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Evaluation of the effects of cotton roll-biting on debonding pain: a split-mouth study

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ABSTRACT

Introduction: Debonding pain is an unpleasant sensation that is frequently encountered during debonding procedure.

Aim of the study: To investigate the effectiveness of cotton roll-biting on pain caused by the debonding procedure.

Materials and methods: 102 patients (61 females, 41 males) who were at the debonding stage in orthodontic treatment were included in the research. The study was planned using a split-mouth design: one side of the jaw was the study, and the other side was the control. The anxiety level of participants was measured before debonding. On the study side, debonding was performed while patients were biting a cotton roll. On the control side, debonding was implemented as a routine debonding procedure. Study and control sides were assigned differently in each successive patient. The debonding pain of each tooth was recorded using the Visual Analog Scale prepared separately for each tooth. Shapiro–Wilk and Mann–Whitney U tests were used for statistical analysis. For both gender groups, patients were sequenced according to the average amount of pain per tooth. Subsequently, statistical analysis was repeated by using 50% of patients suffering more pain.

Results: In the lower second premolar tooth, a statistically significant difference was detected. Pain scores were statistically higher in the study side for this tooth. No statistically significant differences were found for all other teeth.

Conclusion: Cotton roll-biting has no alleviating effect on debonding pain. When debonding is performed gently using a squeezing action without applying torsional forces, additional pain relief methods are not required.

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INTRODUCTION

Pain and discomfort are unpleasant sensations that are frequently encountered during orthodontic treatment. Studies have reported 80%–95% of orthodontic patients experience pain at some stage of their treatment.[1-3] One survey showed that pain was 4th among the major fears at the beginning of the treatment, and it ranked as the most disliked experience during treatment.[4] Additionally, 8% of patients preferred to terminate their treatment due to pain.[5] Even if the pain does not lead to a discontinuation of treatment, it adversely affects quality of life by limiting the patient's daily activities. In order to avoid pain, patients prefer to consume soft foods and their eating habits change over time.

Some orthodontic procedures, such as separator placement, arch wire placement and activation, orthopedic forces, and the debonding procedure can cause pain and discomfort.[6] In particular, pain caused by separator placement and arch wire activation has been extensively studied in the literature.[1,2,6] The issues relating to the nature of orthodontic pain, such as the formation mechanism and its affecting factors, were generally explained based on the data obtained from these studies.

There are various opinions about the neurophysiological mechanism of orthodontic pain. The most accepted concept can be summarized briefly as follows: Orthodontic tooth movement leads to releases of algogens at the periodontal ligament area such as substance P, histamine, enkephalin, dopamine, serotonin, etc., and causes hyperalgesia. Hyperalgesic status triggers the pain when the orthodontic force is applied.[6] Generally, pain appears within 2 hours after the orthodontic force application, reaches peak point at about 24-48 hours, starts to decrease on the third day, and disappears entirely within 6-7 days.[1] Individual variations such as age, sex, pain threshold, the magnitude of the applied force, emotional status, cultural differences, and previous pain experiences affect the pain of perception.[6]

Debonding pain has attracted the attention of researchers relatively late, and studies were only published after the early 1990s.[7] At the

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present time, there are insufficient published studies on this topic, and this area has not yet been adequately researched.

Different approaches - such as analgesics, adjunctive protocols, and special debonding instruments - have been introduced to reduce debonding pain.[8,9] Williams and Bishara state that, during debonding, the pain perception of the patient is influenced by two factors: the mobility of the tooth and the direction of force application. They claim that providing an intrusive force to the teeth alleviates pain as it stabilizes them and counteracts the sheer/peel and torsional debonding forces applied to the periodontal ligament.[7] Therefore, finger pressure and biting on cotton rolls - or on other partially compressible materials - were recommended for providing the necessary intrusive force during debonding procedure.[10]

In the existing literature, there are just a few articles that investigate the effects of techniques that provide an intrusive force on the teeth.[11-13] A systematic review, published in 2019 by Almuzian et al., was able to present just two studies related to providing intrusive force.[10-12] As a result of our research, we were able to access one additional article published recently.[13] Finger pressure, biting soft wafer, and biting soft wax were investigated in these studies; none of them examined the cotton roll-biting. The aim of the present study is to investigate the effects of cotton roll-biting on debonding pain.

