Magna Scientia Advanced Research and Reviews

eISSN: 2582-9394

Cross Ref DOI: 10.30574/msarr

Journal homepage: https://magnascientiapub.com/journals/msarr/

(REVIEW ARTICLE)

Check for updates

Assessing pain intensity in patients undergoing orthodontic treatment with fixed appliances: A systematic review

Florian Adelis Andriniaina *, Tahina Ratsirarisoa, Marie Olga Rasoanirina and Henri Martial Randrianarimanarivo

Department of Dentofacial Orthopedic, Institute of Tropical Odonto-Stomatology of Madagascar, University of Mahajanga, Madagascar.

Magna Scientia Advanced Research and Reviews, 2024, 10(01), 143–152

Publication history: Received on 16 December 2023; revised on 27 January 2024; accepted on 30 January 2024

Article DOI: https://doi.org/10.30574/msarr.2024.10.1.0012

Abstract

Orthodontic treatment commonly induces pain in a significant majority of patients, ranging from ninety to ninety-five percent. This study aimed to systematically review and assess the intensity of orthodontic pain associated with fixed appliances. A comprehensive search was conducted on Pubmed and Hinari databases, as well as orthodontic journal sites, spanning from March to May 2021. Articles reporting on pain intensity in individuals undergoing labial fixed orthodontic treatment were meticulously selected using specific keywords. The Visual Analog Scale was employed to evaluate pain intensity, and each included article underwent a rigorous evaluation based on essential criteria for scientific writing. Data compilation and analysis were performed using SPSS software.

The findings revealed a mean pain intensity of 20.2 mm ± 15.8 across the general study population, with a minimum intensity of 0.2 mm and a maximum of 63.2 mm. Effective communication by practitioners, preemptively addressing and explaining the anticipated discomfort and pain during treatment, results in a reduced need for analgesics.

Keywords: Pain measurement; Orthodontic appliances; Orthodontics treatment; Fixed appliances

1. Introduction

Pain is a significant factor leading to treatment discontinuation in dentistry. Patients may intentionally miss dental appointments due to fear of pain [1].

Pain during orthodontic treatment adversely affects patient cooperation, acting as a deterrent to continued treatment. During orthodontic procedures, 90 to 95% of patients experience pain [2]. According to Lew [3], 8 to 30% of patients discontinued their treatment due to pain during the initial therapeutic phase. O'Connor [4] reported that pain was the most significant discomfort during treatment and the fourth most common fear before initiating orthodontic treatment.

Fixed appliances are therapeutic devices utilized to correct dental malocclusion or skeletal dysmorphosis. They are bonded or cemented to the teeth throughout the treatment period, exerting extrinsic forces through appropriately configured arches or springs attached to brackets or bands on each tooth. This allows for three-dimensional control of dental displacement in response to applied force on the tooth crowns [5].

Throughout orthodontic treatment, the forces generated by arches and brackets cause dental movement within the alveolar bone. This force triggers the activation of specific pain and inflammation receptors [1].

* Corresponding author: Florian Adelis Andriniaina

This study aimed to assess and synthesize, through a systematic review, the intensity of pain experienced by patients wearing labial fixed appliances.

2. Methodology

The execution and reporting of this review adhere to the PRISMA statement [6]. The primary question addressed by this review is: "What is the orthodontic pain intensity experienced by patients undergoing treatment with labial fixed appliances ?"

An electronic search applied to PubMed and Hinari databases, as well as major orthodontic journal websites (such as the American Journal of Orthodontics and Dentofacial Orthopedics, Orthodontie Française, Revue d'Orthopédie Dento-Faciale, West African Journal of Orthodontic, etc.), was conducted. This is a systematic review, covering the period from March to May 2021, with a study duration spanning from November 2020 to January 2022, totaling 14 months.

2.1. Study Population

The PICO method was adopted :

- P (Patient) : patients with labial fixed appliances,
- I (Intervention) : no specific intervention, as the objective is to assess pain intensity,
- C (Comparison) : no specific comparison with other types of orthodontic appliances,
- (Outcome) : orthodontic pain intensity.

