Original Article

Clinical comparison of pain: Self-ligating versus conventional fixed orthodontic appliance systems

ABSTRACT

Background: Orthodontic treatment is always taken as a painful procedure. Pain from orthodontic treatment has been shown to have negative effects on oral hygiene efforts and to be a major reason for missing appointments.

Materials and Methods: Thirty consecutive eligible patients were alternated between two groups. Group I individuals were bonded with 0.022-inch preadjusted edgewise brackets. Group II individuals were bonded with self-ligating brackets. At the end of the first appointment, the patients were given printed sheets to record visual analogue scale (VAS) scores. Discomfort was assessed again at the first wire change as to whether one side was more or less comfortable when untied and when the new wire was ligated.

Results: The minimum VAS score recorded was 0 and the maximum VAS score recorded in Group I was 5 and in Group II 6. The pain characteristic "while biting" was most commonly reported; none reported shooting pain.

Conclusion: Engagement of archwire with both conventional ligating and self-ligating brackets causes pain, the difference between the two groups was statistically insignificant. After placement of the second archwire, more number of patients in SLB Group reported no pain, the measure mean intensity of pain was higher in conventional ligating group as compared to SLB Group; however, the difference between the two groups was statistically insignificant. The intensity of pain did not show any specific peaks. Patients rated disengagement of archwire as being not painful in both groups in the present study.

Keywords: Preadjusted edgewise appliance, self-ligating brackets, visual analog scale

INTRODUCTION

Pain has been rated as the greatest dislike during treatment and fourth among major fears and apprehensions before orthodontic treatment.[1] Orthodontic treatment starts from the stage of the initial examination till the date of debonding which includes major events like extraction of few teeth, separator placement, banding and bonding, archwire placement and activation as well as debonding. Hence, patients are exposed to pain stimuli throughout the orthodontic treatment.

Pain from orthodontic treatment has been shown to have negative effects on oral hygiene efforts and to be a major reason for missing appointments;[2] in addition, almost all orthodontic patients report pain when chewing and biting food, causing them to change their diet. Finally, pain and discomfort during orthodontic treatment affect the patient's overall satisfaction with their orthodontic treatment outcomes.

The experience of pain is measured indirectly, and the visual analog scale (VAS) is the most reliable method of measuring pain perception. Nonlinear relationships have been shown between pain experienced after the archwire material and its initial placement and also with age, social class, quantum of force applied, dental arch relationships, and crowding of dentition.

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According to Damon,[3] his fixed appliance system is superior to other systems because of the combination of a low-friction bracket and a low force generated by superelastic nickel-titanium archwires that result in more efficient tooth movement and less pain.

Technological advances have long influenced orthodontic mechanotherapy approaches. Introduction of superelastic, heat-activated archwires to orthodontics claims to enable the practitioner to reduce the treatment time by combining different stages of orthodontic treatment done separately earlier, namely alignment, leveling and tooth movement. The extent of such approach might affect the type and amount of the tooth movement, the perception of pain and discomfort experienced, and also the tooth response is not known. The orthodontic profession needs critical clinical data on the relative efficiencies of different biomechanical strategies of tooth movement. From a cost-benefit point of view, orthodontic treatment should be performed as quickly as possible without jeopardizing the affected tissues. A major question is which approach provides minimum discomfort and the most rapid orthodontic tooth movement with the least damage to the teeth and the supporting structures.

Aim

The aim of the study was to evaluate whether any significant difference in the pain and discomfort experience could be found during initial alignment with a self-ligating system versus a conventional preadjusted edgewise bracket system in patients for orthodontic fixed appliance therapy.

Objectives

i. To evaluate if there is any difference in the pain experienced during the week following initial placement of two orthodontic appliances
ii. To evaluate if there is any difference in the pain experienced during removal and insertion of orthodontic archwires with these brackets.

MATERIALS AND METHODS

This research was guided by the principles of human subject protection and was carried out after a formal approval from the ethical committee of the institution. This study included subjects attending the outpatient clinic of a tertiary care orthodontic center.

Based on sample size calculation, 54 consecutive patients were initially included in the study before the commencement of their respective orthodontic treatment. Twenty four patients failed to meet the following selection criteria to participate in the study: (i) nine patients were not symmetrical, either having asymmetrical extractions or missing teeth, (ii) three had chosen all esthetic lower brackets over metal (iii) six opted for only maxillary arch treatment, (iv) two had the maxillary lateral incisor brackets flipped for torque control of palatally placed lateral incisors, and (v) four patients could not be followed up at this center as the patients had to relocate to a different city due to transfer of their fathers.

