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HISTOPATHOLOGICAL EVALUATION OF DENTAL PULP IN TEETH WITH DIFFERENT TYPES OF PULPAL DISEASES IN PESHAWAR

Dr Tanzeela[1*], Dr neelofar nausheen[2], Dr Bushra Irum[3], Dr.Rooshanay Haroon[4], Dr palwasha khan[5], Dr Gulshad aziz[6]

[1*]BDS,M.phil oral biology, Lecturer in sardar begum dental college,Peshawar.
tanzeelamalik722@gmail.com
[2]BDS,MCPS (surgery),M.Phil (oral biology) associate professor Sardar Begum dental college.
Email:neelofarnausheen@hotmail.com
[3]BDS,FCPS (operative), Assistant professor, Khyber college of dentistry Peshawar
bushrairum50@gmail.com
[4]BDS, DCD (Operative), Demonstrator Khyber college of dentistry Rooshanayharoon@gmail.com
[5]Msc periodontology Senior registrar Sardar begum dental college Palwasha_ khan88@hotmail.com
[6]BDS MPH MPhil Anatomy demonstrater Institute KMU kohat institute of dentistry
Email : gulshadaziz@yahoo.com

***Corresponding Author:** Dr Tanzeela
[*]BDS,M.phil oral biology, Lecturer in sardar begum dental college,Peshawar.
tanzeelamalik722@gmail.com

Abstract
Pulpal disorders produce severe changes in the dental pulp's structure and function, which in turn induce tooth morbidity. In Peshawar, this study intends to examine the pulp's histological features in teeth that have been extracted due to various pulpal illnesses. Fifty patient teeth that had been extracted were examined histopathologically for signs of tissue degradation, vascular changes, necrosis, and inflammatory response. The results shed light on how pulpal disorders develop and emphasize the significance of acting quickly to treat them.

Introduction
The pulp of the tooth is a highly specialized soft tissue that insulates the tooth, supplies nutrients, and acts as an immune system (1). It is essential for protecting teeth against decay, trauma, and microbe invasion, among other outside threats, and for keeping teeth healthy overall. Pulpal inflammation in teeth can range from treatable (reversible) pulpitis to irreversible (irreversible) pulpitis and, if untreated, pulpal necrosis (2). An important diagnostic technique for determining the severity of pulpal pathology, histopathology can reveal important details about cellular alterations, inflammation, and degenerative processes (3).

Pakistan has a high prevalence of pulpal disorders because people there do not practice good oral hygiene, are unaware of the disease, and have limited access to dental care. The prevalence of pulpal disorders caused by tooth infections is high in Peshawar, a city with ongoing problems with oral health. Extraction or endodontic intervention may be necessary when pulpitis progresses to necrosis and causes periapical disease (4). Clinicians can make better decisions and come up with better

treatment plans for the local community if they understand the histological characteristics of pulpal illnesses.

There is a lack of Peshawar-specific data despite prior research on the histology of pulpal disorders in other populations. By analyzing the histological changes in dental pulp from teeth extracted with various pulpal disorders, this study intends to fill this knowledge gap. A histological profile of pulpal disorders in this region can be established by analyzing inflammatory infiltration, necrosis, fibrosis, vascular alterations, and odontoblastic integrity.

Methodology

Study Design and Sample Collection

This cross-sectional study was carried out at the histopathology laboratory of a tertiary care hospital in Peshawar. A total of 50 extracted teeth diagnosed with pulpal diseases were obtained from patients attending the dental outpatient department. The inclusion criteria included teeth exhibiting clinical and radiographic evidence of pulpal disease, such as irreversible pulpitis, pulp necrosis, and internal resorption. Teeth extracted for orthodontic or periodontal reasons were excluded to maintain a focus solely on pulpal pathology.

Histopathological Processing

Subsequent to extraction, the teeth were immersed in 10% neutral buffered formalin for 24 hours to maintain tissue integrity (5). Decalcification was conducted with a 10% formic acid solution over a period of 7 to 10 days, ensuring sufficient softening for sectioning. After decalcification, the specimens were dehydrated, encased in paraffin wax, and sectioned to a thickness of 5 µm using a rotary microtome. The sections were subsequently stained with hematoxylin and eosin (H&E) for histological analysis using a light microscope (6).

