Original Article

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Orthodontic pain control following arch wire placement; a comparison between pre-emptive tenoxicam and chewing gum: a randomized clinical trial

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Background: Pain during fixed orthodontic treatment can have a detrimental effect on patient treatment compliance. To overcome this, there is a definite need to establish the best pain-relieving methods suitable for orthodontic patients in terms of efficacy and use. The objective of this study was to compare the effect of chewing gum and pre-emptive tenoxicam on pain after initial archwire placement and to evaluate the pain perceptions of orthodontic patients in the two groups while performing various functions at specific time intervals.

Methods: Forty-two patients were selected and randomly divided into two groups: group A (chewing gum) and group B (pre-emptive tenoxicam). Pain perception was documented by patients immediately; at 4 h; at bedtime on the day of archwire placement; the next morning; at 24 h; and at bedtime on the 2nd, 3rd, and 7th day after the initial archwire placement. Pain scores were noted during fitting of the posterior teeth, biting, and chewing using a visual analog scale. The data obtained were subjected to statistical analysis.

Results: Group A showed a significant increase in pain until the next morning while fitting the posterior teeth, biting, and chewing [36.2, 52.0, 33.4, respectively]], followed by a gradual decrease by the 7th day. Group B showed a significant increase in pain at bedtime on biting, with a peak value of 47.5. Pain on chewing, fitting posterior teeth, peaked the morning of the next day (100.0, 45.0). The Freidman test showed a statistically significant difference with a p-value of < 0.01. Higher pain scores were observed while chewing and biting compared with that while fitting the posterior teeth in both groups. The overall comparison of pain control between the two groups was not statistically significant [$P > 0.05$] between the two groups.

Conclusions: Chewing gum was not inferior to pre-emptive tenoxicam. Thus, chewing gum is a non-pharmacological alternative to analgesics for orthodontic pain control that eliminates the chance of adverse reactions and can be used in the absence of adult observation.

Keywords: Chewing Gum; Orthodontic Treatment; Pain Control; Tenoxicam.

INTRODUCTION

Anxiety regarding pain and uneasiness during the treatment phase is a concern for orthodontic patients. It is a crucial limiting factor for fixed-appliance therapy and may have a negative impact on patient compliance [1]. Soon after placement of the initial archwire, biological

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variations occur in the periodontal ligament (PDL), resulting in the release of inflammatory mediators such as prostaglandins and bradykinin etc., [2] which mediate orthodontic pain [3,4]. Pulpal inflammation during fixed appliance therapy may also induce the pain [5,6]. The pain typically intensifies progressively after 2 h of applied orthodontic force, reaches a peak by 24 h, and gradually reduces by the seventh day [7-9].

To relieve pain and discomfort, clinicians employ either conventional pharmacological analgesic administration of nonsteroidal anti-inflammatory drugs (NSAIDS) or nonpharmacological methods. The latter includes the use of a plastic wafer [10], chewing gum [11,12], transcutaneous electrical nerve stimulation [13], low-level laser therapy [14,15], and vibratory stimulation [16].

Cheng et al. [17] revealed that preemptive analgesia is effective for orthodontic pain control. The mechanism involves the generation of analgesia prior to the induction of a pain stimulus, which may reduce pain intensity [18]. The inhibition of prostaglandin synthesis by NSAIDs also have adverse effects on tooth movement [19]. Tenoxicam (20 mg) was convenient for pain control without any impediments related to upper canine tooth movement [20]; hence, tenoxicam was used in the present study. Tenoxicam belongs to the oxicam group of non-selective COX inhibitors (NSAIDs) with a half-life of 67 h. It is beneficial in terms of usage to administer only a single dose of tenoxicam per day for orthodontic pain relief. In contrast, other non-selective COX inhibitors are prescribed three times a day, which increases drug intake.