2.1.1. Inclusion Criteria

Inclusion was limited to articles describing pain in patients undergoing labial fixed orthodontic treatment. Articles in English and French, including cross-sectional, prospective, retrospective clinical studies, as well as meta-analyses, with full-text availability, were included provided that :

- the subject underwent orthodontic treatment with a labial fixed appliance,
- the study was exclusively conducted in humans,
- subjects were free of specific craniofacial syndromes that could influence treatment,
- the subject did not undergo orthognathic surgery during treatment,
- the article reported on the prevalence or intensity of pain during fixed appliance wear,
- pain intensity was assessed using the visual analog scale,
- the number of cases was equal or greater than 5.

2.1.2. Exclusion Criteria

Exclusion criteria included case reports, literature reviews, studies with inaccessible full-text or difficult-to-interpret pain intensity data, studies associating pain with removable or functional appliances, and studies in languages other than English or French.

2.2. Data Collection

Keywords were employed on different databases and orthodontic journal websites to refine the search. Study selection occurred in two phases :

- First phase involved a review of titles and abstracts obtained from electronic searches ; articles that were evidently irrelevant were excluded at this stage ;
- Second phase involved downloading or reviewing web versions of selected articles ; articles with inaccessible full texts were excluded at this stage ; full-text reading led to the exclusion of articles not meeting inclusion criteria.

Data were extracted into an Excel spreadsheet, including parameters such as title, author, publication year, population (age, gender), orthodontic therapeutic system (type of archwire, brackets), study period, pain assessment scale (visual analog scale in millimeters or centimeters), intensity, frequency, and pain management. The primary outcome regarding pain intensity was expressed by the visual analog scale value.

We conducted a quality assessment of studies based on an analysis table derived from recommendations by Chan and Bandhari [7] and a model proposed by Diouf et al [8]. The quality of studies was also evaluated according to essential criteria for scientific writing [9].

An evaluation form with ten questions was developed, with possible responses being “Yes”, “Uncertain”, or “No”. A score of 2 was given for “Yes”, 1 for “Uncertain”, and 0 for “No”. The maximum score an article could achieve was 20, and the minimum was 0. Any study with a score of 12 or below was considered to have a significant risk of bias, a score above 12 and up to 15 indicated a moderate risk of bias, and a score above 15 suggested a low risk of bias.

Universal variables were gender and age. Pain intensity, frequency, and analgesic use were dependent variables, while bracket type and initial arc type and diameter were independent variables.

Data were entered and processed using SPSS version 20 (Statistical Package for the Social Sciences) and Excel 2016.

