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Comparison Of Pain Perception During Debonding Between Conventional And Vibratory Therapy

JananiJayapal, Uma Maheshwari, DevakiVijayalakshmi
,
Meenakshi Academy of Higher Education and Research,
MeenakshiAmmal Dental College and Hospitals, Chennai, Tamilnadu, India

ABSTRACT

Aim of the study: The main intent of the study is to evaluate the pain perception during debonding using low-level vibrational therapy.

Materials and methods: This split-mouth study design examined 36 patients, who had approached the final stage of debonding procedure after completion of their fixed orthodontic appliance therapy. Before starting of the debonding procedure, arch wires were removed from both the arches. Group I – comprised of the control side in which conventional debonding was done and Group II-comprised of the experimental side where the application of low-level vibrations prior to debonding procedure was carried out. Post this, patients were requested to rate their pain perception scores in visual analogue scale. The data were evaluated using IBM.SPSS statistics software 23.0 version and the probability value was predetermined as 0.05 and was considered significant value.

Results: The results derived from the present study suggest that there is a highly significant reduction in pain levels using vibrations (16.23%). Upon comparing the maxillary and (12.3%) mandibular arch (20.9%), there was significant reduction in pain perception in the mandibular arch.Amongst the various regions, highly significant pain reduction was evident in mandibular anterior teeth($p<0.001$) followed by maxillary posterior($p<0.001$), maxillary anterior($p<0.032$) and mandibular posterior teeth respectively (<0.052).

Conclusion: Low-level vibratory therapy prior to debonding procedure reduces pain level significantly. On comparing maxilla and mandible, pain intensitywasmuch lower in the mandible when compared with the maxilla. Highest pain reduction was evident in the mandibular anterior region teeth, and the least was encountered in the mandibular posterior region.

INTRODUCTION

Pain is the most undesirable reaction encountered during any orthodontic treatment proceeding, which hinders patients from seeking orthodontic treatment.[1-3] It is defined as an ‘‘unpleasant sensory and emotional experience associated with actual or potential tissue damage’’ by International Association for the Study of Pain in 1994.[4] Pain being a subjective response to noxious stimuli varies from person to person due to different threshold levels which primarily is dependent on factors such as age, gender, ethnicity, cultural differences, mood, stress and anxiety, type of appliance, previous pain experience, emotional state and magnitude of the orthodontic force.[5-9]

The principal cause of pain and discomfort during orthodontic treatment is due to various factors such as pressure, ischemia, inflammation and oedema related to tooth movement.[10] During orthodontic treatment using fixed appliances, the force exerted allows movement of

the teeth within the alveolar bone, which causes compression of blood vessels and nerves which results in an outpour of inflammatory reactions, including vascular, neural, cellular and immunological responses which ultimately leads to orthodontic pain. [11,12] Hereby, it can be inferred that both orthodontic tooth movement and pain are interrelated and inseparable. Although it is intractable to keep away the unpleasant physical sensation, it can be controlled.

Orthodontic treatment procedures like separator placement, aligning, retraction and debonding will eventually lead to an unpleasant feeling, to deal with which several pharmacological and non-pharmacological modalities have been introduced in the past.

The most awaited moment of every patient after orthodontic treatment is the withdrawal of the appliance. Although patients at the time of debonding are expected to be exuberant, it is not likely to happen because of their anticipation of pain. And till now, analgesics, bite wafers and soft bite wax have been found to be effective in reducing pain during debonding.[13-15] Although several pharmacological agents are known for their analgesic effects, the presence of systematic side effects limits the usage of these agents and are also known to decline the rate of tooth movement and on the other hand, non-pharmacological methods used for reducing pain during debonding like bite wafers and chewing gums are easily available modalities, they are shown to reduce pain only in specific region and not uniformly.

Low-level vibration therapy, is one such non-pharmacological modality which was introduced in the field of orthodontics by Dr Powers for midline closure associated with pain.[16] Many studies exhibiting an increase in bone remodelling, which ultimately fastens the rate of tooth movement post vibrational therapy have been proven. However, the studies relating to clarify its association with pain reduction is insufficient.

