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ORIGINAL ARTICLE

# EVALUATION OF PAIN PERCEPTION AND ENAMEL LOSS BY TWO DIFFERENT TECHNIQUES OF DEBONDING: A RANDOMIZED CONTROLLED TRIAL

## Evaluación de la percepción del dolor y de la pérdida de esmalte mediante dos técnicas diferentes de descementado: Un ensayo controlado aleatorizado

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## ABSTRACT

**Objective:** To assess the level of discomfort experienced by patients during the debonding procedure using two different debonding instruments, as well quantify the iatrogenic enamel loss following debonding.

**Materials and Methods:** A total of 50 patients who were due for debonding were randomly allocated into two equal groups of 25 each by SNOSE method. The group-A (GDC Bracket Remover # Straight Plier (3000/83)) and group- B (#095-S - Bracket and Adhesive Removing Plier. Orthopli, Philadelphia, Pa) were utilized for debonding by a standard procedure. Patients were given a pain-perception worksheet with a visual analogue scale (VAS) to note the pain/discomfort experienced. The amount of residual enamel attached to the bracket base pad was evaluated by elemental mapping using backscattered scanning electron microscopy technique. Mann Whitney U test and Kruskal-Wallis test were utilized for analysing pain perception. The bracket adhesive remnant index (BARI) and adhesive remnant index (ARI) scores were analysed using Chi-Square Test.

**Results:** The pain perception with ORTHOPLI adhesive and bracket debonding plier (22.5) was less compared to that of GDC plier (30) and statistically significant. BARI scores showed 39% more enamel loss in Group B compared to Group A. ARI scores showed less amount of adhesive attached to tooth surface in Group B (58%) compared to group A. Whereas, the percentage of enamel attached to the bracket base of both the groups showed no significant difference.

**Conclusion:** ORTHOPLI adhesive and bracket debonding plier is more effective in debonding as it causes comparatively less pain and adhesive attached to the tooth surface.

**Keywords:** Adhesives; Orthodontic Brackets; Dental debonding; Dental instruments; Orthodontics; Pain.

## RESUMEN

**Objetivo:** Evaluar el nivel de incomodidad que experimentan los pacientes durante el procedimiento de desconsolidación de los brackets utilizando dos instrumentos de desprendimiento diferentes, así como determinar la frecuencia de daño iatrogénico del esmalte después del desprendimiento.

**Materiales y métodos:** Se distribuyó aleatoriamente a un total de 50 pacientes que necesitaban despegar los brackets en dos grupos iguales de 25 cada uno mediante el método SNOSE. El grupo A (GDC Bracket Remover # Straight Plier (3000/83)) y el grupo B (#095-S - Bracket and Adhesive Removing Plier. Orthopli, Philadelphia, Pa) se utilizaron para el desprendimiento mediante un procedimiento estándar. Se les entregó a los pacientes una hoja de trabajo de percepción del dolor con una escala analógica visual (EAV) para anotar el dolor/incomodidad que experimentaban. La cantidad de esmalte residual adherido a la almohadilla de la base del bracket se evaluó mediante un mapeo elemental utilizando la técnica de microscopía electrónica de barrido retrodispersada. Se utilizaron la prueba U de Mann Whitney y la prueba de Kruskal-Wallis para analizar la percepción del dolor. Los puntajes del índice de remanente adhesivo del bracket (BARI) y del índice de remanente adhesivo (ARI) se analizaron utilizando la prueba de Chi-cuadrado.

**Resultado:** La percepción del dolor con el alicate para descementar brackets y adhesivo ORTHOPLI (22,5) fue menor en comparación con el alicate GDC (30) y estadísticamente significativa. Los puntajes BARI mostraron una mayor pérdida de esmalte en el grupo B (39,8%) en comparación con el grupo A. Los puntajes ARI mostraron una menor cantidad de adhesivo adherido a la superficie del diente en el grupo B (58%) en comparación con el grupo A. Mientras que el porcentaje de esmalte adherido a la base del bracket de ambos grupos no mostró diferencias significativas.

**Conclusión:** El alicate para descementar brackets y adhesivo ORTHOPLI es más efectivo para descementar, ya que causa comparativamente menos dolor y adhesivo adherido a la superficie del diente.

**Palabras Clave:** Adhesivos; Soportes ortodóncicos; Desconsolidación dental; Instrumentos dentales; Ortodoncia; Dolor.

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## INTRODUCTION

A significant degree of discomfort with orthodontic treatment, such as tension, pressure, tooth sensitivity, and even pain, may be experienced. Age, gender, emotional state, cultural background, and previous pain experiences all affect how intensely a person feels pain, which is a physiological and emotional experience. The perception of pain is extremely subjective and varies widely from person to person.[1]

The International Association for the Study of Pain defines pain as "a painful sensory and emotional experience related to actual or potential tissue damage."[2] Up to 95% of patients suffer pain or discomfort during orthodontic treatment, which is frequently stated as a reason for treatment termination. There are several studies on the relationship between pain and separator placement, archwire placement and activations, orthopaedic force application, and debonding procedures.[1-3] Pain during debonding is poorly understood in terms of its existence, causes, and treatment.