The overuse and adverse reactions of NSAID challenge their use in contemporary analgesic management in adolescent patients [21,22]. Owing to these limitations, non-analgesic pain control methods have been approved [10]. Few studies have reported the efficacy of chewing gum for orthodontic pain control [23-25].

However, in a recent systematic review by Fleming et al. [26], very low-quality evidence was observed regarding pain relief with the use of chewing adjuncts. In this context, the present study aimed to compare the effectiveness of chewing gum and tenoxicam for pain relief following initial archwire placement in patients receiving orthodontic treatment. To date, few randomized controlled trials (RCTs) have been included in systematic reviews on orthodontic pain management methods. To our knowledge, no RCTs has compared chewing gum and tenoxicam for pain relief in orthodontic treatment. Therefore, the present study aimed to compare the pain-relieving effect of chewing gum with that of pre-emptive tenoxicam.

METHODS

The present study was a uni-centered, two-arm parallel investigation approved by the Institutional Research Ethics Committee (University registration number: D168408007). One hundred twenty-one subjects requiring fixed orthodontic therapy were assessed for eligibility. Only female patients were included in the investigation to eliminate the influence of sex on the outcome assessment, as sex-dependent differences in pain perception have been reported [27].

Inclusion criteria: physically and mentally healthy women in the age group of 18–25 years, patients undergoing fixed orthodontic treatment for the first time, full arch bonding in both arches, extraction in both arches, and crowding with a minimal index of 4–9 mm.

Exclusion criteria: patients with systemic diseases, pregnant patients, patients in whom tenoxicam is contraindicated, patients under medication for chronic pain, and patients undergoing functional appliance therapy and orthognathic surgery.

A comprehensive medical history and informed consent were obtained.

Sample size determination: This was designed to preserve the power of the study at 0.8 (80%) and the level of significance at 0.05 (5%). [28] A total of 34 subjects were needed for the trial to detect a minimum difference of 10 mm on pain scale on visual analog scales (VAS) between any two subjects for any given function or time point. Considering a possible dropout rate of 20%,