Previous studies suggested a significant reduction in pain level following low-level vibrations post archwire or separator placement. [17-19] And it was stated that low-level vibrations aid in the blocking of the pain channels by increasing the blood flow which flushes off the inflammatory mediators like substance P, bradykinin, histamine, serotonin and prostaglandins to decrease the pain perception.[20,21] This ultimately draws attention towards the need to further inspect the requirement of low-level vibrations in the branch of orthodontics for reducing pain.

This study is the first attempt to evaluate the effectiveness of low-level vibratory therapy in reducing pain during debonding of metallic brackets by means of a subjective assessment using visual analogue scale.

MATERIAL AND METHODS

The Institutional review board of MeenakshiAmmal Dental College and Hospital approved the study protocol with the protocol number MADC/IRB-XVI/2017-308 and is in accordance with the ethical principles of the World Medical Association's Declaration of Helsinki.The subjects enrolled for this study, underwent fixed orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopaedics in MeenakshiAmmal Dental College from March 2018 to March 2019 between the age group of 14 to 30 years with a mean age of 19 ± 3.11

years. The current study comprised 22 female subjects (61.1%) and 14 male subjects (38.9%). Patients who had approached the final stage of appliance withdrawal after the completion of fixed appliance treatment were chosen for the debonding procedure.

INCLUSION CRITERIA FOR PATIENT SELECTION

- Both males and females aged 14-30 years were included;
- Patients undergoing fixed orthodontic treatment using 0.022×0.028 metallic MBT bracket system, (ORMCO California USA).

EXCLUSION CRITERIA FOR PATIENT SELECTION

- Patients who have undergone extraction for orthodontic treatment;
- With systemic diseases;
- Under medications;
- With local infection, periodontal problems, dental pain, or any psychological disorder that might affect the pain threshold level;
- With syndromes and genetic problems.

RANDOMIZATION

An intra-individual split mouth study design was adopted for the study, the sides were randomly allocated into two groups in which the intervention and control were used. Computerized randomization was done using 'Minitab computerized software' for the allocation of sides and the concealment of allocation was done using sealed envelopes, which were opened upon recruitment of the patient.

Patients were well acquainted about the study and an informed consent was acquired from all the patients or from their parents, who were chosen for this study.

METHODOLOGY

GROUPS

The debonding procedures applied to each side were as follows:

1. **Group I - Conventional Side:** Debonding was performed using conventional method and teeth were not in contact with their counterparts during the operation.

2. **Group II - Experimental Side:** Before debonding procedure, low-level vibratory therapy was performed. Following which debonding procedure was carried out similar to the conventional side.

For this prospective randomized controlled trial, a split-mouth study design was adopted because of the variable threshold level of pain encountered in different individuals. Both the appliance placement and withdrawal was carried out by the same orthodontist. (JJ)

After removal of the maxillary and mandibular archwires, the debonding procedure was first carried out on the control side in a conventional manner using straight bracket removing plier (800-0345) from the posterior region to the anterior region in the maxilla followed by

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mandible. Immediately post debracketing the maxillary posterior teeth, the visual analogue scale was given to the patient and asked to record their pain experienced in that particular region, followed by maxillary anterior region, mandibular posterior region and mandibular anterior region, ensuing which, subject was asked to rate their scores for each region separately.

Consecutively, patient was given the customized vibratory device. Mouthpiece of the device was made to be seated along the occlusal contacts of the maxillary and mandibular dentition to receive the vibrations for 20 minutes. Subsequently, the debonding procedure was carried out on the experimental side similar to the conventional side with the same straight Bracket Removing Plier (800-0345) from posterior teeth to the anterior teeth. Forthwith, the second visual analogue scale was given to the patient to rate their pain score in all the four regions- maxillary posterior region, maxillary anterior region, mandibular posterior and mandibular anterior region separately.

After the debonding procedure, both the visual analogue scales for each patient were assessed and compared.

