IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 6 Ser.12 (June. 2023), PP 06-12
www.iosrjournals.org

The Impact Of Adhesive Remnant Removal Using Burs During Debonding Of Orthodontic Brackets On The Pulp – A Systematic Review

Dr. Mathew Koshy Vaidyan[1], Dr. Anshul Singhla[2] , Dr. Amrita Puri[3] , Dr. Neel Lalmani Maurya[4] , Dr. Shruti Sharma[5] , Dr Apoorva Gupta[6]
Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[1]
Professor and Head, Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[2]
Professor, Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[3]
Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[4]
Senior Lecturer, Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[5]
Professor, Dept. of Orthodontics and Dentofacial Orthopaedics, I.T.S. Dental College, Hospital and Research Centre[6]

Abstract:
The Debonding Procedure In Orthodontics Is A Very Crucial Step In The Entire Treatment Plan As It Involves The Proper Removal Of The Attachment And All The Adhesive Resin From The Tooth Surface. Debonding Of Brackets Is Followed By Clean-Up Procedures To Remove Residual Composite. This Clean- Up Can Be Accomplished By Scraping Of The Remnant Adhesive With A Very Sharp-Edged Plier Or Scalers, Or By Use Of Burs. Therefore, The Purpose Of This Study Is To Analyse The Impact Of Adhesive Remnant Removal Using Burs Post Debonding Of Orthodontic Brackets On The Pulp. The Electronic Search Was Performed From 2000 To 2022 Producing A Total Of 627 Records By Different Databases: Pubmed, Web Of Science, Scopus. After Duplicates Removal, A Total Of 41 Potentially Significant Records Were Assessed. Titles And Abstracts Were Screened And 10 Full-Text Articles Were Identified For Eligibility, While 31 Records Were Excluded According To Inclusion And Exclusion Criteria. Procedures Without Water Cooling Significantly Raised The Temperature In The Pulpal Chamber When Compared To Procedures With Water Cooling, And Clean-Up With Water Cooling Never Produced Temperature Changes That Exceeded The Critical Value. According To The Findings, Removal Of The Majority Of The Residual Resin With Water Cooling And Cleaning Up The Remaining Adhesive With Adequate Air Cooling Is Recommended So That The Enamel And Adhesive Can Be Distinguished.
***Key Word**: Debonding, Pulpal Necrosis, Burs, LASER, Adhesive Remanent Removal*

Date of Submission: 15-06-2023 Date of Acceptance: 25-06-2023

I. Introduction

Orthodontists have placed considerable importance on evaluating the quality of the remaining enamel surface after employing various debonding techniques. Furthermore, they have directed their attention towards assessing the enamel loss that may occur during clean-up procedures[1]. The clean-up procedure may have a damaging effect on pulpal tissue because of the increase in the temperature which has beena matter of concern for dentists. This may result in various histopathological changes such as burn reactions at the periphery of the pulp including the formation of ‘‘blisters,’’ ectopic odontoblasts and their destruction, protoplasm coagulation, and expansion of the liquid in the dentinal tubules and pulp, with increased outward flow from tubules[2]. This procedure has the potential to impact the blood vessels within the pulp, resulting in vascular damage and subsequent tissue death.

The debonding procedure in orthodontics is a very crucial step in the entire treatment plan as it involves the proper removal of the attachment and all the adhesive resin fromthe tooth surface without damaging the tooth and restoring the surface back as closely as possible to its pre-treatment condition without inducing iatrogenic damage. There are 4 different techniques of bracket debonding, which are

1. Mechanical
2. Thermal

3. LASER
4. Ultrasonic

Debonding with mechanical aid involves the use of a debonding plier, whose beaks areengaged against the mesial and distal edges of the bracket and the wings are squeezed mesiodistally and the bracket is pulled with a peel force. Thermal debonding involves the use of heated tips of a utility plier which are engaged into the bracket and a light rotational force is given after some time, which leads to snapping of the bracket from the tooth surface. The debonding done by LASER's work on three mechanisms, i.e.

1. Thermal softening
2. Thermal ablation
3. Photoablation.

Thermal softening involves the heating of the bonding agent with LASER leading to sliding off of the bracket from the tooth surface. In thermal ablation, there is fast heating of the resin, enough to reach the resin's vaporization range, and photoablation occurs when high-energy LASER light interacts with the adhesive material. The ultrasonic technique works by applying vibrations on the adhesive-bracket interphasewhich causes the particles to move leading to a lowering of the bond strength and causing the bracket to get debonded.