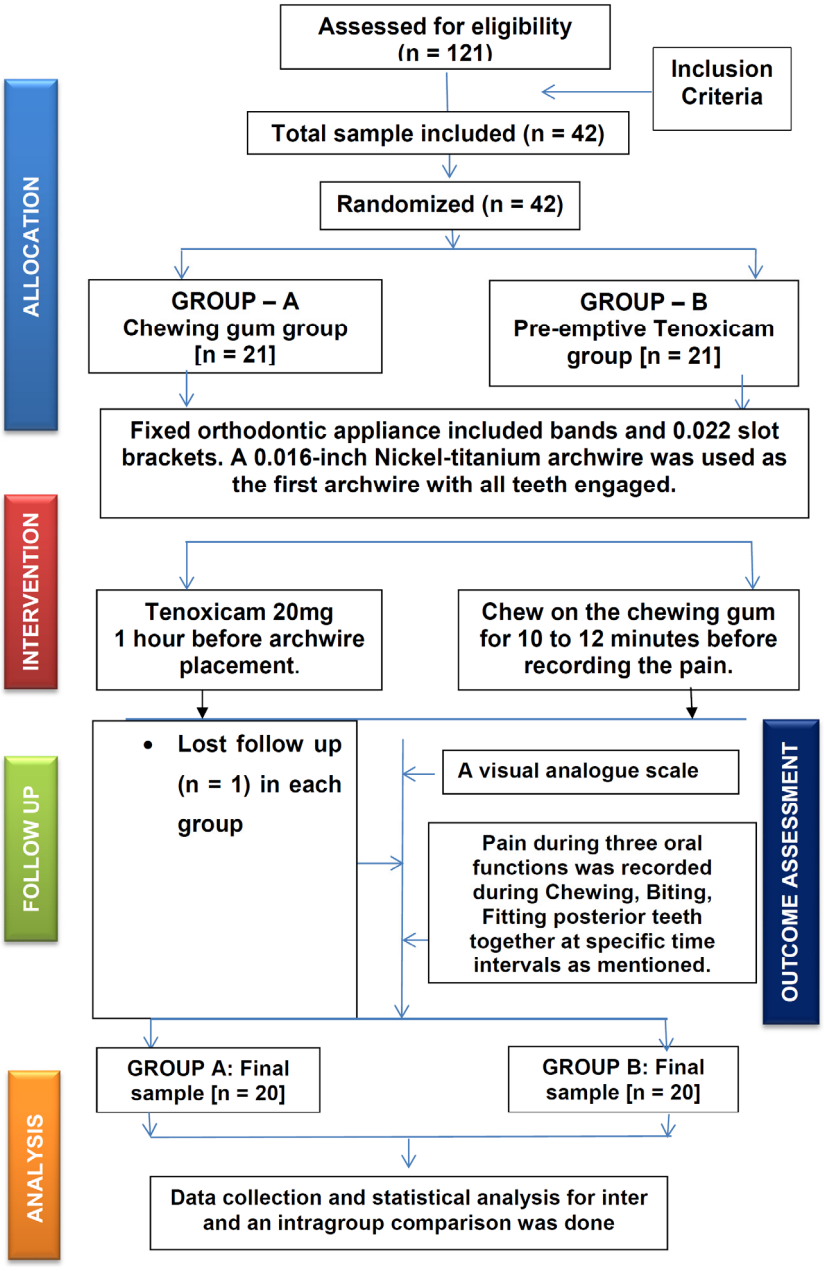

Fig. 1. Consolidated Standards of Reporting Trials flow diagram showing the study design.

a total of 42 female participants were selected for the trial and equally divided into two groups of 21 each.

Randomization: The patients were coded with a numerical value, and the data were entered into an Excel sheet and fed to a computer application. Simple randomization was performed using a 1:1 allocation. The sequences of the subjects assigned to the chewing gum group (group A) and the tenoxicam group (group B) were computer-generated with random numbers using a research randomizer. Allocation was performed using opaque sealed envelopes. On the day of archwire placement, which was also the first day of the intervention, each subject chose one envelope to detect her randomized allocation.

Treatment: In both groups, orthodontic appliances included bands and 0.022 slot M.B.T brackets (3M Unitek™ Gemini Metal Brackets, USA). As an initial archwire, 0.016-inch nickel-titanium was placed. Patients

Table 1. Depiction of the differences in the demographic data between the 2 groups (Chewing gum and Tenoxicam group) (P-value > 0.05) is statistically insignificant

Demographic characteristic	Group	Number of participants	Mean ± SD	P-value
Age	Group A	20	19.6±1.6	0.64
	Group B	20	20±3.4	
Height	Group A	20	165.05±7.1	1.00
	Group B	20	165.05±5.4	
Weight	Group A	20	53.5±8.2	0.76
	Group B	20	53.15±6.8	

SD, standard deviation.

in the chewing gum group were asked to chew on chewing gum (Trident, sugar-free gum with xylitol, U.S.A.) whenever they experienced discomfort. However, patients were advised to chew it for 10 to 12 min prior to pain recording at specific time intervals. In the tenoxicam group, the subjects took Tenoxicam B.P. (Tilkotil, 20 mg, Radiant Pharmaceuticals, Bangladesh.) 1 h before archwire placement. The work strategy was illustrated using a Consolidated Standards of Reporting Trials flowchart (Fig. 1).

Data collection: Subjects were given regular post-treatment guidelines and were suggested to fill out a feedback form at suitable intervals in the week after the bonding procedure. The questionnaire was given in a 7-page booklet containing a succession of 10 cm VAS, and each centimeter was divided into 10 mm. The patients were instructed to note the grade of pain experienced, from 0 to 100 (with 0 representing no pain and 100 representing severe pain), at the indicated time intervals, immediately after archwire placement (T_0), 4 h after archwire placement (T_1), at bedtime of the day of archwire placement (T_2), the next morning (T_3), at 24 h (T_4), and bedtime of the 2nd (T_5), 3rd (T_6), and 7th day after the engagement of the initial archwire (T_7).

