

**Original Research**

## Comparative Evaluation of Presence of Butterfly Effect in Transverse Sections of Incisors, Canines and Premolars – An In-Vitro Study

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### ABSTRACT

**Aim:** To compare the occurrence of the butterfly effect in the roots of incisors, canines and premolars. **Materials and methodology:** A total of 30 extracted teeth were selected (incisors, canines and premolars of 10 each) and embedded in the clear acrylic and then sectioned into six thin sections of 1-mm thickness and are observed under light microscope at 5× magnification. Scoring was given on the presence or absence of the butterfly effect. **Results:** 80% of the incisor and canine groups showed the presence of butterfly effect, whereas it is 70% in case of premolar group. **Conclusion:** No significance difference in presence of butterfly effect in incisors, canines and premolars, with very slight predominance in incisors and canines. If present, this was uniform all along the root.

**KEYWORDS:** Butterfly effect, Dentinal tubules, Vertical fractures, Density ,sensitivity, intertubular dentin, instrumentation

### INTRODUCTION

The butterfly effect is an optical phenomenon observed in the horizontal sections of the tooth roots under light microscope [1]. This was the physiological phenomenon that was formed because of variations in the dentinal tubule density in mesio-distal and bucco-lingual directions. This was completely different from sclerosis which occurs in the older population, and there is no specificity for the presence of sclerosis which is in contrast with the butterfly effect which is found only in mesio-distal direction [12]. According to study by Russell *et al.*, there is no age specificity for the occurrence of butterfly effect [1]. If present, the effect can be seen in whole length of the tooth. According to Von Arex *et al.* [4] this difference in dentinal tubule density is more observed in posterior tooth rather than anteriors [3].

### AIM

The aim of the study is to observe the butterfly effect in the transverse sections of tooth roots and to compare the occurrence in between incisors, canines and premolars.

### MATERIALS

A total of 30 extracted tooth without any caries and fractures were selected (10 each from incisors, canines and premolars) and are grouped into three groups of 10 in each according to type of tooth, self-cure clear acrylic resin for embedding the tooth, micro-motor with straight hand piece (Marathon), diamond abrasive disc, light microscope of observation of the butterfly effect.

### METHODOLOGY

Teeth were embedded in the clear acrylic using a

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custom made silicon putty mould of 1 cm length, 1 cm width and 3 cm height (Figures 1–3). Using a diamond abrasive disc and a straight hand piece and micro-motor (Figures 4 and 5), each specimen was sectioned into six transverse sections, two sections from each coronal, middle and apical thirds of the root. Each section was made in to 1-mm uniform thickness (Figure 6), and the thickness of each section confirmed using verniercalipers, if any uneven thickness found it is made uniform by using an abrasive stone. The sections were then observed under the light microscope (Figure 7) at 5<sup>x</sup> magnification [1] for the presence or absence of the butterfly effect (Figure 8), and scores are given based on the presence of the effect, if butterfly effect is absent – score 1, if butterfly effect is present – score 2. Each tooth can have a maximum score of 12 and minimum of 6. Score 12 represents the presence of butterfly effect along the whole length of the root, and score 6 represents the complete absence of the butterfly effect (Tables 1-4).

## RESULTS

Basing on the observation under the light microscope and respective scores, the results in each group are described in Tables 1–4.

## DISCUSSION

The difference in the dentinal tubule density is one of the major causes for the vertical root fractures of the endodontically treated tooth. As most of the root fractures are occurring in the buccolingual direction than mesiodistal [5], the butterfly effect is showing a greater correlation with the buccolingual fractures of the roots [1,2,7]. The effect shows the increased dentinal tubule [6] density in the buccolingual direction when compared with mesiodistal direction [1,2]. Similar pattern of occurrence of butterfly effect is observed in the present study (Table 1- 3) Increase in the tubule density decreases the inter-tubular dentin which makes the dentin brittle and more susceptible for fractures. Care should be taken while filing in the bucco-lingual direction to prevent vigorous instrumentation in this area. This butterfly effect is also affecting the sealing ability of the resin-based sealers which binds to the dentin by forming resin tags in to the dentinal tubules [10]. Variations in the density may surely affect the sealing property of the resin-based sealers [11]. In rotary methods of canal preparation, when a file gets occluded in the canal and during retraction by rotating in the opposite direction, fracture lines [8] are more