Debonding of brackets is followed by clean-up procedures to remove residual composite. The amount of remnant adhesive on the tooth surface can be evaluated with the help of the ARI (Adhesive remnant index) given by Artun (1984). This clean-up can be accomplished by scraping of the remnant adhesive with a very sharp-edgedplier or scalers, or by use of burs such as dome-shaped tungsten carbide bur or ultrafinediamond bur or white stone finishing bur. However, use of rotary instruments were found to generate heat and may have adverse effects on the pulpal tissues if not dissipated with an appropriate coolant. Various factors can influence the production of heat, including the size and type of bur utilized, the length of contact, torque, the abrasiveness of the instrument, the load applied, and the extent of residual adhesive removal. According to Zach and Cohen (1965), temperature increases of more than 5.50°C in the dental pulp caused inflammation that could not be reversed, they also discovered that any temperature increase of 11°Cor greater resulted in necrosis[3]. As a result, determining a suitable debondingprocedure for removing brackets in orthodontic practice is critical.

Characterizing the leftover enamel surface following various debonding methods has been a primary emphasis in orthodontics. In addition, the enamel loss linked with clean-up operations has gotten a lot of attention. Some rotating instrument techniqueshave also shown to generate heat, which can harm pulpal tissues if not dispersed witha suitable coolant.

Regardless of the pressure used or the type of bur linked with the equipment, air-waterspray cooling is important in adhesive cleaning procedure post orthodontic bracket debonding. With diamond tips, steel, or carbide burs, adequate cooling prevents excessive drying and enhances cutting efficiency. Hand devices, sandpaper discs, green rubber wheels and pumice, and tungsten carbide burs have all been recommended for cleaning in orthodontics. A tungsten carbide bur has been claimed to be the best tool for removing residual composite left on the enamel surface following debonding.

However, very less information about pulp chamber temperature changes associated withroutinely used adhesive remnant clean-up techniques is available. Therefore, the purposeof this study is to analyse the impact of adhesive remnant removal using burs post debonding of orthodontic brackets on the pulp.

II. Material And Methods

Research was carried by hand searching and 30yrs database records based on following inclusion and exclusion criteria:

Inclusion criteria:

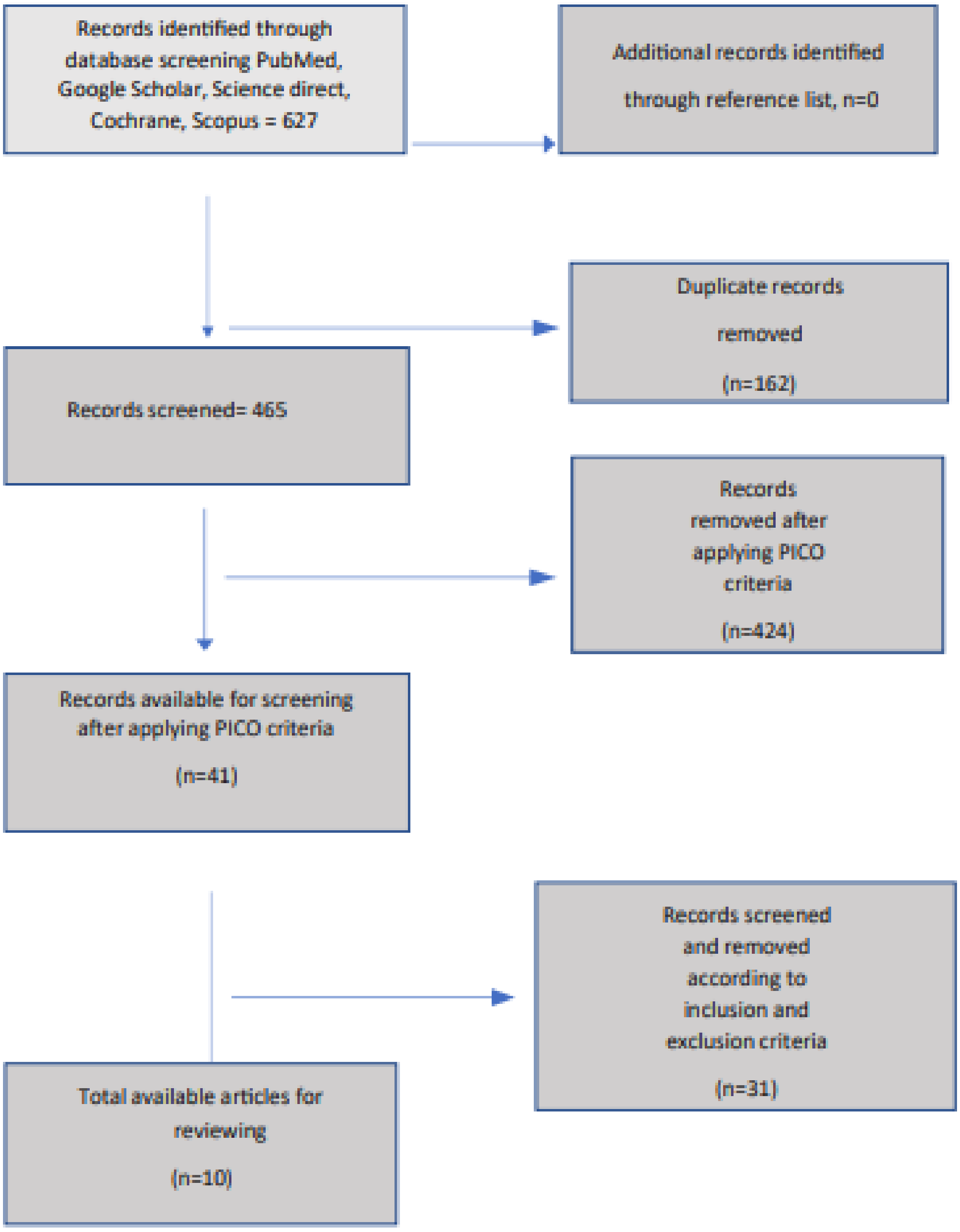
1. Cohort study
2. Randomized control trial
3. Cross-sectional studies
4. Survey-based study