CUSTOMIZED VIBRATORY DEVICE

A customized low-level vibratory device which could be handheld was designed in the department with the help of 'Tronic zone company' at New Delhi for this study. Mechanical stimulation was directed in oscillatory motion with a high frequency and was of low magnitude.(Fig.1, 2)

Fig.1. Customized Vibratory Device

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Fig.2. Frontal view of the patient with the vibrator

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COMPONENTS

It consisted of an activator, mouthpiece and two pin plug with wire.
i) Activator- Small extraoral component that generated vibrations at a frequency of 30Hz and force amplitude of 20 grams.
ii) Mouthpiece - Patient occludes on to the mouthpiece in order to transfer vibrational force from the activator to the dentition. Three differently sized mouthpieces which were fabricated based on the patient's facial forms were designed. These were constructed with a thickness of 3mm.
-Narrow Archform – Leptoprosopic facial form
-Broad Archform – Euryprosopic facial form
-Normal Archform – Mesoprosopic facial form
Material Used for Fabrication of Mouthpiece: Polymethyl methacrylate (Heat cure polymer) was used because of its easy processability, cost efficiency and easy availability.
iii) Two-pin plug with wire - Aids in generating vibrations.

TRAY SELECTION

Before debonding, impression was taken with the brackets in place using alginate and was poured with dental stone. This was done to interpret the form of the mouthpiece that closely approximates the patient’s archform. Selection of the tray should be such that it does not impinge the soft tissue while delivering vibrations.

STERILIZATION PROTOCOL

Mouthpieces before and after being used were soaked in 2% glutaraldehyde solution over night.

STATISTICAL ANALYSIS

The collected data were analyzed with IBMSPSS software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for

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categorical variables and the mean, median, and standard deviation were used for continuous variables. To find the significant difference between the bivariate samples in Independent groups (Cases and Controls) the descriptive statistical analysis was used. For intergroup comparison paired t test was used. For correlating age and gender, the co-relation analysis conducted using Pearson's correlation analysis was done. In all the above statistical tool the probability value .05 is considered as significant level.

RESULTS

The results of descriptive statistical analysis has been tabulated in Table.1 and shows, a high statistically significant ($p<0.001$) reduction in pain using the vibrational therapy from the results comparing the control group (14.23 ± 5.23) and the experimental group (11.92 ± 3.19). Thus, the vibrational therapy reduces pain perception in the experimental group by 16.23%.

Table 1 - Group Analysis of control and experimental groups

SUBJECTS	Mean ± SD	P value
Control	14.23 ± 5.23	<0.001***
Experimental	11.92 ± 3.19	

Further analyzing the results, the higher VAS scores are reported in maxilla (C = 6.79 ± 2.34: E = 5.95 ± 4.93) as compared to mandible (C = 5.98 ± 1.89; E = 4.73 ± 2.91) in both control and experiment groups. However, vibrational therapy produces higher statistically significant ($p <0.001\%$) pain reduction of 20.9% in the mandible and 12.3% in the maxilla. (Table.2)

Table 2 - Maxilla & Mandible Pain Perception Results

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VARIABLES	CONTROL GROUP	EXPERIMENT GROUP	P value
	Mean ± SD	Mean ± SD	
Maxilla	6.79 ± 2.34	5.95 ± 4.93	<0.001
Mandible	5.98 ± 1.89	4.73 ± 2.91	<0.001

The inter-group analysis using paired t test relating the maxilla to the mandible shows an increased reduction in pain perception in the mandibular anterior region ($p<0.001$***) compared against the maxillary anterior region ($p<0.032$*). However, the maxillary posterior ($p<0.001$***) region shows increased reduction in pain perception when compared with the mandibular posterior region ($p<0.052$*). Thus, relating to the individual region analysis, highest statistically significant reduction of pain perceptions are recorded in the regions of mandibular anterior ($p<0.001$) and maxillary posterior ($p<0.001$), followed by statistically significant results in maxillary anterior region ($p<0.032$) and mandibular posterior region ($p<0.052$) respectively. (Table.3)

The further inter-group peak analysis results tabulated (Figure-3,4) reveals, the pain experienced by the participants from both the control and experiment groups show the greatest pain levels in mandibular anterior teeth (C = 2.22 ± 1.31; E = 0.55 ± 0.55) followed by maxillary anterior teeth (C = 1.44 ± 0.77; E = 0.27 ± 0.45), maxillary posterior teeth (C = 1.05 ± 0.71; E =0.25 ± 0.43) and least experienced in the mandibular posterior region (C = 0.91 ± 0.69; E = 0.22 ± 0.42). The paired sample -t-test results relating the inter-group analysis of vibrational therapy, shows the increased pain reduction in anterior regions as compared to the posterior region in both maxilla and mandible of the experimental groups.

