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Evaluation of Pulpal Temperature Changes in Response to Interproximal Reduction Using Oscillating System

Romario Jerie [1], Jithesh kumar[2], Panchami Marish[3], Steve Mathew Jacob[3], Manas[3], Thrishna[3]

[1,2,3]Department of orthodontics and Dentofacial orthopedics, Mahe institute of dental sciences and hospital, mahe, Puducherry.

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KEYWORDS
Interproximal reduction, Pulpal temperature, Oscillating kit

ABSTRACT:

Background- Non extraction treatment protocol has gained a lot of popularity over extraction for orthodontic treatment. Interproximal reduction of enamel is one such procedure that helps to do orthodontic treatment without extraction. This procedure which can be done by various techniques causes rise in temperature in the pulp chamber. Temperature change in pulp chamber during interproximal reduction has been exhibited by various studies. Therefore, this study aimed to evaluate the temperature changes in the pulp chamber of the various teeth during interproximal enamel reduction using IPR kit.

Aim- To determine the amount of heat produced by IPR kit (oscillating kit) during interproximal reduction and to evaluate and compare the heat generated during the IPR procedures in different teeth.

Materials- 36 extracted teeth (upper Central incisor, upper lateral incisor, upper canines, upper Ist premolar, upper 2ND premolar and lower incisor) were collected. The extracted teeth were divided into 6 groups. The teeth which are subjected to determine heat generation were isolated. A k type thermocouple wire was used to measure the temperature in the pulp chamber and the wire was inserted into the pulp chamber which was attached to a data logger. After recording the baseline temperature, interproximal enamel reduction was performed on both mesial and distal sides of the tooth during which the changes in pulp temperature were recorded in degree Celsius (°C). The temperature of all 36 teeth were recorded using the same methodology, and the temperature change was then compared and the average of temperature readings on the mesial and distal sides was calculated by adding the mesial and distal temperature readings and then dividing it by 2. The resultant reading was then subtracted from the baseline temperature in order to calculate the temperature rise.

Results- This study clearly indicates that highest temperature rise observed in the upper 2ND premolars (group 5), followed by upper 1ist premolar (group 4) and the least temperature rise in the upper central incisors (group 3).

Conclusion- IPR was found to be a safe adjunct procedure for orthodontic space gaining, with this study proving that the temperature rise due to the oscillating kits is safe on the dentition.

1. Introduction

In view of the current emphasis on non-extraction-based orthodontics, alternative space- gaining procedures including arch expansion, molar distalization and interproximal reduction are increasingly being explored. Interproximal enamel reduction is defined as the “clinical procedure that requires the proximal enamel surfaces to be reduced, anatomically recon toured for the correction of any inconsistency in the tooth shape” [1]. The other common terms used for this procedure are “stripping”, “re-approximation”, “slenderization”, “coronoplastica”, “slicing”, “mesio-distal reduction”, “selective grinding”, and

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"Hollywood trim". The universal objective of orthodontic treatment was propounded by Dr. Charles H Tweed as "aesthetically pleasing, healthy, functional and stable occlusion which should aesthetically match the harmony of soft tissue profile [2]. Achieving this objective is sometimes difficult particularly in patients with crowding which is caused as a result of discrepancy between the tooth size and the arch length and is one of the most common types of malocclusions encountered by an orthodontist [3]. Inter-proximal reduction is mainly indicated for solving Bolton discrepancy, for treatment of crowding, for reshaping of the proximal contact [4] [5], for introducing gingival papillary retraction, and for stabilizing the dental arches. Enamel stripping can also be done in patients with an indication of Frankel I or II appliance, in cases where the deciduous molar needs to be retained when the premolar is congenitally absent. [6] [7]. Various methods have been introduced for the process of interproximal reduction that includes abrasive strips, diamond- coated segmented discs, rotating diamond burs and mechanical oscillating abrasive strips [6]. Although, the procedure is used frequently in orthodontic treatment, there are various drawbacks of interproximal reduction of enamel. All rotary cutting instruments produce heat and mechanical vibration that can harm the pulp of the tooth [8]. The heat transferred to the pulp, can lead to histopathological changes and can cause necrosis of the pulp [8] [9]. Various studies have examined the effect of a regulated amount of heat applied to the human dental pulp [9]. They exhibited that under the cavities of those teeth extracted immediately and not exposed to heat there were no appreciable changes. Under the cavities exposed to heat and extracted immediately, there was marked aspiration and loss of odontoblasts [9]. Lefkowitz et al [10] conducted a study to test four methods of cavity preparation for evidence of pulp injury. Collection of specimens was done at 1, 7, and 28 days. Examination of the pulps depicted that the techniques described were safe as measured by accepted standards. Continuous application at 24,000 p.m. with a water stream coolant, dry intermittent application of rotary instruments at 5,000 r.p.m, air-abrasive, and ultrasonic techniques are biologically acceptable methods as measured by pulpal response [10]. Visibility is another crucial factor whilst performing the IPR procedure. Proper access and visibility are imperative in order to avoid periodontal tissue injuries and also to prevent scarring of the proximal enamel [11]. Conventional polishing methods have failed to remove enamel surface injuries [12]. Radlanski et al. [13] noted the formation of furrows in the posterior enamel surfaces because of improper stripping, resulting in an increase of plaque accumulation. It is advised to use wires, elastics, separators, coil spring, etc. to achieve an even proximal surface, natural morphology of the tooth and to prevent ledges whilst performing IPR procedures. Apart from these studies, there is vast scientific literature in which thermal changes in the pulp during various IPR procedure have been evaluated.

