Original Article

Pain experience in adults undergoing treatment: *A longitudinal evaluation*

Ama Johal[a]; Asma B. Ashari[b]; Nasser Alamiri[b]; Padhraig S. Fleming[c]; Usman Qureshi[d]; Shirley Cox[d]; Nikolaos Pandis[e]

ABSTRACT

Objectives: To quantify the intensity and duration of pain experience in adults over the initial three visits of fixed appliance–based orthodontic treatment. A secondary objective was to assess the relationship between pain experience and analgesic use, dental irregularity, gender, and age.

Materials and Methods: A prospective longitudinal study design was adopted. Fifty-eight adults undergoing fixed appliance treatment in five orthodontic practices recorded pain experience at four time points (4 hours, 24 hours, 3 days, and 7 days) following the initial bond-up appointment (T0) and first (T1) and second (T2) routine follow-up adjustment appointments using a visual analogue scale. In addition, subjects recorded the dosage and frequency of analgesic use.

Results: A slightly greater proportion of women (57%) were recruited, with a mean sample age of 34.69 (SD 12.11) years. Peak pain was experienced between 24 hours and 3 days following appliance placement (T0) and subsequent adjustments (T1 and T2). The highest mean pain score arose at T0 followed by T2 and T1 adjustments, with the difference between pain levels at these appointment intervals being statistically significant ($P < .001$). The use of analgesics following each appointment mirrored pain experience, with pain score, appointment, and time point all being significant predictors of analgesic consumption. The level of dental irregularity, gender, or age did not predict pain levels reported.

Conclusions: Adults undergoing fixed orthodontic therapy should be advised that they are most likely to experience increased levels of pain for 1 to 3 days following placement of their appliance and subsequent adjustment visits. (*Angle Orthod.* 2018;88:292–298.)

KEY WORDS: Adult; Orthodontic treatment; Pain

INTRODUCTION

Pain is a near pervasive unpleasant experience encountered during orthodontics, which can impair compliance and lead to avoidance or discontinuation of treatment and failed appointments.[1] Patients are often apprehensive in relation to both orthodontic extractions and pain attached to treatment, with potential impacts on quality of life and compliance.[2] Most studies investigating the pain experience in orthodontics have focused on preadolescents and adolescents, with relatively little known in relation to the duration and severity of orthodontic pain among adults.[3,4] It is therefore surprising, particularly as treatment continues to become more accepted in adult populations and better informed patients demonstrate a more positive attitude toward treatment.[3,5–8] Moreover, the literature concerning the initial pain experience has typically focused on the first week following appliance placement,[9–12] with relatively few studies evaluating more prolonged effects.[3,13]

[a] Professor, Centre for Orobioengineering, Institute of Dentistry, Queen Mary University of London, London, United Kingdom.

[b] Registrar, Centre for Orobioengineering, Institute of Dentistry, Queen Mary University of London, London, United Kingdom and Trainee Lecturer, Department of Orthodontics, Faculty of Dentistry, University of Kebangsaan, Malaysia.

[c] Reader, Centre for Orobioengineering, Institute of Dentistry, Queen Mary University of London, London, United Kingdom.

[d] Lecturer, Centre for Orobioengineering, Institute of Dentistry, Queen Mary University of London, London, United Kingdom.

[e] Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, University of Bern Medical Faculty Dental School, Bern, Switzerland, and Private Practice, Corfu, Greece.

Corresponding author: Dr Ama Johal, Institute of Dentistry, Turner Street, Whitechapel, London E1 2AD, UK (e-mail: a.s.johal@qmul.ac.uk)

Accepted: January 2018. Submitted: August 2017.
Published Online: March 6, 2018

Orthodontic pain has been related to a range of factors, such as the degree of malalignment, analgesic use, and the type of appliance used.[2,9,12] A recent Cochrane review[14] concluded that there was no significant difference in the type of initial aligning archwire with the pain experienced. Furthermore, bracket type has not been linked to variation in pain experience.[15] Given that these mechanical factors seem to have little association with pain experience, detailed epidemiological data that may better allow prediction of the timing and severity of pain experience among adult populations would be welcomed.