The basic goal of bracket debonding is to remove appliances and any bonding material from the teeth, restoring their original appearance and shapes while minimising iatrogenic enamel loss.[4] The tooth mobility caused by forces applied by debonding appliances were critical contributing factors for pain perception.[5]

Normando *et al.,*[6] discovered that the lift-off instrument caused nearly two times less pain than the wire cutting plier during debonding. Mangnall *et al.,*[7] investigated the effect of soft acrylic bite wafers and found that there was much reduced pain in the posterior region. According to research, 8% of a study population dropped out of orthodontic treatment due to pain.[8]

Debonding procedures are associated with loss of enamel surface and it has to be minimized during the procedures. Zachrisson *et al.,*[9] recommended using tungsten carbide burs at low speeds followed by pumice and/or polishing cups to cause the finest scratch pattern and the least loss of surface enamel. Zarinnia *et al.,*[10] also suggested using a tungsten carbide bur at high speed, completing with graded medium, fine, and superfine Sof-Lex discs at low speed, and ending with a rubber cup and Zircate paste.

Instruments such as the straight cutter plier, Howe plier, ligature cutter plier, Weingart plier, anterior bracket debonding plier, straight debonding plier, side cutter, Eltee debonding plier, and lift off debonding instrument were all employed in prior investigations. Despite the various ways discussed, few authors are concerned about the discomfort caused to orthodontic patients by the various debonding methods.[11]

Recently a new debonding plier was introduced by Orthopli Corporation a most efficient bracket and adhesive removing plier that is #095-S - Bracket and Adhesive Removing Plier (Orthopli, Philadelphia, Pa).

The manufacturers claim that this novel instrument effectively debonds the bracket without leaving much adhesive residue on the enamel surface, and there have been no previous studies comparing the instrument's efficacy to that of already available debonding pliers. So the purpose of this clinical study was to assess the level of discomfort experienced by patients during debonding procedure with this newly introduced instrument to that of GDC debonding plier. It also aims to assess the iatrogenic enamel damage following debonding.

## MATERIALS AND METHODS

This randomized control trial, two-arm parallel unicentered study was approved by the Institutional Ethical Committee (Ref No. ICE/NDCH/2019/P-41) and was registered in Clinical trials Registry-India (CTRI/2021/06/034174). Written consent was obtained from the patients prior to participation.

**Sample selection:** The sample is drawn from a cohort group of consecutive patients who had undergone full fixed appliance orthodontic treatment and in whom debonding was done after completion of treatment.

A total of 92 patients were debonded during this period and 50 patients were selected after applying inclusion and exclusion criteria. This sample of 50 provides a power of ≥ 80% power and a 95% confidence interval (CI) to detect a clinically significant difference in mean pain of 10mm recorded on visual analogue scale (VAS) and to detect a minimum loss of 1Sq.mm of enamel over bracket base. (G*Power version 3.1.9.4.)[12] (Figure-1).

**Inclusion criteria:** All orthodontic patients in the age group of 18-24 years with Angle class I malocclusion with crowding or spacing less than 3-5mm, good periodontal health and presence of all permanent teeth were included. All the cases were treated by a non-extraction method. No history of taking medicine periodically or in the last 24 hours (eg, painkillers, corticosteroids, and antiflu drugs) that may affect the outcome of pain perception. Patients undergoing treatment of both arches with 0.022 MBT 0.022-inch metal brackets (ORMCO) and 0.017X0.025 inch SS wire finishing arch wires present for at least two months.

**Exclusion criteria:** Patients with previous history of orthodontic treatment and debonding were excluded. Patients with caries lesions, buccal restoration, hypoplasia, fluorosis, and with craniofacial syndromes or cleft lip and palate were not included in the study. Patients with history of pain due to third molar impactions with pain were also excluded. Patients with bond failure during the course of orthodontic treatment were excluded.

A total of 50 patients who were due for debonding were randomly allocated into two equal groups of 25 each by SNOSE method. The group-A (GDC Bracket Remover # Straight Plier (3000/83)) and group- B (#095-S - Bracket and Adhesive Removing Plier. Orthopli, Philadelphia, Pa) were utilized for debonding by a standard procedure. It is double-blind procedure as the participant and the score assessor were blinded.

**Debonding procedure:**

A standard debonding procedure was used for both group A and group B. Debonding is accomplished after removal of arch wires and a layoff period of half hour was given before the original debonding of brackets was carried out. The teeth were kept out of occlusion (biting on cotton roll) during the debonding procedure. The purchase point for the beaks of the pliers was obtained under both occlusal and gingival wings, and as well as above the bracket base. The pliers' handles were pressed together until the angled ends met, and the instrument was rotated towards the occlusal edge of the bracket until it was removed from the upper and lower right side of the jaws respectively (Figure 2).

