

## Article

# Predictors of Analgesic Consumption in Orthodontic Patients

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**Abstract:** During orthodontic treatment, pain is a subjective experience influenced by several factors. Orthodontic patients consume analgesics at different rates to alleviate this pain. Correlations between orthodontic pain and analgesic consumption were analyzed. Predictive factors to analgesic consumption were not statistically analyzed. This study was conducted to identify the predictive factors for analgesic consumption after initiation of orthodontic treatment with fixed appliances. Two hundred and eighty-six patients involved in this study kept a seven-day diary in which they recorded pain intensity (using a 0–10 numerical rating scale), analgesic consumption, localization of pain, pain triggers, and pain characteristics. Univariable analyses identified potential predictive factors: age, gender, pain intensity, pain localization, pain while chewing, pain at rest, night pain, headache, pulsating pain, sharp pain, dull pain, and tingling. Logistic regression was conducted to create a model that could predict analgesic consumption. Multivariate analyses demonstrated that analgesic consumption was increased by increased age, increased intensity of pain, and presence of a headache. Overall, the model explained 33% of analgesic requirement variability. Age, intensity of pain, and headache proved to be predictors of analgesic consumption. Knowledge of such factors may help clinicians identify orthodontic patients who will consume analgesics on their own.

**Keywords:** orthodontic pain; pain intensity; analgesics; VNS scale; buccal appliances; fixed orthodontic appliances; headache



**Citation:** Juloski, J.; Vasovic, D.; Vucic, L.; Pajevic, T.; Gligoric, N.; Mirkovic, M.; Glisic, B. Predictors of Analgesic Consumption in Orthodontic Patients. *Appl. Sci.* **2022**, *12*, 3390. <https://doi.org/10.3390/app12073390>

Academic Editors: Giuseppe Minervini, Fabrizia d'Apuzzo and Vincenzo Grassia

Received: 28 February 2022

Accepted: 24 March 2022

Published: 27 March 2022

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## 1. Introduction

During orthodontic treatment, after administration of orthodontic forces, patients experience pain. Orthodontic pain is a subjective experience influenced by several factors, such as patient's age, gender, orthodontic forces, emotional factors, type of orthodontic appliances, periodontal pain, bite forces, etc. [1–6]. Pain experienced in orthodontic patients treated with fixed orthodontic appliances is well established. It appears almost immediately after treatment initiation, peaks during the first day of treatment, and declines within the first week [7–9]. A certain percentage of patients still experience some pain after 7 days of treatment [7]. The intensity of orthodontic pain is mostly moderate, triggered by chewing and biting, and is usually described as discomfort or pressure [10]. In order to alleviate this pain orthodontic patients consume analgesics at different rates. According to relevant literature, about 30–40% of orthodontic patients consume self-administered analgesics [11,12]. Only correlations between orthodontic pain and analgesic consumption were analyzed [11].

To the best of our knowledge predictive factors to analgesics consumption, in order to alleviate orthodontic pain, were not statistically analyzed.

The aim of this study was to further analyze the predictors of analgesics consumption and to identify the predictive factors for self-administration of analgesics in orthodontic

patients after initiation of orthodontic treatment with fixed appliances. The null hypothesis was that the intensity of pain is the only predictive factor for analgesic consumption.

## 2. Materials and Methods

The patients were enrolled consecutively in this trial which was performed at the University Orthodontic Department over the period of three years. For each patient, the treating orthodontic specialist made a treatment plan according to the patient's needs. The inclusion criteria for this investigation were: patients older than 11 years, healthy patients who have accepted necessary comprehensive orthodontic treatment with fixed buccal orthodontic appliances, patients that have signed informed consent. Exclusion criteria were patients consuming analgesics for other medical reasons, patients with cleft lip and/or palate, patients with syndromes, patients that were previously treated with fixed orthodontic appliances, and patients whose treatment included extra-oral appliances or additional intra-oral appliances (palatal arches, quad-helix, etc.).

For patients enrolled in the study, straight wire orthodontic appliances were bonded (brackets and tubes slot size 0.018", prescription Ricketts) with universal sealant and bonding primer (Ortho Solo byOrmco) and light cure orthodontic adhesive composite (Enlight byOrmco). All bonding appointments were scheduled between 9 a.m. and noon. After bonding, an initial superNiTi archwire was placed, whose size was assessed by the orthodontic specialist (0.012" or 0.014" depending on the degree of crowding). Immediately after bonding, all the patients included in the study were asked to keep a seven-day pain diary. At the beginning of the pain diary, the orthodontic specialist completed baseline data for each patient (age, gender, degree of crowding which was previously assessed on dental cast models, brackets prescription and slot size, archwire size, and tooth extractions prior to orthodontic treatment). All patients were verbally instructed to complete the pain diary at home, preferably each day at the same time, starting from 24 h after the orthodontic appointment until the seventh day. In the pain diaries, patients were asked to record their pain experience, by answering the questions concerning:

