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ORIGINAL ARTICLE

A Histopathological Study on Carious Permanent Teeth in the Population of Jalalabad

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Abstract

Background: Dental caries is an irreversible, multi-factorial disease that is ranked among the top most prevalent diseases. It involves the dissolution of inorganic components and the decomposition of the organic components of the tooth. It may extend from the enamel surface towards the inner structures in a horizontal, vertical, or oblique manner resulting in pain, sensitivity, and even extraction of the affected tooth.

Objective: To determine the histological classification and extent of dental caries on ground sections of the permanently extracted teeth.

Material and Methods: In this cross-sectional study, Participants were selected according to the inclusion criterion of the study; the sample teeth were collected, sterilized, decalcified, and ground with a slow hand-piece, lathe, and sandpaper to achieve 3-4mm thickness. Conventional H&E stain was used for tissue staining followed by light microscopy for reporting the observed cases.

Results: Caries were more prevalent (84%) in the dentin-pulp complex. Males (77%) were more commonly affected as compared to females and the most common age group for caries development was 7-12 years. Mandibular molars were predominantly affected by dental caries, in permanent teeth, followed by maxillary molars.

Conclusion: It can be concluded that the extent of dental caries is significantly associated with the path of decomposition of the inorganic and organic matrix of the tooth.

Keywords: Carious permanent teeth; Histopathology, Jalalabad, Tooth_

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Introduction

Caries is a chronic, multi-factorial disease of dental hard tissues 1 World Health Organization (WHO) defines dental caries as a local pathological process, leading to enamel decalcification, decomposition of dental hard tissue, and ultimately formation of a cavity[2]. According to a Global Burden of Disease study conducted in 2017 by the Institute of Health Metrics and Evaluation, dental caries was ranked first among a list of 328 diseases for prevalence, and second for incidence[3]. Additionally, according to the 2019 statistics, approximately 2 billion people are globally affected by this pathology; with 3 out of 4 people suffering from some form of caries in middle-income countries[4].The etiology of dental caries is multi-factorial, however, Streptococci; especially Streptococcus mutans and Lactobacilli are primarily implicated as the causative bacteria for this disease[5]. Similarly, high

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frequency of sugar intake, reduced salivary flow rate, insufficient exposure to fluoride, poor oral hygiene, and inaccessible oral health care, are other factors that increase the likelihood of acquiring the disease[6]. According to the Centers for Disease Control and Prevention (CDC) guidelines, regular dental check-ups, proper brushing of teeth, with fluoride toothpaste, flossing, and oral hygiene practices can help prevent the initiation and even progression of carious lesions[7].

GV Black has classified carious lesions into five classes depending upon their location as pits & fissure lesions, posterior proximal lesion, anterior proximal caries without angular involvement, anterior proximal caries with angular involvement, gingival caries, and cuspal caries[8]. However, besides this clinical classification, caries have also been categorized by many other classification systems as well. Based on the progression of the lesion it can be classified as acute, chronic, or arrested. Based on the virginity of the lesion it can be divided into primary or secondary/recurrent. Additionally, based on the direction of spread it can be categorized as forward or backward etc[9].

Material and Method:

Study design: The study design was a Cross-sectional Descriptive study.

Study duration: with the duration of 06 months after the approval of AS&RB.

Study setting: The study was conducted at Nangarhar Regional Hospital, Jalalabad, Afghanistan.

Sample size: A total of 100 patients were recruited into the study by non-probability convenience sampling based on the following inclusion and exclusion criteria.

Inclusion criterion:

1. Permanent teeth.
2. Teeth extracted due to clinically diagnosed caries.
3. Participants aged 6 years and above belonging to either gender.
4. Patients consenting to participation in the study.

Exclusion criteria:

1. Teeth are extracted for reasons other than caries.

Procedure: This study was conducted after seeking approval from the Graduate Study Committee, the Advanced Study and Research Board, and the Ethical Review Committee of Khyber Medical University, Peshawar, (approval no. KMU/IPDM/IEC/2023-13).

Patient Selection and Sampling:

100 participants, fulfilling the inclusion criterion of the study, were selected from the Endodontic Department of Nangarhar Regional Hospital, Jalalabad, Afghanistan. All the participants had grossly carious teeth and were advised of extraction as management. The selection was done by non-probability convenience sampling. The patients who were willing to participate in the study were asked to sign the informed consent and the demographic data was also recorded before the procedure.

The teeth were extracted by qualified dental surgeons in minor oral surgery as per the standard protocol. The extraction was completed under local anesthesia. The sample tooth was collected by the researcher and labeled with a tag.

The tooth samples were then autoclaved at 121°C temperature and 15lbs pressure, for 30 minutes to achieve sterilization. The samples were then preserved in 10% formalin to maintain the structural integrity. After initial formalin fixation for 24 hours, the tooth samples were placed in 7% formic acid, for 4-5 days, to achieve decalcification of inorganic tissue.