Table. 3 - Intergroup analysis of pain perception between different Regions

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Variables	Control group	Experimental group	P value
	Mean ± SD	Mean ± SD	
Age	19.16 ± 3.11	19.16 ± 3.11	1.00
Max Antr	1.44 ± 0.77	0.27 ± 0.45	<0.032*
Max Postr	1.05 ± 0.71	0.25 ± 0.43	<0.001***
Mand Antr	2.22 ± 1.31	0.55 ± 0.55	<0.001***
Mand Postr	0.91 ± 0.69	0.22 ± 0.42	<0.052*

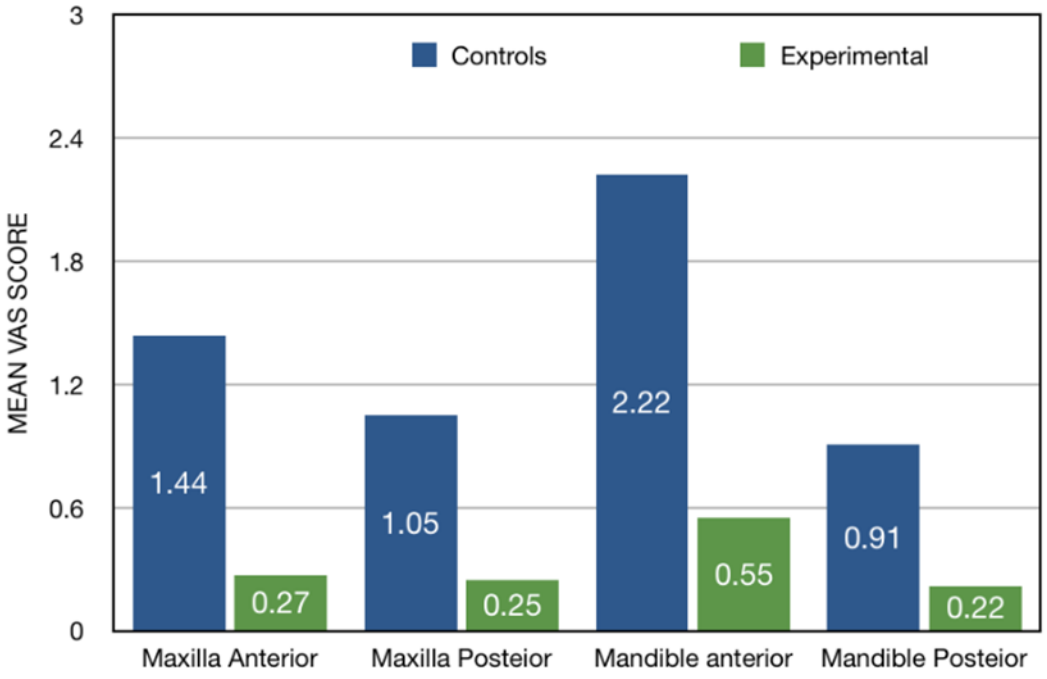

Fig.3 - Intergroup analysis of pain perception

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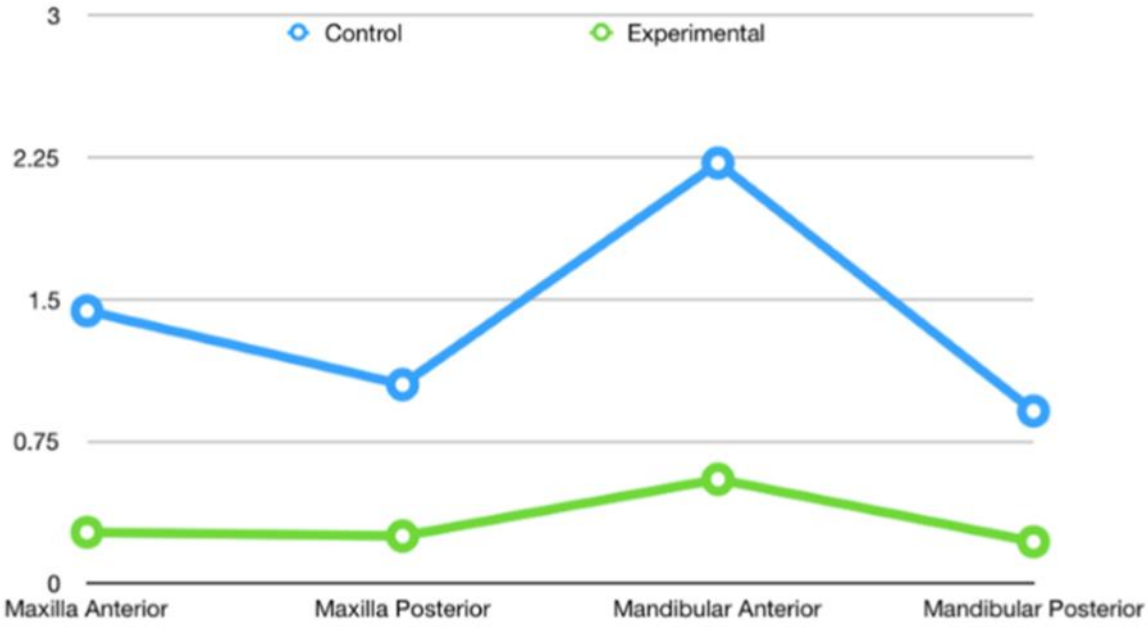

Fig.4 - Inter-group peak pain analysis in experimental and

control groups

DISCUSSION

Pain is the most displeasing physical sensation which ceases the rejoice of withdrawing the appliance after orthodontic treatment is completed. Since it is a subjective response, it largely depends on every individual's threshold level. Hence, for the current study, a split-mouth study design was adopted in order to understand better the pain experienced by patients. Thus, the site as a confounding factor will be eliminated.[17,18]

Williams and Bishara (1992) in their study have evaluated the effect of direction of debonding force on pain threshold and found a significant difference in which the patients were able to tolerate the intrusive forces better than any other direction of force intended for debonding.[19] It was also postulated that the neutralization of the periodontal ligament from the torsional and shear debonding force by the intrusive force applied during debonding as a possible reason for the reduced pain perception. They also stated that the type of debonding instrument or bracket is not related to the pain threshold during debonding.