Thus, the present study aimed to address these shortcomings in the literature and primarily evaluated the longitudinal pain experience in adults undergoing orthodontic treatment. Secondary outcomes assessed the relationship between pain experience and analgesic consumption, dental irregularity, gender, and age.

MATERIALS AND METHODS

Subjects

Ethical approval was obtained for a prospective longitudinal cohort study (Ref QMREC2013/82). Adults (older than 18 years) were recruited by five specialist orthodontists, undertaking adult orthodontic treatment in the South East of England. Subjects who were due to receive fixed orthodontic treatment alone, in the absence of any supplementary arch expansion or anchorage reinforcement, were included. Subjects requiring separation for band placement; demonstrating periodontal disease, temporomandibular joint dysfunction, or craniofacial syndrome; or who were prescribed analgesics or antidepressants for chronic medical conditions or psychiatric disease were excluded.

Methods

Training and calibration were organized for all clinicians involved in treating the potential adult participants, emphasizing the nature of the study, method of standardizing occlusal photographs, appliance placement, ligation method, and archwire sequencing for the three subsequent appointments. Following written informed consent, standardized occlusal photographs were obtained at baseline (T0). All patients received a bonded preadjusted Edgewise fixed appliance (0.022 $\times$ 0.028-inch slot size), in either the upper arch only or both arches. The initial archwire following bracket placement was a standardized 0.014-inch super-elastic nickel-titanium, to be relegated at the first (T1) and replaced with a standardized 0.016-inch super-elastic nickel-titanium at the second (T2) routine follow-up adjustment appointment, with each appointment being 6 ($\pm$1) weeks apart. Archwires were engaged using elastomeric ligatures only, avoiding full engagement at the bond-up appointment for notably displaced teeth. After placement of the orthodontic appliance (T0), subjects were asked to record their pain experience, using a visual analogue scale (VAS), at 4 hours, 1 day, and then each consecutive day for a total of 7 days and any analgesic use, in terms of the type of medication, dosage, and frequency. This was repeated after T1 and T2 routine follow-up adjustment appointments. The VAS had an unmarked horizontal 100-mm line, with *no pain* and *extreme pain* at either end. Subjects were asked to mark a vertical line along the VAS, which best represented their pain intensity, at the given time points. For the purpose of data analysis, the VAS scores were reduced to four time points: 4 hours, 24 hours, 2 and 3 days, and 4–7 days after the adjustment.

Questionnaires were returned using a prepaid self-addressed envelope to the host institute. With regard to protocol deviations, all subjects who failed an appointment were sent a further appointment and telephoned to confirm attendance. Any patients wishing to withdraw from the study were free to do so at any point with the assurance that it would not affect their continuing care.

Baseline data included demographic characteristics. Little's irregularity index (LI; 29) was used to assess the degree of dental irregularity, from the sum of the linear distances between adjacent contact points from the mesial of the right canine to the mesial of the left canine.[16] This was calculated for each dental arch at baseline (T0) using a digital caliper (150 mm DIN 862, ABSOLUTE Digimatic Calliper, Mitutoyo Standard Model No. 500-191U, Mitutoyo Ltd, Hampshire, UK) with a resolution of $\pm$0.01 mm.

Statistical Analysis

Descriptive statistics were calculated for pain (VAS) scores and analgesic consumption per appointment (T0, T1, and T2) and time point. Consumption of analgesics was aggregated into four time points: 4 hours, 24 hours, 3 days, and 7 days after the adjustment.

Univariable and multivariable random effects linear regression was implemented to evaluate the effect of the irregularity index, appointment, time point, age, and gender on both the VAS score and analgesic consumption counts. Predictors that were not significant at $P = .10$ in the univariable analysis were excluded from the multivariable analysis. Possible interaction between appointment and time point was also assessed. All analyses were conducted using Stata 15 statistical package (Stata Corp, College Station, Tex).