Previously, studies have been done which have evaluated the temperature changes inside the pulp chamber of extracted premolars, during proximal enamel reduction and also compared with different techniques of IPR. Therefore, this study aimed to evaluate the temperature changes in the pulp chamber of the various teeth during interproximal enamel reduction using IPR kit.

2. Methodology

The source of collecting data for the study was the maxillary and mandibular teeth of patients for whom extraction had been advised. The study was performed in the Department of Orthodontics & Dentofacial Orthopaedics, Mahe institute of dental science, Kerala, India. A power analysis using the G power computer program (Faul & Erdfelder, 2007) indicated that a total sample of 36 (6 in each group) would be needed to detect large effects (d=.70) with 85% power using mean comparison by

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ANOVA test with alpha at .05. 36 extracted teeth (upper Central incisor, upper lateral incisor, upper canines, upper Ist premolar, upper 2ND premolar and lower incisor) were collected.

The inclusion criteria are teeth without caries and the exclusion criteria is teeth with fractured crowns and with pulp pathologies.

The extracted teeth were randomly divided into 6 groups,

Group 1 – upper central incisor (6)

Group 2 - upper lateral incisor (6)

Group 3 – upper canines (6)

Group 4 – upper I^{st} premolar (6)

Group 5 – upper 2^{ND} premolar (6)

Group 6 – lower incisor (6)

Digital thermometer with K-type thermocouple probe (Generic). The K-type thermocouple probe was used in this study due to its longer life span and larger temperature range (−454°F to 2300°F/−270°C to 1260 °C).

Figure 1:
ARMAMENTARIUM

The root portions were sectioned with carborundum disks approximately 2 mm below the cementoenamel junction perpendicular to the long axis of the teeth. The opening into the pulp chamber was enlarged as needed to insert the thermocouple wire. The pulp chamber was cleaned of remaining pulpal tissues with a spoon excavator and sodium hypochlorite application for 1 minute. Then the pulp chambers of the teeth were rinsed with distilled water and air dried. The teeth which are subjected to determine heat generation were isolated. A k type thermocouple wire was used to measure the temperature in the pulp chamber and the wire was inserted into the pulp chamber which was attached to a data logger.

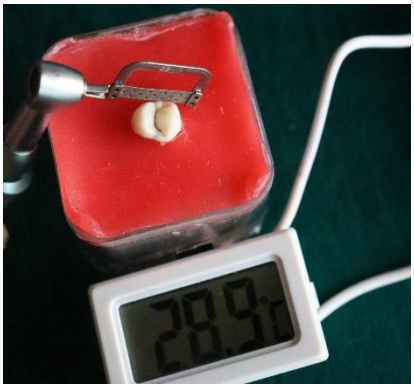

Fig 2: TEMPERATURE MEASUREMENT DURING IPR KIT

Baseline temperature was recorded after 5 min of access opening time (mean time taken for the pulp temperature to return to normal and stabilize after access opening).

After recording the baseline temperature, interproximal enamel reduction was performed using oscillating kit on both mesial and distal sides of the tooth during which the changes in pulp temperature were recorded in degree Celsius (°C). Orthodontic interproximal enamel reduction kit is one of the latest oscillating systems for IPR. It consists of a contra-angle hand piece onto which saw-type diamond oscillating IPR strips (saw type) can be attached, which move in an oscillating or a “to and from” motion. A Digital Vernier calliper is used to check the amount of proximal enamel, reproximated.

