

## Comparison of Dentinal Tubule in Primary and Permanent Molar under Transmitted Light, Polarised Light and Scanning Electron Microscope: An in-Vitro Study

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### Abstract

**Background:** Dentin is considered as a fundamental substrate of restorative dentistry and its physical, chemical & histological properties and characteristics are key determinants of nearly all restorative, preventive and disease processes of the teeth. It is dentinal tubules intrinsic permeability that is responsible for permitting bacterial or chemical substances to diffuse across the dentin and irritate the pulpal and periradicular tissues in both primary & permanent tooth dentin. There is a need for improved understanding of the dentin structure and nature which will have important consequences for today's dental procedures. The aims of the study were to observe the direction of dentinal tubule in primary & permanent molar.

**Aims:** The aims of the study were to observe the direction of dentinal tubules.

**Methods and Material:** Present in vitro study was carried out in the Department of Oral and Maxillofacial Pathology, Rajasthan Dental College and Hospital, Jaipur and Material Research Center, Malviya National Institute of Technology, Jaipur following clearance from the ethical committee of the institution. A total of 20 teeth (10 primary and 10 permanent molars), unrestored, noncarious, hypoplastic extracted molars were ground sectioned & used in the present study. All the data was entered on the Proforma & subjected to statistical analysis using Fisher's exact test.

**Results:** Examination of ground sections of the primary teeth dentin showed "s"-shaped curvature in none (0 %) specimens and a straight course of dentinal tubules in all 10 (100%) specimens out of 10 teeth examined whereas in permanent teeth, 7 (70%) specimens showed an "s"-shaped curvature and 3 (30%) specimens out of 10 specimens examined. These results are statistically significant ( $P < 0.003$ ).

**Conclusions:** Dentinal tubules followed an “s”-shaped course in 7 (70%) permanent molars and in none (0 %) primary molars & the results were significant.

**Keywords:** Dentinal tubules, Primary Tooth Dentin, Polarized Light Microscopy

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## Introduction

Dentin is part of the pulp-dentin complex and it is a mineralised connective tissue with the largest volume in the dentinary piece. [1] It forms slightly before the enamel and determines the shape of the crown portion of tooth with cusps and ridges, and roots number and size. [2]

Dentin is rigid but elastic tissue consisting of large number of small parallel tubules in a mineralized collagen matrix. The tubules contain the long processes of the cells which forms odontoblasts and dentinal ECF [3] and neurons. The dentinal matrix collagen provides the resiliency necessary for the crown enamel and dentin to with stand the masticatory forces and protects the pulp. The penetration of bacteria occurred first in the dentinal tubules and then invasion of bacteria destruction of the interglobular dentin.[4]

Dentinal tubules in the outer two-thirds of the dentin were empty and inner dentin contains a well - defined odontoblastic processes were seen lying inside the sheath.[5] It is the intrinsic permeability of the dentin which is responsible for permitting the bacteria in the oral cavity and chemical substances and its diffusion across the dentin and irritates pulpal tissues as well as the tissues in the peri radicular region.[6] As response to external stimuli like restorative procedures, caries and attrition there is formation of dentin around the pulp known as tertiary dentin. [7]

Studies of dentin structure date back to the early history of light microscopy.[8] A wide range of techniques have been used to reveal its detailed structure, including

histo-chemistry,[9] immunofluorescence microscopy,[10] various types of light microscopy such as polarized,[11] phase-contrast and interference microscopy,[12] micro-radiography,[13] and transmission[14] and scanning electron microscopy (SEM).[15] Most studies focused on the permanent teeth dentin, and relatively few examined structural differences between the permanent teeth and primary teeth dentin.[16] Understanding the microstructure of the dentin can provide a basis for improved understanding of the correlation between its structure and properties.[17]

## Subjects and methods

### Histological Study Procedure

The dentinal tubules in primary molars and permanent molars under transmitted light, polarised light and scanning electron microscope will be compared.

A total of 20 teeth (10 primary and 10 permanent molars), un-restored, non-carious extracted molars will be mechanically cleaned using pumice and water slurry and will be stored in distilled water till further use for the study.

The roots of the selected tooth will be removed 2 mm below the cemento-enamel junction and the coronal portion of the tooth will be mounted in a self cure acrylic for longitudinal sectioning in such a way that two- third of coronal portion will be exposed for the sectioning.

### Preparation of the ground section

A longitudinal ground section of the teeth will be obtained for all the teeth.

