ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 2, March - 2022, Page No. : 346 - 352

Study of the patterns of External Root Resorption Under Different Condition- A Scanning Electron Microscopic Study

[1]Dr.Mitul Prajapati, Senior Lecturer, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

[2]Dr.Monali Shah, Professor and Head, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

[3]Dr.Amena Ranginwala, Professor, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

[4]Dr.Hiren Bhojak, Senior Lecturer, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

[5]Dr.Saurabh Nayak, Senior Lecturer, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

[6]Dr.Lalbahadur Sadhu, Senior Lecturer, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

Corresponding Author: Dr. Mitul Prajapati, Senior Lecturer, Department of Oral Pathology & Microbiology, Ahmedabad Dental College and Hospital, Gujarat University, Ahmedabad, Gujarat, India.

Citation of this Article: Dr. Mitul Prajapati, Dr. Monali Shah, Dr. Amena Ranginwala, Dr. Hiren Bhojak, Dr. Saurabh Nayak, Dr. Lalbahadur Sadhu, "Study of the patterns of External Root Resorption Under Different Condition- A Scanning Electron Microscopic Study", IJDSIR- March - 2022, Vol. – 5, Issue - 2, P. No. 346 – 352.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aims: The aim of this study was to examine qualitative differences in the appearance of external root resorption patterns of primary teeth undergoing physiologic root resorption and permanent teeth undergoing pathological root resorption in different conditions using scanning electron microscope.

Material and Method: A total of 40 teeth undergoing external root resorption in different conditions were divided into 4 groups and prepared for examination under scanning electron microscopy at magnifications ranging from 20x to 1000x. Group I:10 primary molars exfoliated due to physiologic root resorption Group II: 10 permanent teeth with periapical granulomas showing signs of resorption Group III:10 permanent teeth extracted during the course of orthodontic therapy with evidence of resorption, and Group IV: 10 permanent teeth associated with odontogenic tumors.

Results: In Group I, primary teeth showed smooth multilocular appearance reflecting the slow ongoing physiologic process. In Group II, teeth with Periapical granulomas showed funnel shaped appearance at resorption area. In Group III, teeth showed the presence of numerous resorption craters. In Group IV, teeth showed haphazard and ragged appearance of the root with extensive loss of root length.

Conclusions: Study showed the differences in the patterns of external root resorption in primary teeth undergoing physiologic root resorption and permanent teeth undergoing pathological root resorption.

Keywords: Scanning electron microscopy, Root resorption.

Introduction

The hard tissue of human teeth is composed of enamel, cementum and dentin. Multinucleated cells called odontoclasts resorb roots of teeth. Root resorption was first described by Bates in 1856. Root resorption is broadly classified into two types 1) Physiologic root resorption and 2) Pathologic root resorption.[1] Physiologic root resorption is emerging permanent tooth applies pressure on the primary predecessor leading to activation of odontoclasts and ultimately exfoliation. It is an intermittent process with periods of resorption alternating repair activity.[2]

Pathologic root resorption may be broadly classified into 1) Internal and 2) External resorption. Internal resorption is relatively rare and occurs as a result of trauma or caries related inflammation of the pulp. External resorption begins in the periodontal ligament (PDL). It has various causes, including infective/inflammatory conditions, traumatic injuries, pressure/mechanical stimulation, neoplastic conditions. Various methods have been advocated to assess resorption including histology, the use of panoramic and periapical radiography[5] and scanning electron microscope (SEM) [3]. SEM allows the visualization of images at high technique, an electron beam scans the surface of the sample to produce a variety of signals, the characteristics of which depend on many factors, including the energy of an electron beam and the nature of the sample, since a beam of electrons hit the sample and the response is collected by a detector.[2] The use of SEM has certain advantages over the other traditional methods, as it permits the assessment in multiple planes.