The subjects were advised to record pain during three oral functions: fitting the posterior teeth together, chewing, and biting. To fit the posterior teeth, the subjects were instructed to fit the posterior teeth using a slight force. The patients used an almond for biting and chewing. They bit and chewed almonds and recorded their perceived pain.

Table 2. The Descriptive Data of the VAS scores for the 2 groups under study

		Chewing gum	Tenoxicam
Function	Time interval	Mean ± SD	Mean ± SD
Fitting posterior teeth	T_0	11.1 ± 7.5	4.4 ± 6.4
	T_1	16.7 ± 5.35	16.2 ± 6.01
	T_2	30.6 ± 9.32	27.7 ± 5.93
	T_3	36.2 ± 10.04	31.3 ± 5.25
	T_4	31.5 ± 9.19	18.7 ± 5.51
	T_5	29.4 ± 9.69	13.2 ± 2.78
	T_6	23.6 ± 8.19	10.07 ± 2.32
	T_7	16.8 ± 5.44	5.35 ± 1.49
Biting	T_0	17.5 ± 4.27	14.0 ± 4.46
	T_1	29.1 ± 4.90	28.2 ± 6.48
	T_2	39.9 ± 9.44	47.5 ± 11.5
	T_3	52.0 ± 11.1	47.3 ± 9.41
	T_4	41.6 ± 8.59	39.6 ± 6.98
	T_5	41.6 ± 8.86	32.9 ± 7.81
	T_6	28.4 ± 4.53	28.0 ± 4.11
	T_7	11.6 ± 3.24	12.7 ± 6.03
Chewing	T_0	12.2 ± 3.71	24.9 ± 4.95
	T_1	33.1 ± 5.79	39.0 ± 8.60
	T_2	33.7 ± 5.34	62.6 ± 9.62
	T_3	42.9 ± 4.35	68.1 ± 8.76
	T_4	34.1 ± 6.62	45.5 ± 6.80
	T_5	33.7 ± 6.13	33.7 ± 5.52
	T_6	18.8 ± 3.62	29.5 ± 5.13
	T_7	13.3 ± 3.95	11.4 ± 2.90

SD, Standard deviation.

All patients were stringently communicated to prevent the intake of supplementary analgesics. If rescue medicine was needed, the patient was advised to contact the investigator immediately and to document the

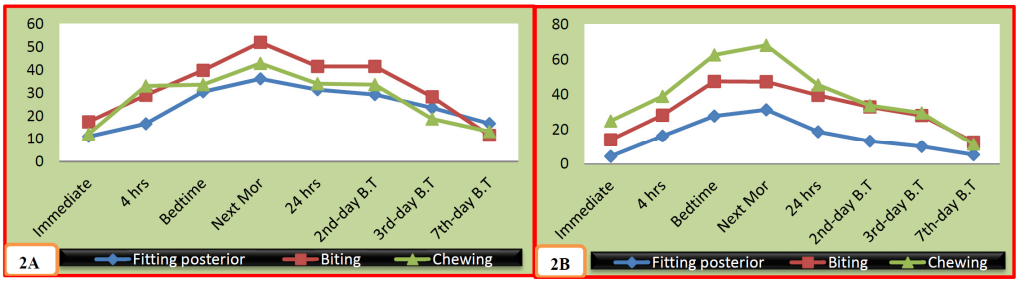

Fig. 2. Comparison of VAS scores while performing various functional activities at different points of time in the two groups (A) chewing gum group, (B) tenoxicam group