All visible remaining adhesive is meticulously removed using a slow-speed handpiece and a 12-bladed carbide finishing bur after debonding techniques.[13,14] Immediately after debonding each bracket on individual teeth, patients were given a pain-perception worksheet with Visual analogue scale (VAS) to note the pain/discomfort experienced. The upper arch teeth were debonded first followed by lower, in the sequence of first, second, third and fourth quadrants. The residual adhesive on tooth surface is evaluated by naked eye using ARI index 15 and the brackets were collected from each subject, sterilized in autoclave and investigator evaluated the residual adhesive on bracket base by naked eye using BARI index.[16]

Ten maxillary right central incisor brackets that had BARI score of 4 and 5 from each group were randomly collected and sterilised using 4.1 kGy gamma irradiation. Backscattered scanning electron microscopy at 60 times magnification was used to visualise brackets (low vacuum; no coating;


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backscatter mode; spot size 4; 15 kV; resolution 2048 3 1768; Quanta 200F scanning electron microscope; JEOL SEM 6000 plus JAPAN 2020) and an elemental map of calcium, phosphorus, aluminium, and silicon on the bracket base was obtained to measure amount of residual enamel present on the bracket base pad (Figure 3).[16]

### STATISTICAL ANALYSIS

Data was analysed using IBM SPSS (version 27). Normality of the data was assessed by Kolmogorov Simonov test. All the pairwise comparisons of pain perception within and between the groups were analysed using Mann Whitney U test and comparisons within the quadrants were analysed using Kruskal-Wallis Test. All the pairwise comparisons within and between the groups, for the BARI scores [4,5] and ARI scores 0,1 were analysed using Chi-Square Test. All the values with "*p*" < 0.05 were considered statistically significant.

## RESULTS

The mean age of subjects in group A (GDC straight debonding plier) and group B (ORTHOPLI adhesive and bracket debonding plier) (Figure 2) was 20.68 + 4.34 and 21.76 + 3.95 respectively. There was no statistically significant difference in age distribution between two groups (Table 1). Descriptive data of VAS, BARI, ARI scores among quadrants of both the groups are shown in (Table 2).

Pain perceived is almost one and half times less pain with ORTHOPLI adhesive and bracket debonding plier (22.5) compared to the GDC plier (30). Almost double pain perception is perceived by upper arch in group A (30) compared to the upper arch of group B (20). Whereas, considering quadrants, upper 2nd quadrant (40) shows double the pain perception compared to the 1st quadrant (20) in group A. Whereas, at tooth level comparisons no statistically significant difference was, (Table 3).

BARI scores 4,5 indicates enamel loss, which is more in group B (39.8%) compared to group A. Upper archs (52,58.7%) showed more enamel loss than the lower arches of respective groups. Right side quadrants in group A (80,65.6%) showed more enamel loss than the left side quadrants. Whereas, in group B 2nd quadrant (59%) showed more enamel loss than 1st quadrant and no statistically significant difference between 3rd and 4th quadrants (Table 4).

ARI scores 0,1 indirectly indicates the more enamel loss. Group B (58%) showed less amount of adhesive attached to the tooth surface than group A. Upper arches (45.5, 56.2%) of both the groups showed less amount of adhesive attached than lower arches. Coming to quadrant wise comparisons, right side quadrants in group A (18, 52%) showed less adhesive attached to tooth surface whereas in group B no such significant difference is seen among quadrants of respective arches (Table 4).

SEM analysis of enamel residue of bracket base with BARI scores of 4 and 5 in both group A and group B showed in Table 7 (Figure 4). The percentage of enamel attached to the bracket base between both the groups showed no significant difference (Table 5).

**Table 1.** Descriptive parameters of the study-Mean Age Distribution.

| | Group A (n=25) (Mean+ SD) | Group B (n=25) (Mean+ SD) | 95% CI | t-value | *p*-value |
|---|---|---|---|---|---|
| Age in years | 20.68 + 4.34 | 21.76 + 3.95 | 1.08 ± 2.35 | -0.92 | 0.361* |
| SEM | 0.86 | 0.79 | | | |

**Statistics:** Students independent T test. ***:** By conventional criteria, this difference is considered to be not statistically significant. The two groups are similar in relation to age. **CI:** Confidence interval.