MATERIALS AND METHODS

This study was reviewed and approved by the Clinical Research Ethics Committee of the Tokat Gaziosmanpasa University (20-KAEK-052). The sample size was determined by using a computer software (PASS 2008 Power Analysis and Sample Size Software, NCSS, Kaysville, Utah). It was calculated that the minimum amount of subjects per group should be 19 participants to achieve a power of 80%. Patients who had undergone fixed orthodontic treatments and whose treatments were at the debonding stage were selected according to the inclusion criteria. The inclusion criteria were as follows:

- Patients who had the bracket bonding procedure, carried out using Transbond XT primer and Transbond XT Adhesive paste (3M Unitek, Monrovia, California, USA),
- Patients who had 0.018 × 0.025-inch metal brackets and tubes,
- Patients who did not use analgesic medicine periodically or in the last 48 hours,
- Patients with no previous history of orthodontic treatment,
- Patients who did not have restoration at the bracket/tube-placed area,
- Patients who did not have acute or chronic dental pain caused by periodontal/periapical lesions or caries,
- Patients who did not have any craniofacial syndromes.

61 females (17.01±2.99 years) and 41 males (17±2.76 years) were enrolled in the study. All subjects had the conventional type of metal bracket (twin brackets). Subjects were invited to the clinic between 10 am and 2 pm for bracket debonding. Before the procedure, participants were asked to complete the Beck Depression Inventory. Subjects with scores above 17 were excluded from the study. The flow chart of the study was presented in Figure 1.

For the bracket debonding procedure, each patient's mouth was divided into two parts. For the first patient, the right side - including the upper and lower quadrants - was used as the cotton roll-biting side; the other side - including upper and lower quadrants - was used as the control side. For the second patient, the reverse procedure was implemented. The study and control sides were assigned to be different in each successive patient. Prior to debonding, a cotton roll was placed on the study side. The patients were instructed to bite the cotton roll in a way of firmly but not excessively. The fact that the patient bit the cotton roll on the study side ensured that the teeth were not in contact with counter teeth at the control side. While debonding the brackets and tubes, just gently squeezing action was performed and clinician avoided torsional forces as much as possible. Removal of the brackets was carried out from posterior to anterior, and the clinician waited for a while after the debonding of each bracket; the next bracket was then removed. During waiting, pain measurement of the tooth whose bracket was removed was carried out. The sequence of the bracket debonding was as follows: 16, 36, 46, 26; 15, 35, 45, 25; 14, 34, 44, 24; 13, 33, 43, 23; 12, 32, 42, 22; 11, 31, 41, 21. The archwires were in situ during the procedure. The debonding procedures were performed by the same clinician, and the clinician was right-handed.

Pain perception was measured by using a 10-cm Visual Analog Scale (VAS); patients were trained on how to record their pain perceptions. At the VAS forms, 0 and 10 points indicated no pain and intolerable pain, respectively; a separate form was used for each tooth.

Statistical analysis

The results were subjected to statistical analysis using Number Cruncher Statistical System (NCSS 2007, NCSS, LLC, Kaysville, Utah, USA). For all data, descriptive statistics - including mean, standard deviation, minimum, maximum, and median - were calculated and the distribution of the data was evaluated using the Shapiro-Wilk test. The Mann-Whitney U test was utilized for comparing the study and control sides. Statistical significance was evaluated at $p < 0.05$ level.