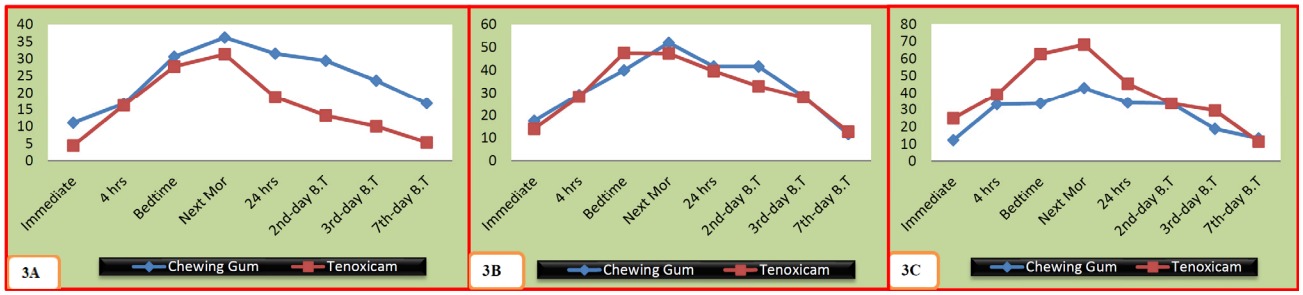

Fig. 3. Comparison of VAS scores among the two groups while performing various functions at different points of time. (A) fitting posterior teeth, (B) biting, (C) chewing. VAS, visual analog scale.

analgesic used. Patients were requested to return to the completed pain diary at the next appointment.

Blinding: The clinician and patients were not blinded to the intervention because the usage instructions needed to be explained based on the intervention. However, the operator dealing with the feedback forms and the statistician evaluating the records were blinded to the intervention.

Outcome: Valuation of pain by patients using VAS at specific time intervals after initial archwire placement.

Statistical analysis: All statistical analyses were performed using SPSS Statistics for Windows software package, Version 21.0. (Armonk, NY: 2012). The histogram assessed the normal distribution of the sample variables and the results showed that the parameters were normally distributed. An unpaired t-test was used to demonstrate the differences in demographics between the two groups. The Freidman test was used to compare pain experienced at different points in time during the different functions within the group in both clusters. The Mann–Whitney U test was performed to determine pairwise comparisons between the two groups at different time points for different functions and to assess the overall pain perception between the two groups.

RESULTS

Two patients, one in each group, discontinued participating in the study for personal reasons. Finally, the final sample size for statistical analysis was 20 participants in each study group. The demographic details of the study participants are presented in Table 1. The unpaired t-test revealed no significant differences in the mean age, height, and weight between the groups.

1. The course of post intervention pain

The descriptive data for the two groups displayed in Table 2 shows that the peak pain occurred at T3 in chewing gum group during biting and in the tenoxicam group during chewing. There was a slow decrease in T_7 pain in both groups. The pain experienced during biting or chewing was greater than that experienced while fitting posteriors in both groups.

Table 3. Comparison of Pain experienced at different points of time during the different functions in Chewing gum and Tenoxicam group- Freidman test (P-value = < .001)** is statistically significant

		Chewing gum group		Tenoxicam group	
Function	Time intervals	Friedman test value	P value	Friedman test value	P value
Fitting Posterior	T_0–T_7	129.42	< 0.001**	129.956	< .001**
Biting	T_0–T_7	133.66	< 0.001**	133.581	< .001**
Chewing	T_0–T_7	123.10	< 0.001**	139.180	< .001**

Table 4. Pairwise comparisons of pain perceptions between the two groups at different points of time for different functions - Mann-Whitney test (P-value < 0.05)*, ** is statistically significant (P-value > 0.05) is statistically insignificant

Time intervals	Different functional activities		
	Mann-Whitney test P-value		
	Fitting posterior	Biting	Chewing
T_0	< .001**	0.002*	< .001**
T_1	0.577	0.532	< .001**
T_2	0.227	0.002*	< .001**
T_3	0.043*	0.023*	< .001**
T_4	<.001**	0.174	< .001**
T_5	<.001**	< .001**	0.849
T_6	<.001**	0.633	< .001**
T_7	<.001**	0.630	0.102

1) Chewing gum group

A significant increase in pain was observed until T_3 during fitting of the posterior teeth, biting, and chewing, followed by a gradual decrease by T_7 (Fig. 2A). The p-value was highly significant (P < 0.001) at all time points while performing various functional activities (Table 3).