However, in the study done by Pithon et al. (2015) which compared pain perception using four different debonding instruments – Lift off debonding instrument, straight cutter plier, howe plier and bracket removal plier, it was concluded that straight cutter plier had the highest of pain compared to lift off debonding instrument which showed the lowest. Both howe plier and bracket removal plier did not show statistically significant results.[20]Yadav et al. (2019) did a similar study comparing lift-off debonding plier, straight cutter plier and howe plier and reported similar results. Therefore, in the current study, a standardized debonding plier which could be used for debonding anterior, as well as posterior teeth, was used.[21]

Several techniques that scale down pain perception during debonding have been analyzed and implemented. Donald rinchuse et al. (1994) reported significant pain reduction during debonding while biting on occlusal rim wax.[22]Delal Dara et al. (2018) compared pain perception experienced between three modalities which included patients who consumed acetaminophen, 1hour before debonding, soft acrylic group and soft bite wax group and reported no significant difference between them in terms of pain reduction.[23]Bavbek et al. (2016) compared-''finger pressure, elastomeric wafer, or stress relief groups'' and reported that the stress relief group had no significant effect on pain reduction. Whereas, higher pain reduction was reported in the finger pressure group, specifically in the lower anterior region when compared with elastomeric wafer group.[24]Mangnall et al. (2013) reported significant pain reduction using soft acrylic wafer, particularly on the posterior teeth.[25]ArthyPriya et al. (2018) described a significant decrease in pain levels when administered with paracetamol and ibuprofen, 1 hour before debonding. All these methods, although considered harmless, economical, simple, quick and easy to be carried out in the clinic,[26] these methods do not seem to reduce pain uniformly in all the regions, which calls upon a technique which will address all the teeth uniformly in terms of pain reduction.

