #12 area	8
BON13	Intrabony tooth #13 area	10
BON14	Intrabony tooth #14 area	17
BON15	Intrabony tooth #15 area	2
BON16	Intrabony tooth #16 area	1
BON18	Intrabony tooth #18area	2
BON19	Intrabony tooth #19 area	20
BON2	Intrabony tooth #2 area	2
BON20	Intrabony tooth #20 area	6
BON21	Intrabony tooth #21 area	4
BON22	Intrabony tooth #22 area	1
BON23	Intrabony tooth #23 area	5
BON24	Intrabony tooth #24 area	1
BON25	Intrabony tooth #25 area	4
BON26	Intrabony tooth #26 area	1
BON28	Intrabony tooth #28 area	4
BON29	Intrabony tooth #29 area	4
BON3	Intrabony tooth #3 area	19
BON30	Intrabony tooth #30 area	25
BON31	Intrabony tooth #31 area	4
BON32	Intrabony tooth #32 area	1
BON4	Intrabony tooth #4 area	3
BON5	Intrabony tooth #5 area	11
BON6	Intrabony tooth #6 area	7
BON7	Intrabony tooth #7 area	5
BON8	Intrabony tooth #8 area	16
BON9	Intrabony tooth #9 area	16
BONA	Mandible, anterior	27
BONL	Mandible, left	10
BONM	Maxilla	5
BONR	Mandible, right	19
BONU1	Maxilla, right	29
BONU2	Maxilla, left	29
BONUA	Maxilla, anterior	56
PX1	Periapical area tooth #1	3
PX10	Periapical area tooth #10	620
PX11	Periapical area tooth #11	170

Location	Description	N
PX12	Periapical area tooth #12	323
PX13	Periapical area tooth #13	487
PX14	Periapical area tooth #14	819
PX15	Periapical area tooth #15	94
PX16	Periapical area tooth #16	2
PX17	Periapical area tooth #17	6
PX18	Periapical area tooth #18	68
PX19	Periapical area tooth #19	502
PX2	Periapical area tooth #2	98
PX20	Periapical area tooth #20	73
PX21	Periapical area tooth #21	80
PX22	Periapical area tooth #22	59
PX23	Periapical area tooth #23	92
PX24	Periapical area tooth #24	151
PX25	Periapical area tooth #25	125
PX26	Periapical area tooth #26	68
PX27	Periapical area tooth #27	55
PX28	Periapical area tooth #28	95
PX29	Periapical area tooth #29	85
PX3	Periapical area tooth #3	784
PX30	Periapical area tooth #30	504
PX31	Periapical area tooth #31	59
PX32	Periapical area tooth #32	2
PX4	Periapical area tooth #4	501
PX5	Periapical area tooth #5	336
PX6	Periapical area tooth #6	191
PX7	Periapical area tooth #7	728
PX8	Periapical area tooth #8	671
PX9	Periapical area tooth #9	745
TO	Tooth	3

Table 10. Tooth Locations

Tooth	Tooth Type	Max Man	Ant Post	Left Right	N
1	Molar	Maxillary	Posterior	Right	3
2	Molar	Maxillary	Posterior	Right	101
3	Molar	Maxillary	Posterior	Right	809
4	Premolar	Maxillary	Posterior	Right	506
5	Premolar	Maxillary	Posterior	Right	350
6	Canine	Maxillary	Anterior	Right	202
7	Incisor	Maxillary	Anterior	Right	742
8	Incisor	Maxillary	Anterior	Right	688
9	Incisor	Maxillary	Anterior	Left	770
10	Incisor	Maxillary	Anterior	Left	629
11	Canine	Maxillary	Anterior	Left	181
12	Premolar	Maxillary	Posterior	Left	333
13	Premolar	Maxillary	Posterior	Left	497
14	Molar	Maxillary	Posterior	Left	837
15	Molar	Maxillary	Posterior	Left	98
16	Molar	Maxillary	Posterior	Left	3
17	Molar	Mandibular	Posterior	Left	6
18	Molar	Mandibular	Posterior	Left	72
19	Molar	Mandibular	Posterior	Left	528
20	Premolar	Mandibular	Posterior	Left	80
21	Premolar	Mandibular	Posterior	Left	85
22	Canine	Mandibular	Anterior	Left	62
23	Incisor	Mandibular	Anterior	Left	101
24	Incisor	Mandibular	Anterior	Left	153
25	Incisor	Mandibular	Anterior	Right	132
26	Incisor	Mandibular	Anterior	Right	70
27	Canine	Mandibular	Anterior	Right	55
28	Premolar	Mandibular	Posterior	Right	102
29	Premolar	Mandibular	Posterior	Right	90
30	Molar	Mandibular	Posterior	Right	530
31	Molar	Mandibular	Posterior	Right	64
32	Molar	Mandibular	Posterior	Right	3
					716
		Mandibular			2
		Mandibular		Left	19
		Mandibular		Right	10
		Mandibular	Anterior		27
		Maxillary			5
		Maxillary		Left	29
		Maxillary		Right	29
		Maxillary	Anterior		56

