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Perception of pain during orthodontic treatment with fixed appliances

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SUMMARY The aims of this study were to investigate the initial time at which pain occurs after insertion of two initial wires of different sizes, the duration of the pain, the areas affected within the mouth, the level of self-medication, the effect of this pain on daily life, and whether gender is important in the perception of pain. The study group consisted of 109 patients (52 boys, 57 girls) with a mean chronological age of 13.6 years for boys and 14.7 years for girls. Insertion of either a 0.014 or 0.016 inch wire was by random selection. Following insertion of the archwires, a questionnaire comprising a total of 49 questions was given to the patients. They described the time of initial pain in the first question, answered the next 24 questions as 'yes' or 'no', and used a visual analogue scale for the final 24 questions.

No significant differences were found in terms of gender, in the perception period of initial pain as regards the areas affected within the mouth or the effect of pain on daily living when the 0.014 and 0.016 inch wire groups were compared at 6 hours, 1, 2, 3, 4, 5, 6 and 7 days. At 24 hours, which was found to be statistically significant, more pain relief was used in the 0.014 inch archwire group. The results show that in both groups, initial pain was perceived at 2 hours, peaked at 24 hours and had decreased by day 3.

Introduction

Pain is one of the most important reasons why patients are discouraged from seeking orthodontic treatment (Oliver and Knapman, 1985). Although the reason for the pain encountered during orthodontic tooth movement is not fully understood, various concepts have been discussed.

Furstman and Bernick (1972) suggested that periodontal pain is caused by a process of pressure, ischaemia, inflammation, and oedema. Burstone (1964) identified an immediate and delayed pain response; the former being related to the initial compression of the periodontal ligament (PDL) immediately after placement of the archwire. The latter response, which started a few hours later, was termed hyperalgesia of the PDL. Prostaglandins have been shown to cause hyperalgesia, which is an increased sensitivity to noxious agents such as histamine, bradykinin, serotonin, acetylcholine and substance P. There are indications that perceptions of pain are due to changes in blood flow in the PDL (Burstone, 1964; White, 1984; Kvam *et al.*, 1987) and are correlated with the presence of substances such as prostaglandins and substance P (Burstone, 1964; White, 1984; Kvam *et al.*, 1987; Ngan *et al.*, 1989).

The subjective perception of pain is difficult to measure. Burstone (1964) noted a wide range of individual responses when similar forces were applied to the teeth. Several investigations have described patient responses to fixed orthodontic appliances. These reported that pain begins a few hours after application of an orthodontic force and lasts approximately 5 days (Jones, 1984; Jones and Richmond, 1985; Sinclair *et al.*, 1986; Kvam *et al.*, 1987; Ngan *et al.*, 1989; Wilson *et al.*, 1989; Jones and Chan, 1992). Jones (1984), in a study examining the discomfort experienced by patients after placement of initial archwires, found statistically higher discomfort experienced by adults compared with adolescents.

Ngan *et al.* (1989) suggested the use of non-steroid anti-inflammatory agents such as aspirin and ibuprofen to provide a level of relief.

The aims of this study were to determine following application of two wires of different sizes: (1) the time at which pain starts, (2) the duration of the pain, (3) the areas it affects within the mouth, (4) the level of self-medication, (5) the effect of this pain on daily living and (6) whether gender is important in the perception of pain. Comparisons were made between each wire group and also by comparing the two wire groups with each other.

Subjects and method

The study group comprised 109 patients (52 boys, 57 girls) treated at the Department of Orthodontics, Faculty of Dentistry, University of Ege, İzmir, Turkey. The chronological mean age was 13.6 years for the boys [standard deviation (SD) = 1.38)] and 14.7 years for the girls (SD = 1.47). Dental crowding was not evaluated.