**Table 2.** Descriptive data of VAS, BARI, ARI scores among quadrants in group A and group B.

| GROUPS VAS Scores | QUADRANTS | | MIN | MAX | MEDIAN |
|---|---|---|---|---|---|
| **GROUP A** | First | Incisors | 0 | 30 | 5 |
| (GDC Bracket Remover) | | Canines | 0 | 60 | 0 |
| | | Premolars | 0 | 10 | 5 |
| | Second | Incisors | 0 | 25 | 5 |
| | | Canines | 0 | 20 | 10 |
| | | Premolars | 0 | 80 | 5 |
| | Third | Incisors | 5 | 40 | 5 |
| | | Canines | 0 | 60 | 10 |
| | | Premolars | 5 | 25 | 5 |
| | Fourth | Incisors | 5 | 40 | 5 |
| | | Canines | 0 | 60 | 10 |
| | | Premolars | 5 | 20 | 5 |
| **GROUP B** | First | Incisors | 0 | 30 | 0 |
| (Bracket and Adhesive | | Canines | 0 | 60 | 0 |
| Removing Plier. Orthopli) | | Premolars | 0 | 30 | 0 |
| | Second | Incisors | 0 | 50 | 0 |
| | | Canines | 0 | 80 | 0 |
| | | Premolars | 0 | 30 | 0 |
| | Third | Incisors | 0 | 40 | 5 |
| | | Canines | 0 | 80 | 0 |
| | | Premolars | 0 | 20 | 5 |
| | Fourth | Incisors | 5 | 30 | 5 |
| | | Canines | 0 | 70 | 0 |
| | | Premolars | 0 | 20 | 5 |

| **BARI SCORE** | | **0** | **1** | **2** | **3** | **4** | **5** | **total** |
|---|---|---|---|---|---|---|---|---|
| **GROUP A** | First | 29 | 12 | 16 | 12 | 53 | 3 | 125 |
| (GDC Bracket Remover) | Second | 22 | 41 | 47 | 1 | 13 | 1 | 125 |
| | Third | 29 | 17 | 11 | 24 | 37 | 7 | 125 |
| | Fourth | 26 | 25 | 37 | 14 | 18 | 5 | 125 |
| **Total/Frequency (%)** | | **106 (21)** | **95 (19)** | **111 (22)** | **51 (10)** | **121 (24)** | **16 (3)** | **500** |
| **GROUP B** | First | 27 | 6 | 11 | 33 | 44 | 4 | 125 |
| (Bracket and Adhesive | Second | 15 | 12 | 13 | 16 | 60 | 9 | 125 |
| Removing Plier. Orthopli) | Third | 23 | 13 | 21 | 26 | 39 | 3 | 125 |
| | Fourth | 14 | 11 | 37 | 23 | 33 | 7 | 125 |
| **Total/Frequency (%)** | | **79 (16)** | **42 (8)** | **82 (16)** | **98 (20)** | **176 (35)** | **23 (5)** | **500** |
| **ARI SCORE** | | | | | | | | |
| **GROUP A** | First | 1 | 15 | 87 | 22 | -- | -- | 125 |
| (GDC Bracket Remover) | Second | 3 | 70 | 27 | 25 | -- | -- | 125 |
| | Third | 8 | 59 | 29 | 29 | -- | -- | 125 |
| | Fourth | 6 | 34 | 60 | 25 | -- | -- | 125 |
| **Total/Frequency (%)** | | **18 (4)** | **178 (36)** | **203 (41)** | **101 (20)** | **--** | **--** | **500** |
| **GROUP B** | | | | | | | | |
| (Bracket and Adhesive | First | 10 | 75 | 25 | 15 | -- | -- | 125 |
| Removing Plier. Orthopli) | Second | 4 | 74 | 19 | 28 | -- | -- | 125 |
| | Third | 4 | 64 | 34 | 23 | -- | -- | 125 |
| | Fourth | 6 | 53 | 48 | 18 | -- | -- | 125 |
| **Total/Frequency (%)** | | **24 (5)** | **266 (53)** | **126 (25)** | **83 (17)** | **--** | **--** | **500** |


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**Table 3.** Inter group, intra group and pairwise comparisons of VAS scores between group A and group B after debonding, using the Mann-Whitney U Test and Kruskal-Wallis Test.

| KRUSKAL- WALLIS TEST Within quadrant (Tooth wise) | | | | MANN- WHITNEY TEST Between quadrants | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quadrant-wise | h- value | p- value | | Arch-wise | Quadrant-wise | u-value | z-value | p-value |
| **Group A** | First | 0.39 | 0.82 | **Group A** | Upper arch | First versus Second | 150 | -3.13 | 0.001* |
| (GDC Bracket | Second | 0.75 | 0.68 | (GDC | Lower arch | Third versus Fourth | 273 | -0.75 | 0.44 |
| Remover) | Third | 0.28 | 0.86 | Bracket | Upper arch *versus* Lower arch | | 272 | -0.77 | 0.43 |
| | Fourth | 2.25 | 0.32 | Remover) | | | | | |
| **Group B** | First | 0.002 | 0.99 | **Group B** | Upper arch | First versus Second | 293 | -0.35 | 0.71 |
| (Bracket Adhesive | Second | 0.07 | 0.96 | (Bracket | Lower arch | Third versus Fourth | 289 | -0.43 | 0.65 |
| Removing Plier. | Third | 2.08 | 0.35 | Adhesive | Upper arch *versus* Lower arch | | 235 | -1.48 | 0.13 |
| Orthopli) | Fourth | 3.14 | 0.20 | Removing Plier. Orthopli) | | | | | |
| | | | | **Group A** *versus* **Group B** | | | 211 | 1.96 | 0.04* |
| | | | | | | | 233 | 1.53 | 0.12 |
| | | | | | | | 202 | 2.14 | 0.03* |