### Preparation of the sections

The ground sections will be observed under scanning electron microscopy and will be mounted on a microscopic glass slide using mounting media, Dystereene Polystyrene Xylene, and cover with a cover slip to observe under transmitted light, polarized light microscope for the direction of dentinal tubules

### Results

Present in vitro study was carried out in the Department of Oral and Maxillofacial Pathology, Rajasthan Dental College and Hospital, Jaipur and Material Research Center, Malviya National Institute of Technology, Jaipur following clearance from the ethical committee of the institution.

In the present study under a transmitted light and polarized light microscopy and the scanning electron microscope, the following histological features were observed:

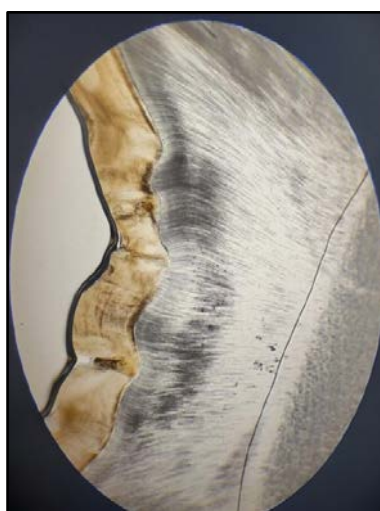
On examination of ground sections of primary molars, dentin showed an “s”-shaped curvature of dentinal tubules in none of the 0 (0 %) specimens and a straight course of dentinal tubules in all 10 (100%) of specimens from the DEJ towards pulp chamber out of 10 primary molar teeth examined whereas, in permanent molar teeth, 7 (70 %) of specimens showed an “s”-shaped course of dentinal tubules and 3 teeth (30%) showed straight course of dentinal tubules. These results are statistically significant ( $P < 0.003$ )

Discussion: Dentin in permanent and primary teeth has similar morphology and composition and it has been assumed that dentin of both kinds of teeth are similar in histological structure. The findings of teeth have been assumed to apply to primary teeth, but some evidence [18,19,20] suggests significant differences are present between them. Thus, an attempt is made to compare the histological features of dentin in both the dentition.

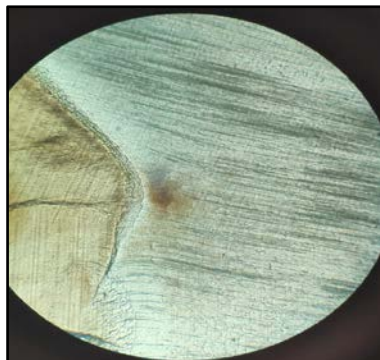
**Table 1: Direction of dentinal tubules**

Type of teeth	Direction of Dentinal Tubules		Total (%)	Exact Sig. (2-sided) <sup>#</sup>
	S-Shaped (%)	Straight (%)		
Primary (n=10)	0 (0)	10 (100)	10 (100)	0.003*
Permanent (n=10)	7 (70)	3 (30)	10 (100)	

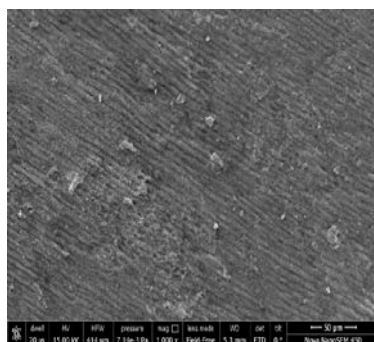
\*Significant ( $p < 0.05$ ), <sup>#</sup> Fisher's Exact Test



**Fig 1 Dentinal tubule follows a straight path from dentinoenamel junction towards pulp chamber under transmitted light microscope (Magnification 4x)**



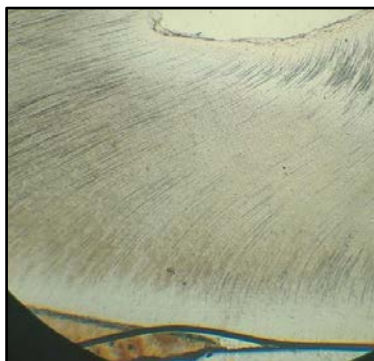
**Fig.2 Dentinal tubule of primary molar follows a straight course from the dentinoenamel junction towards pulp chamber under polarized light (Magnification 10x)**



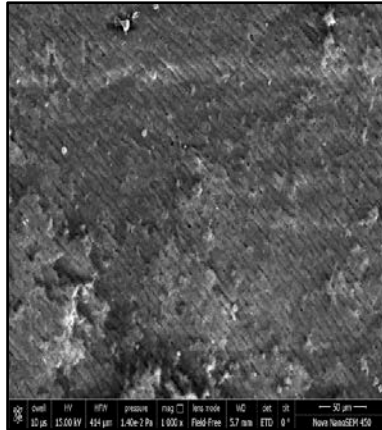
**Fig.3 Dentinal tubule of primary molar follows a straight line of course under Scanning Electron Micrograph. (Magnification 1000X)**