The purpose of exploring morphology is to get an insight into function. The morphologic image represents the visual expression of functional activity and thus the aim of this study was to examine if there are qualitative differences in the appearance of external root resorption patterns of primary teeth undergoing physiologic resorption and permanent teeth undergoing pathological root resorption in different conditions. Electron microscopic studies of root resorption also help in the diagnosis and treatment planning.[6, 7, 8]

Material and Method

This clinical study evaluated in 40 teeth which divided into four different groups. Group I- 10 primary molars exfoliated due to physiologic root resorption, Group II- 10 permanent teeth with periapical granuloma, Group III- 10 permanent teeth extracted after short duration of orthodontic forces and Group IV- 10 permanent teeth associated with odontogenic tumors. Method for obtaining apical root of teeth: After examination, teeth were placed in 5% sodium hypochlorite solution for 12 hours to remove soft tissues. The apical third portions of the roots were removed by low-speed high torque micromotor. (400 -800 rpm) Specimens then analysed at Gujarat Forensic Science Laboratory (FSL), Gandhinagar. In examination room of SEM at FSL following steps has been done.

1. Selected tooth root specimens were assembled on coded stubs.
2. Specimens were placed in a vacuum chamber and sputter-coated with a 300 Å gold layer and prepared for SEM examination.
3. Specimens then analysed using a Scanning Electron Microscope (JEOL JSM6380A, JEOL, Tokyo Japan) at 20 kv beam current.
4. The regions of the apical third and apical foramen were observed at magnification of up to 1000X and photographed.
5. Photomicrographs were analyzed by an examiner. The specific areas of interest on the teeth were examined under various magnifications - 20x, 100x, 500x and 1000x.
6. The lowest magnifications were used to identify the areas of resorption and the higher magnifications to study the specific patterns of resorption
7. The resorption patterns were described on the basis of extent and the distinct surface appearance.

Results

Group 1 shows primary molar undergoing physiologic root resorption. Primary molars undergoing resorption examined at 20x magnification showed presence of extensive areas of resorption on the lingual aspect of all roots leading to blunting of the apical regions. (Figure 1.a) At 100x the resorption area has a smooth multilocular appearance. The shiny white area inside the apical foramen was present suggesting remnant of pulpal soft tissue. (Figure 1.b) At 500x magnification, the presence of several individual resorption lacunae can be clearly appreciated. The area looks as if individual adjacent areas of tooth material have been scooped out from the root surface. (Figure 1.c) At 1000x magnification, the dentinal tubule entrance is visible. (Figure 1.d)

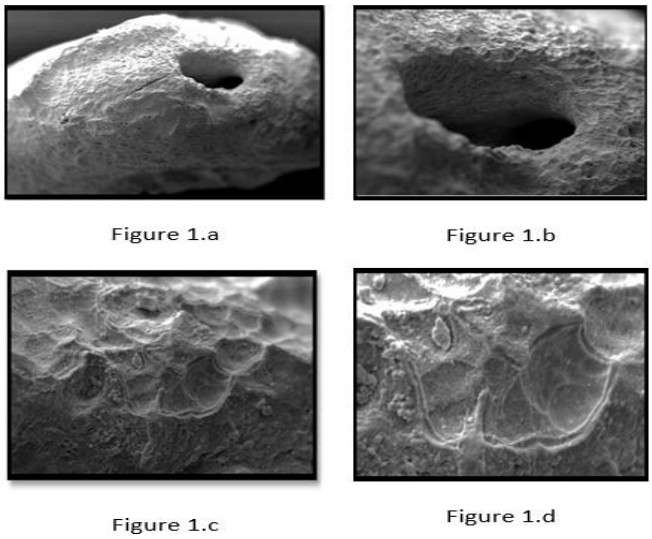

Figure 1: Physiologic Root resorption of Primary molar at 20x (1.a), 100x (1.b), 500x (1.c), 1000x (1.d) magnifications.

Group 2 shows mandibular permanent molar undergoing root resorption due to periapical pathology. At 20x magnification, there was a blunting of the entire apical region of the roots and the entire apical root surface has a smooth eggshell like appearance and showed resorption near the foramen. (Figure 2.a) At 100x, there were evidence of exposed dentinal tubules and resorptive activity in the apical third of the root, particularly close to the apex, leading to a funnel like appearance. There was a widening of the apical foramen diameter due to the loss of cementum around the periapical region. The resorptive activity seems to be radiating outward from the apex. (Figure 2.b) At 500x, the periphery of the foramen shows areas of normal cementum interspersed with resorption craters. Differently from the primary teeth, the resorptive areas were not uniformly seen. (Figure 2.c) At 1000x sheet-like structures at the site of resorption were observed. These structures could be bacterial filaments or rod-shaped organisms, and were located in the apical areas of the resorption close to the cavity wall of the pulpal side. (Figure 2.d)