Table 11. Excluded Diagnoses

Excluded Diagnosis
(Null)
Amalgam tattoo
Amorphous necrotic material
Atypical epithelial cell proliferation
Blue nevus, (NOS)
Bone fragments and connective tissue
Bone, dense viable
Bone, non-vital
Bone, normal
Candidiasis
Chronic gingivitis
Chronic mucositis
Chronic pulpitis
Dentigerous cyst
Dentigerous cyst, inflamed
Eosinophilic amorphous material
Epithelial dysplasia, mild
Erosive mucositis
Fibroma
Fibroma with hyperkeratosis
Fibroma with neural proliferation
Fibroma with neural proliferation.
Fibroma with ulceration
Fibrous hyperplasia
Fistula
Focal fibrous and epithelial hyperplasia
Focal inflammatory fibrous and epithelial hyperplasia
Focal inflammatory fibrous hyperplasia
Foreign body
Hemangioma, cavernous
Hematoma, (NOS)
Hyperkeratosis
Hyperkeratosis with lichenoid change
Hyperorthokeratosis and acanthosis
Hyperparakeratosis and acanthosis
Insufficient tissue for diagnosis
Internal resorption
Intramucosal nevus
Keratinaceous material
Keratinaceous slough
Lichen planus
Mucocele with chronic sialadenitis
Mucous retention cyst
Mucous retention cyst with sialolith

Excluded Diagnosis
Mucous retention phenomenon
Necrosis, (NOS)
Necrotic calcified fragments
Necrotic debris and bacterial colonies
Non-vital tooth
Non-vital tooth tip
Oral melanotic macule
Papilloma
Parulis
Peripheral giant cell granuloma
Peripheral ossifying fibroma
Pulp calcification
Pulp necrosis
Pyogenic granuloma
Root tip
Sequestrum
Sequestrum, (NOS)
Sialolithiasis
Subacute gingivitis
Submucosal abscess
Tooth fragment
Tooth fragments
Tooth with external resorption
Tooth with internal resorption
Torus mandibularis
Unknown diagnosis

Table 12. Included and Excluded Biopsy Locations

Location	Description	N	save/delete
0	Not supplied	418	save
1001	Listed below	378	save
AR1R	Alveolar ridge, right mand.	2	delete
AR2L	Alveolar ridge, left maxilla	2	delete
BON	Mandible	2	save
BON10	Intrabony tooth #10 area	4	save
BON11	Intrabony tooth #11 area	8	save
BON12	Intrabony tooth #12 area	8	save
BON13	Intrabony tooth #13 area	9	save
BON14	Intrabony tooth #14 area	15	save
BON15	Intrabony tooth #15 area	2	save
BON18	Intrabony tooth #18area	2	save
BON19	Intrabony tooth #19 area	19	save
BON2	Intrabony tooth #2 area	1	save
BON20	Intrabony tooth #20 area	6	save
BON21	Intrabony tooth #21 area	2	save
BON22	Intrabony tooth #22 area	1	save
BON23	Intrabony tooth #23 area	4	save
BON24	Intrabony tooth #24 area	1	save
BON25	Intrabony tooth #25 area	4	save
BON26	Intrabony tooth #26 area	1	save
BON28	Intrabony tooth #28 area	4	save
BON29	Intrabony tooth #29 area	2	save
BON3	Intrabony tooth #3 area	17	save
BON30	Intrabony tooth #30 area	26	save
BON31	Intrabony tooth #31 area	5	save
BON32	Intrabony tooth #32 area	2	save
BON4	Intrabony tooth #4 area	3	save
BON5	Intrabony tooth #5 area	11	save
BON6	Intrabony tooth #6 area	8	save
BON7	Intrabony tooth #7 area	3	save
BON8	Intrabony tooth #8 area	13	save
BON9	Intrabony tooth #9 area	12	save
BONA	Mandible, anterior	26	save
BONL	Mandible, left	11	save
BONM	Maxilla	3	save
BONR	Mandible, right	20	save
BONU1	Maxilla, right	28	save
BONU2	Maxilla, left	26	save
BONUA	Maxilla, anterior	54	save
BU	Buccal mucosa	2	delete
BU1L	Vestibule, left maxillary	4	delete
BU1R	Vestibule, right maxillary	2	delete
BU2L	Vestibule, left mandibular	2	delete