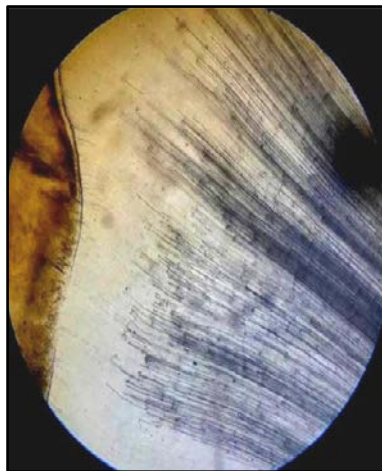
**Fig.4 Dentinal tubule follows an 'S' shaped curvature from the dentino enamel junction towards the pulp chamber under the transmitted light microscope (Magnification 4x)**



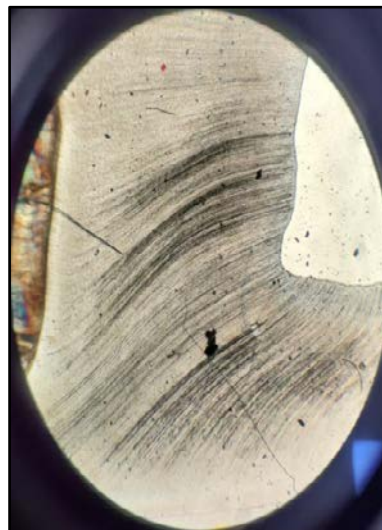
**Fig.5 Dentinal tubule of permanent molar follows the 'S' shaped curvature from the dentinoenamel junction towards the pulp chamber under polarized light microscope (Magnification 4x)**



**Fig. 6 Dentinal tubule of permanent molar follows the curvature under Scanning Electron Micrograph (Magnification 1000X)**



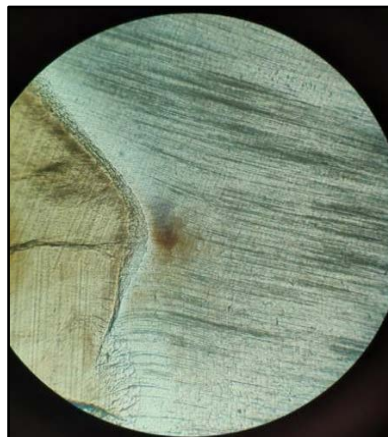
**Fig.7 Dentinal tubules of permanent molar under transmitted light microscope. (arrow) Shows less curvature of dentinal tubule near the dentinoenamel junction beneath the cusp. (Magnification 10x)**



**Fig.8 Dentinal tubule of permanent molar under polarised light microscope. (arrow) less curvature of dentinal tubule near the dentinoenamel junction beneath the cusp. (Magnification 4x)**



**Fig.9 Dentinal tubule of primary molar teeth under transmitted light. (Arrow) Dentinal tubule runs a straight course throughout its course from the dentinoenamel junction towards the pulp chamber and have more straight course as it reaches DEJ beneath the cusp & also shows the most profuse dentinal tubules & its branches near DEJ. (Magnification 4x)**



**Fig.10 Dentinal tubule of primary molar teeth under polarized light microscope (Arrow) Dentinal tubule runs a straight course throughout its course from the dentinoenamel junction towards the pulp chamber and have more straight course as it reaches DEJ beneath the cusp (Magnification 10x)**

#### Direction of Dentinal Tubules

Dentin of the tooth is permeated by the dentinal tubule, which runs from pulpal surface towards DEJ. Course taken by the dentinal tubule follows a curve sigmoid. The configuration of dentinal tubule indicates the course taken by odontoblasts during the process of formation of dentin. [21]

In our study on examination of longitudinal ground sections of primary and permanent teeth dentin for dentinal tubules direction, there was a significant difference ( $P < 0.003$ ). Primary molar teeth dentin showed dentinal tubules

following a straight course in all 10 (100%) specimens under the transmitted light [Fig. 1], Polarised light [Fig.2], and SEM [Fig. 3],

Dentinal tubule follows a straight line of path when observed under SEM in the deciduous molar [Fig.5.] as compared to the permanent molars [Fig.6]. Same straight path of course of dentinal tubules were also observed in primary molars under the transmitted light [Fig.4.1] and polarized light microscope [Fig. 2]

Whereas in the permanent molar teeth dentin 7(70%) specimens showed an “s”-shaped curve of the dentinal tubule and 3

(30%) specimens straight course of the dentinal tubules under transmitted light [Fig. 4], Polarized light [Fig.5], and SEM [Fig.6].