3. Results

3.1. Articles selection

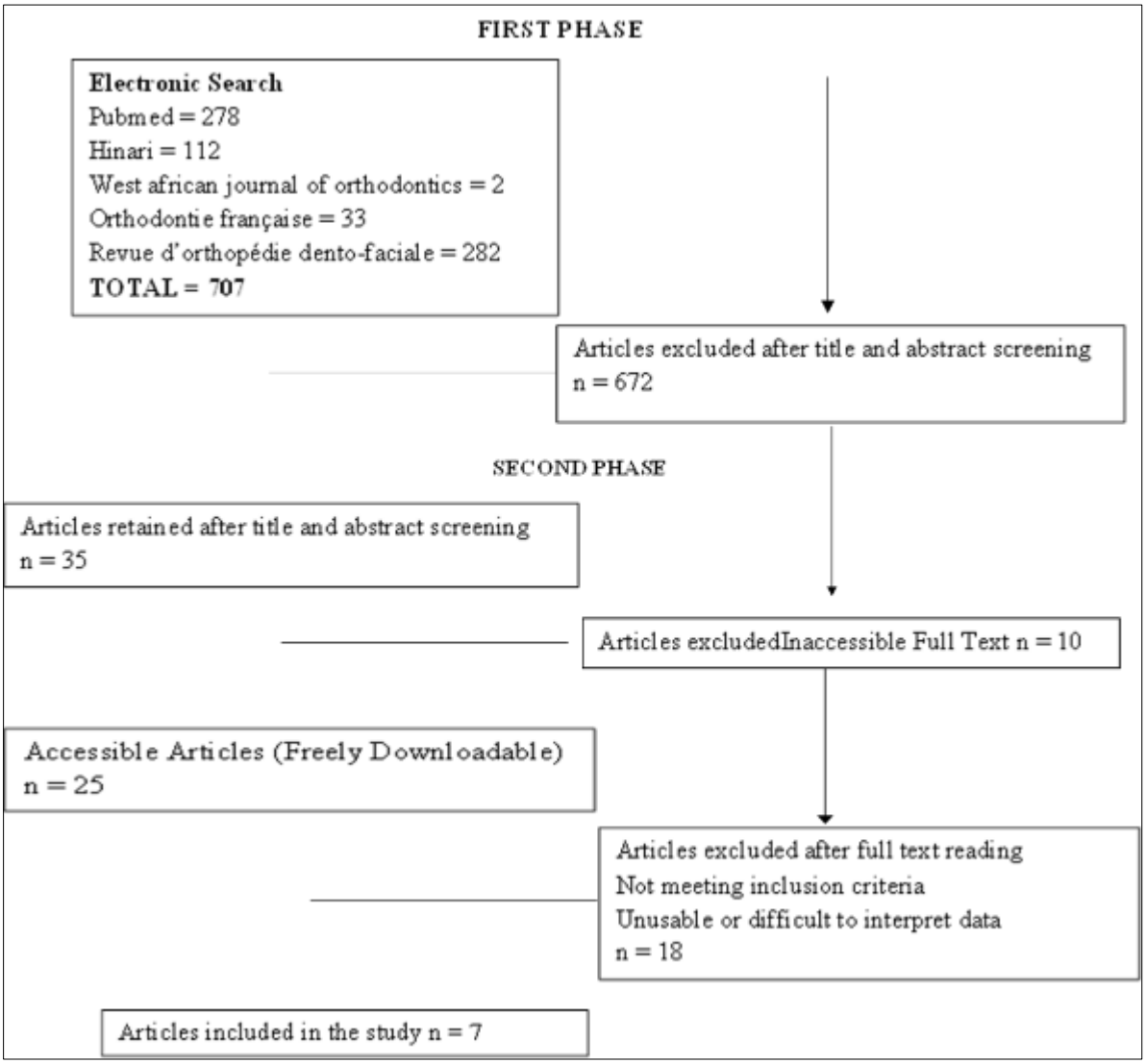

Figure 1 Flowchart for Article Selection

Table 1 Evaluation of Article Quality

Authors and year of publication	Title and Content	Objectives	Subject		Outcome criterion		Clearly Defined Protocol	Results			Final Score
	Concordance	Clearness of Objectives	Inclusion Criteria	Exclusion Criteria	Description and Validity	Unchanged at Follow-up		Precision	Clearness	Clearness of Tables and/or Figures	
Tecco et *al.* 2009 [10]	2	1	2	0	2	2	2	2	2	2	17
Almasoud N. 2018 [11]	2	2	2	2	2	2	2	2	2	2	20
Erdinç EMA and Dinçer B. 2004 [12]	1	2	0	0	2	2	1	2	2	2	14
Abdelrahman et *al.* 2015 [13]	2	2	2	2	2	2	2	2	2	1	19
Sandhu SS and Sandhu J. 2013 [14]	2	2	2	2	2	2	2	2	2	2	20
Pringle MA et *al.* 2009 [15]	2	2	2	2	2	2	2	1	1	1	17
Sahoo N. 2019 [16]	2	2	0	0	2	2	1	2	1	1	13

Table 2 Distribution of Studies According to Average Age

Authors	Mean	SD
Tecco S et al. [10]	16.8	-
Almasoud N N [11]	23.56	5.44
Ertan Erdinç A M and Dinçer B [12]	Male : 13.6	-
	Female : 14.7	
Abdelrahman R S et al. [13]	18.6	4.6
Sandhu S et Sandhu J [14]	14.1	2
Sahoo N [15]	-	-
Pringle A M et al. [16]	-	-
Mean total	16.89	3.7