The analysis was carried out in two stages. In the first stage, the pain perceptions of the study and control sides were compared in all subjects. In the second stage, participants were sequenced from highest to lowest according to the mean pain scores at the control side. The participants who made up the top half of the sequence were selected and their data were recorded in an excel worksheet. This procedure was carried out separately for male and female participants. Thus, 2 new groups (50%-females suffering more pain, 50%-males suffering more pain) were created with patients who had more pain at the control side. The statistical analysis was repeated using these groups. Since it would be difficult or impossible to detect the true effects of the investigated method in subjects with little or no pain at the control side, such a pathway has been followed.

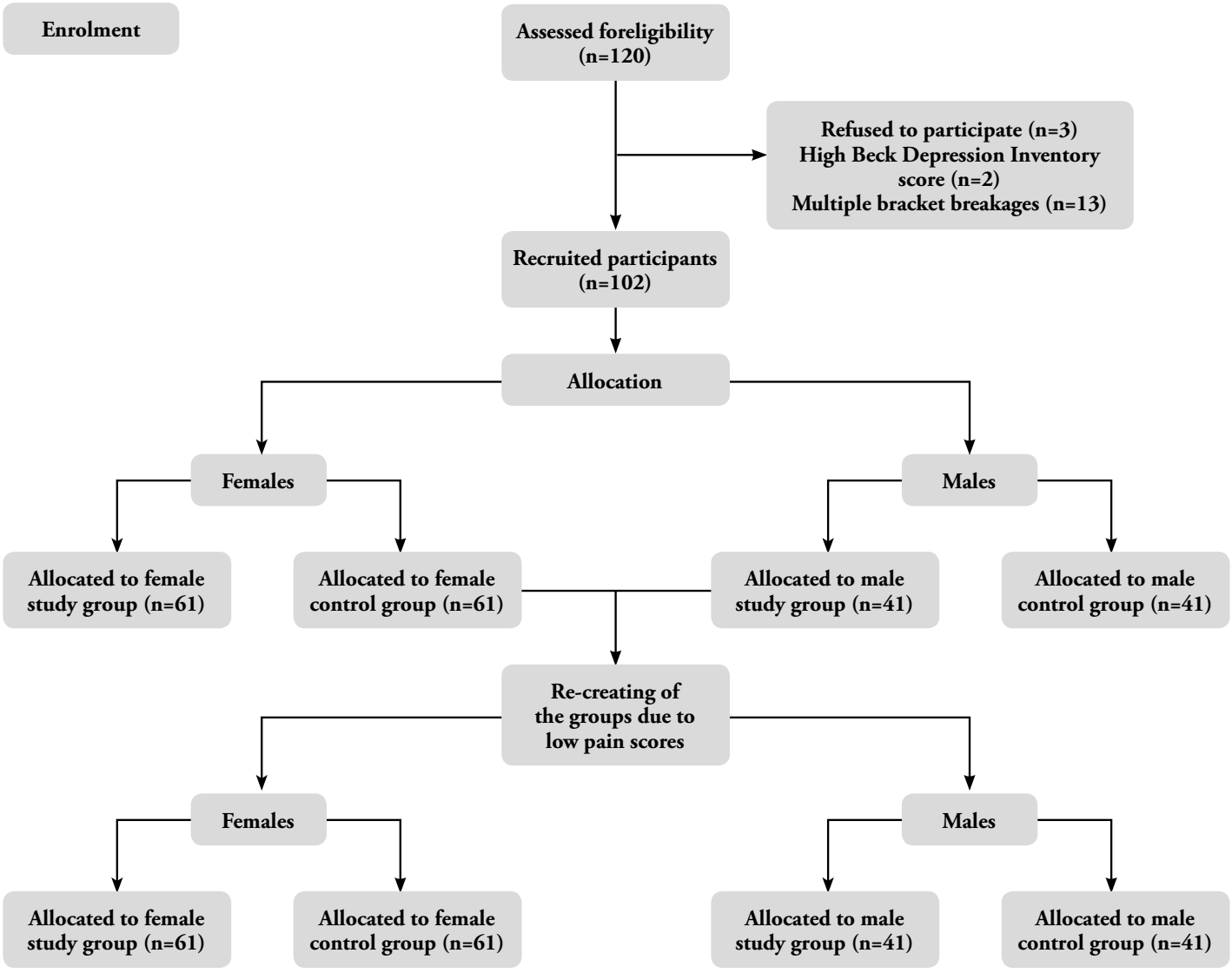

Figure 1. *Flow chart of the study.*

RESULTS

The mean ages and the other descriptive statistics of the gender groups are presented in Table 1. The minimum ages of the female and male participants were 12 and 12.5 years, respectively. The maximum ages of the female and male participants were 28.1 and 24.3 years, respectively (Table 1).