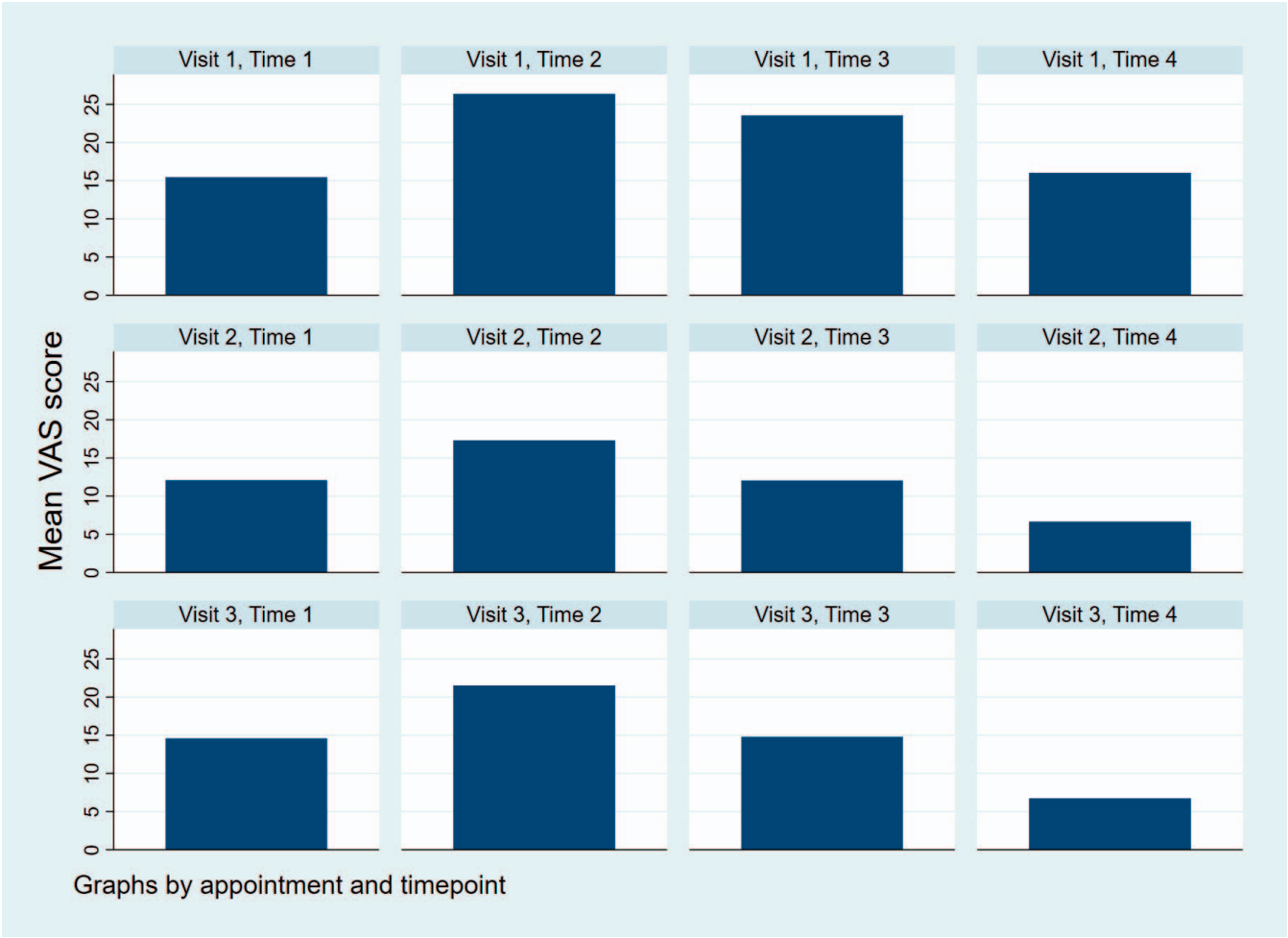

Figure 1. Mean visual analogue scale (VAS) scores at each of the three appointments (represented on the *y*-axis: initial bond-up, first and second routine follow-up adjustment) and the four time points (represented on the *x*-axis: 4 hours, 24 hours, 3 days, and 7 days after the appointments) for the whole sample (N = 58).