**Table 1: Incisor group**

Sample	Cervical 3 <sup>rd</sup>		Middle 3 <sup>rd</sup>		Apical 3 <sup>rd</sup>		Total 2 <sup>nd</sup>
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	
1	2	2	2	2	2	2	12
2	2	2	2	2	2	2	12
3	1	1	1	1	1	1	6
4	2	2	2	2	2	2	12
5	2	2	2	2	2	2	12
6	2	2	2	2	2	2	12
7	2	2	2	2	2	2	12
8	1	1	1	1	1	1	6
9	2	2	2	2	2	2	12
10	2	2	2	2	2	2	12

Total positive – 8, Total negative – 2.

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**Table 2: Canine group**

Sample	Cervical 3 <sup>rd</sup>		Middle 3 <sup>rd</sup>		Apical 3 <sup>rd</sup>		Total 2 <sup>nd</sup>
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	
1	2	2	2	2	2	2	12
2	2	2	2	2	2	2	12
3	2	2	2	2	2	2	12
4	1	1	1	1	1	1	6
5	2	2	2	2	2	2	12
6	2	2	2	2	2	2	12
7	1	1	1	1	1	1	6
8	1	1	1	1	1	1	6
9	2	2	2	2	2	2	12
10	2	2	2	2	2	2	12

Total positive – 8, Total negative – 2.

**Table 3: Premolar group**

Sample	Cervical 3 <sup>rd</sup>		Middle 3 <sup>rd</sup>		Apical 3 <sup>rd</sup>		Total 2 <sup>nd</sup>
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	
1	1	1	1	1	1	1	6
2	2	2	2	2	2	2	12
3	2	2	2	2	2	2	12
4	1	1	1	1	1	1	6
5	2	2	2	2	2	2	12
6	2	2	2	2	2	2	12
7	2	2	2	2	2	2	12
8	1	1	1	1	1	1	6
9	1	1	1	1	1	1	6
10	2	2	2	2	2	2	12

Total positive – 7, Total negative – 3.

**Table 4:**

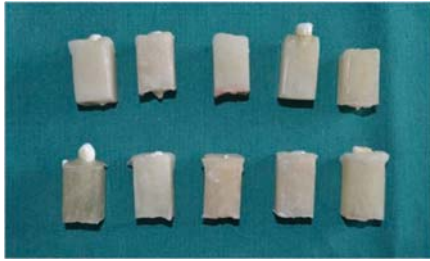
Tooth group	Total samples	Butterfly effect	
		Positive	Negative
Incisors	10	8 (80%)	2 (20%)
Canines	10	8 (80%)	2 (20%)
Premolars	10	7 (70%)	3 (30%)

predominant in bucco-lingual direction [9]. With increased tubule density, the butterfly effect render them more susceptible to hypersensitivity [12].

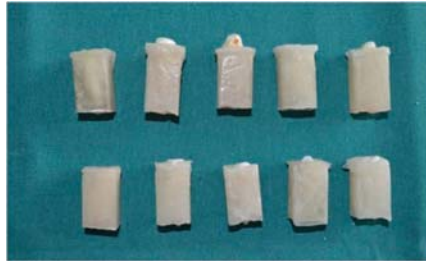
**CONCLUSION**

Root sections with the butterfly effect have a lower density of tubules mesiodistally, corresponds to the