There were no statistically significant differences between the study and control sides for all of the teeth in the all-female participants group. The highest mean VAS scores in study and control sides were detected at the lower lateral incisor (1.66 cm) and the upper central incisor teeth (1.33 cm), respectively (Table 2). Similarly, it could not be reached significant differences between the study and control sides for all of the teeth in the 50% of females group suffering more pain. The highest mean VAS scores in study and control sides were detected at the lower lateral incisor (2.65 cm) and the upper central incisor teeth (2.3 cm), respectively (Table 3).

In the all-male participants group, there was a statistically significant difference for the lower second premolar tooth ($p < 0.05$); more pain was detected in the study side. For the other teeth, there were no statistically significant differences. The highest mean VAS scores in both study and control sides were detected at the upper central incisor (1.24 and 1.43 cm) (Table 4). In the 50% of males group suffering more pain, it could not be reached significant differences between the study and control sides for all of the teeth. The highest mean VAS scores in both study and control sides were detected at the upper central incisor (2.21 and 2.82 cm) (Table 5).

DISCUSSION

Todd et al. stated that the minimum clinically significant difference in patient-assigned Visual Analog Scale (VAS) pain scores is 1.3 cm.14 Based on this finding, it was calculated that the minimum amount of subjects per group should be

Table 1. Descriptive statistics of the gender groups

	N	Mean±Standart Deviation (years)	Minimum-Maximum (Median) (years)
Female (all participants)	61	17.01±2.99	12-28.1 (16.5)
Female (50% of participants suffering more pain)	30	17.56±3.73	13.2-28.1 (16.5)
Male (all participants)	41	17±2.76	12.5-24.3 (17.1)
Male (50% of participants suffering more pain)w	20	16.76±2.90	12.5-21.8 (16.7)

Table 2. Comparison of the VAS scores in all-female participants

Teeth		Mean±SD (cm)	Median (IQR)	[a]p
Upper first molar	Study Control	0.71±1.29 0.64±1.06	0 (1) 0 (1)	0.813
Lower first molar	Study Control	0.6±1.03 0.66±1.01	0 (1) 0 (1)	0.619
Upper second premolar	Study Control	0.48±1.18 0.54±1.05	0 (0.3) 0 (1)	0.377
Lower second premolar	Study Control	0.56±1.26 0.47±0.94	0 (1) 0 (0.5)	0.893
Upper first premolar	Study Control	0.73±1.38 0.33±0.6	0 (1) 0 (0.55)	0.301
Lower first premolar	Study Control	0.41±0.7 0.41±0.78	0 (1) 0 (1)	0.936
Upper canine	Study Control	0.63±1.15 0.87±1.36	0 (1) 0 (1.2)	0.301
Lower canine	Study Control	0.7±1.24 0.47±1.08	0 (1) 0 (0.15)	0.122
Upper lateral incisor	Study Control	1.06±1.52 1.28±1.51	0.3 (2) 1 (2)	0.340
Lower lateral incisor	Study Control	1.66±1.9 1.18±1.68	1 (3) 1 (2)	0.159
Upper central incisor	Study Control	1.16±1.93 1.33±2.09	0 (2) 0.4 (1.75)	0.497
Lower central incisor	Study Control	1.06±1.53 1.08±1.5	0.9 (1) 0 (2)	0.762
Average amount of pain per tooth	Study Control	0.85±0.86 0.82±0.86	0.64 (1.235) 0.5 (1.07)	0.846

SD: Standard deviation, IQR: Interquartile range, aMann-Whitney U Test, *p<0.05

19 participants to achieve a power of 80% for a clinically significant difference in mean pain of 1.3 cm recorded on a VAS scale. Therefore, it was designed in this study in a way that the number of participants per group was not less than 19.