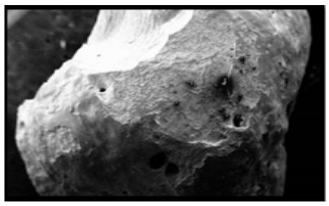
Figure 2.a

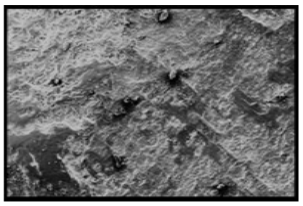
Figure 2.b

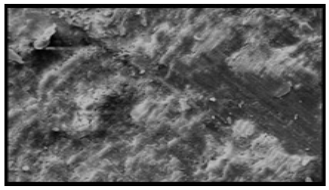
Figure 2.c

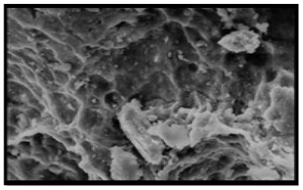
Figure 2.d

Figure 2: Root resorption of Permanent molar associated with Periapical pathology at 20x (2.a), 100x (2.b), 500x (2.c), 1000x (2.d) magnifications.

Group 3 shows mandibular premolar undergoing pressure resorption during the course of orthodontic treatment. At 20x magnification resorption was seen mostly along the mesial and buccal aspect. (Figure 3.a) At 100x, the presence of resorption bays with adjoining areas of cemental repair (light arrow) can be appreciated. Active resorption characterized by smooth multilocular surfaces; cementum was undermined by How ship lacunae. (Figure 3.b) At 500x, the presence of an individual resorption crater of irregular size and shape was specifically visible. (Figure 3.c) At 1000x, the individual craters of resorption were more visible. (Figure 3.d)


Figure 3.a

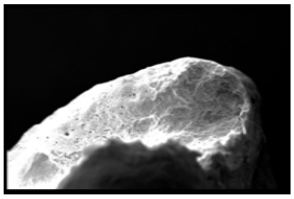
Figure 3.b

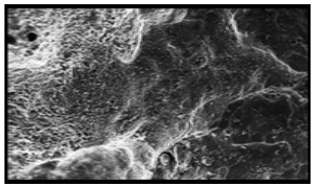
Figure 3.c

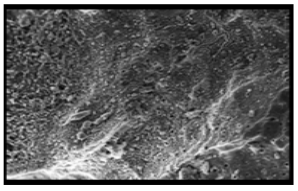
Figure 3.d

Figure 3: Root resorption of a Premolar subjected to orthodontic force at 20x (3.a), 100x (3.b), 500x (3.c), 1000x (3.d) magnifications.

Group 4 shows permanent molar undergoing pressure resorption associated with dontogenic tumors. At 20x shows a haphazard and ragged appearance of the root of an anterior tooth with extensive loss of root length which revealed loss of normal smooth root surface topography. (Figure 4.a) At 100x, the presence of a single very large resorption crater in between the roots was seen. (Figure 4.b) At 500x showed extensive loss of normal smooth root surface topography. (Figure 4.c) At 1000x active resorption characterized by smooth multilocular surfaces and cementum was undermined by How ship lacunae. (Figure 4.d)

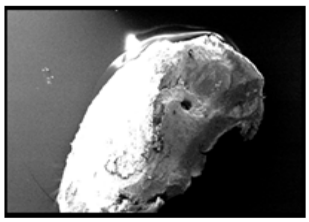
Figure 4.a

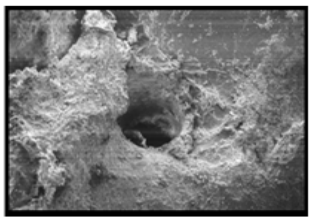
Figure 4.b

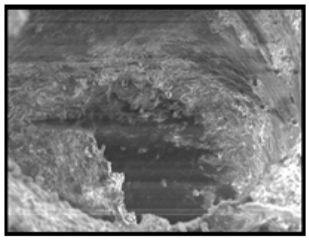
Figure 4.c

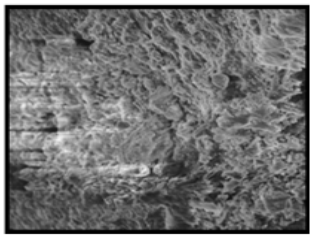
Figure 4.d

Figure 4: Root resorption of Permanent molar associated with Odontogenic tumor at 20x (4.a), 100x (4.b), 500x (4.c), 1000x (4.d) magnifications.