All patients were informed of the purpose of the study but were not aware of which bracket was of a newer design. None declined to participate.

Consecutive eligible patients were alternated between two groups. Group I individuals were bonded with 0.022-inch MBT preadjusted edgewise brackets (Di-MIM Mini-Twin Bracket's from Ortho Organizer®). Group II individuals were bonded with 0.022-inch Damon® 3MX (Ormco).

The final sample comprised 30 individuals (17 females and 13 males); average age 20.43 years (standard deviation 4.26), range 15–26 years). There were 15 individuals in each group.

The bonding method was standardized between groups. A 0.014-inch superelastic copper-nickel-titanium archwire (Ormco®) was placed in both arches. The wire was engaged in the Damon 3 bracket by closing the slide. No tooth was left unattached/partially attached from the archwire. All 4 tie-wings of the 0.022-inch MBT preadjusted edgewise brackets were engaged with stainless steel ligature, partial ligation was done if full engagement of the archwire was not possible.

The first archwire used in all patients was 0.016/0.014-inch Damon Copper Ni-Ti (Ormco®). In the initial Ni-Ti light round wire phase, archwires are carefully selected to minimize binding between the "tube" of the passive self-ligating bracket and the archwire. This allows sliding of the teeth and brackets along the wire as they start to level and align.

At the first wire change at approximately 10 weeks, a 0.014 × 0.025-inch Damon copper NiTi wire (Ormco®) was placed in all patients of both groups. This phase starts working on torque, root angulations and levels, completes rotation control, continues arch form development, consolidates space in the anterior segments, and prepares for the third phase of archwire sequencing.

At the end of the first appointment, the patients were given printed sheets to record VAS scores. The patients were recalled within the first few days of bracket placement to assess whether the teeth were painful and whether

the brackets felt more or less comfortable on the lips. Discomfort was assessed again at the first wire change as to whether one side was more or less comfortable when untied and when the new wire was ligated. The representative intraoral photographs of Group I and Group II are as in Figures 1 and 2.

To record the presence of pain (yes/no), its intensity as recorded on a VAS ("no" pain to "the highest pain possible"), the characteristics of the pain and the use of analgesics (including the type and dose). The characteristics of the pain were indicated using yes/no responses for four descriptors according to the McGill Pain Questionnaire[4] "constant", "shooting", "dull" and "pain when chewing or biting," as previously used.[5]

The VAS was chosen to measure the degree of discomfort/pain. A 10-cm horizontal VAS scale was distributed to all the patients, along with a two-page questionnaire. The VAS questionnaire was designed with anchors of no pain at all (0 cm) and worst pain imaginable (10 cm). Patients were asked to rate their expectation of pain consequent to the placement of the initial aligning archwire on this VAS scale. These were recorded by the patients at the following time intervals: 4 h posttreatment; at bedtime on the day of the appointment; after 24 h; and after 2, 3, 4, 5, 6, and 7 days after the ligation of the initial aligning archwire. Subsequently, recordings were made by the patient after removal of the first archwire, placement of the second archwire, and removal of the second archwire.

RESULTS

The present study had thirty patients, divided into two groups of 15 each and the VAS scores, pain characteristics, and pain medication used, as reported by the patients were entered into the data sheets. The mean age of patients at the start of treatment in both groups was well matched [Table 1].

The minimum VAS score recorded was 0, and the maximum VAS score recorded in Group I was 5, and in Group II, it was 6. The pain characteristic 'while biting' was most commonly reported; none reported shooting pain. One patient of Group I and two of Group II reported no pain for the duration of the first archwire. Only one patient reported pain at the time of removal of the first archwire. Four patients reported no pain after placement of second archwire in Groups I and six patients in Group II. None of the patients reported any pain after the removal of the second archwire.

Area under the curve (AUC) was used as a statistical tool for comparing the VAS of the two groups. AUC is a simple and effective method of obtaining a summary measure from plotted data.

Although more number of patients in Group II reported no pain, however the mean AUC for the first archwire of Group II was higher than Group I [Table 2], the difference between the two groups was statistically insignificant [Table 3]. After placement of the second archwire more number of patients in Group II reported no pain, the mean AUC was higher in Group I as compared to Group II, however, the difference between the two groups was statistically insignificant [Table 3].

In Group I, 13.3% reported a AUC of 0 and 71, respectively. The highest AUC was 445. In Group II 40% reported AUC of 0.