Table 3 Synthesis of Data from Articles

Authors	**Subject**	**Therapeutic system**	**Comparison**	**Initial archwire**	**Pain intensity**					
					Mean value	H4	H6	D1	D2	D7
Tecco S et al. [10]	30	Self-lig : 15 Conv: 15	Self-ligating vs conventional bracket	0.014 NiTi	-	-	-	17.5 52.3	42.5 52	9 20
Almasoud N N [11]	32	Self-lig : 32	-	0.014 Cu NiTi	-	55.6± 32.5	-	60 ± 34.1	-	26.9 ± 30.9
Ertan Erdinç A M and Dinçer B [12]	109	Roth system	0.014 vs 0.016 NiTi archwires	0.014 : 56 0.016 : 53	-	-	38±26.9 45±30.1	49±28.3 48±28.1	39±21.8 40±20.9	13±6.3 9±5.3
Abdelrahman R S et al. [13]	75	Roth system	Comparison of 3 different 0.014 NiTi archwires.	0.014 superelastic : 25 0.014 thermally elastic : 25 0.014 conventional : 25	57.2±23.2 63.2±27.2 62.1±19	-	-	-	-	-
Sandhu S and Sandhu J [14]	85	Roth system	NiTi vs stainless steel archwires	0.016 NiTi superelastic : 42 0.0175 SS multistrand : 43	-	8.6±4 8.4±4.3	14.6±7 12.7±6	28.8±11 26.4±9	24.6±10.4 23±5.8	3.5±1.5 3.2±1.3
Sahoo N [15]	40	-	Metallic vs ceramic bracket	0.016 NiTi	-	12.85±9 17.35±8.7	-	15.8±10.9 26.4±14.3	14.3±10.05 24.45±13.8	-
Pringle A M et al. [16]	52	Self-lig : 24 Conv : 28	Self-ligating vs conventional bracket	0.014 Cu NiTi superelastic	-	-	-	35 44.5	25.5 40.1	0.8 7.9

Table 4 Average Pain Intensity (VAS) in the Hours (H) or Days (D) Following Appliance Placement

	Mean (mm)	SD	Minimum	Maximum
H4	19.3	14.8	5.6	55.6
H6	27.5	16.3	12.7	45
J1	33.1	15.6	7.8	60
J2	29.4	13.1	6.7	52
J7	10.3	8.4	0.8	26.9

Table 5 Average Pain Intensity (VAS) According to Bracket Type, Diameter, and Initial Archwire Type

	Mean (mm)	SD
Bracket type		
Self-ligating	15.5	16.9
Conventional	22.8	17.3
Not Specified	16.3	11.3
Initial archwire size		
0.014	23.7	19.1
0.016	16.9	12.1
0.0175	11	8.7
Initial archwire type		
NiTi	20.1	15.8
Cu NiTi	21.8	19.2
Multistrand Stainless Steel	11	8.7

4. Discussion

4.1. Methodology Discussion

The articles addressing pain during orthodontic treatment with labial fixed appliances have been compiled and synthesized in this systematic review.

Studying pain and mastering its management are essential to the success of orthodontic treatment. This is the main reason why we conducted this study.

4.2. Study Limitations

Our study was constrained to articles freely available through the mentioned search engines.

We encountered difficulties in incorporating into our results some articles where the pain intensity during orthodontic treatment was presented only in graphical form, as their interpretations proved to be highly challenging.

4.3. Results Discussion

We collected data ourselves following a predefined protocol. In the initial phase of electronic research, we identified 707 articles. After reviewing titles and abstracts, 672 were excluded, leaving 35 articles. In the second phase, 10 out of

the 35 were inaccessible online. After a thorough reading of the remaining 25, 18 were excluded, resulting in the final selection of seven articles for our study (Figure 1).