BU3L	Buccal mucosa, left	19	delete
BU3R	Buccal mucosa, right	18	delete
BU4R	Vestibule, right buccal	1	delete
DT	Tongue, dorsum	1	delete
FL	Floor of mouth	2	delete
FLR	Floor of mouth, right	1	delete
FRMX	Frenum, maxillary labial	2	delete
G	Gingiva	7	delete
G10	Gingiva tooth #10 area	2	delete
G11	Gingiva tooth #11 area	2	delete
G12	Gingiva tooth #12 area	6	delete
G13	Gingiva tooth #13 area	3	delete
G14	Gingiva tooth #14 area	3	delete
G15	Gingiva tooth #15 area	1	delete
G18	Gingiva tooth #18	1	delete
G19	Gingiva tooth #19	2	delete
G2	Gingiva tooth #2 area	3	delete
G22	Gingiva tooth #22	3	delete
G23	Gingiva tooth #23	2	delete
G24	Gingiva tooth #24	3	delete
G25	Gingiva tooth #25	1	delete
G28	Gingiva tooth #28	2	delete
G3	Gingiva tooth #3 area	5	delete
G30	Gingiva tooth #30	5	delete
G31	Gingiva tooth #31	5	delete
G5	Gingiva tooth #5 area	1	delete
G6	Gingiva tooth #6 area	1	delete
G7	Gingiva tooth #7 area	1	delete
G8	Gingiva tooth #8 area	4	delete
G9	Gingiva tooth #9 area	6	delete
L	Lip	1	delete
L1L	Lip, upper, left	4	delete
L1R	Lip, upper, right	4	delete
L3L	Lip, lower, left	2	delete
L3M	Lip, midline lower	1	delete
L3R	Lip, lower, right	3	delete
L4L	Labial mucosa, lower, left	1	delete
L4R	Labial mucosa, lower, right	1	delete
LL	Lip, lower	14	delete
MASR	Maxillary sinus, right	2	delete
P	Palate	5	delete
PA	Hard palate	1	delete
PA1L	Hard palate, left	4	delete
PA1R	Hard palate, right	3	delete
PA2L	Soft palate, left	8	delete
PA2M	Soft palate, midline	1	delete