RESULTS

Recruitment and Demographic Data

Between March 2014 and June 2015, a total of 70 subjects who met the study criteria were consecutively recruited. Fifty-eight subjects completed all the questionnaires. Eleven (16%) subjects failed to complete the questionnaires and were lost from the study. Both the demographic and clinical characteristics (dental irregularity) of these 11 patients were examined, and their loss was not found be at risk of introducing bias. One subject was removed because of protocol deviation by use of a different-size initial archwire.

A slightly greater proportion of women (57%) was recruited, with a mean age 34.69 (SD 12.11). The mean baseline (T0) incisor irregularity index score was 7.5 mm (SD 3.9). Only six patients (10%) underwent extraction therapy.

Pain (VAS) Scores

For the second (24 hours) and third (3 days) time points, the VAS scores increased compared with the first (4 hours) time point by 7.69 and 2.75 units, respectively, after adjusting for irregularity and appointment, whereas for the last (7 days) time point, the VAS score decreased by 4.23 units compared with the first time point. The interaction between appointment and time point was not significant (Figure 1; Table 1).

From the univariable unadjusted analysis, it can be seen that only the appointment and time point were significant pain (VAS) score predictors at the $P \leq .10$ level of significance. In the multivariable model, no meaningful changes were observed compared with the unadjusted model, with appointment and time point maintaining their strong association with VAS scores. For the second (T1) and third (T2) appointments, the VAS scores decreased compared with the first (T0)

Table 1. Mean and Standard Deviation (SD) Pain (Visual Analogue Scale) Scores Following Bond up (T0) and First (T1) and Second (T2) Follow-up Adjustments at the Four Time Points (4 Hours, 24 Hours, 3 Days, and 7 Days After the Appointments), for the Whole Sample (N = 58)

	4 Hours	24 Hours	3 Days	7 Days
	Mean Score (SD)	Mean Score (SD)	Mean Score (SD)	Mean Score (SD)
T0	15.44 (23.56)	26.35 (25.92)	23.53 (26.31)	16.02 (21.75)
T1	12.08 (16.43)	17.29 (22.45)	12.05 (18.09)	6.66 (14.38)
T2	14.57 (18.77)	21.51 (24.30)	14.78 (23.04)	6.73 (13.93)

appointment by 8.32 and 5.94 units, respectively, after adjusting for dental irregularity and time point (Table 2; Figure 2).

Analgesic Use

For the second (T1) and third (T2) appointments, there was a decrease in analgesic consumption by 55% and 46% compared with the first appointment, respectively, after adjusting for VAS score, irregularity, age, and time point (Figure 3; Table 3). For the second and third time points, the analgesic consumption increased compared with the first (4 hours) time point, by 84% and 23%, respectively, after adjusting for VAS score, irregularity, age, and appointment. For the last time point (7 days), the analgesic consumption decreased by 48% compared with the first time point. The interaction between appointment and time point was not significant.

From the univariable analysis, it can be seen that pain (VAS) score, dental irregularity, age, appointment (T0, T1, and T2), and time point (4 hours, 24 hours, 3 days, and 7 days after the adjustment) were significant analgesic consumption predictors at the $P \leq .10$ level of significance (Figure 3; Table 3). In the multivariable model, only pain (VAS) score, appointment, and time point remained significant predictors of analgesic consumption. For every unit increase in VAS score, there was a 3% increase in total analgesic consumption, after adjusting for dental irregularity, age, appointment, and time point.

DISCUSSION

This longitudinal study demonstrated that varying levels of pain are experienced during the first week after each appointment, over the first 3 months of treatment. This mirrors the findings from adolescents and is in keeping with limited research evaluating adults.[1,17] This may in turn have a negative impact on quality of life and offers further insight into the findings from a recent prospective study in adolescents, in which a significant reduction in oral health–related quality of life was observed during the first 3 months of treatment, with pain proposed as one of the contributory domains.[8]

Pain scores reported over the three appointment intervals were consistent with other studies, in which an equally large individual variation in pain response was observed and can be explained by the subjective nature of pain.[9,10] Arbitrarily, previous investigators have equated a score greater than 54 mm as severe.[18] In the present study, the mean recorded pain score peaked between 24 hours and 3 days in all appoint-