In the current study, low-level vibrations are preferred over the other mechanical modalities like TENS and PEMF because of the elimination of the need for patient compliance, reduced duration of application with improved chairside efficiency owing to their immediate and uniform action in pain reduction. This makes them, a useful alternative to TENS and PEMF, which requires the patient compliance, planning and execution of the procedure because of prolonged application for their maximal effect.[27]

Low-level vibration technique has till now been used in the field of orthodontics for accelerating tooth movement and have also shown to reduce pain during orthodontic tooth movement.[28] This study evaluated effect of low-level vibrations in changing the pain perception among patients. Vibrational therapy was applied on to the experimental side prior to debonding to stimulate the flush of inflammatory mediators by increasing blood flow.

The mechanical vibrations were delivered with a frequency of 30Hz and 20 grams of amplitude for 20 minutes, which was derived from Dr Rubin's study which assessed the role of mechanical vibratory signals to bring about osteoporosis in the entire body. It was concluded in the study that it could be used for passive exercise and also stated that such mild vibrations did not have any potential to damage the skeletal system.

Patients after debonding procedure being carried out on the control and experimental sides were asked to rate their scores for maxillary posterior, maxillary anterior, mandibular posterior and mandibular anterior regions separately for both sides for comparison using VAS. Studies by Bavbek et al. and Mangnall et al. have reported significantly higher pain levels in the anterior region using bite wafer. Wherefore, rating the pain scores separately for the four regions of the two sides is critical in order to best understand which region experiences more pain and discomfort.[24,25]

And since the anterior region has more pain perception as compared to posterior teeth as reported in the previous studies. The debonding procedure was advocated from the posterior

region to the anterior region in order to avoid the confusion of the patient in pain perception, since patients tend to remember the sextant, which is getting debonded first.[29]

Subjects were acquainted to mark their pain perception scores in the visual analogue scales provided to them. Hayes and Patterson did the first scientific description of Visual analogue scale in 1921. It is a 100mm numeric scale marked from 0mm to 100mm with descriptors to uphold the patients in marking their pain scores.[30]Hjermstad et al. (2011) in his systematic review has stated that it is considered as the most superior method used to assess the pain level of patients since it could be used in children as well as adults, illiterate patients, it is simple to understand and could be recorded in writing as well as verbally.[31]

The 36 subjects included in the study, have a distribution of 61.1% of females (22) and 38.9% of males (14) and a mean age of 19.16 ± 3.11 years. The overall results show an effective reduction in pain perception by a mean percentage of 16.23% in VAS scoring amongst vibrational therapy group. This amount of reduction in pain perception amongst the subjects far exceeds the previous literature.[25,26]

The inter-group analysis of results of this study report a higher mean percentage of pain reduction in the mandible (20.9%) when compared with the maxilla (12.3%), which is in accordance with the previous results from studies using finger pressure technique.[25]

On further analysis of region-specific sites within maxilla and mandible, the anterior region have reported higher pain perception in both the control and experimental groups, which are also in accords with a study by Louise A R Mangnall.[25] The results of our study show the most significant pain reduction in the anterior region compared to the posteriors after vibrational therapy which differs from the results of Louise, which had reported the most considerable reduction in the posteriors with the use of bite wafers due to the morphology and function of posterior teeth. Also, this study result shows a statistically significant pain reduction in the region on mandibular posteriors which differs from previous study results showing no changes from baseline scores. Comparing the posterior regions, the maxillary posteriors have shown more significant changes in pain levels, which is are also agreed with existing study reports. The correlation analysis assessing the age and sex factors in this study presents conflicting results to the existing data supporting, increased pain perception in female subjects at the debonding procedure. However, with vibrational therapy, there exists an overall change in pain perception irrespective of age and sex is a highlight of this study.