PA2R	Soft palate, right	1	delete
PA3M	Hard palate, anterior midline	1	delete
PAJ	Junction hard and soft palate	13	delete
PH2L	Pharyngeal wall, left	1	delete
PL	Palate, left	8	delete
PR	Palate, right	6	delete
PX1	Periapical area tooth #1	3	save
PX10	Periapical area tooth #10	590	save
PX11	Periapical area tooth #11	166	save
PX12	Periapical area tooth #12	313	save
PX13	Periapical area tooth #13	461	save
PX14	Periapical area tooth #14	787	save
PX15	Periapical area tooth #15	90	save
PX16	Periapical area tooth #16	1	save
PX17	Periapical area tooth #17	6	save
PX18	Periapical area tooth #18	67	save
PX19	Periapical area tooth #19	492	save
PX2	Periapical area tooth #2	95	save
PX20	Periapical area tooth #20	71	save
PX21	Periapical area tooth #21	78	save
PX22	Periapical area tooth #22	59	save
PX23	Periapical area tooth #23	87	save
PX24	Periapical area tooth #24	137	save
PX25	Periapical area tooth #25	115	save
PX26	Periapical area tooth #26	63	save
PX27	Periapical area tooth #27	53	save
PX28	Periapical area tooth #28	91	save
PX29	Periapical area tooth #29	81	save
PX3	Periapical area tooth #3	740	save
PX30	Periapical area tooth #30	489	save
PX31	Periapical area tooth #31	61	save
PX32	Periapical area tooth #32	2	save
PX4	Periapical area tooth #4	475	save
PX5	Periapical area tooth #5	327	save
PX6	Periapical area tooth #6	179	save
PX7	Periapical area tooth #7	694	save
PX8	Periapical area tooth #8	640	save
PX9	Periapical area tooth #9	693	save
RMPL	Retromolar pad, left	2	delete
RMPR	Retromolar pad, right	3	delete
SP	Soft palate	5	delete
T	Tongue	2	delete
T3L	Tongue, lateral left	1	delete
TO	Tooth	3	save
TUL	Tuberosity, left	3	delete
UL	Lip, upper	6	delete

VT	Tongue, ventral	2	delete

Table 13. Collapsed Diagnoses

Diagnosis	N
Cyst	
Cyst of the mandible	4
Cyst of the maxilla	10
Cyst of undetermined origin	25
Granulation tissue and reactive epithelium	64
Lateral radicular cyst	2
Radicular cyst	2188
Radicular cyst, inflamed	63
Residual cyst	1
Periapical Granuloma	
Abscess	3
Chronic inflammation	4
Chronic inflammation of fibrous connective tissue and bone	15
Chronic inflammatory reaction	3
Chronically inflamed fibrous connective tissue	108
Chronically inflammed granulation tissue	9
Compatible with a periapical granuloma	1
Compatible with periapical granuloma	1
Periapical abscess with keratinaceous material	1
Periapical granuloma	6873
Periapical granuloma with abcess	1
Periapical granuloma with abscess	8
Periapical granuloma with foreign body	1
Periapical granuloma with foreign material	13
Root tip with associated periapical granuloma	1
Subacute inflammation of fibrous connective tissue and bone	1
Subacute inflammatory reaction	2
Subacutely inflamed fibrous connective tissue	91
Subacutely inflamed fibrous connective tissue and bone	4
Subacutely inflamed granulation tissue	47
Subacutely inflamed granulation tissue with foreign body	1
Subacutely inflamed granulation tissue and bacterial colonies	1
Other	
Ameloblastoma (mandible)	1
Benign fibro-osseous lesion	8
Central cemento-ossifying fibroma (mandible)	6
Central cemento-ossifying fibroma (maxilla)	2
Central giant cell granuloma	5
Central ossifying fibroma (maxilla)	1
Chronic osteomyelitis	9
Condensing osteitis	2
Eosinophilic granuloma	1
Incisive canal cyst	2
Lateral periodontal cyst	3

Diagnosis	N
Odontogenic keratocyst (orthokeratin type)	3
Odontogenic keratocyst (parakeratin type)	13
Odontoma, NOS (maxilla)	1
Osteomyelitis, (NOS)	2
Osteoporotic bone marrow defect	2
Pleomorphic adenoma	1
Sequestrum with associated osteomyelitis	2
Small cell carcinoma	1
Squamous cell carcinoma	1
Subacute osteomyelitis	1
Traumatic bone cyst	1
Scar	
Fibrous bony defect	162

Vita

Dr. Claire Siegel Gerhard was born on February 10, 1985, in Cincinnati, Ohio. Dr. Siegel Gerhard received her Bachelor of Science in Biology from Virginia Polytechnic Institute and State University in 2007. She received her Doctor of Dental Surgery in 2011 and completed a Fellowship in Endodontics in 2012 at The Ohio State University. Dr. Siegel Gerhard then enrolled in the Advanced Specialty Program in Endodontics at Virginia Commonwealth University, School of Dentistry. Dr. Siegel Gerhard is a member of the ODA, AAE and ADA and will enter private practice in Richmond, Virginia. She will graduate from Virginia Commonwealth University with a Master of Science in Dentistry and a Certificate in Endodontics.