Discussion

Root resorption of primary teeth is a normal, essential and physiologic process. Usually it is a necessary precursor to the eruption of the permanent teeth. It is believed that erupting permanent tooth applies pressure on the primary predecessor leading to activation of the

osteoclast and ultimately exfoliation.[14] In the present study, the primary teeth examined with SEM were in different stage of root resorption but most of them had lost more than two thirds of their root length prior to exfoliation. We observed extensive areas of resorption on the lingual aspect of the roots suggesting a site of pressure applied by lingually placed permanent tooth. We also observed very regular polycyclic shallow lacunae representing a uniform slow ongoing physiologic process of root resorption. In some specimen we also identified a remnant of pulpal soft tissue due to extensive loss of root surface from the lingual aspect of root.

Delzangles, vier, and figueiredo (2001), showed apical inflammatory root resorption usually forms part of the periapical pathology associated with periapical granuloma whereas in our study we found more severe resorption in the apical third than in the middle and cervical thirds of the root.[9,10,12]

In this study the resorptive process was not quantified. The analysis has shown external root resorption in 100% of the specimens, similar to that found by Rosa Neto et al. These results were different from those obtained by Malueg (1996) et al., Ferlini and Vier and Figueiredo (2001) who reported 12.5%, 10% and 8.9% of specimens with no resorption respectively. Resorption areas were concentrated mainly in the foraminal region and their diameter and depth were variable. Similar observation was described by Siqueira and Lopes.[9, 10,11,16,17]

Numerous resorption cavities were observed. In many specimens, cementum had superficial and deep areas of resorption of varying size and intact areas, both adjacent to the apical foramen. Similar findings were described by Delzangles and Leonardo etal. Vier and Figueiredo (2001) also observed the presence of one or two isolated lacunae, surrounded by an integral cementum surface or by a set of interconnected gaps that were occasionally related to other resorption zones. According to Consolaro, the multiple and superficial gaps suggest a lateral and in rotation cell movement during clastic activity.[12, 17, 18]

In our study in cases of severe resorption, alterations in the foramen outline became irregular. Rosa Netoet al. also found that the apical root surfaces of teeth with chronic periapical lesion were irregular, eroded, with cementum-dentinal resorption.[15] The funnel-like appearance seen in our study has previously been described by Malueg et al and Sreeja et al (2009). This indicates that resorption was actively taking place mainly along the localized areas of pressure from the periapical granuloma. The areas of resorption were localized at the apex with a clear border demarcating it from the adjoining normal area indicating that pressure from the lesion could be a major contributing factor to the process.[11, 15]

Orthodontic tooth movement is possible as cementum has greater resistance to resorption than bone. However, similar to Weiland F et al in our study root resorption was also seen after the application of light orthodontic force even within a short duration period. The point of force application with conventional orthodontic mechanics was from the buccal aspect. In the early stages of treatment, this causes buccal tipping of crown and lingual tipping of root of premolars leading to opposing areas of tension and compression in the crown and root. The resorption process on examination with SEM was however not restricted to any particular area. Based on extent varying degrees of orthodontically induced inflammatory root resorption has been described by Brezniak et al in 2002. In our study, we found resorption seen mostly along the mesial and buccal

aspect. In the present study, the resorption in all premolars was restricted to mild surface cemental resorption probably because of the short duration for which teeth were subjected to force application. The extent and site of resorption was not uniform to reach a categorical conclusion as a multitude of local and systemic factors play a vital role in orthodontically induced root resorption. It is important to know that even in early stages of orthodontic treatment there is evidence of cemental resorption, which may not always be evident on radiographs unless it reaches an advanced stage.[13, 15] Sreeja et al in 2009 concluded that in the teeth associated with odontogenic tumors, no particular pattern was discernable as they were variable in appearance. Similar to that in our study, we also found haphazard and ragged appearance of the root with extensive loss of root length which reveals loss of normal smooth root surface topography. Most teeth, however, showed an extensive loss of root length form the resorptive process. Previously there have been reports of root resorption in teeth in the proximity of odontogenic tumors, such as ameloblastoma. Two teeth associated with ameloblasto mas were chosen for closer examination as they had a strikingly different appearance of roots. A sharp cut appearance of the roots was visible echoing the aggressive nature of the rapidly growing lesion. Root resorption was haphazard and ragged as previously described in literature. This aggressive root resorption pattern reflects the loss of cellular regulatory control synonymous with tumor pathology.[15]

