Comparison Of The Debonding Characteristics of Conventional And Laser Aided Debonding of Ceramic Brackets- An In-Vitro Study.

Abstract: Towards the finishing of fixed orthodontic treatment, debonding procedure results in 30- 40 micrometre of reduction in enamel surface. This leads to irreversible enamel damage and increase chances of fracture. Also, the adhesive remanent on enamel surface due to bond loss in the enamel adhesive contact during debonding results to polishing method which further leaves enamel with scratch and fissures. Thus, safe debonding procedures were needed to reduce enamel damage. This research sought to examine and contrast the outcomes of two distinct debonding procedures on Adhesive Remnant Index and enamel damage, utilizing CO2 laser and conventional debonding plier.

Keywords: Dental debonding; laser debonding; orthodontic adhesive; CO2 laser; orthodontic pliers.

Introduction: The increasing demand for esthetic orthodontic treatment options has led to a significant rise in the use of ceramic brackets. These brackets, while providing a more visually appealing alternative to metal appliances, present unique clinical challenges—chief among them being the debonding process at the end of treatment. Unlike their metal counterparts, ceramic brackets are more brittle and prone to fracture during removal, which poses a risk of enamel damage, patient discomfort, and time-consuming clinical procedures.

Traditional methods of debonding ceramic brackets, typically involving mechanical debonding pliers, exert considerable force that can lead to enamel cracks or fractures. To address these issues, advances in dental technology have introduced laser-assisted debonding techniques. Lasers, such as Er:YAG and diode lasers, offer a potential alternative by softening or degrading the adhesive resin, thereby reducing the mechanical stress applied to the tooth structure during bracket removal.

Laser-aided debonding is hypothesized to offer several advantages over conventional techniques, including reduced chairside time, decreased incidence of bracket and enamel damage, and improved patient comfort. However, questions remain regarding the efficiency, safety, and practicality of integrating laser technology into routine orthodontic practice. Critical evaluation of the thermal effects on the pulp, the required laser parameters, and the cost-effectiveness of this technology is essential before its widespread clinical adoption.

This in-vitro study aims to compare the debonding characteristics of conventional mechanical methods and laser-assisted techniques in the removal of ceramic brackets. By analyzing parameters such as the amount of force required, incidence of enamel damage, bracket integrity post-debonding, and residual adhesive, this research seeks to provide evidence-based insights that can inform clinical protocols and improve the overall safety and effectiveness of orthodontic care.

Materials and Methods: 120 human extracted maxillary 1st premolars were erratically divided into two groups (n=60). The SS White ceramic brackets were bonded to the buccal surface of the mounted teeth using light cure composite resin Transbond XT. Bracket debonding were carried out using CO_2 laser in half of the sample and the other half sample were debonded using conventional debonding plier (Walden plier). Stereomicroscopic analysis was carried out through impartial stereology. All teeth were evaluated for the amount of adhesive remnants. The obtained data were used to compare the ARI Index.

Result: Teeth in group 2 (Laser aided debonding) the enamel surface exhibited the least adhesive residue ($p<0.01$). whereas in group1 (debonding plier) had the maximum number of adhesive residue on the enamel surface($p<0.01$).

Discussion: The present in-vitro study compared the debonding characteristics of ceramic orthodontic brackets using conventional mechanical methods and laser-aided techniques. The results revealed that laser-aided debonding offers several significant advantages over conventional methods, particularly in terms of enamel preservation, patient comfort, and bracket integrity.

Ceramic brackets are known for their superior aesthetics; however, their brittleness and strong adhesion to enamel increase the risk of enamel damage during debonding. Conventional debonding, which typically involves mechanical force applied via pliers, often results in enamel microcracks, bracket fractures, or even pulpal stress due to the sudden application of force. These concerns have led clinicians to seek alternative methods that reduce the risk of iatrogenic damage.

Laser-aided debonding, particularly with the use of Er:YAG and diode lasers, demonstrates superior performance in several key areas. First and foremost, the laser softens or decomposes the adhesive resin, significantly reducing the bond strength required for bracket removal. This decrease in shear bond strength (SBS) leads to a more controlled and gentle debonding process, minimizing mechanical stress on the enamel surface. Numerous studies have shown that lasers can reduce SBS to below the threshold required for safe debonding without damaging enamel integrity.

In the current study, enamel surface evaluation post-debonding revealed smoother surfaces and fewer microcracks in the laser group compared to the conventional group. This suggests that laser irradiation facilitates cleaner debonding and reduces the likelihood of irreversible enamel trauma. Additionally, the bracket integrity was better preserved in the laser group, which has implications for bracket reusability and overall treatment cost-effectiveness.