The temperature of all 36 teeth were recorded using the same methodology, and the temperature change was then compared and the average of temperature readings on the mesial and distal sides was

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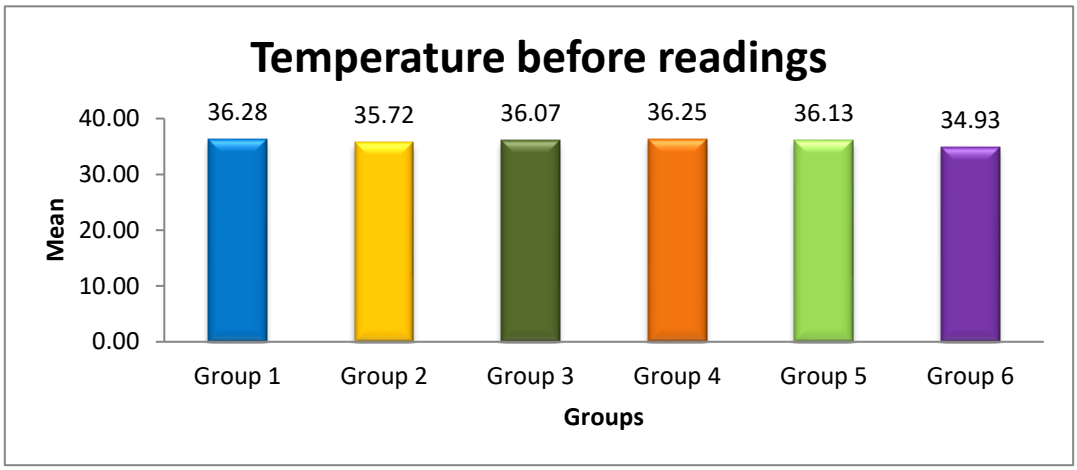
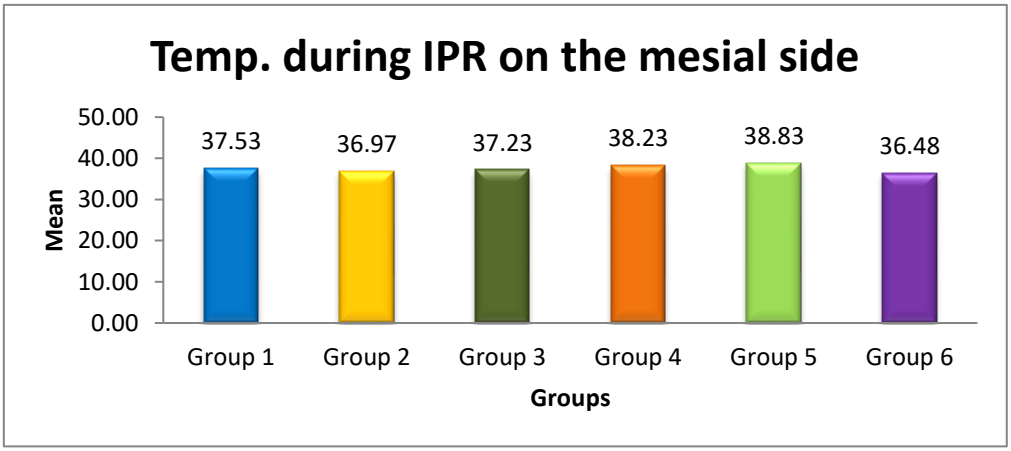
calculated by adding the mesial and distal temperature readings and then dividing it by 2.





Groups	N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value	Result
				Lower Bound	Upper Bound		
Group 1	6	37.53	0.39	37.13	37.94	<0.0001	Significant
Group 2	6	36.97	0.54	36.40	37.53		
Group 3	6	37.23	0.39	36.83	37.64		
Group 4	6	38.23	0.29	37.93	38.54		
Group 5	6	38.83	0.35	38.47	39.20		
Group 6	6	36.48	0.65	35.80	37.17		