***:** p< 0.05 significant. **Test static:** Mann Whitney U Values, Kruskal- Wallis test.

**Table 4.** Pairwise comparisons of BARI and ARI scores between group and group B after debonding, using the Chi-Square Test.

| **BARI SCORES** | | **Intra group comparisons** | | | |
|---|---|---|---|---|---|
| **Group description** | | **Individual pairs/scores** | | | |
| | | **Quadrant wise** | **Arch wise** | **$X^2$** | ***p*-value** |
| **Group A** | Quadrant-wise | First *versus* Second | Upper arch | 66.63 | 0.0* |
| | | Third *versus* Fourth | Lower arch | 25.29 | 0.0001* |
| | Arch wise | Upper arch *versus* Lower arch | | 20.70 | 0.0009* |
| | | BARI Score 4 *versus* 5 | | 5.46 | 0.14 |
| **Group B** | Quadrant-wise | First *versus* Second | Upper arch | 15.87 | 0.007* |
| | | Third *versus* Fourth | Lower arch | 9.05 | 0.10 |
| | Arch wise | Upper arch *versus* Lower arch | | 21.48 | 0.0006* |
| | | BARI Score 4 *versus* 5 | | 2.81 | 0.42 |
| **Group A** | **Inter group comparisons** | Upper arch *versus* Lower arch | | 69.76 | 0.0* |
| versus | | Lower arch *versus* Lower arch | | 13.22 | 0.02* |
| **Group B** | | Score 4 Group A *versus* Group B | | 26.27 | 0.0* |
| | | Score 5 Group A *versus* Group B | | 7.46 | 0.058 |
| | | Group A total *versus* Group B total | | 58.34 | 0.0* |
| **ARI SCORES** | | **Intra group comparisons** | | | |
| **Group description** | | **Individual pairs/scores** | | | |
| | | **Quadrant wise** | **Arch wise** | **$X^2$** | ***p*-value** |
| **Group A** | Quadrant-wise | First *versus* Second | Upper arch | 68.35 | 0.0* |
| | | Third *versus* Fourth | Lower arch | 18.10 | 0.0004* |
| | Arch wise | Upper arch *versus* Lower arch arch | | 9.47 | 0.02* |
| | | ARI Score 0 *versus* 1 | | 4.65 | 0.19 |
| **Group B** | Quadrant-wise | First *versus* Second | Upper arch | 15.87 | 0.007* |
| | | Third *versus* Fourth | Lower arch | 9.05 | 0.10 |
| | Arch wise | Upper arch *versus* Lower arch | | 21.48 | 0.0006* |
| | | ARI Score 0 *versus* 1 | | 3.17 | 0.36 |
| **Group A versus Group B** | | **Inter group comparisons** | | **$X^2$** | ***p*-value** |
| | | Upper arch *versus* Lower arch | | 54.35 | 0.0* |
| | | Lower arch versus Lower arch | | 5.47 | 0.14 |
| | | Score 0 Group A *versus* Group B | | 8.14 | 0.04* |
| | | Score 1 Group A *versus* Group B | | 28.12 | 0.0* |
| | | Total Group A *versus* Group B | | 38.07 | 0.0* |

**Table 5.** Percentage of bracket base covered with enamel of group A and group B.

| Percentage (%) | **Group A** (GDC Bracket Remover ) | | **Group B (Bracket and Adhesive Removing Plier. Orthopli)** | |
|---|---|---|---|---|
| | **Score 4 (n=5)** | **Score 5 (n=5)** | **Score 4 (n=5)** | **Score 5 (n=5)** |
| 0 | 29.1 | 16.2 | 29.7 | 13.2 |
| >0-<1 | 12.9 | 16.3 | 13.6 | 15.6 |
| 1-<5 | 22.9 | 16.2 | 23.1 | 15.3 |
| 5-<10 | 6.2 | 0.1 | 7.1 | 2.3 |
| >10 | 28.9 | 51.2 | 26.5 | 53.6 |