The Beck Depression Inventory is a psychometric test and is constituted of a series of questions for detecting the severity of depression. Scores above 17 indicate moderate and severe depression.[15,16] The subjects who had scores above 17 points were excluded. Additonally, patients with ceramic or self-ligating brackets were not included in the study, as they require special debonding instruments and procedures.

Table 3. Comparison of the VAS scores in 50% of females suffering more pain

Teeth		Mean±SD (cm)	Median (IQR)	[a]p
Upper first molar	Study Control	0.77±1.6 1.18±1.31	0 (0.5) 1 (2.2)	0.113
Lower first molar	Study Control	0.7±0.86 1.24±1.22	0.5 (1) 1 (1.5)	0.139
Upper second premolar	Study Control	0.85±1.56 0.91±1.34	0 (1) 1 (1)	0.476
Lower second premolar	Study Control	0.94±1.65 0.92±1.2	0.2 (1) 0.5 (1)	0.701
Upper first premolar	Study Control	1.32±1.8 0.63±0.76	1 (2) 0 (1)	0.385
Lower first premolar	Study Control	0.63±0.75 0.74±1.01	0 (1) 0 (1)	0.865
Upper canine	Study Control	0.96±1.19 1.6±1.63	1 (2) 1 (2.5)	0.118
Lower canine	Study Control	0.85±1.27 0.92±1.41	0 .1 (1) 0 (1.5)	0.840
Upper lateral incisor	Study Control	1.69±1.71 2.28±1.52	1 (3) 2 (3)	0.104
Lower lateral incisor	Study Control	2.65±2.01 2.01±2.01	2 (3) 1 (2.25)	0.162
Upper central incisor	Study Control	2.13±2.36 2.3±2.48	1.5 (3) 1 (2)	0.763
Lower central incisor	Study Control	1.58±1.85 1.75±1.75	1 (2) 1 (3)	0.685
Average amount of pain per tooth	Study Control	1.32±0.89 1.45±0.83	1.23 (1.08) 1.25 (1.21)	0.416

SD: Standard deviation, IQR: Interquartile range, aMann-Whitney U Test, *p<0.05

Pain is a phenomenon that is highly affected by individual variations and, unfortunately, is difficult to evaluate using objective methods. As an objective and adjunctive method, biomarkers - taken from gingival crevicular fluid - can be used for relatively long-term pain, such as archwire or separator pain.[17] However, these biomarkers cannot be used for instant pain during debonding. In this study, it was used VAS for assessing the severity of pain perceptions. This is because VAS is widely utilized in orthodontic pain studies.[1,2,8,9,12,18,19] Furthermore, it was mentioned that VAS has two significant advantages compared to other subjective methods: the freedom to choose the exact intensity of pain and the maximum opportunity for pain expression in an individual style.[6]

Mangnall et al. claim that operating on the right side of the mouth requires a more rotated hand position causing a grip that has a greater chance of applying more painful torsional forces when debonding.[11] Therefore, study and control sides were changed in each successive patient in this study. The present study was constituted as a split-mouth design; nevertheless, additional measures were also taken to minimize the individual variations, which could affect the outcomes. The scores of the Beck Depression Inventory were measured and subjects who were at moderate and severe depression were excluded. It was stated that the intensity of orthodontic pain fluctuates over the