Table 2. Estimates, 95% Confidence Intervals (CIs), and *P* Values From Univariable and Multivariable Random Effects Linear Regression for the Effect of Irregularity Index (IR), Appointment, Time Point, Sex, and Age on Visual Analogue Scale Scores

	Univariable Analysis		Multivariable Analysis	
Predictor	β-Coefficient (95% CIs)	*P* Value	β-Coefficient (95% CIs)	*P* Value
IR (per unit)	−0.89 (−1.92, 0.15)	.09	−0.88 (−1.92, 0.15)	.09
Appointment				
First (T0)	Reference		Reference	
Second (T1)	−8.32 (−11.08, −5.56)	<.001	−8.32 (−10.95, −5.68)	<.001
Third (T2)	−5.94 (−8.70, −3.18)	<.001	−5.94 (−8.57, −3.30)	<.001
Time point				
4 hours	Reference		Reference	
24 hours	7.69 (4.55, 10.83)	<.001	7.69 (4.65, 10.73)	<.001
3 days	2.75 (−0.39, 5.89)	.08	2.75 (−0.29, 5.79)	.08
7 days	−4.23 (−7.37, −1.09)	<.01	−4.23 (−7.27, −1.19)	<.01
Appointment × time point interaction				.21[a]
Sex				
Female	Reference			
Male	2.42 (−5.87, 10.72)	.57		
Age (per year)	−0.13 (−0.47, 0.21)	.45		

[a] Log likelihood ratio test between models with and without interaction.

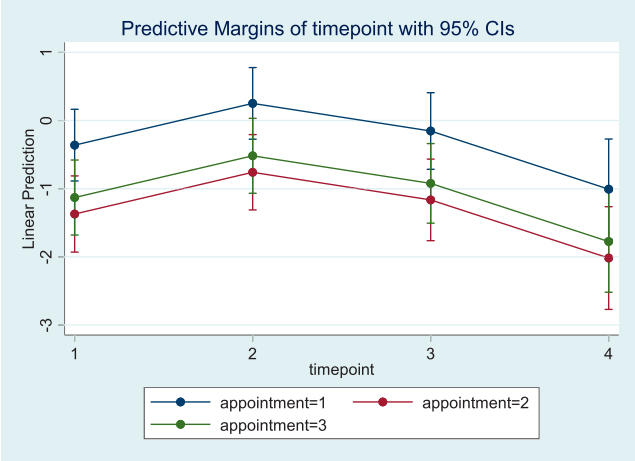

Figure 2. Predicted visual analogue scale (VAS) scores at each of the three appointments (initial bond-up, first and second routine follow-up adjustment) and the four time points (4 hours, 24 hours, 3 days, and 7 days after the appointments) for the whole sample (N = 58).

ment intervals. Again, these data were consistent with other studies in which the level of discomfort tended to peak at 24 hours and subsequently decreased.[9,19,20] These patterns reflect biochemical changes, with cytokines known to be involved in inflammatory-induced sensitization, which are related to the development of hyperalgesia and known to peak approximately 24 hours following appliance manipulation.[21] Furthermore, prostaglandins and IL-1, both inflammatory mediators of pain, are also found to peak at 24 hours and to reduce to baseline levels after a period of 1 week to 1 month.[22]

In comparing all three appointments, pain was greatest following the initial bond-up appointment (T0), followed by the second adjustment (T2), with the first adjustment (T1) associated with the lowest pain score. At T0, the heightened pain levels may also be compounded by additional soft-tissue inflammation and ulceration. Soft-tissue discomfort is likely to dissipate over time with adaptation.[23,24] However, an