A slow-speed handpiece was used to divide the sample tooth into two halves. A dental lathe was used for coarse-grinding the obtained halves to a thickness of 20-30 microns. The sample tooth was further thinned and polished with the help of sandpaper and pumice slurry to achieve the desired feather-edge thick sections that could transmit light.

Histological Analysis:

These ground sections of the teeth were then stained with Hematoxylin & Eosin stain (H&E stain) according to the standard protocol. The stained sections were fixed on the slides by using a DPX solution.

The prepared slides were examined under a light microscope to record the extent of carious lesions (in mm) and to classify them as enamel, dentin, or pulpal caries.

Statistical Analysis:

Data was recorded in Excel sheets and statistical analysis was performed with SPSS software version 22 (IBM Corp, Armonk, NY, USA). P-value ≤ 0.05 was considered statistically significant. The Chi-square Test was used for the analysis of the Data set.

Results:

For this study, 100 samples of carious teeth from patients were selected. The ages of the participants ranged from 7 years to 65 years, with the maximum number of participants (n>25) belonging to the first and second decades of life (Figure 1). Additionally, gender distribution data showed that 77% of the participants were males and only 22% were females (Figure 2).

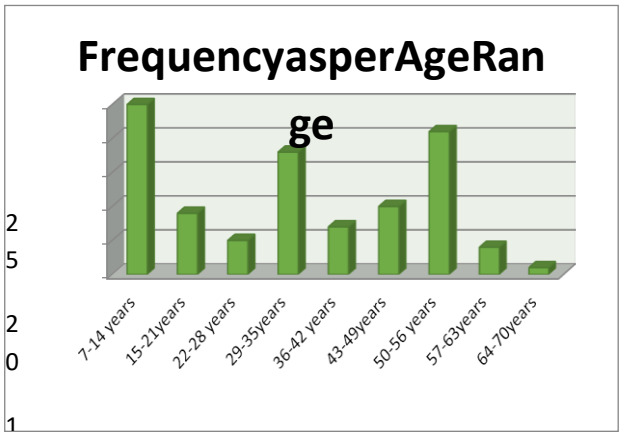

Figure 1: Graph showing the age distribution of the participants of the study.

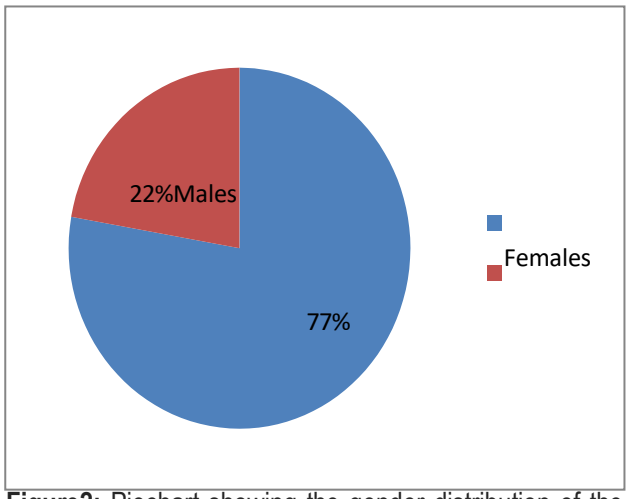

Figure2: Piechart showing the gender distribution of the participants of the study.

Among the 100 participants, 42% had carious lesions involving enamel and dentin complex along with coronal defects. The major complaint of these participants was spontaneous throbbing pain, lasting for more than 20 minutes, and sensitivity to hot and cold foods. In addition to this, 84% of the participants presented with carious lesions extending from dentin, towards pulp. This showed a higher involvement of the Dentin-pulp complex as compared to the Enamel-dentin complex (Table 1).

Table1.Showingtherelativeinvolvementofenamel-dentinanddentin-pulpcomplex.

	Enamel-Dentin	Dentin-Pulp	horizontal	vertical
Valid	42	84	100	100
Missing	58	16	0	0
Median	1.350	3.000	4.500	9.500
Std. Deviation	1.3498	1.6733	2.8860	5.7267

In samples with Enamel-dentin caries, the extent of the carious lesion was 1mm for the majority of the cases (n=12) as seen in Table 2. Whereas, in the case of Dentin-pulp caries majority of the cases showed a maximum extent of the lesion to be 3mm (n=18) as seen in Table 3.

Table2.ShowingtheextentoflesionsinEnamel-dentincaries.

Extent in mm	Frequency	Percentage	Valid Percent
0.5	5	5.0	11.9
0.8	3	3.0	7.1
1	12	12.0	28.6
1.2	1	1.0	2.4
1.5	9	9.0	21.4
2	2	2.0	4.8
2.5	1	1.0	2.4
3	2	2.0	4.8
3.3	1	1.0	2.4
3.5	1	1.0	2.4
4	3	3.0	7.1
5.5	1	1.0	2.4
6	1	1.0	2.4
Total	42	42.0	100.0
System	58	58.0	
	100	100.0	

Table3.ShowingtheextentoflesionsinDentin-pulpcaries.