Table 4. Comparison of the VAS scores in all-male participants

Teeth		Mean±SD (cm)	Median (IQR)	[a]p
Upper first molar	Study Control	0.32±0.77 0.78±1.68	0 (0) 0 (1)	0.120
Lower first molar	Study Control	0.43±1.13 0.37±0.69	0 (1) 0 (0.7)	0.742
Upper second premolar	Study Control	0.3±0.81 0.31±0.7	0 (0) 0 (0.1)	0.509
Lower second premolar	Study Control	0.49±0.84 0.42±1.5	0 (1) 0 (0)	**0.043***
Upper first premolar	Study Control	0.54±0.9 0.57±1.17	0 (1) 0 (0)	0.484
Lower first premolar	Study Control	0.24±0.74 0.32±0.84	0 (1) 0 (0.05)	0.531
Upper canine	Study Control	0.59±1.2 0.42±0.86	0 (1) 0 (0.8)	0.906
Lower canine	Study Control	0.45±0.91 0.36±0.89	0 (0.6) 0 (0)	0.454
Upper lateral incisor	Study Control	0.91±1.53 0.95±1.6	0 (1) 0 (1)	0.821
Lower lateral incisor	Study Control	0.65±1.27 0.63±1.25	0 (1) 0 (1)	0.910
Upper central incisor	Study Control	1.24±1.97 1.43±2.36	0 (2) 0 (1.25)	0.857
Lower central incisor	Study Control	0.73±1.27 0.67±1.23	0 (1) 0 (1)	0.812
Average amount of pain per tooth	Study Control	0.7±0.93 0.72±0.94	0.23 (0.945) 0.35 (0.795)	0.809

SD: Standard deviation, IQR: Interquartile range, aMann-Whitney U Test, *p<0.05

Table 5. Comparison of the VAS scores in 50% of males suffering more pain

Teeth		Mean±SD (cm)	Median (IQR)	[a]p
Upper first molar	Study Control	0.53±0.99 1.47±2.13	0 (1) 1 (2)	0.089
Lower first molar	Study Control	0.71±1.59 0.67±0.91	0 (1) 0.2 (1)	0.518
Upper second premolar	Study Control	0.5±1.09 0.61±0.95	0 (1) 0 (1)	0.418
Lower second premolar	Study Control	1.04±1.04 1±2.24	1 (2) 0 (1)	0.118
Upper first premolar	Study Control	0.88±1.08 1.13±1.46	0.55 (1.5) 0 (3)	0.933
Lower first premolar	Study Control	0.53±1.06 0.65±1.21	0 (1) 0 (1)	0.816
Upper canine	Study Control	1.16±1.52 0.79±1.1	0.6 (2) 0.4 (1)	0.616
Lower canine	Study Control	0.81±1.17 0.83±1.22	0 (1.5) 0 (1.5)	0.967
Upper lateral incisor	Study Control	1.61±1.88 1.71±2.01	1 (3) 1 (3)	0.937
Lower lateral incisor	Study Control	1.25±1.73 1.19±1.72	0.5 (2) 0.5 (1.5)	0.919
Upper central incisor	Study Control	2.21±2.36 2.82±2.77	1 (4.25) 1 (5)	0.349
Lower central incisor	Study Control	1±1.71 1.06±1.57	0 (1.5) 1 (1)	0.509
Average amount of pain per tooth	Study Control	1.23±1.09 1.35±1.02	1.03 (1.685) 0.89 (1.425)	0.449

SD: Standard deviation, IQR: Interquartile range, aMann-Whitney U Test, *p<0.05

course of a day and this factor may cause a contradiction in the results of pain studies.[20,21] The debonding procedures in this study were always performed at mid-day; thus, the potential effect of diurnal variation was prevented.

When the data was obtained, it was observed that the pain scores of the control side were already lower in most of the patients. Since we thought it would be difficult to detect the effectiveness of the method in these patients, we decided to exclude these participants and to create two new groups using the subjects with high pain at the control side (50%-females suffering more pain; 50%-males suffering more pain). In order to apply this flow chart, it was needed more patients because the number of participants would be halved. For instance, the number of male subjects dropped from 41 to 20 at the group of 50%-males suffering more pain.

Providing an intrusive force on the teeth (biting force) during debonding was first suggested by Williams and Bishara. However, they did not scientifically prove the effectiveness of this method.[7] There was no previous studies on cotton roll-biting; therefore, it could not be directly compared our results to previous outcomes. In the literature, there are a few articles related to different pain relief methods providing an intrusive force on the teeth during debonding.[11-13] Our findings are partially consistent with some of these.