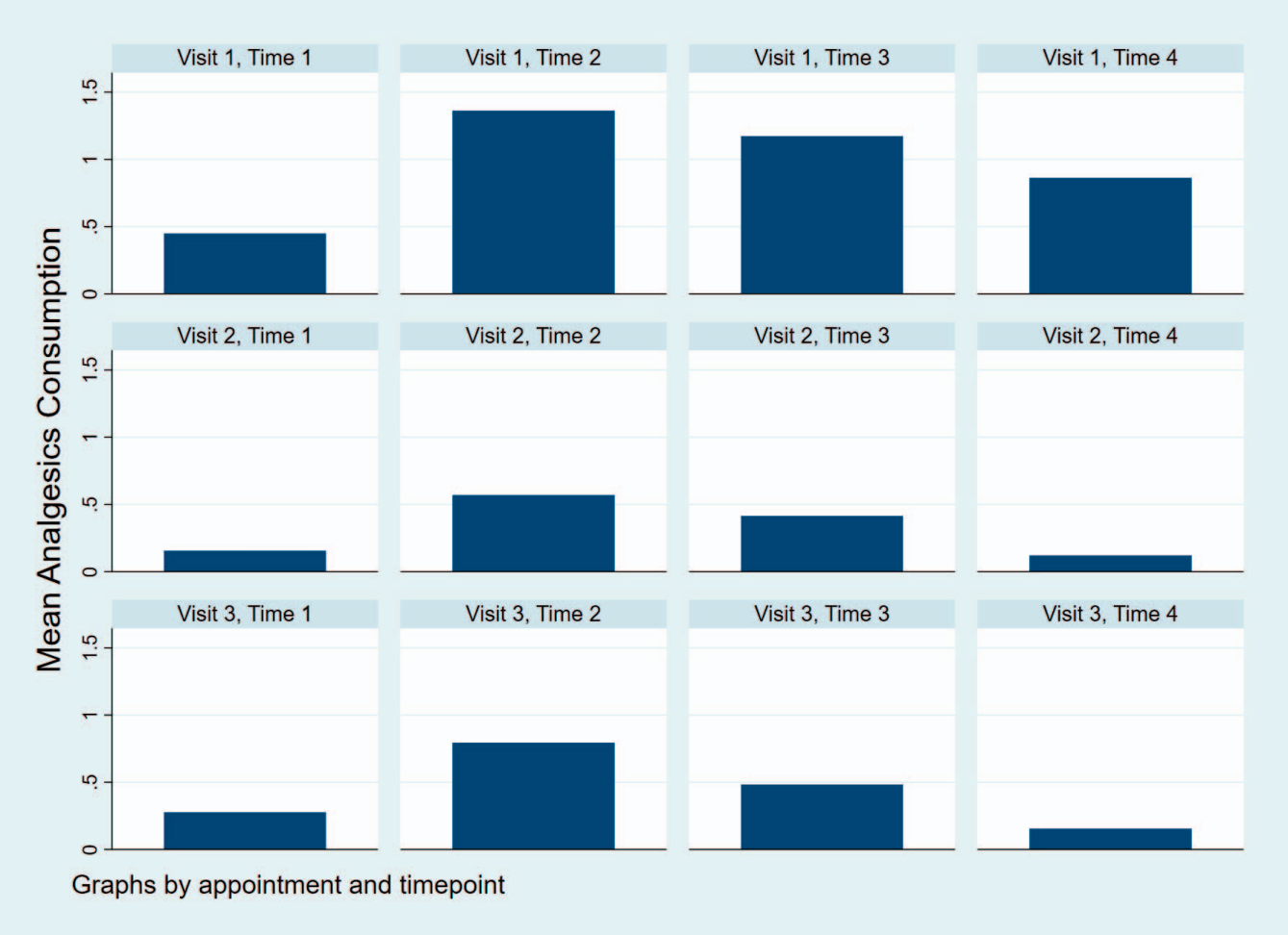

Figure 3. Mean of analgesic consumption scores at each of the three appointments (represented on the *y*-axis: initial bond-up, first and second routine follow-up adjustment) and the four time points (represented on the *x*-axis: 4 hours, 24 hours, 3 days, and 7 days after the appointments) for the whole sample (N = 58).