Pre-angulated and pre-torqued 0.018 inch Edgewise appliances 'Roth System' (Forestadent, Pforzeim, Germany) were used in all patients. After bracket bonding, 0.014 or 0.016 inch NiTi (Ormco, CA, USA) wires were used initially. The patients were randomly

selected for insertion of the 0.014 or 0.016 inch wires. Following placement of the archwires they were ligated to all teeth. The 0.014 inch group consisted of 56 subjects (29 boys, 27 girls). The wire was inserted in both arches in 42 patients and in the maxilla in 14 patients in this group. The 0.016 inch group consisted of 53 subjects (23 boys, 30 girls). In this group, the wire was inserted in both arches in 41 patients and in the maxilla in 12 patients. No extra-oral appliances, palatal arches or quad-helix appliances were used during the experimental period.

Following archwire insertion the patients were given previously prepared questionnaires and instructed on how they should be completed. The questionnaires were completed by all 109 patients and returned at the following appointment. Question 1 asked the time at which pain was first perceived after archwire insertion. In the following questions, the patients were asked separately for each day, from 6 hours to day 7, whether they had pain, in which areas they perceived the pain, whether they took pain relief and whether the pain affected their daily living (Figure 1). The patients were allowed to take medication when they felt it necessary. The questions relating to daily living asked whether any of the activities carried out in their free time, such as sports and/or social activities, were affected. The questionnaire comprised 49 questions in total. The patients described the initial pain in the first question, they answered 24 questions as 'yes' or 'no', and in the other 24 questions the patients with 'yes' answers were provided with a visual analogue scale (VAS) divided into tens, in which 0 indicated no pain and 100 the greatest pain. This method is widely used for measuring pain and has been described by other investigators as being sensitive and reliable and having certain advantages over verbal scales (Huskisson, 1974; Seymour *et al.*, 1985).

Statistical analysis

For statistical analysis the Statistical Package for Social Sciences 10.0 (SPSS Inc., Chicago, IL, USA) was used. Gender was taken into consideration and chi-squared and Fisher's exact tests were applied. The Kolmogorov–Smirnov test of normality was used for the VAS scores. A Mann–Whitney *U*-test was applied because of non-normal distribution. For assessment of the relationship between VAS scores and consumption of pain relief, the Spearman rank correlation analysis was utilized.

The level of statistical significance was set at $P < 0.05$.

Results

Because gender differences were not found to be statistically significant in the perception of pain, the findings were evaluated without sex discrimination.

Initial pain (Table 1 and Figure 2)

Initiation of pain was perceived 2 hours after wire insertion in both groups. There were no statistically significant differences between the groups. In the 0.014 inch group,

QUESTIONNAIRE

When did you perceive the initial pain?	1st hour	2nd hour	3th hour	4th hour	5th hour	6th hour		
	6th hour	1st day	2nd day	3rd day	4th day	5thday	6th day	7thday
Have you got pain?								
Yes No								
VAS INDEX VALUE								
In which part(s) do you feel the pain?								
Anterior teeth								
VAS INDEX VALUE								
Posterior teeth								
VAS INDEX VALUE								
Have you consumed any pain relief?								
Yes								
No								
Has your daily life been affected?								
Yes								
No								

Figure 1 The questionnaire used in the present study.

Table 1 Distribution of initial pain versus wire size and time.

Time after insertion (hours)	0.014 inch wire		0.016 inch wire	
	%	*n*	%	*n*
1	7.1	4	3.7	2
2	32.1	18	35.7	20
3	16	9	7.1	4
4	10.7	6	22.6	12
5	3.5	2	–	–
6	19.6	11	16.9	9

%, percentage of total reporting pain; *n*, number of respondents.

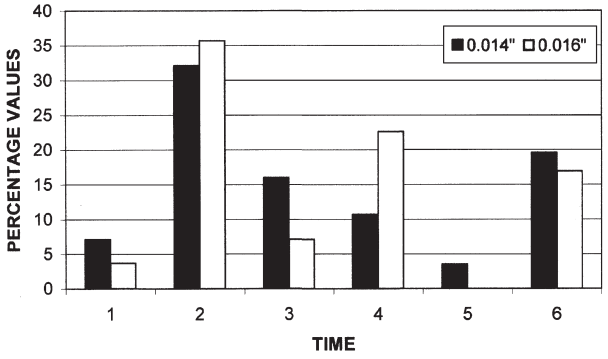

Figure 2 Time of initial pain perception.