**Figure 1.** Methodology of the study (Consort flow diagram).

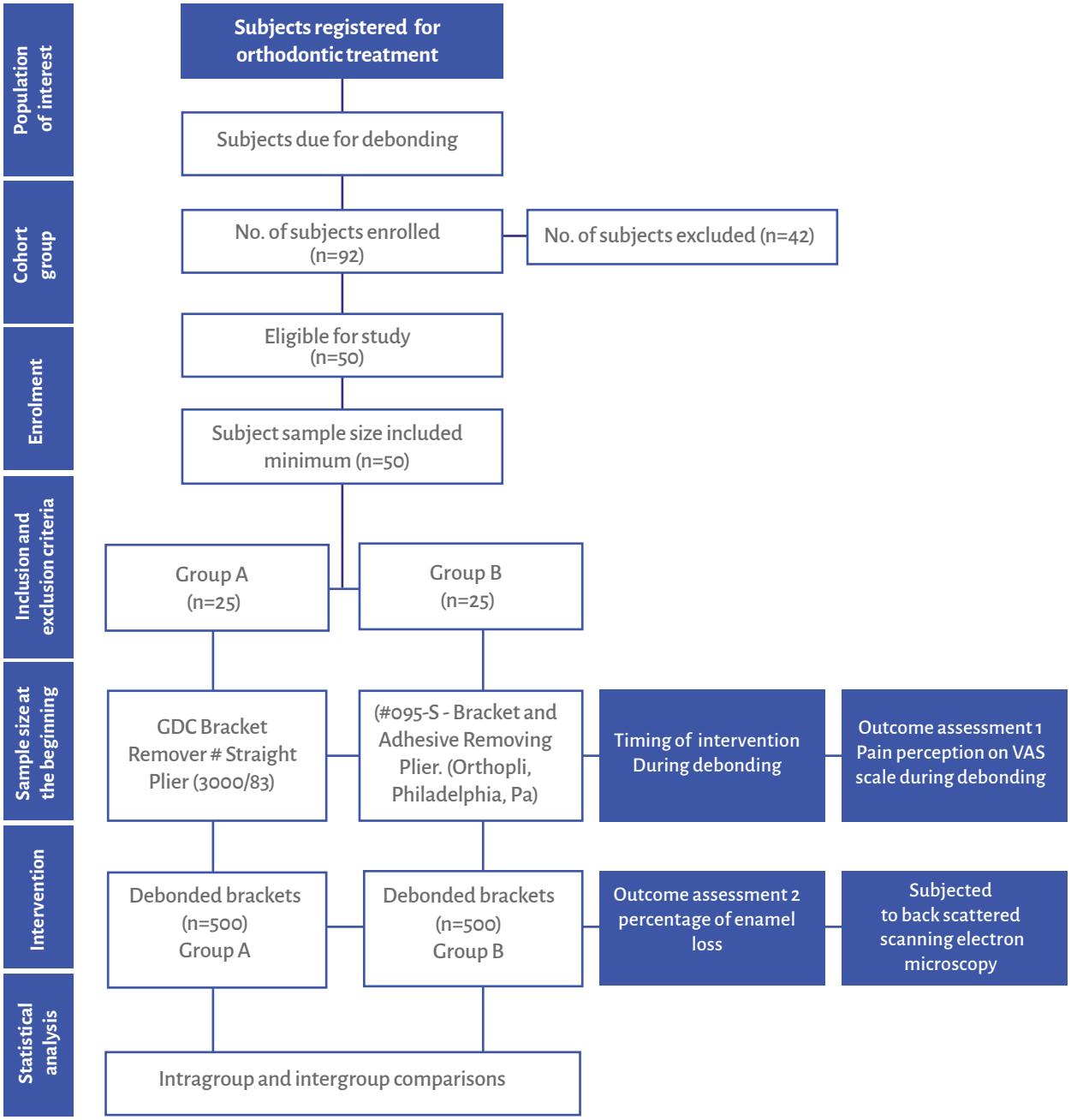



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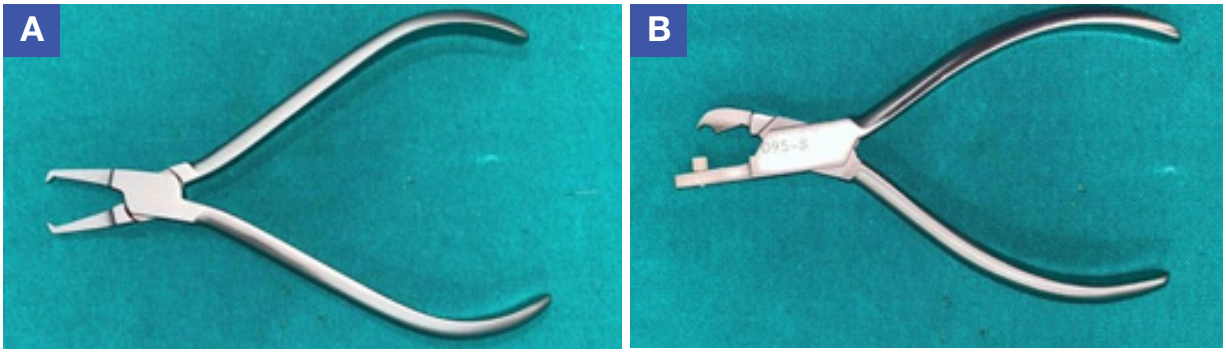
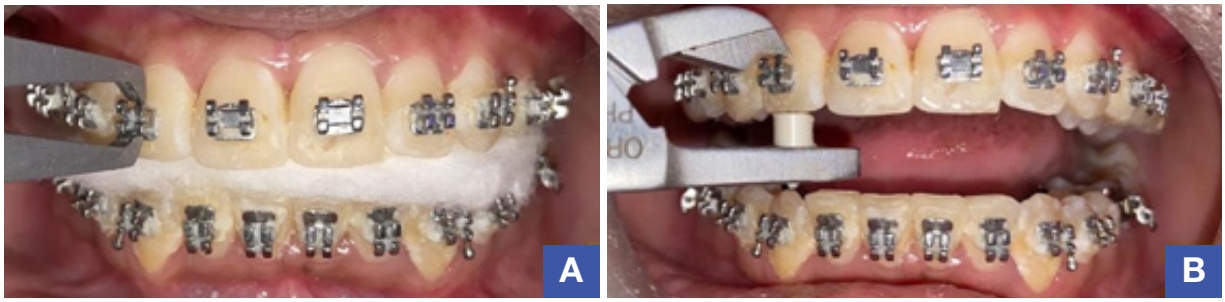
**Figure 2.** Designs of debonding instruments used in this study.