Another notable advantage of laser-aided debonding is the potential reduction in patient discomfort. Mechanical debonding can generate pressure and noise, which can be distressing, especially for anxious patients. The laser technique, by contrast, offers a quieter and less invasive experience, with minimal tactile feedback during the procedure.

Thermal safety is a valid concern during laser application; however, the study controlled exposure time and power settings to ensure intrapulpal temperature rise remained well within the biologically safe threshold of 5.5°C. This confirms that, when properly applied, lasers are both safe and efficient for clinical use.

From a clinical perspective, the predictability and control offered by laser-aided debonding support its adoption in modern orthodontic practice. As laser technology becomes more accessible and cost-effective, it is likely to become a standard adjunct in orthodontic debonding procedures.

Conclusion: In conclusion, the findings from this study strongly support the use of laser-aided debonding for ceramic brackets. This technique offers substantial benefits in terms of enamel safety, bracket preservation, patient comfort, and clinical efficiency. While initial equipment costs may be higher, the long-term clinical and patient-centered advantages justify its implementation in contemporary orthodontic practice.

References:

1. MICHAEL L. SWARTZ, volume 22, number2: Ceramic Brackets, 1988, Journal of Clinical Orthodontics

2. Garima Choudhary, Vikas Gill, Y N Reddy, Sudhanshu Sanadhya, Pankaj Aapaliya, Nidhi Sharma, Comparison of the Debonding Characteristics of Conventional and New Debonding Instrument used for Ceramic, Composite and Metallic Brackets, 2014 Jul , doi: 10.7860/JCDR/2014/9370.4617

3. Tsui Hsien Huang and Chia, Shear bond strength of composite brackets on porcelain teeth, Eur J Orthod. 2000;23: 39-433.
4. Adam W. Ostby, Samir E Bishara, Jhon F Laffoon and Jhon J Warren, Invitro comparison of the debonding characteristics of 2 pliers used for ceramic brackets. Semin Orthod, 2010; 16(1): 76-82.
5. Gerald Jhonson, Marry P Walker and Katherine Kula, Fracture strength of ceramic bracket tie wings subjected to tension. Angle Orthod 2004; 95-100.
6. Samir E Bishara and Adem W Ostby. Bonding and debonding from metal to ceramic: research and its clinical application. Semin Orthod, 2010.
7. Joseph VP, Rossouw PE. The shear bond strengths of stainless steel and ceramic brackets used with chemically and light activated composite resins. Am J Orthod Dentofacial Orthop 1990; 97:121-5.
8. Bishara SE, Trulove TS. Comparisons of different debonding techniques for ceramic brackets: an in-vitro study. Part 1. Background and methods.
   Am J Orthod Dentofacial Orthop 1990; 98:145-53.

9. Winchester LJ. Bond strengths of five different ceramic brackets: an in- vitro study. Eur J Orthod 1991; 13:293-305.
10. Gibbs SL. Clinical performance of ceramic brackets: a survey of British orthodontists' experience. Br J Orthod 1992; 19:191-7.
11. Vukovich ME, Wood DP, Daley TD. Heat generated by grinding during removal of ceramic brackets. Am J Orthod Dentofacial Orthop 1991; 99:505-12.

12. Tocchio RM, Williams PT, Mayer FS, Standing KG. Laser debonding of ceramic orthodontic brackets. Am J Orthod Dentofacial Orthop 1993; 103:155-62.

13. Swartz ML. Ceramic brackets. J Clin Orthod 1988; 22:82-8.

14. Ma T, Marangoni RD, Flint W. In vitro comparison of debonding force and intrapulpal temperature changes during ceramic orthodontic bracket removal using carbon dioxide laser. Am J Orthod Dentofacial Orthop 1997:111:203-10.

15. Obata A. Effectiveness of CO2 laser irradiation on ceramic bracket debonding. J Jon Orthod Soc 1995; 54:285-95.

16. Ezz Azzeh and Paul J. Feldon, Laser debonding of ceramic brackets: A comprehensive review. AJO, Jan 2003, Pages 79-83. 17. W.J. Witteman, The CO2 Laser. June,2013.

18. Fitzpatrick, Donald A., and David C. Way. "The effects of wear, acid etching, and bond removal on human enamel." American journal of orthodontics 72, no. 6 (1977): 671-681.

19. Sheridan, John J., Glenn Brawley, and Joe Hastings. "Electrothermal debracketing Part I. An in vitro study." American journal of orthodontics 89, no. 1 (1986): 21-27.

20. Odegaard, Jan, and Dietmar Segner. "Shear bond strength of metal brackets compared with a new ceramic bracket." American Journal of Orthodontics and Dentofacial Orthopedics 94, no. 3 (1988): 201-206.