2) Tenoxicam group

There was a significant increase in pain during biting at T_2. Pain on fitting the posterior teeth and chewing showed a peak value at T_3 (Fig. 2B). P-values indicated high significance (P < 0.001) at all the mentioned points of time while performing various functional activities (Table 3).

2. Comparison of VAS scores between two groups while performing various functions at different points of time

- The tenoxicam group showed less pain than the chewing gum group during fitting of the posterior teeth at all times (Fig. 3A). In both groups, the pain increased until T3 and gradually decreased by T_7.
- During biting, the tenoxicam group reported less pain, followed by the chewing gum group at all time points except T_2 (Fig. 3B). The tenoxicam group showed peak pain at T_2, whereas the chewing gum group showed peak pain at T_3.
- During chewing, patients in the chewing gum group reported less pain, followed by those in the tenoxicam group at all time points (Fig. 3C). Both groups showed an increase in pain until T_3 and a gradual decrease in pain by T_7.

3. Comparisons of pain perceptions between the two groups at different points of time for various functions (Table 4)

T_0, T_3: There was a statistically significant difference (P < 0.05) between the two groups in all functional activities.

T_1, T_2: There was a statistically significant difference (P < 0.05) between the two groups during chewing. However, statistical significance was not observed when fitting posterior teeth and biting.

T_4, T_6: There was a statistically significant difference (P < 0.05) between the two groups while performing all functional activities, except while biting, where there was no statistical significance.

T_5: There was a statistically significant difference (P < 0.05) between the two groups while performing all functional activities except chewing, which showed no statistical significance.

T_7: There was a statistically significant difference (P < 0.05) between the two groups while fitting posterior

teeth, whereas during chewing and biting, the difference was not statistically significant.

The Friedman test values of the two groups were similar during fitting posterior teeth and biting, whereas during chewing, the chewing group showed a lower value of pain (123.10) than the tenoxicam group (139.180), indicating that chewing gum is not inferior to tenoxicam in controlling orthodontic pain (Table 3). The overall comparison of tenoxicam and chewing gum revealed no significant difference (P = 0.305) between the groups.

DISCUSSION

Tenoxicam is a long-acting nonsteroidal anti-inflammatory agent that is effective in pain control. Its long-acting effect may be correlated with its high serum binding properties [29]. Previous investigations have focused on the efficacy of chewing gum for pain management (12). Few studies have compared two analgesics [30], chewing gum, and short-acting NSAIDs [31] in regulating orthodontic pain. No study has compared the efficacy of chewing gum with that of long-acting NSAIDs for pain reduction during orthodontic therapy.

Therefore, this work aimed to compare the effects of chewing gum and pre-emptive tenoxicam on pain perception once initial archwire engagement was done. In this study, the present pain levels for both groups followed a similar curve. In both groups, the intensity of pain during various functions gradually increased from T_0, reached its extreme intensity at T_2 and T_3 and gradually decreased by T_7. This outcome was supported by the observations of Law et al. [32], Polat et al. [33], and Jones and Chan [34]. They established that the pain was maximum in the morning after initiating treatment, with uneasiness progressively declining by day 6.