In Group I, 100% males and 66.67% females reported an AUC of <100 as compared to 75% males and 42.85% females in Group II [Table 4]. In Group I, the maximum AUC reported by females was 445, and by males 71, thus females perceived more pain than males in Group I. In Group II, the maximum AUC reported by females was 345 and by males 229, thus females perceived more pain than males in Group II. Females perceived more pain in Group I as compared to Group II and males in Group II perceived more pain as compared to Group I. Males of Group I perceived the least pain and females of Group II perceived the most pain [Table 5].

In the present study, the intensity of pain did not show any specific peaks. All patients reported pain during the first 6 days of placement of the first archwire; none reported pain on the seventh day after placement of the first archwire.

Consumption of pain relief medication was required by three patients each in Group I and Group II. Tablet Combiflam (ibuprofen 400 mg, paracetamol 325 mg) was the analgesic used by all patients, as it is the standard analgesic

Table 1: Demographics of sample

Variable	Total (n=30)	Conventional (n=15)	Self-ligating (n=15)	P*
Age (years), mean (SD)	20.43 (4.26)	20.00 (4.07)	20.87 (4.53)	NS
Sex (%)				
Male	43.33	40.00	53.33	NS
Female	56.67	60.00	47.67	

*P value for comparison of group means by t-test or differences in proportion by Chi square test. NS: Not significant, SD: Standard deviation