LIMITATIONS

Limitations of the current study are as follows:

- Even though the same primer and bonding agent are used for all the samples involved in the study, the bond strength is not determined and is not uniform.
- Debonding force which was directed in an intrusive manner, could not be measured and quantified.
- Samples enrolled for the study had a major number of females which could have a bias in the results.

FUTURE SCOPE

- To understand the cascade of pain reduction, further studies should be carried out with biomarker evaluation with respect to orthodontic pain during debonding.
- Identification of bond strength at tooth bracket interface and amount of force applied during debonding should be standardized with a proper technique which would enhance the outcome of the future studies.

CONCLUSION

From the present study, the following conclusions can be made:

- Low-level vibrational therapy reduces the pain perception during debonding of metallic brackets.
- On comparing pain perception during debonding using conventional and vibratory therapy, pain was significantly shown to be reduced in the experimental group.
- More pain reduction was evident in the mandibular arch when compared with maxillary arch.
- Pain reduction was more pronounced in the mandibular anterior region and least evident in the mandibular posterior region.
- Irrespective of age and sex the low-level vibrations showed a significant pain reduction.

REFERENCES

[1]. Oliver RG, Knapman YM. Attitudes to orthodontic treatment. Br J Orthod 1985; 12: 179-188 PMID: 3863673.

[2]. Jones M, Chan C. The pain and discomfort experienced during orthodontic treatment: a randomized controlled clinical trial of two initial aligning arch wires. Am J OrthodDentofa-cialOrthop 1992; 102: 373-381. PMID: 1456222.

[3]. Krukemeyer AM, Arruda AO, Inglehart MR. Pain and orthodontic treatment. Angle Or-thod 2009; 79: 11751181. PMID: 19852612.

[4]. Rolf-DetlefTreede. The International Association for the Study of Pain definition of pain: as valid in 2018 as in 1979, but in need of regularly updated footnotes. Pain Reports9 0 (2018) e643.

[5]. Brown DF, Moerenhout RG. The pain experience and psychological adjustment to orthodontic treatment of preadolescents, adolescents, and adults. Am J OrthodDentofacialOrthop1991;100:349-56.

[6]. Kenneth K. Lew. Attitudes and perceptions of adults towards orthodontic treatment in an Asian community. Community Dent Oral Fpidemiol 1993; 21; 31-5.

[7]. Peter Ngan, Stephen Wilsonb, Joseph Shanfeldc,1, HomaAmini. The effect of ibuprofen on the level of discomfort in patients undergoing orthodontic treatment. July 1994 Volume 106, Issue 1, Pages 88–95.

[8]. Scheurer PA, Firestone AR, Bürgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod 1996; 18: 349-357.PMID: 8921656.