Microscopic Examination

The stained sections were analyzed for the following histopathological parameters:

• **Inflammatory cell infiltration:** Classified as mild, moderate, or severe based on the density of infiltrating cells.
• **Pulpal necrosis:** Categorized as partial or complete, depending on the extent of necrotic tissue.
• **Fibrosis and calcifications:** Evaluated to assess chronic degenerative changes in the pulp.
• **Vascular changes:** Including blood vessel congestion, dilatation, and hemorrhage.
• **Odontoblastic layer integrity:** Recorded as intact, disrupted, or absent.

The collected data were analyzed using SPSS version 25. The association between pulpal disease type and histopathological findings was examined using the Chi-square test, with a significance level set at $p < 0.05$.

Results

Patient Demographics
Out of the 50 extracted teeth analyzed, 30 (60%) were from male patients, while 20 (40%) were from female patients. The age of the patients ranged from 18 to 65 years, with a mean age of 35.4 ± 8.2 years.
Histopathological Findings
Inflammation
Inflammatory cell infiltration was observed in 36 cases (72%). Among these, 18 cases (36%) showed severe inflammation, 12 cases (24%) had moderate inflammation, and 6 cases (12%) exhibited mild inflammation. The inflammatory response was primarily composed of lymphocytes and plasma cells, with neutrophils present in cases of acute exacerbation.
Pulpal Necrosis
Complete pulpal necrosis was identified in 22 cases (44%), whereas 10 cases (20%) had partial necrosis. The necrotic areas were characterized by disorganized tissue structure, loss of cellular components, and bacterial infiltration.
Fibrosis and Calcifications

Fibrotic changes were present in 15 cases (30%), indicating chronic inflammation and reparative responses. Dystrophic calcifications were detected in 8 cases (16%), often associated with long-standing pulp disease.
Vascular Changes
Vascular congestion was observed in 28 cases (56%), with dilated and engorged blood vessels. Hemorrhage was evident in 12 cases (24%), particularly in cases of severe inflammation and necrosis.
Odontoblastic Layer Integrity
Disruption of the odontoblastic layer was noted in 38 cases (76%), while complete absence of odontoblasts was seen in 12 cases (24%). The loss of odontoblastic integrity was more frequent in cases with severe inflammation and necrosis.
Statistical analysis revealed a significant correlation between inflammation severity and pulpal necrosis ($p < 0.05$).

Discussion

Histopathological assessment of tooth pulp offers critical insights into the development and advancement of pulpal disorders. The results of this investigation correspond with current literature on pulpal pathology, indicating that inflammation is a primary characteristic of diseased pulp (7). Severe inflammatory infiltration was noted in 36% of patients, aligning with prior investigations that document analogous inflammatory responses in permanent pulpitis (8). Pulpal necrosis was observed in 44% of instances, indicating the severe stage of disease progression in numerous individuals. This discovery aligns with global evidence suggesting that untreated pulpitis often results in necrosis, especially in areas with restricted access to dental treatment (9). The occurrence of fibrosis and calcifications in 30% and 16% of patients, respectively, indicates reparative efforts by the pulp, as previously documented in degenerative pulpal diseases (10). Vascular congestion and hemorrhage, noted in 56% and 24% of cases respectively, signify ischemia injury and impaired blood flow, which lead to pulpal necrosis (11). The compromise of odontoblastic integrity in 76% of instances corroborates other studies suggesting that odontoblast breakdown is a characteristic feature of advanced pulpal pathology (12).

Clinical Implications

This study's findings underscore the significance of early intervention in pulpal disorders. Preventive strategies, including prompt caries intervention, enhanced dental cleanliness, and heightened public awareness, can diminish the prevalence of advanced pulpal disease (13). Endodontic procedures, including root canal therapy, must be prioritized to maintain tooth integrity and avert development to necrosis (14).

Limitations

This study was confined to removed teeth, perhaps omitting patients that could have been treated conservatively. The sample size was limited, and the results may not be applicable to the broader population of Peshawar.

Conclusion

Pulp histopathology of Peshawar teeth that had pulpal disorders and were extracted showed extensive inflammation, necrosis, vascular abnormalities, and disruption of the odontoblastic layer. These results highlight the need of prompt identification and treatment in avoiding permanent pulp injury. It is suggested that future studies include more examples of conservative treatment and use bigger sample sizes.

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