4.3.1. Evaluation of Article Quality

A specific evaluation sheet was developed to assess the quality of the studies. Table 1 reveals the quality assessments of the seven articles included in our study, with final scores ranging from 13/20 to 20/20. Two articles obtained the maximum score, while three others scored above 15.

Thus, most articles (5/7) demonstrated a low risk of bias, attributable to their adherence to evaluation criteria, including consistency between title and content, transparency of objectives and population selection criteria, as well as the precision and clarity of results.

4.3.2. Study Characteristics

The seven selected articles covering a total population of 423 individuals were analyzed. The studies were conducted between 2000 and 2019 in six distinct countries, namely Italy, Saudi Arabia, Turkey, Jordan, India, and the United Kingdom.

Within the studied population, three studies, representing 63.6% of the sample, were treated with the Roth system [12, 13, 14]. A percentage of 16.77% underwent treatment using a self-ligating bracket system [10, 11, 16].

Two studies, constituting 19.40% of the sample, analyzed the pain intensity generated by self-ligating brackets compared to conventional brackets [10, 16]. One study assessed pain intensity between 0.014 and 0.016 NiTi archwires [12], while another compared three different types of 0.014 NiTi archwires [13]. One study compared superelastic 0.014 archwires, thermally activated 0.014 elastomeric archwires, and conventional 0.014 NiTi archwires [13]. Finally, one study examined pain intensity between metallic and ceramic brackets [15].

Regarding the initial archwire diameter, five out of seven studies (57.94%) used a 0.014 diameter archwire [10, 11, 12, 13, 16]. The 0.016 and 0.175 archwires represented 31.92% and 10.17%, respectively [12, 14, 15]. The NiTi archwire was most used as the initial archwire, accounting for 70.99%, followed by Cu NiTi at 19.86%, and stainless steel at 10.17% [10, 11, 12, 13, 14, 15, 16].

A female predominance in the studied population was observed (50.1%). It is noteworthy that one article did not specify the gender of its population, representing 9.5% of the total sample.

This female predominance may be explained by more pronounced orthodontic treatment needs among young girls, often associated with greater aesthetic concerns. Similar findings were observed in a previous study by Ousehal et al. [17, 18].

The overall mean age was 16.9 years ±3.7, ranging from 13.6 to 23.56 years. Two articles did not provide information on the age of their study population [15, 16].

4.3.3. Pain Intensity during Orthodontic Treatment

The Visual Analog Scale (VAS) data were converted into millimeters to standardize the presentation of pain intensity in each article (Table 3). The average pain intensity in the overall studied population was 20.2 mm ± 15.8. The minimum intensity was 0.2 mm, and the maximum was 63.2 mm.

Table 4 presents the average pain intensity in the hours and days following the placement of the orthodontic appliance. Four hours after appliance placement, the average pain intensity was 19.3 mm ± 14.8, with a maximum value of 55.6 mm. At six hours post-placement, the average pain intensity was 27.5 mm ± 16.3.

The average pain intensity reached its highest level after a day of appliance wear, measuring at 33.1 mm ± 15.6. The minimum value was 6.7 mm, and the maximum value reached 60 mm. Subsequently, the average VAS value gradually decreased after the first day of appliance wear, reaching 29.4 mm on the second day and 10.3 mm on the seventh day.

Costa et al.'s study emphasizes that the peak of pain is observed as early as the first day [19]. Additionally, the findings of Abdelrahman et al. [13] highlight a correlation between the evolution of pain and the biological response to orthodontic forces. Their study indicates a peak in pain within the first two days after arch insertion, followed by a

gradual decrease until the seventh day. This dynamic is associated with an increased concentration of interleukin-1b, an inflammatory mediator, in gingival fluid.

The study conducted by Larrea et al. reported an average duration of 4.8 days for orthodontic pain after appliance placement [20].

Finally, Stewart et al.'s conclusions highlight a crucial period of 4 to 7 days after appliance placement, during which patients experience significant levels of discomfort and difficulty in performing normal oral functions [21]. They underscore the importance of effective pre-communication to inform patients about the sensations they may experience during this period, thereby helping alleviate any anxiety associated with wearing orthodontic appliances [21].