**A:** GDC Bracket Remover # Straight Plier (3000/83).
**B:** Bracket and Adhesive Removing Plier #095-S - Orthopli, Philadelphia, Pa.

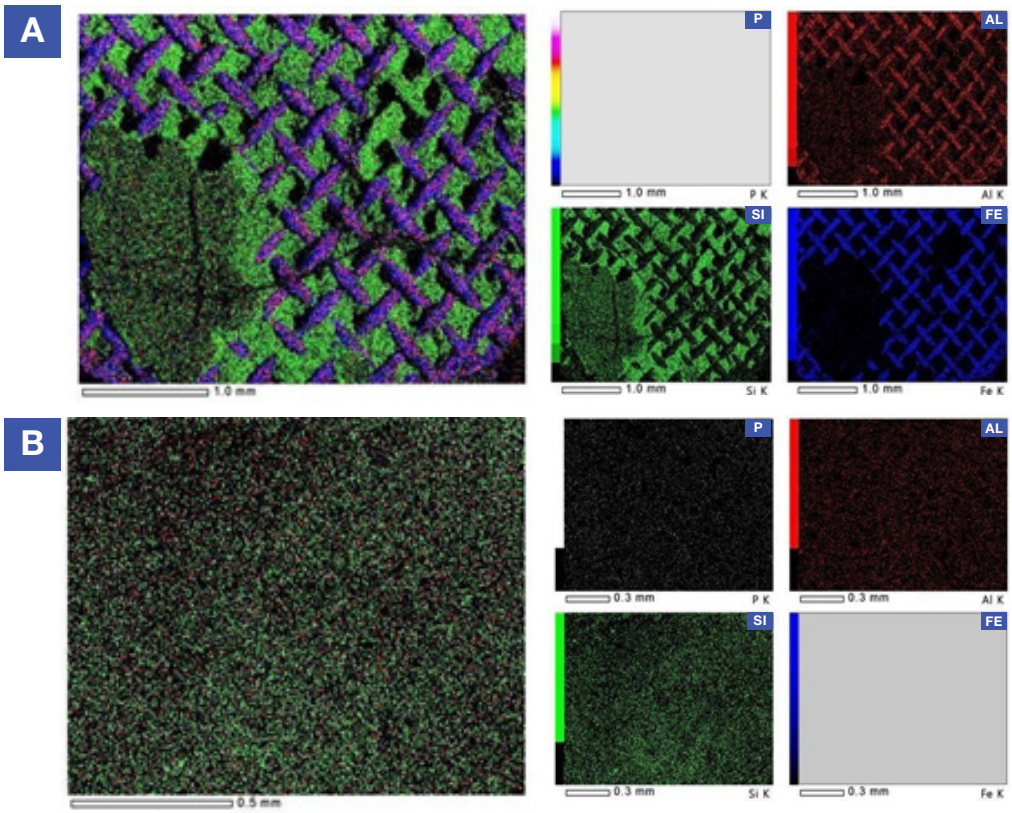
**Figure 3.** Placement of beaks of debonding pliers over brackets.




*et al.,*[19]

**A:** Debonding using GDC Bracket Remover # Straight Plier (3000/83).
**B:** Debonding using #095-S - Bracket and Adhesive Removing Plier.

**Figure 4.** Elemental mapping of bracket base by scanning electron microscopy (SEM).




**Al:** Aluminum. **P:**Phosphorus. **Ca:** Calcium. **Si:** Silica. **Fe:** Iron.

# DISCUSSION

Traditional methods of debonding include using of pliers or wrenches, ultrasonic methods that use special tips, electrothermal devices that transmit heat to the adhesive through the bracket, air pressure impulse devices that are commonly used in prosthodontics for crown removal, diamond burs to grind the brackets off the tooth surface, and lasers.[17] Although all these methods can be used successfully to debond brackets, the use of pliers to apply a shear or tensile force on the bracket is perhaps the most convenient and continues to be the most popular method used for debonding brackets.[18]

The ARI scores are evaluated by naked-eye in this study as the previous study showed no statistical differences between estimators' scores of adhesive remnant index (ARI) using special image analysis software with 320 magnification and naked-eye methods.[19]

## Pain perception

In the current study the direction of applied force is maintained constant with the principal investigator applying the force to the patient by standing to the right side of the patient. The patient is seated upright in the dental chair, with the operating area maintained below the level of the elbow of the principal investigator. This procedure is done so as to standardize the effect of direction of force applied which was not done in previous studies.