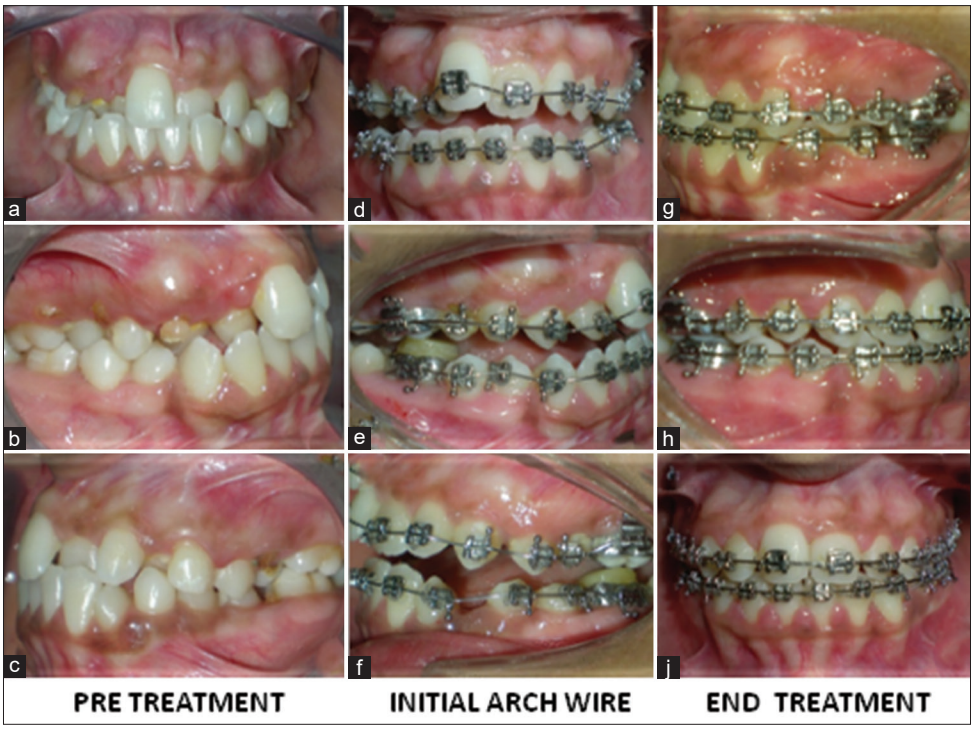

Figure 1: Representative intra oral photographs – Group I

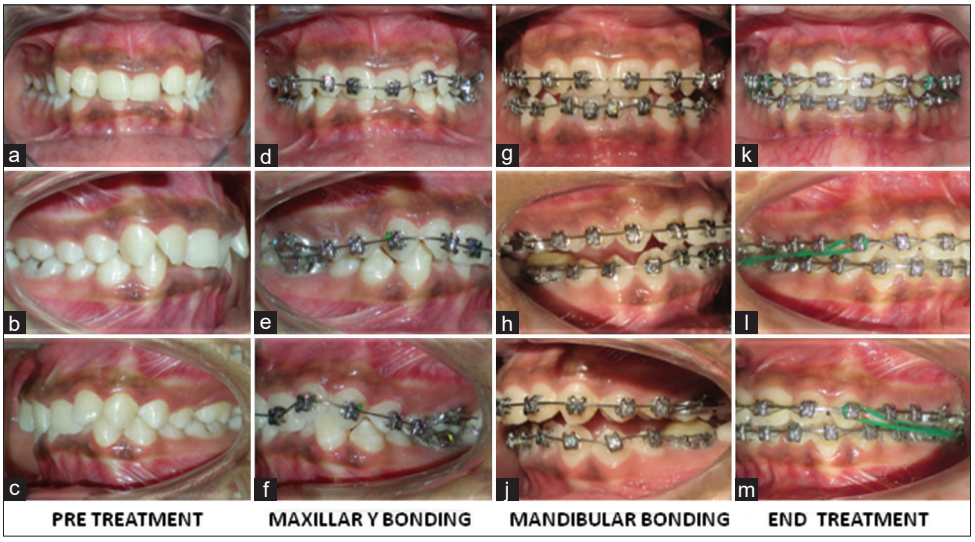

Figure 2: Representative intra oral photographs – Group II

dispensed out from the dispensary of this institution at no cost to the patient.

DISCUSSION

Pain is an important concern in dentistry in general and orthodontics in particular. Pain during orthodontic treatment is a prevalent condition that has an impact on patients' fear, quality of life, treatment compliance, and even cessation of treatment.[6] Nevertheless, pain management and prevention are sometimes overlooked. To deal effectively with patients' pain, orthodontists should relate to pain duration and intensity.[7]

Patients in both groups were asked to record the level of pain/discomfort in a VAS questionnaire booklet at specified time intervals. The VAS scale is one of the most commonly used tools in the measurement of perceived pain/discomfort[8] and has been proven to be a reliable and accurate tool with good reproducibility.[9] However, this scale measures the subjective experiences of the patients, thereby providing only a global measure of pain/discomfort and does not help

the patient distinguish between the different sources of pain/discomfort.[10]

Table 2: Group statistics

Group	*n*	Mean AUC	SD	SEM
1	15	84.00	124.989	32.272
2	15	98.20	123.909	31.993

SD: Standard deviation, SEM: Standard error of mean, AUC: Area under the curve

Table 3: Mann–Whitney test ranks

AUC (VAS)	Group	*n*	Mean rank	*P*	Mann–Whitney U test
First arch wire	1	15	16.13	0.69 (NS)	223.0
	2	15	14.87		
	Total	30			
Second arch wire	1	15	18.17	0.079 (NS)	112.5
	2	15	12.83		
	Total	30			

AUC: Area under the curve, VAS: Visual Analogue Scale, NS: Not significant

Table 4: Area under the curve

Group	AUC	Frequency	Percent	Valid percent	Cumulative percent
I	0	2	13.3	13.3	13.3
	6	1	6.7	6.7	20.0
	9	1	6.7	6.7	26.7
	19	1	6.7	6.7	33.3
	20	1	6.7	6.7	40.0
	29	1	6.7	6.7	46.7
	36	1	6.7	6.7	53.3
	45	1	6.7	6.7	60.0
	71	2	13.3	13.3	73.3
	87	1	6.7	6.7	80.0
	125	1	6.7	6.7	86.7
	297	1	6.7	6.7	93.3
	445	1	6.7	6.7	100.0
	Total	15	100.0	100.0	
II	0	6	40.0	40.0	40.0
	3	1	6.7	6.7	46.7
	10	1	6.7	6.7	53.3
	91	1	6.7	6.7	60.0
	116	1	6.7	6.7	66.7
	180	1	6.7	6.7	73.3
	181	1	6.7	6.7	80.0
	229	1	6.7	6.7	86.7
	318	1	6.7	6.7	93.3
	345	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

AUC: Area under the curve

The use of a self-prescribed analgesic log by the patients gave another independent form of assessment for the degree of pain the subjects were experiencing.