The mean VAS score was 22.8 mm for subjects with conventional brackets and 15.5 mm for those with self-ligating brackets (Table 5). Several previous studies confirm that orthodontic pain is lower in patients treated with self-ligating brackets compared to conventional brackets. Miles et al. and Pringle et al. both reported greater comfort and significantly reduced pain intensity in patients using self-ligating brackets compared to those treated with conventional brackets [10, 16, 22].

Some studies have reported no clinically significant difference in pain perception between patients treated with self-ligating brackets and those with conventional brackets [11].

However, Bertl et al. [23] observed that the insertion and removal of archwires caused more pain with self-ligating brackets compared to conventional brackets. This increase in pain could result from the manipulation and insertion of archwires, associated with the specific design of the clip [23].

According to the initial archwire diameter, the average pain intensity varied with values of 23.7 mm for the 0.014 arch, 16.9 mm for the 0.016 arch, and 11 mm for the 0.0175 arch (Table 5). The results of our study showed that pain tends to decrease as the diameter of the initial arc increases. This observation is less commonly explored in the literature, where comparisons often focus on alloy types rather than archwire diameters.

While discomfort is often associated with high forces applied to the teeth, histological studies indicate that light forces are more efficient, biologically favorable, and less painful. Recent studies reported that substantial forces generate more pain than light forces 24 hours after their application [24, 25, 26, 27].

The pain intensity is nearly identical with NiTi archwires (20.1 mm) and Cu NiTi archwires (21.8 mm) and significantly lower with stainless steel multistranded archwires (11 mm) (Table 5).

A wide variety of archwires are available on the market. An archwire exerting light and continuous forces is recommended to achieve tooth movement close to physiological displacement, thus minimizing pathological effects on teeth and their surrounding structures. There are no definitive conclusions regarding the type of archwire that causes the least pain [13].

5. Conclusion

The synthesis of the seven articles included in our study revealed an average pain intensity within the studied general population, measuring at 20.2 mm ± 15.8. Pain levels ranged from a minimum intensity measured at 0.2 mm to a maximum intensity reaching 63.2 mm.

Pain and discomfort are widely acknowledged as the most challenging aspects of orthodontic treatment. Orthodontist must pay particular attention to these aspects from the outset of treatment to ensure better patient management. It is generally accepted that the prescription of analgesics can be reduced if the practitioner thoroughly explains in advance the levels of discomfort and pain that the patient may anticipate during the treatment.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Polat-Ozsoy OF. Pain and Discomfort After Orthodontic Appointments. Seminars in Orthodontics 2007 ; 13(4) : 292-300.

[2] Lew KK. Attitudes and perceptions of adults towards orthodontic treatment in an Asian community. Community Dent Oral Epidemiol 1993 ; 21(1) : 31-5.

[3] Scheuer PA, Firestone AR, Burgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod 1996 ; 18(4) : 349-57.

[4] O'Connor PJ. Patients' perceptions before, during, and after orthodontic treatment. J Clin Orthod 2000 ; 34(10) : 591-2.

[5] Kerner A, Montluc N, Brandy I, Dumitrache M, Lejoyeux E, Garcia R. Multi-bracket Techniques. EMC (Elsevier Masson SAS, Paris), Odontology/ Dentofacial orthopedic, 23-490-C-10, 2011.

[6] Page MJ, Moher D, Bossuyt PM et al. (2021) PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. BMJ 372:n160.

[7] Chan K, Bhandari M. Three-minute critical appraisal of a case series article. Indian J Orthop. 2011 ; 45(2) : 103-4.

[8] Diouf JS, Beugre-Kouassi AML, Diop-Ba K, Badiane A, Ngom PI, Ouedraogo Y, Diagne F. Long-term stability and relapse in treatments for overbite: A systematic review. Orthod Fr 2019 ; 90(2) : 169-87.