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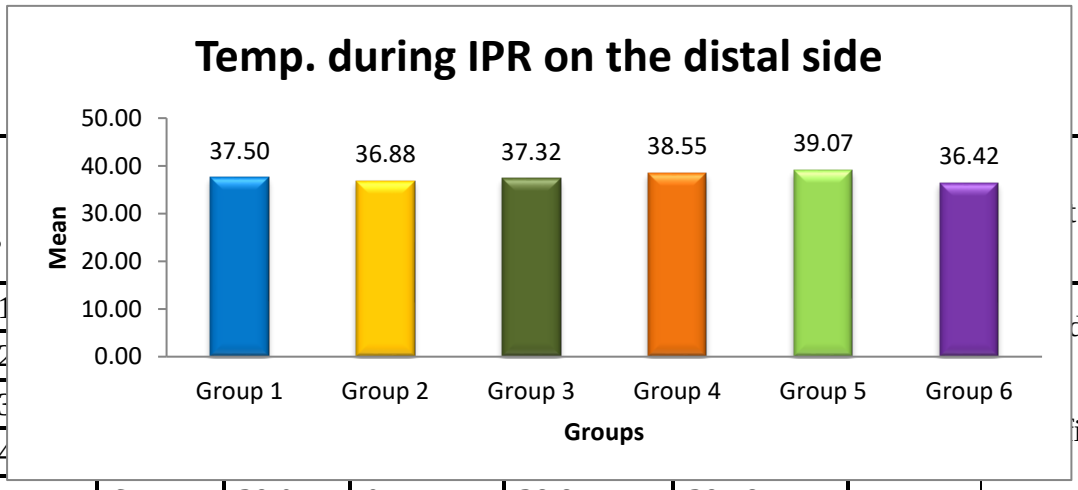
Groups	N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value	Result
				Lower Bound	Upper Bound		
Group 1	6	37.53	0.39	37.13	37.94	<0.0001	Significant
Group 2	6	36.97	0.54	36.40	37.53		
Group 3	6	37.23	0.39	36.83	37.64		
Group 4	6	38.23	0.29	37.93	38.54		
Group 5	6	38.83	0.35	38.47	39.20		
Group 6							

Table 3: Inter-group comparison of Temp. during IPR on the distal side

Graph 3: MEAN TEMPERATURE DURING IPR ON THE DISTAL SIDE



Groups							
Group 1							
Group 2							
Group 3							
Group 4							
Group 5	6	39.07	0.21	38.85	39.28		
Group 6	6	36.42	0.59	35.80	37.04		

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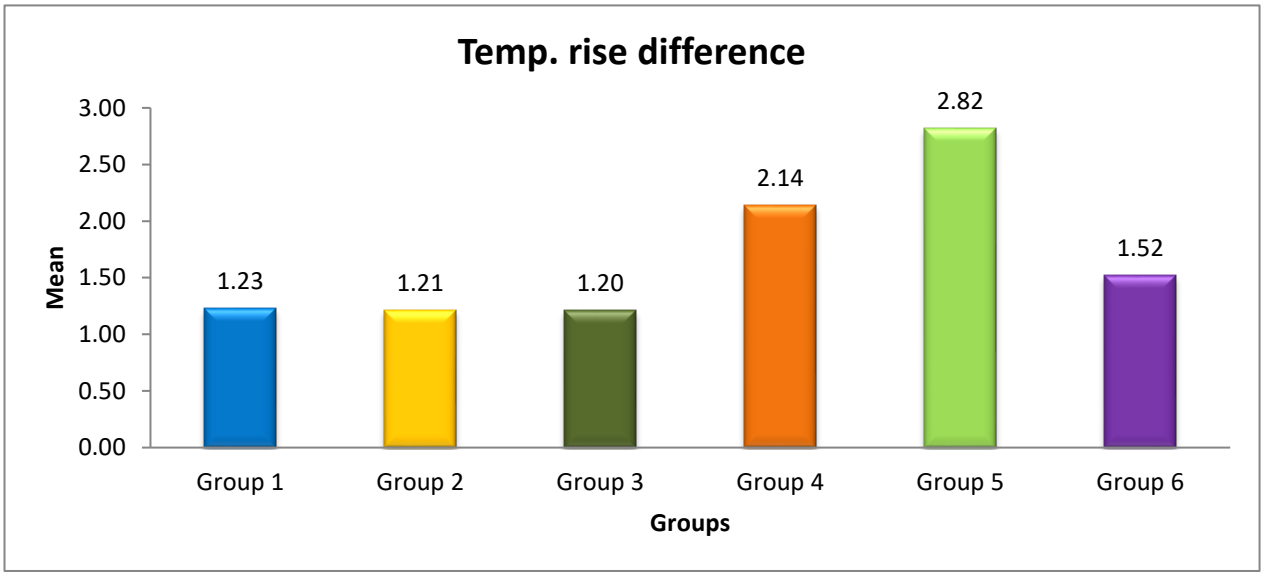
Groups	N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value	Result
				Lower Bound	Upper Bound		
Group 1	6	1.23	0.33	0.89	1.58	<0.0001	Significant
Group 2	6	1.21	0.22	0.98	1.44		
Group 3	6	1.20	0.21	0.98	1.43		
Group 4	6	2.14	0.23	1.90	2.38		
Group 5	6	2.82	0.37	2.43	3.21		
Group 6	6	1.52	0.43	1.06	1.97		