Engagement of archwire in both groups caused pain, more in patients with the self-ligating brackets than conventional ligating brackets. This was similar to the studies by Bertl *et al*.,[11] Fleming *et al*.[12] and Miles *et al*.[13] but not consistent with the findings of Tecco *et al*.[14] who reported less pain with SLB. The Damon 3 system requires pressure to the archwire for engagement. Hence this could be attributed as a cause of increased pain in SLB group. The chair-side pain experience is a result of tooth displacement caused by the force necessary to close the engagement mechanism; manipulation of rigid and full-size archwires can be associated with more discomfort in self-ligating brackets. If elastic ligatures are used on conventional brackets, full engagement is not always achieved. In the present investigation, SS ligatures were used to maximize and therefore match the level of engagement in both systems. However, complete slot engagement of the archwire in cases of severely malaligned teeth was not attempted with the conventional ligating brackets, instead they were loosely ligated with SS ligatures.

Patients rated disengagement of archwire as being not painful in both groups in the present study, this was dissimilar to the findings of Bertl *et al*.[11] The Damon 3 clip is easy to open, hence, it may account for the absence of any discomfort on archwire removal, unlike the study reported by Fleming *et al*.,[12] in which the nature of this clip may therefore account for the more unfavorable ratings on archwire removal in self-ligating brackets.

There was no distortion or breakage of the Damon 3 clip during the course of the present study, in contrast to other studies on different system of SLB.[15] This could be due to the advanced, easy to use design of the Damon 3 Clip.

The findings of the present study seem to indicate that, in general, regardless of the type of appliance used (conventional or self-ligating), pain is higher during the first 5 days of initial archwire placement. This is consistent with those of several investigations that evaluated pain associated with orthodontic treatment.[9,14,16-18]

Table 5: Mean area under the curve according to gender

Group	Gender	*n*	Minimum (AUC)	Maximum (AUC)	Mean (AUC)	SD
I	Female	9	0	445	122.11	151.033
	Male	6	0	71	26.83	26.619
II	Female	8	0	345	95.88	148.806
	Male	7	0	229	100.86	99.877

AUC: Area under the curve, SD: Standard deviation

In the present study, none of the patients reported pain on the 7th day after initial archwire placement. This is in general agreement with several investigations that show pain levels following archwire placement return to a minimal baseline level by 7 days.[10,16-18]

The data on the nature of pain during the present study reported that the pain characteristic "while biting" was most commonly reported in both groups; none reported shooting pain in both groups. This is not comparable with previous investigations by Tecco *et al*.[14] They reported in their study that patients treated with the Damon SL II showed a higher frequency of chewing/biting pain, while those treated with Victory Series brackets reported a higher degree of constant pain. They attributed it to the primary mechanical difference between the two appliances used in this investigation concerned the bracket – archwire interface, this could explain the different nature of pain reported by the patients.

As pain during orthodontic treatment is mostly associated with the level of compression of the periodontal ligament and hypothesized that lower frictional forces generate less compression of the periodontal ligament and blood vessels, and so alter the type of pain experienced. Hence, on the basis of the aforementioned, it can be hypothesized that in the present study low force levels were used in both the study groups.

With regard to the use of analgesics, 20% patients in both groups used analgesics, however, these data were not consistent with previous studies of Tecco *et al*.[14] who reported that 10 and 16.5% of the patients in the SLB and conventional ligating groups, respectively, used painkillers and Kohli[19] in their study have stated that the requirement for analgesia was also high, at more than 63.33% of participants. They state that this further underscores the severity of orthodontic pain. It would therefore be prudent to prescribe preemptive analgesia, particularly in patients with low pain thresholds.

In the present study, it was observed that females exhibited more discomfort as compared to males in both groups [Table 5]. This is in contrast with previously known findings which state that sex does not influence perceived pain during orthodontic therapy.[15,18,19]

The results of this study indicated no statistical difference in the pain intensity between CB and SLB after 24 h and after 2, 3, 4, 5, 6, and 7 days after the ligation of the initial aligning archwire. This was similar to the study by Kalemaj *et al*.[20] and Lai *et al*.[21] who concluded in their study that there was no evidence that the pain intensity differs between CB and SLB at 4 h, 24 h, 3 days, 1 week, and 1 month.

Limitations of the present study

The presented results are particular to the Damon 3 brackets and cannot be generalized to other self-ligating systems with different designs. A split-mouth design, wherein one half of the arch is bonded with SLB and the other half with conventional ligating brackets would have provided a better control. However, it was not used in the present study as it would have required a rigorous recruitment regarding dental arch asymmetries and patients' acceptance of an esthetic compromise during treatment, resulting from the uneven bracket appearance and the inherent disadvantage of split-mouth approach involves an inability to locate accurately the source of discomfort, particularly near the midline. The influence of anxiety levels on the pain experienced may be considered a potential confounding variable on reported pain.

