

EVALUATE THE PRESENCE OF BUTTERFLY EFFECT IN THE TRANSVERSE SECTIONS OF THE ROOTS OF INCISORS, CANINES AND PREMOLARS

Shivani N, Santhanam A

Department of oral pathology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

Abstract

To evaluate the presence of butterfly effect in the transverse sections of the roots of incisors, canines and premolars.

The butterfly effect is an optical phenomenon seen generally in the cross sections of root under light microscope. It occurs due to the change in the dentinal tubule density which causes light to refract and scatter when passed through it.

A total of 30 single rooted freshly extracted teeth without any caries and fractures were selected and were grouped in three groups (Group I =10 incisors, Group II =10 canines, Group III premolars respectively). Using a Micro motor and a diamond abrasive bur, the crowns were decoronated and the root were sectioned into 3 transverse sections. Each section is made into 1mm uniform thickness and were observed under light microscopy to detect the presence or absence of butterfly effect and the scoring was given accordingly.

In 90% of incisors and canines showed butterfly effect, whereas only 20% of the premolars showed the effect. The butterfly effect was found to be more in the buccolingual direction than in the mesiodistal direction.

The presence of butterfly effect in transverse sections of root helps in understanding the root fractures which has its significance in endodontics during instrumentation.

Key words: butterfly effect, dentinal tubules, sclerotic dentin

Introduction

Dentin is a calcified tissue which forms the bulk of the tooth and is capped on the exterior surface by highly mineralized enamel on the crown and by cementum on the root. Physiologically and anatomically, dentin is a complex structure which contains dentinal tubules that starts from the DEJ to the dentin–pulp border [1]. Dentinal fluid fills in the dentinal tubules and the fluid content of the dentin tubules varies by depth, with superficial dentin containing the lowest fluid content and dentin closest to the pulp, containing more fluid [2]. The cell processes of the odontoblasts also traverse the walls of the dentinal tubules which explains the dentin sensitivity reaction [3]. Dentin is the first vital tissue to meet any external irritation.

When ground sections of dentin are viewed under light microscope, the dentinal tubules causes light to refract and scatter [4]. The density of the dentinal tubules varies depending on its location [5]. A decrease in the number of dentinal tubules results in greater light transmission to give a translucent appearance. In sclerosed dentin there is a decrease in the number of the dentinal tubules due to the obliteration which makes it more translucent than normal dentin. Also, sclerosis of dentinal tubules differs in buccolingual and mesiodistal directions which creates a characteristic butterfly shape due to the different shades of dentin [6]. “Butterfly” effect of dentinal tubules was first documented by Beust in 1931 as an optical phenomenon in transverse sections of roots. There is limited literature on the butterfly effect and its effect on the tooth [7]. Hence, the aim of the study is to observe the butterfly effect in the transverse sections of tooth roots and to compare the occurrence between incisors, canines and premolars.

Materials and methods

Sample design

A total of 30 single rooted freshly extracted human teeth were collected from the outpatient department of a private dental institution in Chennai and were divided into three groups.

Group I = 10 incisors,

Group II = 10 canines,

Group III = 10 single rooted premolars.

Inclusion criteria are :teeth without any caries, no evidence of fractures.

Exclusion criteria are :external root resorption, abnormal root anatomy.

Study design

The extracted teeth were cleaned with hydrogen peroxide. Using a micro motor (Marathon 4) and a diamond abrasive disc, the teeth were decoronated and each root was sectioned into 3 transverse sections, one from cervical third, middle third and apical third respectively. Each section was made into 1mm thickness using Arkansas stone and the thickness of each section was confirmed using Vernier callipers, if any uneven thickness was found it was made uniform by using an abrasive stone. The sectioned teeth were mounted on a glass slide with DPX and xylene and were allowed to dry. The sections were observed under light microscope (Olympus CH20i) using 10 x magnification for the presence or absence of butterfly effect in the transverse sections of the roots.

Scoring criteria:

Score 1 represented absence of butterfly effect (where the dentin had uniform colour).

Score 2 represented presence of butterfly effect (root section displaying 2 shades of dentin).

The scores for each tooth were summed. A score of 6 represented a tooth in which the effect was present in all sections, whereas 3 represented a tooth in which the effect was totally absent. The direction of the butterfly effect (buccolingual or mesiodistal) in each root section if present was also noted (figure1 and figure 2). The results were collected, tabulated and analysed.

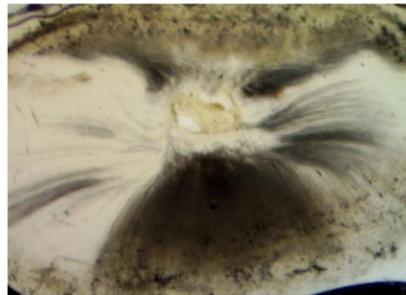


Figure 1. Butterfly effect in mesiodistal direction

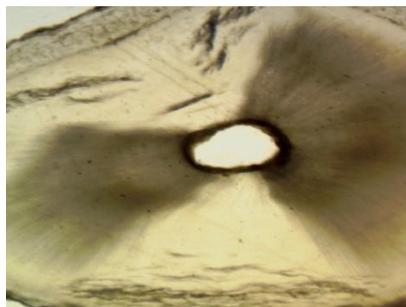


Figure 2. Butterfly effect in buccolingual direction

Results

Based on the observation under light microscope, the results for each group are described in figure 3. From the present study it is evident that the butterfly effect was common in incisors and canines, whereas in premolars 80% of the root section did not show the presence of butterfly effect. With regards to the direction of the butterfly effect, for incisors, it was found to be more in the

mesiodistal direction whereas in canine and premolars it was found to be prevalent in the buccolingual direction (figure 4).