Fixed appliance therapy results in variations in the vascular supply. This occurs because of the sensitization of different proprioception centers by prostaglandins, glutamate, and gamma-aminobutyric acid [35,36]. The prostaglandin production reaches a maximum level by 24 h and then decreases in the next 7 to 14 days [37]. Similarly, the increased production of neuropeptides resulting in antidromic inducement of afferent nerve terminals leads to pain. The increased levels of inflammatory mediators could be the reason for the pain experienced by patients after archwire insertion in the present study.

Factors such as the amount of orthodontic force applied to dentoalveolar structures and the severity of crowding do not play a key role in the patient's distress. Evidence regarding the impact of patients' age on pain perception after treatment is unpredictable [38]. To avoid the impact of age on outcome assessment, the current study was limited to 18–25-year age clusters.

To date, investigations related to the use of NSAIDs as pre-emptive analgesic for orthodontic pain control have been successful [30]. According to Davidovitch and Shanfield [37], NSAIDs are the gold standard for pain regulation during orthodontic treatment. According to Law et al. [32], usage of ibuprofen prior to orthodontic therapy shows positive discrimination towards orthodontic pain control. Pre-emptive analgesia works by blocking afferent nerve impulses in advance; therefore, there is no central sensitization of the nervous system. Administration of NSAIDs prior to the initiation of treatment facilitates biotransformation of the drug and further helps minimize inflammation and tissue trauma [33].

The use of certain agents that might momentarily move the teeth and adjacent tissues during orthodontic treatment will aid in the resolution of inflammation, thereby decreasing pain. Based on this conviction, Proffit and Fields [38] suggested chewing gum for orthodontic pain management. Patients often request a substitute pharmacological approach for pain management. Chewing gum is the best alternative because it is economical and safe to use. Therefore, in this study, chewing gum was compared with tenoxicam.

The recorded pain scores were higher while biting and chewing than while fitting posterior teeth in both groups. This could be attributed to the fact that the teeth are in

maximum intercuspation position during biting and chewing. This concurs with the findings of Polat [33]. Both tenoxicam and chewing gum were effective in fitting posterior teeth and biting. Chewing gum helps loosen the firmly arranged PDL fibers around the neurovascular bundles, repairing the regular flow of the lymphoid and circulatory system of the PDL, consequently eliminating inflammation and edema, and finally reducing pain and distress. This might have contributed to the effective pain control in the chewing gum group during chewing. Alshammari et al. [39] also reported the effectiveness of chewing gum as equivalent to paracetamol after initial archwire placement. Silva et al. [40] advocated chewing gum as a non-pharmacological alternative to acetaminophen and ibuprofen. The overall pain perception among the chewing gum and tenoxicam clusters was similar and not statistically significant. Hence, chewing gum might be an alternative to preemptive tenoxicam. The findings of our study were similar to those of Ireland AJ [31].

The limitations of the current study are that it was a unicentric study, and the sample size was small. Another limitation is the possibility of bias during the study, because the previous VAS scores noted by the participants may have influenced the subsequent pain scores. To minimize this, each VAS score was recorded on a new page in the booklet. There is a definite need to perform evidence-based research, including multicenter randomized clinical trials with a larger sample size to formulate a standard protocol for pain management by comparing various non-pharmacological options with long-acting NSAIDs during fixed orthodontic treatment.

In conclusion, the intensity of pain during various functions gradually increased after initial archwire placement, reached its extreme by the next morning or within 24 h, and then gradually decreased by the seventh day in both groups. Pain experienced during biting or chewing was significantly greater than that experienced while fitting posterior teeth. Chewing gum was not inferior to pre-emptive tenoxicam. Thus, chewing gum is a non-pharmacological alternative to analgesics for orthodontic pain control that eliminates the chance of adverse reactions and can be used in the absence of adult observation.

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Sobitha Obili: Data curation, Investigation, Writing - review & editing
Thejasree Keerthipati: Investigation, Validation, Writing - review & editing
Ram Chowdary Basam: Formal analysis, Writing - review & editing
Mandava Prasad: Conceptualization, Supervision, Writing - review & editing

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