[9] Maisonneuve H, Lorette G, Maruani A, Huguier M. Medical writing. 5è édition. 2010.

[10] Tecco S, D'Attilio M, Tetè S, Festa F. Prevalence and type of pain during conventional and self-ligating orthodontic treatment. Eur J Orthod. 2009 ; 31(4) : 380-4.

[11] Almasoud NN. Pain perception among patients treated with passive self-ligating fixed appliances and Invisalign aligners during the first week of orthodontic treatment. Korean J Orthod 2018 ; 48(5) : 326-32.

[12] Erdinç AME, Dinçer B. Perception of pain during orthodontic treatment with fixed appliances. Eur J Orthod 2004 ; 26(1) : 79-85.

[13] Abdelrahman RS, Al-Nimri KS, Al Maaitah EF. Pain experience during initial alignment with three types of nickel-titanium archwires : A prospective clinical trial. Angle Orthod 2015 ; 85(6) : 1021-6.

[14] Sandhu SS, Sandhu J. A randomized clinical trial investigating pain associated with superelastic nickel–titanium and multistranded stainless steel archwires during the initial leveling and aligning phase of orthodontic treatment. J Orthod 2013 ; 40(4) : 276-85.

[15] Sahoo N. Comparison of the Perception of Pain during Fixed Orthodontic Treatment with Metal and Ceramic Brackets. J Pharm Bioallied Sci 2019 ; 11(Suppl 1) : S30-S35.

[16] Pringle AM, Petrie A, Cunningham SJ, McKnight M. Prospective randomized clinical trial to compare pain levels associated with 2 orthodontic fixed bracket systems. Am J Orthod Dentofacial Orthop 2009 ; 136(2), 160-7.

[17] Ousehal L, Lakhdar A, Elquars F. Comparison of the effect of paracetamol and ibuprofen on orthodontic pain. Intern Orthod 2009 ; 7(2) : 193-206.

[18] Deli R, Macrì LA, Radico P, Pantanali F, Grieco DL, Gualano MR, La Torre G. Orthodontic treatment attitude versus orthodontic treatment need: differences by gender, age, socioeconomical status and geographical context. Community Dent Oral Epidemiol. 2012 ; 40 Suppl 1 :71-6.

[19] Costa EOD, Blagitz MN, Normando D. Impact of catastrophizing on pain during orthodontic treatment. Dental Press J Orthod. 2020 ; 25(1) : 64-69.

[20] Larrea M, Salvador R, Cibrian R, Gandia JL, Paredes-Gallardo V. A New Equation for Predicting Evolution of Oral Pain in Orthodontic Treatment : A Longitudinal, Prospective Cohort Study. J Oral Facial Pain Headache. 2017 ; 31(2) : 172-179.

[21] Stewart FN, Kerr WJ, Taylor PJ. Appliance wear : the patient's point of view. Eur J Orthod 1997 ; 19(4) : 377-82.

[22] Miles PG, Weyant RJ, Rustveld L. A clinical trial of Damon 2 vs conventional twin brackets during initial alignment. Angle Orthod. 2006 ; 76(3) : 480-5.

[23] Bertl MH, Onodera K, Čelar AG. A prospective randomized split-mouth study on pain experience during chairside archwire manipulation in self-ligating and conventional brackets. Angle Orthod. 2013 ; 83(2) : 292-7.

[24] Storey E, Smith R. Force in orthodontics and its relation to tooth movement. Aust J Dent 1952 ; 56 : 11-8.

[25] Reitan K. Some factors determining the evaluation of forces in orthodontics. Am J Orthod. 1957 ; 43(1) : 32-45.

[26] Boester CH, Johnston IE. A clinical investigation of the concepts of differential and optimal force in canine retraction. Angle Orthod. 1974 ; 44(2) : 113-9.

[27] Luppanapornlarp S, Kajii TS, Surarit R, Iida J. Interleukin-1beta levels, pain intensity, and tooth movement using two different magnitudes of continuous orthodontic force. Eur J Orthod. 2010 ; 32(5) : 596-601