Exclusion criteria:

1. Animal studies
2. Historic reviews
3. Commentaries
4. Case report
5. Letters to the editor

Search strategy:
Literature was searched systematically, and studies were identified based on the- PICO (Glossary of Evidence Based Terms 2007)
P – Patients who have undergone fixed orthodontic therapy
I – The interventions of significance are debonding of orthodontic brackets and adhesiveclean-up with burs
C – Teeth which do not get debonded or do not undergo any fixed orthodontic therapy
O – Pulpal reaction to debonding and adhesive clean-up

Research Question: is there any impact of adhesive remnant removal using burs during debondingof orthodontic brackets on the pulp?



PRISMA chart (Table 1)

III. Results

The electronic search was performed from 2000 to 2022, producing 627 records by different databases: Pubmed, Web of Science, Scopus. After duplicates removal, a total of 41 potentially significant records were assessed. Titles and abstracts were screened and 10 full-text articles were identified for eligibility, while 31 records were excluded according to inclusion and exclusion criteria.

S. NO.	***FIRST AUTHOR***	**STUDY DESIGN**	**SAMPLE TYPE**	**SAMPLESIZE**	**OUTCOME MEASURE**	**CONCLUSION**
1	Mark E. Vukovich	Experimentalstudy	consecutive	122 ceramic brackets, 8 extracted teeth	A small thermocouple probefixed to the pulpal wall subjacent to the bracket position.	Significant increase in pulp chamber temperature, in case of low-speed grindingwithout coolant
2	TancanUysal	In – vitrostudy	consecutive	90 extracted human maxillary central incisors	A J-type thermocouple wirewas positioned in the centre of the pulp chamber.	Significant temperature in pulpal chamber of maxillaryextracted teeth
3	Seong-SikKim	Experimentalstudy	Consecutive	20 extracted human Pre molars	Temperature change and removaltime were recorded,and surface profileswere examined with3-dimensional profilometry	There were significantly greater temperature changesin the LS group than in the SS group
4	Ali AltugBicakci	In – vivostudy	Consecutive	40 extractedsound max. and mand. Premolars	Histologicalexamination	Adhesive removal withoutwater cooling caused somevascular and pulpal tissue alterations
5	Sabrina Mank	In – vitrostudy	Consecutive	10 Humanincisors	Thermoelement introduced into thepulp chamber	Carbide burs and polishing disks can be used safely andwithout risk to the pulp, even without cooling
6	Sogra Yassaei	Experimentalstudy	Consecutive	90 extractedteeth	Thermocouple sensor fitted on tothe buccal wall ofthe pulp chamber	Tungsten carbide bur and composite bur generated more heat compared to Er:YAG laser and Tungstencarbide bur were the fastestand Er:YAG laser were the slowest to remove adhesive residue
7	Philipp Kley	Experimentalstudy	Consecutive	5 extracted human molars	Temperature measurements witha thermographic infrared camera on the enamel surface and with measuringprobes in the pulp cavity	If a carbide bur is properly used, there is a low risk of reaching critical intra-pulpaltemperatures during debonding of residual bracket adhesive even in the absence of dedicated coolingand no risk if the instrumentation is accompanied by air or water cooling
8	GokmenKurt	Experimentalstudy	Consecutive	80 extractedmax Pre molars	The temperature changes and cooldown times wereevaluated with a thermal camera	Appropriate cooling procedures and fine tungstencarbide burs should be used during the removal of remnant adhesives after bracket debonding in order to prevent adverse pulpal reactions.
9	Maurício Barbieri Mezomo	In – vitrostudy	Consecutive	20 extracted human maxillary second pre molars	Pulp chamber temperature was measured with a thermocouple probeand time spent was recorded with a digital stopwatch	BurH-cool, BurH and BurLare safe adhesive removal techniques, whereas DiscL and BurFGL may damage pulp tissues and time spent on adhesive removal has direct effect on temperaturerise in the