CONCLUSION

Engagement of archwire with both conventional ligating and self-ligating brackets causes pain. Although more number of patients in the SLB Group reported no pain, however, the intensity of pain in patients for the first archwire in this group was higher than in the conventional ligating group. The difference between the two groups was statistically insignificant. After placement of the second archwire, more number of patients in SLB Group reported no pain; the measure mean intensity of pain was higher in conventional ligating group as compared to SLB Group, however the difference between the two groups was statistically insignificant.

In the present study, the intensity of pain did not show any specific peaks. In general, regardless of the type of appliance used (conventional or self-ligating), pain was higher during the first 5 days initial archwire placement. Females exhibited more discomfort as compared to males in both groups.

Patients rated disengagement of archwire as being not painful in both groups in the present study.

The pain characteristic "while biting" was most commonly reported in both groups; none reported shooting pain in both groups. A small percentage of patients in both groups used analgesics.

The pain experience in the present study with both the conventional ligating and self-ligating is statistically not significant.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. O'Connor PJ. Patients' perceptions before, during, and after orthodontic treatment. J Clin Orthod 2000;34:591-2.
2. Polat O, Karaman AI, Durmus E. Effects of preoperative ibuprofen and naproxen sodium on orthodontic pain. Angle Orthod 2005;75:791-6.
3. Damon DH. The rationale, evolution and clinical application of the self-ligating bracket. Clin Orthod Res 1998;1:52-61.
4. Melzack R. The McGill Pain Questionnaire: Major properties and scoring methods. Pain 1975;1:277-99.
5. Bergius M, Kiliaridis S, Berggren U. Pain in orthodontics. A review and discussion of the literature. J Orofac Orthop 2000;61:125-37.
6. Patel S, McGorray SP, Yezierski R, Fillingim R, Logan H, Wheeler TT. Effects of analgesics on orthodontic pain. Am J Orthod Dentofacial Orthop 2011;139:e53-8.
7. Krishnan V. Orthodontic pain: From causes to management – A review. Eur J Orthod 2007;29:170-9.
8. Erdinç AM, Dinçer B. Perception of pain during orthodontic treatment with fixed appliances. Eur J Orthod 2004;26:79-85.
9. Bergius M, Berggren U, Kiliaridis S. Experience of pain during an orthodontic procedure. Eur J Oral Sci 2002;110:92-8.
10. Farzanegan F, Zebarjad SM, Alizadeh S, Ahrari F. Pain reduction after initial archwire placement in orthodontic patients: A randomized clinical trial. Am J Orthod Dentofacial Orthop 2012;141:169-73.
11. 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;83:292-7.
12. Fleming PS, Dibiase AT, Sarri G, Lee RT. Pain experience during initial alignment with a self-ligating and a conventional fixed orthodontic appliance system. A randomized controlled clinical trial. Angle Orthod 2009;79:46-50.
13. Miles PG, Weyant RJ, Rustveld L. A clinical trial of Damon 2 vs. conventional twin brackets during initial alignment. Angle Orthod 2006;76:480-5.
14. 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;31:380-4.
15. Scott P, Sherriff M, Dibiase AT, Cobourne MT. Perception of discomfort during initial orthodontic tooth alignment using a self-ligating or conventional bracket system: A randomized clinical trial. Eur J Orthod 2008;30:227-32.
16. Scheurer PA, Firestone AR, Bürgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod 1996;18:349-57.
17. Ngan P, Kess B, Wilson S. Perception of discomfort by patients undergoing orthodontic treatment. Am J Orthod Dentofacial Orthop 1989;96:47-53.
18. 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 Orthod Dentofacial Orthop 1992;102:373-81.
19. Kohli SS, Kohli VS. Patient pain experience after placement of initial aligning archwire using active and passive self-ligating bracket systems: A randomized clinical trial. Orthodontics (Chic.) 2012;13:e58-65.
20. Kalemaj Z, Buti J, Deregibus A, Canuto RM, Maggiora M, Debernardi CL. Aligning effectiveness, secretion of interleukin 1β and pain control during fixed orthodontic treatment with self-ligating appliances and supplemental vibrational appliances. A randomized controlled clinical trial. J Biomed 2017;2:25-33.
21. Lai TT, Chioue JY, Lai TC, Yuan TC, Li CH, Chen MH. Perceived pain for orthodontic patients with conventional brackets or self-ligating brackets over 1 month period: A single-center, randomized controlled clinical trial. J Formos Med Assoc 2020;119:282-9.