- pain initiation (with possible answers: immediately, after 6 h, after 12 h, it did not hurt), only for day 1,
- intensity of pain (reported on the Visual Numerical Scale (VNS), 0 to 10 scale, where 0 means no pain and 10 means extreme pain),
- analgesic consumption (with possible answers: yes and no),
- pain location (frontal teeth, posterior teeth, all teeth, it did not hurt),
- pain trigger (no pain, chewing, biting, cold food and drink, hot food and drink, at rest, during night, during physical activity),
- pain description (no pain, discomfort, pressure, tingling, dull pain, sharp pain, pulsating pain, headache).

All the questions in the pain diary were answered by circling one of the given answers, except for questions about pain triggers and description, where patients were allowed to circle each answer which coincided with their pain.

The analgesics were not prescribed by the orthodontic specialist. The patients were allowed to take analgesics as needed, and they recorded analgesic consumption for each day of the first week of treatment.

The pain diaries were collected from the patients on the following appointment.

### *Statistical Analysis*

The data were analyzed to investigate differences between patients reporting analgesic consumption and those reporting no analgesics consumption during the first day of orthodontic treatment with fixed appliances. During the first day of orthodontic treatment 93 (33%) patients reported analgesic consumption (analgesics group), and 190 (67%) patients reported that they did not consume analgesics (no analgesics group).

Logistic regression (LR) analysis was used to test the investigated independent variables that would predict the need for analgesic consumption during the first day of the

orthodontic treatment. Univariable analysis was performed to identify variables that would be included in the multivariate analysis. The forward and backward LR method was used in the multivariate analysis to create the preliminary model. The goodness-of-fit of the preliminary model was tested with the Hosmer–Lemeshow test. The results were presented as odds ratios with 95% confidence intervals. According to the sample size calculations, it was presumed that a sample of at least 220 patients should be enrolled in the study, keeping in mind that the sample size should be 10 times greater than the number of independent variables, which was 22 in this study. The sample size also proved to be sufficient in reference to the recommended rules of thumb formula  $EPV = 100 + 50 \times i$ , where  $i$  refers to the number of independent variables in the final model, which was 3 in this study.

Statistical analysis was performed in IBM SPSS Statistics Data Editor (IBM SPSS version 21, Armonk, New York, NY, USA), with a level of statistical significance of  $p < 0.05$ .

### 3. Results

#### 3.1. Sample Characteristics

Two hundred and eighty-six patients (90 males (31.5%), and 196 females (68.5%), aged  $19.25 \pm 6.60$  years) involved in this study recorded that pain mostly started after 6 h (43%), followed by 12 h (35%) after the bonding procedure. The recorded intensity of pain for the first day after bonding was  $4.03 \pm 2.63$  (median 4) (on VNS 1–10 scale),  $3.763 \pm 2.521$  (median 4) for the second day, and  $2.923 \pm 2.309$  (median 3) for the third day and continued to descend as the treatment progressed. Orthodontic patients consumed analgesics mostly during the first days of treatment, 33% of patients on the first day, 23% on the second day, about 9% on the third day. From the fourth day onward, less than 5% of patients consumed analgesics. Patients mostly complained that pain was triggered by chewing and biting, and described it as pressure and discomfort. In Table 1 the descriptive statistics of the investigated sample are given.

**Table 1.** Descriptive statistics for the investigated independent variables.

Parameter	Value	N	Percent	Mean (SD)	Median
Gender	Male	90	31.5		
	Female	196	68.5		
Age				19.25(6.60)	
Degree of crowding	Mild	107	45.5		
	Moderate	58	24.7		
	Severe	70	29.8		
Extraction therapy	Extraction	136	47.6		
	No extractions	150	52.4		
Wire size	0.012"	133	46.7		
	0.014"	140	49.1		
Beginning of pain	Immediately	19	6.7		
	After 6 h	123	43.2		
	After 12 h	99	34.7		
	Did not hurt	15	5.3		
Intensity of pain				4.03(2.63)	4
Pain killers	Yes	93	32.9		
	No	190	67.1		
Localization of the pain	Frontal teeth	105	36.8		
	Posterior teeth	46	16.1		
	All teeth	101	35.4		
	None	33	11.6		

Table 1. Cont.