The results of the present study showed that cotton roll-biting has no effect on reducing debonding pain. Similarly, Kilinc and Dara reported that neither soft wax biting nor soft acrylic wafer biting was superior to conventional debonding in terms of pain.[13] Bavbek et al. evaluated the efficacy of finger pressure, elastomeric wafer, and stress relief methods. They conclude that finger pressure was more effective than the elastomeric wafer, especially for lower jaw. However, neither finger pressure nor elastomeric wafer was better than the stress relief method.[12] There was no control group in their study.

In male group, it was detected statistically significant more pain in the lower second premolar tooth at the study side (p= 0.043) (Table 4). The difficulty of debonding when the posterior teeth bit the cotton roll might have caused this outcome. But, this finding did not express a strong meaning. Because the p-value (p= 0.043) was close to the level of statistically significance (p< 0.05). Furthermore, this difference between the study and control sides has already disappeared at the second analysis repeated in the male group (p=0.118) (Table 5).

It can be questioned that why it was expected different results between the cotton roll biting and previously investigated methods providing the intrusive force such as soft or hard bite wafers. It was expected to observe this difference especially in anterior teeth rather than posteriors. Because, Mangnall et al.

investigated the soft wafer and they concluded that biting soft wafer did not reduce the pain experienced for the anterior teeth, but it was effective at alleviating pain in the posterior teeth. They attribute this difference to the ability of the posterior teeth to provide greater biting force, which is distributed along the long-axis of the tooth. Because, when the wafer is placed and bitten by the teeth, the posterior teeth remain in tight contact; however, the anterior teeth will only be in loose contact. Therefore, cotton roll-biting might be a better alternative in pain-relief methods. They have already suggested cotton roll-biting instead of biting the wafer, because, the cotton roll is smaller, and easier to position.[11]

While assessing the results of these studies, it should be kept in mind that none of them had a split-mouth design. Therefore, it is inevitable that individual factors - such as gender, age, and emotional status - affected the results for these studies; Mangnall et al. state that this condition was a weakness of their study. While the gender distribution was equal in the control group, there were a greater proportion of females in the wafer group.[11] Traditionally, it is believed that females are more fragile and sensitive to pain and males are more stoic and can tolerate pain more easily.[22]

One of the remarkable outcomes of this study was that the average VAS scores per tooth in the control side were already quite low (female: 0.82±0.85 cm, 50% female: 1.45±0.83 cm; male: 0.72±0.94 cm, 50% male: 1.35±1.01 cm). In a study evaluating the clinical significance of reported changes in pain severity, Todd et al. find that the minimum clinically significant difference in patient-assigned VAS pain scores is 1.3 cm.14 It was believed that this outcome was due to the researcher's careful and gentle conduct during the debonding procedure.

While clinicians normally debond the brackets, instead of using a squeezing action, they sometimes attempt to debond the brackets with torsional movements. This type of action will lead to an increased application of force to the tooth and will cause more pain. Williams and Bishara propose applying intrusive force in order to reduce the debonding pain caused by torsional force.[7] When debonding is performed using a squeezing action, without applying torsional force, the pain will be minimal. Consequently, additional pain relief methods will not be required. However, it should be noted that this suggestion is just for the conventional twin brackets. Some bracket types require special debonding instruments and methods due to their morphology and materials.

The overall difference between female and male subjects was not evaluated in this study. If it had been shown, the study could have presented more findings to the scientific community. This can be expressed as a limitation of the present study.

CONCLUSION

In summary, cotton roll-biting did not relieve debonding pain. If there is a conventional twin bracket and the manufacturer does not recommend a special debonding instrument or technique, debonding performed with gently squeezing action will be sufficient to keep pain to minimum levels and no additional pain-relief method will be required.

CONFLICTS OF INTEREST

The author declare no conflict of interest.

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