Extent in mm	Frequency	Percentage	Valid Percent
0.5	1	1.0	1.2
1	4	4.0	4.8
1.2	1	1.0	1.2
1.5	5	5.0	6.0
2	8	8.0	9.5
2.5	10	10.0	11.9
3	18	18.0	21.4
3.5	9	9.0	10.7
4	8	8.0	9.5
4.5	8	8.0	9.5
5	4	4.0	4.8
5.5	3	3.0	3.6
6	3	3.0	3.6
8	1	1.0	1.2
12	1	1.0	1.2
Total	84	84.0	100
System	16	16.0	
	100	100.0	

Furthermore, the association between the extent of Dentin-pulp caries and the physical type (horizontal/vertical) of the lesion was observed using the Chi-square test. As seen in Tables 4 & 5, the test results showed that the histological type of dental caries is affected by the physical type of dental carious lesion that causes demineralization of the inorganic and organic structures of the involved teeth.

Table 4. Showing the Association of Dentin-pulp distance with horizontal caries

Chi-Square Tests						
	Value	df	P-value	Exact sig (2 sided)	Exact sig (1 sided)	Point probability
Pearson chi-square	12.461[a]	6	.052	.050		.011
Likelihood ration	15.022	6	.020	.030		
Fisher Exact Test	12.530			.039		
Linear-by-linear Association	2.914[b]	1	.088	.098	.048	
N of Valid cases	100					

a.5cells(41.7%)havean expectedcountof lessthan5.Theminimumexpectedcountis1.76.
b.The standardized statistic is -1.707

Table5. Showing the association of Dentin-pulp distance with vertical caries

Chi-Square Tests						
	Value	df	P-value	Exact sig (2 sided)	Exact sig (1 sided)	Point probability
Pearson chi-square	20.655[a]	6	.002	.002		.018
Likelihood ration	22.344	6	.001	.002		
Fisher Exact Test	22.029			.001		
Linear-by-linear Association	1.551[b]	1	.213	.231	.117	
N of Valid cases	100					

a. 5 cells (41.7%) have an expected count of less than 5. The minimum expected count is 1.28.
b. The standardized statistic is 1.245.

Discussion:

Dental caries and decay are by far the most prevalent problems worldwide. The risk factors involved depend upon the dietary habits and the overall oral hygiene of the patient. This study was conducted in Nangarhar Regional Hospital, Jalalabad, Afghanistan. It was generally observed that the attitude of the population, regarding oral health, was very laid back, with people seeking dental treatments only in cases where the pain was severe or any other serious problem arose. The reason is a lack of patient education and awareness. It was the first study of its kind involving the people of Nangarhar. This study would serve as a way forward and a useful source of information for patients and dentists.

For this study, 100 samples were collected. During the sampling for the current study, it has been observed that the most prevalent teeth that required extraction for grossly carious lesions were mandibular molars (42%) followed by the right maxillary second molar. Our finding is consistent with the study done by Mustafa et al., 2010 who reported high carious incidence in the maxilla except mandibular molars (10). The reason behind molars being the carious targets is their occlusal complexity as per their structure and functional demand. Dental caries may be called a public health problem because the chances of contracting the infectious disease are present since the day the first tooth erupts in the mouth. In this study, the most prevalent age group with dental caries was 7 to 14 years of age which is by research done by Antunes et al., 2003 who found dental decay a common finding in school-going children of the same age group 11. This is related to the kind of refined food substances the children are taking and also to the degree of their oral hygiene maintenance and brushing techniques being used. Ferraro and Vieira in 2010 found females to be more susceptible to dental caries due to their risk factors related to pregnancy-induced hormones, the presence of the AMELX gene, and their saliva composition 12. This is in contrast with our results; this may be due to the disparity of gender exposure or the inaccessibility of the women to reach out specialty centers for oral and dental care in the region.

Enamel is the outermost tooth structure which is 96% inorganic in its composition. It is made up of hydroxyapatite crystals. It is the hardest tooth structure and can be destroyed by the acid attack of bacteria when they combine with other caries causing risk factors. It is a multifactorial process. The sooner the diagnosis and treatment the better it is for the patient. If left untreated the carious lesion may horizontally or vertically extend

within the deeper tooth structures such as dentin and pulp in the coronal structure and from the cementum to the dentin and pulp into the root of the tooth. The histological variants of dental caries also draw their name from the structures of the tooth that get involved in the decay process. Caries may be detected or diagnosed by optical and visual techniques. One such method devised in the present study is gross section preparations using manual cutting, grinding, and polishing of the tooth surface. Sundström, 1966 and Yadav et al 2019 also used similar methods for the demonstration of dental caries through ground section preparations[13,14].

Limitations: The study was carried out on permanent teeth only.

Conclusion:

It may be concluded that the extent of dental caries is significantly associated with the path of decomposition of the inorganic and organic matrix of the tooth. The greater the defect is the more grossly carious the tooth becomes leading to its extraction.

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