Parameter	Value	N	Percent	Mean (SD)	Median
	Yes	26	9.1		
	No	260	90.9		
	Yes	190	66.4		
	No	95	33.2		
Pain triggers	Yes	205	71.7		
No pain	No	81	28.3		
Pain on bite	Yes	11	3.8		
Pain on chewing	No	274	95.8		
Pain on cold	Yes	8	2.8		
Pain on hot	No	278	97.2		
Pain at rest	Yes	81	28.3		
Pain at night	No	205	71.7		
Pain at physical activity	Yes	29	10.2		
	No	256	89.8		
	Yes	3	1.1		
	No	282	98.9		
	Yes	26	9.1		
	No	220	90.9		
	Yes	124	43.4		
	No	162	56.6		
Pain description	Yes	175	61.2		
No pain	No	111	38.8		
Discomfort	Yes	53	18.5		
Pressure	No	233	81.5		
Tingling	Yes	74	25.9		
Dull pain	No	212	74.1		
Sharp pain	Yes	42	14.7		
Pulsating pain	No	244	85.3		
Headache	Yes	47	16.5		
	No	237	83.5		
	Yes	30	10.5		
	No	256	89.5		

### 3.2. Predictors of Analgesic Consumption

Statistical analyses were performed for each of the possible predictive factors for analgesic consumption (age, gender, degree of crowding, archwire size, tooth extractions prior to orthodontic treatment, pain initiation, intensity of pain, pain location, chewing, biting, cold food and drink, hot food and drink, pain at rest, night pain, pain during physical activity, discomfort, pressure, tingling, dull pain, sharp pain, pulsating pain, and headache). In the first step, univariable analyses identified 12 potential predictive factors listed in Table 2.

Logistic regression was conducted to create a model that could predict analgesic consumption. The goodness-of-fit was tested with the Hosmer–Lemeshow test, the value of which signifies that the preliminary model was the final model. Multivariate analyses demonstrated that analgesic consumption was increased by increased age, increased intensity of pain, and presence of a headache, Table 3. With increasing age, for each year, the probability of the orthodontic patient consuming an analgesic in case of pain increases by 1.142, provided that the intensity of pain and the headache are controlled (remaining two factors). If the pain intensity increases, it also increases the probability that the patient will take an analgesic by 0.693, provided that the remaining factors are controlled. Orthodontic patients with headaches will take an analgesic 0.253 times more often than those who do not have a headache, provided that the other factors are controlled. Overall, the model explained 33% of analgesic requirement variability.

**Table 2.** Variables tested with univariable analysis whose *p* values were less than 0.25 and were therefore included in the further analysis.

Parameter	B	S.E.	Wald	df	<i>p</i>	OR	95% C.I.	
Gender	0.670	0.290	5.335	1	0.021	1.955	1.107–3.454	
Age	134	0.031	18.855	1	0.000	1.144	1.076–1.215	
Intensity of pain	−0.392	0.059	44.072	1	0.000	0.676	0.602–0.758	
Localization of the pain	Frontal	−1.624	0.640	6.435	1	0.011	0.197	0.056–0.691
	Posterior	−1.261	0.692	3.318	1	0.069	0.283	0.073–1.101
	All teeth	−2.038	0.639	10.190	1	0.001	0.130	0.037–0.455
	Constant	2.303	0.606	14.460	1	0.000	10.000	
Pain on chewing	−0.635	0.300	4.472	1	0.034	0.530	0.294–0.955	
Pain at rest	−0.965	0.274	12.372	1	0.000	0.381	0.223–0.652	
Pain at night	−0.739	0.396	3.487	1	0.062	0.478	0.220–1.037	
Tingling	−0.502	0.315	2.546	1	0.111	0.605	0.326–1.122	
Dull pain	−0.408	0.282	2.087	1	0.149	0.665	0.382–1.157	
Sharp pain	−0.968	0.340	8.125	1	0.004	0.380	0.195–0.739	
Pulsating pain	−1.256	0.329	14.552	1	0.000	0.285	0.149–0.543	
Headache	−1.596	0.411	15.043	1	0.000	0.203	0.091–0.454	

B—regression coefficient, S.E.—standard error, Wald—test value, df—degrees of freedom, OR—odds ratio, C.I.—confidence interval.

**Table 3.** Parameters associated with analgesic consumption based on the final model of the logistic regression.

Parameter	B	S.E.	Wald	df	<i>p</i>	OR	95% C.I.
Age	0.133	0.035	14.184	1	0.000	1.142	1.066–1.224
Intensity of pain	−0.367	0.067	30.166	1	0.000	0.693	0.608–0.790
Headache	−1.376	0.494	7.760	1	0.005	0.253	0.096–0.665

Nagelkerke  $R^2$  0.366, Hosmer–Lemeshow test 0.08.