In our study the dentinal tubule seems to follow a curvature on the dentinal surface in the permanent molar teeth when observed under SEM [Fig.6]. This finding could not be compared with other studies as exploration of the available literature revealed that no studies have been reported in literature which has tried to observe the direction of dentinal tubules in primary molar and permanent molar on dentin surface under SEM. This curvature may be due to the 'S' Shaped course of the dentinal tubules in the permanent molars. The same when observed under the transmitted light [Fig.4] and the polarized light [Fig.5] microscopy shows the primary curvature of the dentinal tubules from the DEJ towards pulpal surface.

This result were consistent with the study done by Chowdhary N, Subba Reddy VV in 2010 where on examination of longitudinal ground sections of permanent and primary teeth dentin for the direction of dentinal tubules, there was a highly significant difference. ( $P < 0.001$ )[22]

It showed that there is a some definite difference in the dentinal tubules direction in permanent molar tooth dentin when compared with primary molar tooth dentin. The "s"-shaped curvature of dentinal tubules indicates the course which is taken by the odontoblasts during dentin formation. This "s"-shaped curvature is due to crowding of the odontoblastic process as they run from the periphery toward the center of the pulp surface. [21, 23] Whereas, in primary tooth dentin, most of the dentinal tubules in our study did not show the "s"-shaped curve. The reason can be the surface area and its difference between the dentin near the amelodentinal junction and that of near the pulpal surface and this is evinced by the fact that primary tooth have wider pulpal surface than that of the permanent teeth pulpal surface. [24]

This factor could result in less crowding of the odontoblasts and, hence, a straight course of the dentinal tubules in coronal part of the dentin. [19] This fact is seems to be consistent in our study also which may be assume by the two findings in the present study as first, the primary curvature beneath the cusp near the dentino enamel junction were less pronounced and runs a straighter course in permanent molar teeth [Fig.7] and [Fig. 8]

Both under the transmitted and polarised light microscope in 6 of the permanent molar teeth and second there is no primary curvature were found in all the 10 primary molar sample in our study which runs throughout a straighter course beneath the cusp from the DEJ towards the pulpal surface [Fig.9] and [ Fig.10]. There is also seems to be most profuse pattern of dentinal tubules and its branches near DEJ were present in 6 sample of primary molar teeth observed under both the transmitted and polarized light microscope with in this 4 of the sample also showed union of side branches with other tubules under both transmitted and polarized light microscope. [25] This finding of could not be compared with other studies as exploration of the available literature revealed that no studies have been reported in literature which has tried to observe dentinal tubules and its branches near DEJ in primary molar teeth. In the permanent molar teeth whereas, the dentinal tubules branch near the DEJ were observed in 4 samples and the its union with other tubules within this in 3 sample out of 4 sample observed.

This structural appearance of the dentinal tubule in the primary tooth dentin may be one of the factors contributing to the faster progression of caries. [19] Based on this findings in our study we can assume that this can also be an another reason of early involvement of pulpal horn beneath the cusp in primary molar teeth due to faster progression of caries in these areas where

as, the high pulpal horn is itself one reason.

### Conclusion

On examination of longitudinal ground sections of primary and permanent teeth dentin for the dentinal tubules direction, there was a significant difference ( $P < 0.003$ ). Primary molar teeth dentin showed dentinal tubules following a straight course in all 10 (100%) specimens under the transmitted light, polarised light, and SEM. Dentinal tubule follows a straight line of path when observed under SEM in deciduous as compared to permanent molars. Same straight path of course of dentinal tubules were also observed in primary molars under transmitted and polarized light. Whereas in the permanent molar teeth dentin 7(70%) specimens showed an "s"-shaped curve of the dentinal tubule and 3 (30%) specimens straight course of the dentinal tubules under transmitted light, polarized light, and SEM.

In our study dentinal tubule seems to follow a curvature on dentinal surface in permanent molar teeth when observed under SEM. The same when observed under transmitted and polarized light microscopy shows primary curvature of dentinal tubules from DEJ towards pulpal surface.

There is also seems to be most profuse pattern of dentinal tubules and its branches were present in 6 (60%) sample of primary molar observed under both transmitted and polarized light with in this 4 (40%) of the sample also showed union of side branches with other tubules under both transmitted and polarized light. In permanent molar teeth whereas, dentinal tubules branch near the DEJ were observed in 4 (40%) samples and its union with other tubules within this in 3 (30%) sample out of 4 sample observed. Based on this finding in our study we can assume that this can also be another reason of early involvement of pulpal horn beneath the cusp in primary

molar teeth due to faster progression of caries in these areas where as, the high pulpal horn is itself one reason.

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