Table 3. Mean and Standard Deviation (SD) for Analgesic Consumption Following Bond up (T0) and First (T1) and Second (T2) Follow-up Adjustments at the Four Time Points (4 Hours, 24 Hours, 3 Days, and 7 Days After the Appointments), for the Whole Sample (N = 58)

	4 Hours	24 Hours	3 Days	7 Days
	Mean Score (SD)	Mean Score (SD)	Mean Score (SD)	Mean Score (SD)
T0	0.45 (0.75)	1.36 (1.88)	1.17 (2.15)	0.86 (2.94)
T1	0.16 (0.45)	0.57 (1.20)	0.41 (1.30)	0.12 (0.80)
T2	0.28 (0.59)	0.79 (1.48)	0.48 (1.78)	0.16 (1.06)

interesting finding was the observed increase in mean pain scores at T2. This may relate to the archwire protocol, with the change to a larger dimension; an increase in diameter from 0.014 to 0.016 inches can raise the force level by 50%. Alternatively, at T2, teeth may be more completely ligated, resulting in higher force. Luppanapornlap et al.[22] concluded that the application of heavy force produced substantially greater pain, which peaked at 24 hours after application.

In the present study, analgesic consumption was similar to that reported in other recent prospective clinical trials based on adolescents, confirming that most adult patients found orthodontic pain to be moderate, resulting in the use of analgesics.[18,20,25] Furthermore, and perhaps not surprisingly, pain scores, appointment type (T0, T1, or T2), and time point (4 hours, 24 hours, 3 days, and 7 days) all predicted analgesic consumption. This confirms that recording analgesic consumption can provide a reliable, if not indirect, assessment of pain response.

In terms of identifying predictors of pain and, in turn, analgesic consumption, multivariate modeling was applied. The current study did not identify the level of dental irregularity as having an influence on pain levels or analgesic use. The evidence of a link among adolescents remains unclear in the literature, with evidence suggesting no correlation[10,16,26] or, indeed, the greater the degree of initial crowding, the higher the level of discomfort reported.[9] Theoretically, as the amount of dental irregularity increases, the interbracket span reduces and a greater force is exerted.[27] However, if elastic ligatures are used, as in the present study, full engagement is not always achieved in cases of severe crowding, translating into reduced pressure, lighter forces and, hence, less pain. This may help to explain the lack of predictability between the level of dental irregularity and pain.

The present study could not identify gender or age as a predictor of pain experience or analgesic use and is consistent with studies in adolescents.[4,9,11] In relation to age, it was difficult to compare the findings from the present study with previous studies, as most of the latter studies combined adolescent and adult patients.

Patient-centered care is a concept that has been introduced recently in health care systems. Among the main elements are a need to understand the patient's treatment needs, experiences, satisfaction, and the perceived overall quality of the health care system.[28] With an increasing number of adult patients now seeking orthodontic treatment, there is a growing need for such research in orthodontics. Thus, the current body of work evaluating pain experiences and analgesic use in adults undergoing fixed appliance treatment. Better informing patients of the likely resultant pain experience following appliance placement and subsequent adjustment visits could significantly help manage their expectations and treatment compliance.

The present study was not without its limitations, with subjects recruited from five practices, introducing the potential for inconsistency. However, such inconsistency was limited, with all practitioners undergoing calibration in relation to the study protocol. Moreover, it was felt that recruitment of patients in a specialist practice setting would enhance the generalizability of the findings and better reflect the range and complexity of malocclusion within the adult subpopulation. A further potential limitation was a possibility that patients who had undergone extractions prior to orthodontic treatment may score higher pain levels compared with patients who do not require any extractions for orthodontic treatment.[28] However, these represented only 10% of the sample, and to limit any such risk, a minimum hiatus of 2 weeks was adopted between extractions and appliance placement. Fortunately, no patient experienced problems in relation to the extraction site healing.

CONCLUSION

- Adults undergoing fixed orthodontic therapy should be advised that they are most likely to experience increased levels of pain for 1 to 3 days following placement of their appliance and subsequent adjustment visits for which analgesic use could be considered.

REFERENCES

1. Salmassian R, Oesterle LJ, Shellhart WC, Newman SM. Comparison of the efficacy of ibuprofen and acetaminophen in controlling pain after orthodontic tooth movement. *Am J Orthod Dentofacial Orthop*. 2009;135:516–521.