## 4. Discussion

### 4.1. Summary of Main Findings

This investigation focused on analyzing the factors that could predict the need for analgesics consumption in orthodontic patients treated with fixed appliances. All the patients included in the study were divided into two groups—patients that consumed analgesics during the first day of orthodontic treatment and those who did not. Several variables were investigated: general characteristics, intensity of pain, pain location, pain triggers, and pain description. Our study has revealed that age, intensity of pain, and headaches proved to be predictors for analgesic consumption. The older the patients are, the higher the intensity of pain and if a headache is present, there is a higher chance that orthodontic patients will consume analgesics in order to alleviate pain caused by fixed orthodontic appliance treatment.

### 4.2. Predictors for Analgesic Consumption

Age, as one of the predictors for analgesic consumption, might be explained by the fact that as people get older, they are more used to controlling pain with analgesics, and less willing to put up with pain. The younger patients, besides the fact that they are not so used to controlling the pain with analgesics, are not able to take analgesics themselves, the analgesics have to be administered by their parents. Therefore, the observed difference in analgesic consumption between the patients of different ages. The literature is scarce regarding the topic of the present study. Regarding the association between the pain intensity and age, controversial results can be found [13–15]. In our study, both age and pain intensity were investigated separately, therefore the relationship between the intensity of pain and age would not have impacted the investigation.

The higher the intensity of pain, the more likely patients were to alleviate the pain with analgesics. Even though the average pain level on the first day of treatment of or-

thodontic patients was around 4, some of the patients experienced stronger pain. Almost 12% of patients reported a high pain level (8–10 on the VNS scale). Previous studies have also reported that analgesic intake correlated with pain intensity scores during orthodontic treatment [12,16]. This predictive factor was anticipated, therefore it was set as a null hypothesis.

Orthodontic pain sometimes reflects on the head, and patients report having headaches. This investigation reported that these patients are more likely to consume analgesics than patients without headaches if the two other factors are the same. In the present literature, the influence of headaches on analgesic consumption in orthodontic patients has not been investigated so far. The researchers have shown that the orthodontic pain pathway and headaches have related local inflammatory mechanisms transmitted by the trigeminal nerve, which may partially explain the presence of headaches in orthodontic patients [17]. Furthermore, the literature is ambiguous regarding the question of whether people with malocclusion were more likely to suffer from headaches [18].

It has been proved that peak pain intensity level is on the first day of orthodontic treatment [3,19,20]. The analgesics intake is correlated with pain intensity throughout the first week of orthodontic treatment [12]. These results are in concordance with the results in this study, therefore the data obtained for the first day of orthodontic treatment were used as representative. Analgesics consumption decreased significantly with each day of orthodontic treatment, reaching such low levels which could not be used for statistical analysis.

The pain caused by orthodontic treatment is sometimes underestimated, or even neglected. Patients treated with fixed orthodontic appliances experience pain and have the need to alleviate it with self-prescribed analgesics. The importance of analgesics consumption lies in the fact that there are implications that some analgesics could impact orthodontic tooth movement in terms of reducing it [21]. Monitoring of analgesics consumption has been proposed in order to avoid lengthening of treatment [21]. According to the results of the present study, attention can be also drawn to predictive factors (age, intensity of pain, and headaches). The results of this study indicate the need for further research on the association of orthodontic pain with the occurrence of a headache.

#### 4.3. Limitations

Even though in this study, consumption of analgesics was investigated, not the characteristics of pain, investigating pain correlated features is difficult. The pain itself is a subjective feeling and has a broad range of interindividual differences [16,22–26] and therefore the analgesics consumption could be influenced. Furthermore, we should keep in mind that it was not possible to control completely the initial archwire size because of variations of patients' malocclusion and degree of initial crowding.

#### 4.4. Strength

To the best of our knowledge, this is the first investigation on predictive factors for analgesic consumption in orthodontic patients. Different factors were analyzed as potential predictors, and three were confirmed to be predictors. In the present study, assessment of pain was performed daily, which is a more valid and reliable method, compared to retrospective response on recall [27].

### 5. Conclusions

Within the limitations of this study, the results revealed that age, intensity of pain, and headache are predictors for analgesic consumption.

**Author Contributions:** Conceptualization, J.J., D.V., L.V. and T.P.; methodology, J.J., D.V., N.G. and M.M.; software, J.J. and T.P.; formal analysis, T.P.; investigation, J.J., D.V., N.G. and M.M.; resources, J.J., D.V., L.V., N.G. and T.P.; data curation, J.J., D.V., L.V., T.P. and N.G.; writing—original draft preparation, J.J., D.V., L.V., T.P. and N.G.; writing—review and editing, B.G.; supervision, B.G. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The Institutional Ethical Board of School of Dentistry University of Belgrade, Serbia (No 36/15) has approved the protocol for this clinical trial.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. Written informed consent was obtained from the patient(s) or parent/legal guardian to publish this paper.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

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