						pulp chamber
10	Mihri Amasyali	Experimentalstudy	Consecutive	90 human maxillary premolars	Measurements done using a non-contact optical profilometer	A one-step finisher and polisher bur created the smoothest enamel surface, whereas Er:YAG laser the roughest and Tungsten carbide and aluminium oxide-based burs generatedmore heat than Er:YAG laser.

IV .Discussion

Orthodontic therapy has been an integral part of dentistry since many decades. It is a well- known fact that it has changed many lives by bringing beautiful smile on people's face, but everything has its own merits and demerits. One of the demerits of debonding in orthodontic therapy is that it causes changes in the enamel surface such as remaining adhesive remnants, enamel damage or enamel indentation.

Once the excess resin has been removed, the enamel surface must be left intact. Adhesive remnant and damages caused to the enamel structure are unavoidable regardless of the type of bracket and the removal technique. Using rotating instruments for adhesive remnant removal leads to enamel erosion at both high (19.2 µm) and low (11.3 µm) speeds[4]. Nevertheless, the latter has greater damage to pulp vitality, because of the heat. This incomplete removal of remnant adhesive from the tooth surface leads to irregular surfaces which causes plaque accumulation and a predisposition for decalcification on the surface is also seen. As a result, the adhesives must be removed with the least amount of harm to the enamel and loss of intact enamel tissue possible, and the tooth's vitality must be safeguarded against temperature variations that may occur throughout the treatment.

The prevailing belief is that the temperature within the pulp chamber is akin to the body's temperature, approximately 37 ◦C, despite the absence of precise measurements. Previous in vitro experiments, which aimed to simulate blood flow within the pulp, determined that the pulp temperature ranged from 33 to 35 ◦C, while demonstrating the pulp's ability to tolerate temperature fluctuations within the range of 25 to 42°C.[5-6]. According tothe study done by Monika Machoy, the study concluded that temperature considered safe and within the pulp adaptation range, is about 40–42°C. Rotary instrument techniques have been found to generate heat, which can be harmful to the pulpal tissues if not dissipated with an appropriate coolant. The types of coolant are water coolant and air coolant. In water cooling,a jet of cold or normal water is directed towards the rotating burs and tooth surface during theremnant adhesive removal and air cooling involves the high-pressured air blow which is directed again towards the tooth surface and the rotating bur. These two methods lower down the heat that is generated during the clean-up procedure and tries to maintain the temperature within the safe range.

The size and type of bur used, the duration of contact, torque, instrument abrasiveness, load, and the amount of residual adhesive removed are all factors that influence heat generation. Lee-Knight et al[7] (1997) investigated pulp chamber temperature and found that debonding of metalbrackets without an air or water coolant may harm the pulp. The pulpal and dentinal trauma caused by rotary instruments can be attributed to multiple factors, including pressure, revolutions per minute, bur design and the type of coolant used. These factors collectively impact the temperature increase and the level of vibration experienced. The diverse clinical responses observed in the pulp and dentin are ascribed to the interconnected factors involved. Schuchard[8] (1975) and Sato[9] (1983) reported that excessive heat adduction can resultin structural changes to the hard dental tissues and damage the dental pulp. Robinson and Lefkowitz[10] (1962), Taira et al[11] (1990), and Moulding and Loney[12] (1991) all reported that cooling techniques, such as the use of an air-water spray, were effective in limiting the temperature rise in the pulpal chamber. According to Takla and Shivapuja (1995), they proposed that inflammatory alterations in the pulp can be reversed if the temperature remains below 6.8°C, considering the normal physiological value of 35.3°C, and taking into account the initial condition of the pulp and its reparative capacity.