[9]. Firestone AR1, Scheurer PA, Bürgin WB. Patients' anticipation of pain and pain-related side effects, and their perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod. 1999 Aug;21(4):387-96.
[10]. Marianne Bergius, Ulf Berggren, Stavros Kiliaridis. Experience of pain during an orthodontic procedure. Eur J Oral Sci 2002; 110: 92–98. # Eur J Oral Sci, 2002
[11]. Erdinç AM, Dinçer B. Perception of pain during orthodontic treatment with fixed appliances. Eur J Orthod 2004; 26: 79-85. PMID: 14994886.
[12]. Hobara, Mieko. Beliefs about appropriate pain behavior: Cross-cultural and sex differences between Japanese and Euro-Americans. European Journal of Pain 9 (2005) 389–393.
[13]. Abu Alhaija ES, Aldaikki A, Al-Omairi MK, Al-Khateeb SN. The relationship between personality traits, pain perception and attitude toward orthodontic treatment. Angle Or-thod 2010; 80: 1141-1149. PMID: 20677967.
[14]. Kavaliauskiene A1, Smailiene D, Buskiene I, Keriene D, Pain and discomfort perception among patients undergoing orthodontic treatment: results from one month follow-up study. Stomatologija. 2012;14(4):11825.
[15]. SanamTauheed, Attiya Shaikh. Correlation of pain perception and motivation to seek orthodontic treatment. POJ 2012:4(1) 24-28.
[16]. Stacy Ste Marie, Michael Powers, John J Sheridan. Vibratory Stimulation as a Method of Reducing Pain after Orthodontic Appliance Adjustment. JCO/APRIL 2003.
[17]. Sandhu SS, Sandhu J. Orthodontic pain: an interaction between age and sex in early and middle adolescence. Angle Orthod 2013; 83: 966-972. PMID: 23705940.
[18]. Marques LS, Paiva SM, Vieira-Andrade RG, Pereira LJ, Ramos-Jorge ML. Discomfort associated with fixed orthodontic appliances: determinant factors and influence on quality of life. Dental Press Journal of Orthodontics, 01 May 2014, 19(3):102-107.
[19]. O. Lee Williams, DDS, MS," and Samir E. Bishara, DDS, BDS, D. Ortho., MS b. Patient discomfort levels at the time of debonding: A pilot study. Am J OrthodDentofacOrthop1992;101:313-9.
[20]. MatheusMeloPithon, Daniel Santos Fonseca Figueiredo, Dauro Douglas Oliveira, and Raildo da Silva Coqueiro. What is the best method for debonding metallic brackets from the patient’s perspective?.ProgOrthod. 2015; 16: 17.
[21]. Juhi Yadav1, Madhulika Yadav2, Danish U. Z. Khan3, Nishi Grover4. Feasibility of Different Methods after Debonding of Orthodontic Brackets: An In Vivo Study. International Journal of Dental and Medical Specialty Vol 6 ● Issue 1 ● Jan-Jun 2019.
[22]. vRinchuse DJ. Pain-free debonding with occlusal rim wax. J ClinOrthod. 1994 Oct;28(10):587-8.
[23]. Delal Dara KILINÇ1 Gulsilay SAYAR. Evaluation of pain perception during orthodontic debonding of metallic brackets with four different techniques. J Appl Oral Sci. 2019;27:e20180003.

[24]. NehirCanigurBavbeka; BurcuBalosTuncer. Efficacy of different methods to reduce pain during debonding of orthodontic brackets. Angle Orthodontist, Vol 86, No 6, 2016.

[25]. Louise A R Mangnall, Thomas Dietrich & John M Scholey. A randomized controlled trial to assess the pain associated with the debond of orthodontic fixed appliances. Journal of Orthodontics, 40:3, 188-196.

[26]. Arthy Priya1, Ravindra Kumar Jain1, M. P. Santhosh Kumar2. Efficacy of different methods to reduce pain during debonding of orthodontic brackets. Drug Invention Today | Vol 10 • Issue 9 • 2018.

[27]. Peter M.RothD.D.S., M.S.D.∗WilliamJamesThrashD.D.S., M.A. Effect of transcutaneous electrical nerve stimulation for controlling pain associated with orthodontic tooth movement. Volume 90, Issue 2, August 1986, Pages 132-138.

[28]. Makoto Nishimura,aMireiChiba,b Toshiro Ohashi,c Masaaki Sato,d Yoshiyuki Shimizu,e Kaoru Igarashi,f and Hideo Mitanig. Periodontal tissue activation by vibration : Intermittent stimulation by resonance vibration accelerates experimental tooth movement in rats. American Journal of Orthodontics and DentofacialOrthopedics Volume 133, Number 4.

[29]. Li Xiaotinga ; Tang Yinb; Chen Yangxic. Interventions for pain during fixed orthodontic appliance therapy : A systematic review. Angle Orthodontist, Vol 80, No 5, 2010.

[30]. Hayes, M.H.S. and Patterson, D.G. (1921) Experimental development of the graphic rating method. Psychological Bulletin, 18, 98-99.

[31]. Marianne Jensen Hjermstad, PhDa,b,∗,'Marianne Jensen Hjermstad. Studies Comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for Assessment of Pain Intensity in Adults: A Systematic Literature Review. June 2011Volume 41, Issue 6, Pages 1073–1093.