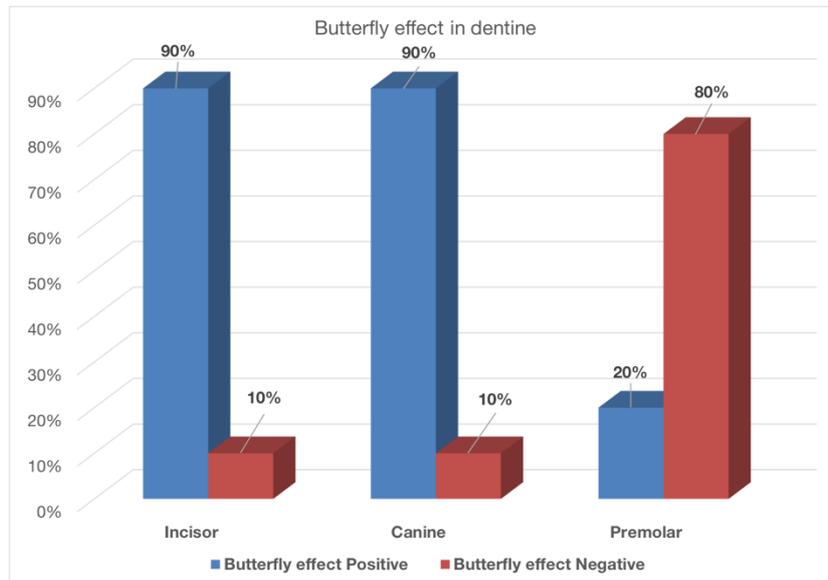


Figure 3. Butterfly effect in the transverse sections of roots of incisors, canines and premolars

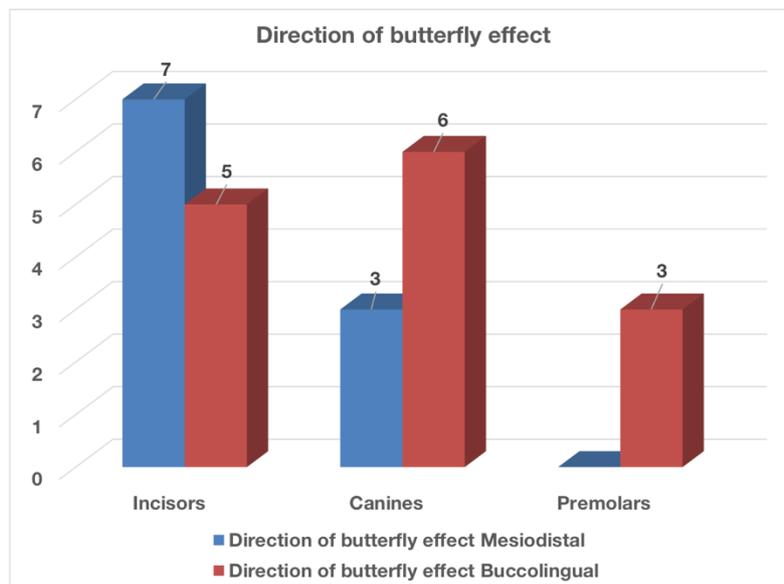


Figure 4. Direction of butterfly effect in the transverse sections of roots of incisors, canines and premolars

Discussion

Butterfly effect is an optical phenomenon which was first described by Beust in 1931 and is seen in the transverse section of roots as different shades of dentin [7]. Dentin is a dynamic biological tissue containing dentinal tubules and when viewed under light microscope the dentinal tubules cause light to refract and scatter [4]. In sclerotic dentin, the tubules are occluded with calcified material. As a result, there is a decrease in the density of the dentinal tubules which is associated with less light scattering and appears more translucent [8]. Hence, the aim of the study is to observe the butterfly

effect in the transverse sections of tooth roots and to compare the occurrence between incisors, canines and premolars.

The present investigation revealed that butterfly effect is more common in anterior compared to the posterior teeth which is in accordance with the study conducted by M.S. Rama Rao et al. [9]. Von Arx et al examined the different characteristics of root sections and described the presence of “frosted dentin,” which was more common in premolars and molars than in anterior teeth [10]. The present study revealed that the distribution of butterfly effect in the transverse section of roots was not uniform throughout the root length and more concentrated in the apical third making them more resistant to tension than coronal ones.

With regards to the direction of butterfly effect, in the present study it was more commonly found in the mesiodistal direction compared to the buccolingual direction which is in accordance with the existing literature. It can be hypothesized that the occlusion with calcified material occurs in an individual tubule causing different shades of dentin.

The significance of direction of butterfly effect correlates with root fractures during instrumentation. Higher the density of the dentinal tubules lesser is the tensile strength of dentin [11, 12].

In sclerosed dentin the density of dentinal tubules is less but the tensile strength is more compared to that of normal dentin. Also, the dentinal walls are thicker buccolingually than that on mesial or distal walls and also masticatory stresses are more in the thickest part of dentin [13]. Hence root fractures are more in buccolingual direction [14, 15]. Dentin hypersensitivity is directly related to the number of dentinal tubules. The greater number of tubules on the buccolingual surfaces of teeth render them more susceptible to hypersensitivity.

Conclusion

Density of dentinal tubules is more in buccolingual direction compared to mesiodistal direction. Also, root sections with butterfly effect have higher tensile strength compared to normal dentin. The presence of butterfly effect in transverse sections of root helps in understanding the root fractures which has its significance in endodontic during instrumentation.

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