The overall comparison of pain perception in this study is (Table 3) similar to the studies which used Lift-off debonding instrument (LODI). Thiene Silva Normando *et al.,*[6] showed that the pain perception of LODI (12.8%) is almost twice less compared with ligature cutter plier (24.3%) (No. 20, Orthoply). The studies of Matheus Melo Pithon *et al.,*[11] (8.3+ 1.1) and Juhi Yadav *et al.,*[20] (2.52 ± 0.50) also revealed that debonding with LODI causes less pain compared with other instruments.

The archwise comparisons (Table 3) are not in accordance with studies of Pont *et al.,*[21] and Zanarini *et al.,*[22] where no statistically significant difference was observed. Whereas, quadrant wise and tooth level comparisons (Table 3) are not in accordance with Kilinç,[23] where highest pain level was on the left side of mandible and upper right lateral incisors (14.28%, 13.09%) respectively. Adhesive remnants on tooth surface and bracket base:

## ARI index

GDC plier group (30.4%) showed results similar to studies used Lift - off debonding instrument (LODI) for debonding[22] showed LODI group had more amount of adhesive attached to enamel surface (12.0%). This is in contrast to previous studies that used the Lift-off debonding instrument (LODI) for debonding, where no significant difference is observed.[6,11,24]

The archwise and quadrant comparisons are not in accordance with a previous studies[21] that reported no statistically significant difference between arches, but highest incidence of ARI tooth score-3 was observed for central incisors,[29] whereas the lowest percentage of score-0 for first molars.[3]

## BARI index

This study results are not in accordance with the study by Zanarini *et al.,*[22] where no statistically significant differences were reported between dental arches, and maxillary incisor and canine brackets showed comparatively lowest percen-tages of resin remnants (28.5%, 32.0%), respectively; Nathan *et al.,*[16] lateral incisors (32.7%) exhibited higher amount of enamel on bracket base compared with the central incisors and canines.

## II. Enamel loss

The current study results differ from that reported Valletta *et al.,*[25] where torsional debonding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stress caused least enamel damage (0.8%) than tensile and shear stress methods,[21] and maxillary teeth (14% + 8.7%) showed more calcium loss; Salehi *et al.,*[26] showed that the application of Dentaurum Debonding Pliers, particularly with Unite adhesive, resulted in a high number of enamel cracks compared with LODI (88.78±14.49).

Radhakrishnan *et al.,* [27] showed ceramic with metal slot brackets (4%) resulted in a significantly greater amount of enamel loss with bracket removing plier (3M Unitek) compared to Self-ligating (Smart clip 3M Unitek) and SS brackets (Gemini 3M Unitek). This is in accordance with with previous studies using using energy dispersive x-ray spectrometry, which reported that the Ca/Si ratio showed no statistically significant difference after debonding.[22,28]

### Limitations of the study

In the present study gender discrimination of pain perception is not evaluated. ARI and BARI scores were evaluated by the naked eye; accuracy could have been improved if stereo-microscope had been used.

## CONCLUSION

During debonding ORTHOPLI adhesive, using bracket removing pliers causes less pain perception than using GDC debonding pliers. Arch level comparisons showed the upper arch of the GDC pliers group reported more pain than the group of bracket removing pliers; the upper second quadrant in group A resulted in more pain than the first quadrant, whilst there was no statistically significant difference of pain perception between individual teeth.

ARI and BARI scores showed enamel loss is more severe in the group using bracket removing pliers; Arch level comparisons showed more enamel loss in upper arches and in the right side quadrant in both the groups.

Scanning electron microscopy analysis showed no statistically significant difference in enamel on bracket base between both groups.

## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

## ETHICS APPROVAL

Study was approved by the institutional ethical committee (Ref No. ice/ndch/2019/p-41) and was registered in clinical trials registry-india (CTRI/2021/06/034174).

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## AUTHORS' CONTRIBUTIONS

**Chowdary LN:** Conceptualization; Data Curation; Formal Analysis; Funding Acquisition; Investigation; Methodology; Project Administration; Resources; Software; Writing; Original Draft; Review and Editing.

**Singaraju GS:** Formal Analysis; Software; Supervision; Validation; Visualization.

**Reddy GV:** Methodology; Supervision; Visualization.

**Johnson P:** Supervision; Visualization.

**Kumari K:** Investigation; Resources.

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