Conclusion

There were differences in the patterns of external root resorption under different conditions when studied under SEM. The resorption pattern reflects the nature of the underlying etiology. By the SEM we can differentiated physiologic and pathologic root resorption which can be valuable in forensic aspect. In case of endodontic application external apical root resorption may be evident under SEM but not radiographically, except when it is advanced. When they are severe, resorption can modify the foramen outline. As the working length is determined radiographically without considering apical root resorption, instrumentation or filling beyond the apical foramen can occur. In orthodontia SEM can be used as a new method for volumetric measurement of orthodontically induced root resorption craters in different kind of forces on different surfaces of teeth. SEM shows the difference in the resorption pattern in more aggressive tumor and less aggressive cyst so can also be used to differentiate tumor from cyst. Although study is valuable as an additional source of basic information, it has limited clinical application in recent era but further investigations on the quantitative and molecular aspects of root resorption will shed light on several unknown features providing a database for exciting new fields like forensic dentistry.

References

1. Gunraj MN. Dental root resorption. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999;88(6):647-53.

2. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997; 30: 297-306.

3. Han G, Huang S, Hoff JW, Zeng X, Kuijpers-Jagtman AM. Root resorption after Orthodontic intrusion and extrusion: an intraindividual study. Angle Orthod. 2005; 75(6): 912-8

4. Brezniak N, Wasserstein A. Orthodontically induced inflammatory root resorption. Part I: The basic science aspects. Angle Orthod. 2002; 72:75-9.

5. Kronfeld R. The resorption of the roots of deciduous teeth. Dent Cosmos.1932;74:103-205.

6. Tronstad L. Root resorption - etiology, terminology and clinical manifestations. Endod Dent Traumatol 1988; 4: 241-52.

7. Nair PNR. Apical periodontitis: a dynamic encounter between root canal infection and Host response. Periodontology 2000 1997; 13: 121-48.

8. Laux M, Abbott PV, Pajarola G, Nair PNR. Apical inflammatory root resorption: a Correlative radiographic and histological assessment. Int Endod J 2000; 33: 483-93.

9. Delzangles B. Apical peridontitis and resorption of the root canal wall. Endod Dental Traumatol 1988; 4: 173-7.

10. Delzangles B. Scanning electron microscopic study of apical and intracanal resorption. J Endod 1989; 15: 281-5.

11. Malueg LA, Wilcox LR, Johnson W. Examination of external apical root resorption with Scanning electron microscopy. Oral Surg Oral Med Oral Pathol Oral RadiolEndod.1996;82:89-93.

12. Vier F and Figueieredo J. Prevalence of different periapical lesions associated with human teeth and their correlation with the presence and extension of apical external root resorption. Int Endo J 2002; 35: 710-719.

13. Brezniak N et al. Orthodontically Induced Inflammatory Root Resorption. Part II: the Clinical Aspects. Angle Orthod 2002; 72: 180-184.

14. E. Ceppi et al. Cementoenamel Junction Of Deciduous teeth: SEM morphology. Eru J Of Paed Dent 2006; 3:131-136.

15. Sreeja et al. A Scanning Electron Microscopic Study of The Patterns Of External Root Resorption Under Different Conditions. J Appl Oral Sci.2009;17(5):481-486.

16. Nair PNR. Apical periodontitis: a dynamic encounter between root canal infection and Host response. Periodontology 2014; 13: 121-48.

17. Siqueira JF, Lopes HP. Bacteria on the apical root surfaces of untreated teeth with Peri radicular lesions: a scanning electron microscopy study. Int Endod J 2015; 34: 216-20.

18. Igarashi K, Adachi H, Mitani H, Shinoda H. Inhibitory effect of topical administration of a biphosphanateon root resorption incident to orthodontic tooth movements in rats. J Dent Res. 2016; 75:1644-1649.