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**Figure 1: Incisor group**



**Figure 2: Canine group**



**Figure 3: Premolar group**



**Figure 4: Micromotor**



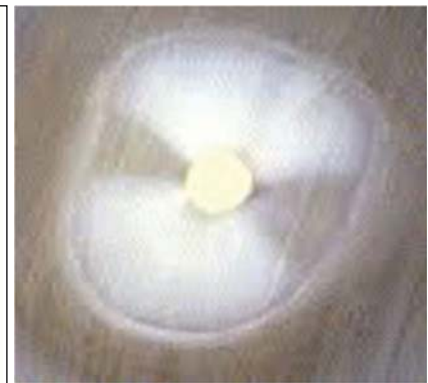
**Figure 5: Sectioning**



**Figure 6: 1 mm thin section**

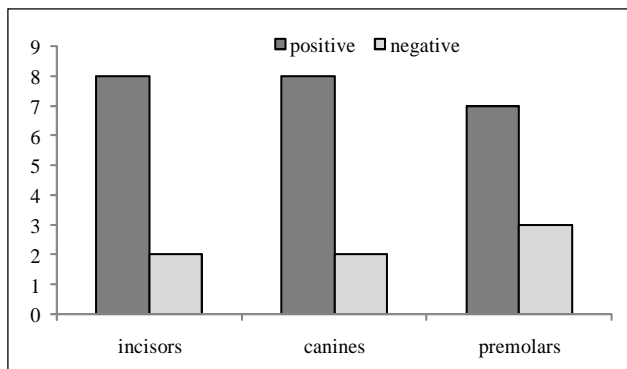


**Figure 7: Light**



**Figure 8: Butterfly effect**

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**Graphical Representation of Results**

wings of the butterfly. This effect causes dentin brittle and results in root fractures, as this is histological observation implication and observation in the clinical practice is very limited. Care should be taken while preparing the root canal with the anticipation of presence of butterfly effect in every tooth. With the use of controlled instrumentation and newer techniques root fractures can be prevented even in the presence of butterfly effect. Present study concludes that if butterfly effect was present, this was uniform all along the root, and no significant difference is observed in the presence of butterfly effect in incisors, canines and premolars, with slight predominance in incisors and canines. Further studies have to be conducted with larger sample size for the occurrence of butterfly effect.

**REFERENCES**

[1] Russell AA, Chandler NP, Hauman C, Siddiqui AY, Tompkins GR The butterfly effect, an investigation of sectioned roots. *J Endod* 2013;39(2):208-10

[2] Russell AA, Chris He LH, Chandler NP Investigation of dentin hardness in roots exhibiting the butterfly effect. *J Endod* 2014;40(6) 842-4.

[3] Russell AA, Chandler NP, Hauman C, Siddiqui AY, Tompkins GR. Investigation of dentin hardness

in roots exhibiting the butterfly effect. *J Endod* 2014;40(6).

[4] Von Arex T, Gemmet Steiner R, Tray FR, Apical surgery: endoscopic findings at the resection level of 168 consecutively treated roots. *Int Endod J* 2011; 44:290–302. Nadim Z. Baba Treatment planning considerations for endodontically treated teeth. In: Baba NZ, editor. *Contemporary restoration of endodontically treated teeth*. Quintessence; 2013. pp. 25–6.

[5] Haueisen H, Gärtner K, Kaiser L, Trohorsch D, Heidemann D. Vertical root fracture: prevalence, etiology and diagnosis. *Quintessence Int* 2013;44:467–74.

[6] Beust TB, Reactions of the dentinal fibril to external irritation. *J Am Dent Assoc* 1931;18:1060–73.

[7] Lertchirakarn V, Palamara JEA. Patterns of vertical root fractures: factors effecting stress distribution in the root canal. *J Endod* 2003;29:524–8.

[8] Sathorn CS, Palamara JM, Messer HH. Effect of root canal size and external root surface morphology on fracture susceptibility and pattern: a finite element analysis. *J Endod* 2005;31:288–92.

[9] Barreto MS, Moraes Rado A, Rosa A. Vertical root fractures and dentin effects: effects of root canal preparation, filling and mechanical cyclining. *J Endod* 2012;38:1135–9.

[10] Darrag AM, Fayyad DM. Adhesives in endodontics *ENDO - Endodontic Practice Today* 2011;5:87–105.

[11] Kuçi A, Alaçam T, Yava° O, Ergul-Ulger Z, Kayaoglu G Sealer penetration into dentinal tubules: a confocal laser scanning microscopic study. *J Endod*. 2014;40(10):1627-31

[12] Rees JS, Addy M. A cross-sectional study of dentine hypersensitivity. *J Clin Periodontol* 2002; 29:997–1003.