TABLE 4: Inter-Group Comparison of Temperature Rise



GRAPH 4: mean temperature during IPR – temperature rise difference.

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Results

The resultant reading was then subtracted from the baseline temperature in order to calculate the temperature rise.

This study clearly indicates that highest temperature rise observed in the upper 2ND premolars (group 5), followed by upper 1st premolar (group 4) and the least temperature rise in the upper canines (group 3).

Discussion

Trauma to the pulp and dentin during tooth preparation results from several factors [14]. Extensive tooth preparation exposes a large number of dentinal tubules, and deeper preparations expose larger diameter tubules [14]. The pressure, revolutions per minute (rpm), bur design, and type of coolant influence the temperature rise, dehydration of the dentin, and the degree of vibration during tooth preparation [15]. The different clinical reactions of the pulp and dentin are attributed to the interconnected characteristics. Schuchard [16] and Sato [17] reported that excessive heat adduction can result in structural changes to the hard dental tissues and damage the dental pulp. Zach and Cohen reported that a 5.58C rise led to necrosis of the pulp in 15% of teeth, an 11.18C rise resulted in necrosis of the pulp in 60% of teeth, and a 16.68 C rise led to necrosis of the pulp in 100% of the teeth [18]. As first stated by Sheridan [19] potential gain of 2.5 mm and 6.4 mm of space may be anticipated by enamel removal from five anterior contacts and eight buccal contacts in an arch respectively.

Frictional heat generated is an enumerated side effect of slenderization procedures using rotary instruments. It is known from fundamental research that temperature increases more than 5.5°C in the dental pulp may lead to irreversible structural changes.

In this study the mean baseline temperature readings (fig 3) were calculated for each group. The temperature of the pulp was noted for each tooth, post which IPR was performed on the both distal and mesial sides (fig 4&5). The slenderization procedure evaluated for the temperature change in this study is by using IPR kit which consisted of a contra-angle hand piece onto which oscillating strips were mounted. This oscillating system is one of the recent techniques in performing Inter proximal reduction. Instead of a J-type, a K-type thermocouple unit (fig 1) was used to measure the change in temperature. This was because of the high precision, reliability and wider temperature range of the K-type thermocouple.

Livas et al. mentioned in a literature review that the use of segmented discs adapted over a shuttle head with oscillating movement has become quite popular. These discs have an advantage of better visual access [20].

Upon using the orthodontic IPR kit, the mean temperature rise was 1.6 °C which were found to be similar to the study done by Banga K [21]. The minimum and maximum temperature changes were 0.9 °C and 2.2 °C, respectively. The temperature rise did not cross the threshold value of 5.5 °C. JT Blank reported that IPR kit hand piece runs at a speed of 5000 RPM, which is significantly less than the speed of an airotor (3–5 lakhs RPM), causing less heat generation as compared to an airotor. The temperature readings were recorded manually which could have made the temperature recordings less accurate, as it is an arbitrary method. A software could be devised in the future, for more accurate readings. Upon mounting, the pulp chamber was exposed to the external environment, and temperature changes may vary in a closed pulp chamber.

Conclusion

Interproximal enamel reduction is an effective orthodontic treatment protocol for gaining a modest amount of space and adjusting the Bolton Index discrepancy, and is a viable alternative to the extraction of permanent teeth in patients with mild to moderate crowding. Amongst many other

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factors, temperature rise in the teeth is one key feature that needs to be considered during IPR.

This study aims to quantify the amount of heat produced by an oscillating IPR kit during proximal reduction and to compare the heat generated on different teeth. Comparison of slenderization procedures of different teeth showed least mean temperature rise with group 3 (upper canines) and the highest mean temperature rise with group 5 (upper 2nd premolars) followed by group 4 (upper 1st premolar).

To summarize, IPR was found to be a safe adjunct procedure for orthodontic space gaining, with this study proving that the temperature rises due to oscillating kits is safe on the dentition.

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