There is very less information available about pulp chamber temperature changes associated with commonly used orthodontic techniques, hence attempt was made to conduct the present systematic review to update the knowledge of available evidence about the impact of adhesive remnant removal using burs during debonding of orthodontic brackets on the pulp.

The review encompassed a total of ten studies. Because of the different risk of bias given by various study designs, as well as the difficulty in assessing outcomes and reaching reliableresults and conclusions, strict methodology in both data extraction and quality analysis was attempted.

These studies concluded that the different orthodontic clean-up procedures resulted in significant temperature changes in the pulpal chamber of extracted maxillary central incisor teeth. Clean-up with a tungsten carbide bur using a high-speed contra-angle handpiece without water cooling produced a temperature increase exceeding the critical 5.58°C value for pulpal health, as compared to the procedures of water cooling and clean-up where they have not found increase in the temperature beyond the critical value. The prevailing method for removal commonly involves employing ultra-sonic scalers, a low-speed handpiece equipped with a tungsten carbide bur, and a high-speed handpiece fitted with a diamond bur.

Eminkahyalıgil et al[14] (2006) found that high-speed tungsten carbide bur application was the most effective and the least time-consuming method to clean the teeth surfaces. Van Waes et al[15](1997) and Zachrisson and Artun[16] (1979) suggested low-speed (below 2,00,000 RPM) tungsten carbide bur application which produced the finest scratch pattern with the least enamel loss. On the contrary, Zarrinnia et al[17] (1995) recommended the use of a high-speed tungsten carbide bur (above 200,000 rpm) with a 12-fluted tungsten carbide bur for removal of remnantresin. Retief and Denys[18] (1979) recommended the use of a tungsten carbide bur at a high speed with adequate air cooling. Adhesive removal without water cooling induced some vascular andpulpal tissue abnormalities such as haemorrhage, vascular congestion, and inflammatory cell infiltration. But these were tolerated by the pulpal tissues, therefore the changes were reversible,according to a few investigations that included histologic and immunohistochemical analyses.

On the contrary the study which was done by Mark E. Vukovich[1] (1991), saw that the removal of a ceramic bracket from the surface of a vital lower incisor tooth by means of a low-speed bur without coolant resulted in numerous histologic pulp changes. These alterations were typical of pulp tissue exposed to temperatures above 42.2 ° C, implying that removing brackets by this manner could result in total necrosis in at least 15% of teeth. Nyborg and Brannstrom[19] (1968),however, reported a relative lack of (aspirated) nuclei in the dentinal tubules. This result is attributed to the direct heating and probable desiccation of dentin in their study. The enamel was intact and the dentin was unexposed during the removal of the bracket in our experiments. Therefore, high temperatures that significantly exceed known thresholds for pulpal damage aregenerated by low-speed grinding of ceramic brackets without coolant or removal of adhesive. During the removal of brackets using either high-speed or low-speed handpieces, with water or air as coolants, temperatures well below the threshold values were consistently attained.

Based on this review, it is evident that removing the residual adhesive while cooling with wateris critical for keeping the temperature stable and effective in keeping the damage within the physiologic limits of the tissues. However, the visibility of the remaining adhesive on enamel surfaces decreases with water cooling, which may result in enamel loss due to confusion of the residual adhesive from the enamel surface with the tungsten carbide bur. In general, residual adhesive on enamel surfaces is difficult to distinguish in wet conditions, and the clinician mustdry the enamel surface with an air spray to clearly see the remaining adhesive layer. According to the findings, the removal of the majority of the residual resin with water cooling and cleaning up the remaining adhesive with adequate air cooling is recommended so that the enamel and adhesive can be distinguished.

V. Conclusion

An important milestone in the field of orthodontics was the transition from banding to bonding, which marked a significant advancement facilitated by evolving bonding techniques. Because of the invention of bonding, orthodontic treatment has become widespread, various treatment techniques have been developed and treatment duration became shorter due to the reduction in number of appointments. Studies about debonding and adhesive clean-up procedures have reported potential risk of pulpal damage caused by the heat generated during debonding. The various techniques of debonding might lead to surface alterations regardless of the adhesive debonding and removal methods used. Surface changes after brackets are important because the external surface of the enamel contains more minerals and fluoride than the deeper layers.