2. Krishnan V. Orthodontic pain: from causes to management—a review. *Eur J Orthod*. 2007;29:170–179.
3. Wu AKY, McGrath C, Wong RWK, Wiechmann D, Rabie ABM. A comparison of pain experienced by patients treated with labial and lingual orthodontic appliances. *Eur J Orthod*. 2010;32:403–407.
4. Erdinç A, Dinçer B. Perception of pain during orthodontic treatment with fixed appliances. *Eur J Orthod*. 2004;26:79–85. Available at: http://ejo.oxfordjournals.org/content/26/1/79.short.
5. Dyer GS, Harris EF, Vaden JL. Age effects on orthodontic treatment: adolescents contrasted with adults. *Am J Orthod Dentofacial Orthop*. 1991;100:523–530.
6. Scott P, Fleming P, DiBiase A. An update in adult orthodontics. *Dent Update*. 2010;34:427–438.
7. Christensen L, Luther F. Adults seeking orthodontic treatment: expectations, periodontal and TMD issues. *Br Dent J*. 2015;218:111–117.
8. Johal A, Fleming PS, Al Jawad FA. A prospective longitudinal controlled assessment of pain experience and oral health-related quality of life in adolescents undergoing fixed appliance treatment. *Orthod Craniofac Res*. 2014;17:178–186.
9. 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;30:227–232.
10. 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;85:1021–1026.
11. Rahman S, Spencer RJ, Littlewood SJ, O'Dywer L, Barber SK, Russell JS. A multicenter randomized controlled trial to compare a self-ligating bracket with a conventional bracket in a UK population. Part 2: pain perception. *Angle Orthod*. 2016;86:149–156.
12. Miller KB, McGorray, SP, Womack R, et al. A comparison of treatment impacts between Invisalign aligner and fixed appliance therapy during the first week of treatment. *Am J Orthod Dentofacial Orthop*. 2007;131:302.e1–302.e9.
13. Brown D Brown DF, Moerenhout RG. The pain experience and psychological adjustment to orthodontic treatment of preadolescents, adolescents, and adults. *Am J Orthod Dentofacial Orthop*. 1991;100:349–356.
14. Jian F, Lai W, Furness S, Gt M, Dt M, Hickman J, Wang Y. Initial arch wires for tooth alignment during orthodontic treatment with fixed appliances. *Cochrane Database Syst Rev*. 2013;(4):CD007859.
15. Fleming PS, Johal A. Self-ligating brackets in orthodontics: a systematic review. *Angle Orthod*. 2010;80:575–584.
16. Little RM. The Irregularity Index: a quantitative score of mandibular anterior alignment. *AmJ Orthod*. 1975;68:554–563.
17. Young AN, Taylor RW, Taylo SE, Linnebur SA, Buschang PH. Evaluation of preemptive valdecoxib therapy on initial archwire placement discomfort in adults. *Angle Orthod*. 2006;76:251–259.
18. Collins SL, Moore RA, Mcquay HJ. The visual analogue pain intensity scale: what is moderate pain in millimetres? *Int Assoc Study Pain*. 1997;72:95–97.
19. Bernhardt MK, Southard KA, Batterson KD, Logan HL, Baker KA, Jakobsen JR. The effect of preemptive and/or postoperative ibuprofen therapy for orthodontic pain. *Am J Orthod Dentofacial Orthop*. 2001;120:20–27.
20. Polat O, Karaman AI. Pain control during fixed orthodontic appliance therapy. *Angle Orthod*. 2005;75:214–219.
21. Zhang JM, An J. Cytokines, inflammation and pain. *Int Anesthesiol Clin*. 2007;45:27–37.
22. 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;32:596–601.
23. Brown DF, Moerenhout RG. The pain experience and psychological adjustment to orthodontic treatment of preadolescents, adolescents, and adults. *Am J Orthod Dentofacial Orthop*. 1991;100:349–356.
24. Caniklioglu C, Ozyurk Y. Patient discomfort: a comparison between lingual and labial fixed appliances. *Angle Orthod*. 2005;75:86–91.
25. 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.
26. Jones ML, Richmond S. Initial tooth movement: force application and pain—a relationship? *Am J Orthod*. 1985;88(2):111–116.
27. Creekmore TD. The importance of interbracket width in orthodontic tooth movement. *J Clin Orthod*. 2016;10:7–9.
28. McGrath C, Bed R. The value and use of "quality of life" measures in the primary dental care setting. *Prim Dent Care*. 1999;6:53–57.