Since this is a relatively unexplored topic, the current systematic review updates our understanding of the available evidence of the topic and the following conclusions can be drawn-

- The use of a tungsten carbide bur with a high-speed contra-angle handpiece without water cooling resulted in a temperature increase that exceeded the critical 5.58°C valuefor pulpal health.
- Procedures without water cooling significantly raised the temperature in the pulpal chamber when compared to procedures with water cooling, and clean-up with water cooling never produced temperature changes that exceeded the critical value.
- The 12 fluted high speed tungsten carbide burs have been reported as the most efficientmethod for residual adhesive clean-up along with water cooling and air cooling as it helps in adequately distinguishing the enamel surface from the remnant adhesive.
- According to the findings, removal of the majority of the residual resin with water cooling and cleaning up the remaining adhesive with adequate air cooling is recommended so that the enamel and adhesive can be distinguished.

References

[1]. Vukovich ME, Wood DP, Daley TD. Heat generated by grinding during removal of ceramic brackets. American Journal of Orthodontics and Dentofacial Orthopedics. 1991 Jun 1;99(6):505-12.
[2]. Uysal T, Eldeniz AU, Usumez S, Usumez A. Thermal changes in the pulp chamber during different adhesive clean-up procedures. The Angle Orthodontist. 2005 Mar;75(2):220-5.
[3]. Usumez S, Orhan M, Usumez A. Laser etching of enamel for direct bonding with an Er,Cr:YSGG hydrokinetic laser system. Am J Orthod Dentofacial Orthop. 2002;122:649–656.
[4]. Zarrinnia K, Eid NM, Kehoe MJ. The effect of different debonding techniques on the enamel surface: an in vitro qualitative study. Am J Orthod Dentofacial Orthop. 1995;108(3):284-93
[5]. Zabel, M. Histologia: Podr˛ecznik dla Studentów Medycyny i Stomatologii; Elsevier Urban & Partner: Wrocław, Poland, 2000.
[6]. Daronch, M.; Rueggeberg, F.A.; Hall, G.; De Goes, M.F. Effect of composite temperature on in vitro intrapulpal temperature rise. Dent. Mater. 2007, 23, 1283–1288.
[7]. Lee-Knight CT, Wylie SG, Major PW, Glover KE, Grace M. Mechanical and electrothermal debonding: effect on ceramic veneers and dental pulp. Am J Orthod Dentofacial Orthop. 1997;112:263– 270
[8]. Schuchard A. A histologic assessment of low-torque, ultrahighspeed cutting technique.J Prosthet Dent. 1975;34:644–651.
[9]. Sato K. Relation between acid dissolution and histological alteration of heated tooth enamel. Caries Res. 1983;17:490–495
[10]. Robinson HB, Lefkowitz W. Operative dentistry and the pulp. J Prosthet Dent. 1962;12:985–1001.
[11]. Taira M, Wakasa K, Yamaki M, Matsui A. Heat generated when cutting natural tooth enamel, composite resin model tooth enamel and glass-ceramic Typodont tooth. Hiroshima Daigaku Shigaku Zasshi. 1990;22:210–212.
[12]. Moulding MB, Loney RW. The effect of cooling techniques on intrapulpal temperature during direct fabrication of provisional restorations. Int J Prosthodont. 1991;4:332–336.
[13]. Takla PM, Shivapuja PK. Pulpal response in electrothermal debonding. Am J Orthod Dentofacial Orthop 1995;108:623-9.
[14]. Eminkahyagil N, Arman A, C¸etins¸ahin A, Karabulut E (2006) Effect of resin-removalmethods on enamel and shear bond strength of rebonded brackets. Angle Orthod 76:314–321
[15]. Van Waes H, Matter T, Krejci I (1997) Three-dimensional measurement of enamel loss caused by bonding and debonding of orthodontic brackets. Am J Orthod Dentofac Orthop 112:666–669
[16]. Zachrisson BU, Artun J. Enamel surface appearance after various debonding techniques. Am J Orthod. 1979;75:121–137.
[17]. Zarrinnia K, Eid NM, Kehoe MJ. The effect of different debonding techniques on the enamel surface: an in vitro qualitative study. Am J Orthod Dentofacial Orthop. 1995;108:284–293.
[18]. Retief DH, Denys FR. Finishing of enamel surface after debonding of orthodontic attachments. Angle Orthod. 1979;49:1–10.
[19]. Nyborg H, Brannstrom M. Pulp reaction to heat. J Prosthet Dent 1968;19:605-12.