32.1 per cent (18 patients) perceived pain. In the 0.016 inch group, 35.7 per cent (20 patients) perceived pain. No pain was reported by 10.7 per cent (six patients) in the 0.014 inch group and 11.4 per cent (six patients) in the 0.016 inch group.

Periods of pain (Table 2 and Figures 3 and 4)

Six hours after appliance insertion, pain was reported by 83.9 per cent (47 patients) in the 0.014 inch group and by 88.1 per cent (47 patients) in the 0.016 inch group. At the end of day 1, 91 per cent (51 patients) in the 0.014 inch group and 90.5 per cent (48 patients) in the 0.016 inch group perceived pain. From day 2 to day 7 there was a daily decrease in pain. On day 7, pain was reported by 41 per cent (23 patients) in the 0.014 inch group and by 26.4 per cent (14 patients) in the 0.016 inch group. These findings were not statistically significant. Some subjects reported the pain as being unbearably strong (score 100), but the mean score of 50 was relatively moderate. The peak for pain intensity was recorded on day 1 in both archwire groups and started to decline after day 3.

Pain regions (Tables 3 and 4 and Figure 5)

Although not statistically significant, in both archwire groups pain was perceived at the anterior and posterior teeth during the first few hours, but this decreased over the following hours. Again, while not statistically significant, the pain perceived at the anterior teeth was greater than at the posterior teeth.

Consumption of pain relief (Table 5)

The highest consumption of pain relief for both groups, although not statistically significant, was recorded at the end of the first 6 hours. On the following days, the consumption of pain relief decreased day by day. At the end of day 1 there was a statistically significant difference ($P < 0.05$) in the consumption of pain relief between the two groups. Fifty-five per cent (31 patients) in the 0.014 inch group and 32 per cent (17 patients) in the 0.016 inch group consumed pain relief. There was no consumption of pain relief in the 0.014 inch group on day 7 and in the 0.016 inch group on days 5, 6 and 7.

VAS scores and consumption of pain relief (Table 6)

There was a statistically significant correlation on days 1, 2, 3 and 4 ($P < 0.01$) and at 6 hours and on days 5 and

Table 2 Distribution of pain periods and mean visual analogue scale scores versus wire size and time.

Time after insertion	0.014 inch wire					0.016 inch wire				
	%	*n*	Mean pain intensity score	SD	Range	%	*n*	Mean pain intensity score	SD	Range
6 hours	83.9	47	38	26.9	0–100	88.1	47	45	30.1	0–100
1 day	91	51	49	28.3	0–100	90.5	48	48	28.1	0–100
2 days	87.5	49	39	21.8	0–100	86.7	46	40	20.9	0–100
3 days	82.1	46	31	20.3	0–60	71.6	38	29	15.1	0–60
4 days	66	37	28	12.5	0–50	50.9	27	23	13.1	0–55
5 days	60.7	34	23	10.2	0–50	45.2	24	20	11.8	0–55
6 days	48.2	27	18	8.6	0–45	35.8	19	11	2.6	0–40
7 days	41	23	13	6.3	0–45	26.4	14	9	5.3	0–45

%, percentage of total reporting pain; *n*, number of respondents answering 'yes'; SD, standard deviation.

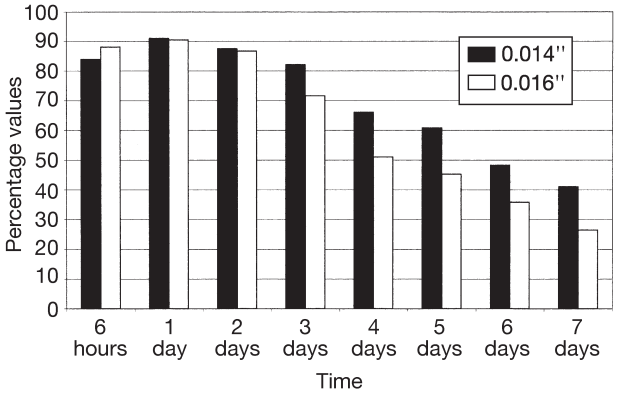

Figure 3 Percentage of patients perceiving pain within a reporting period.

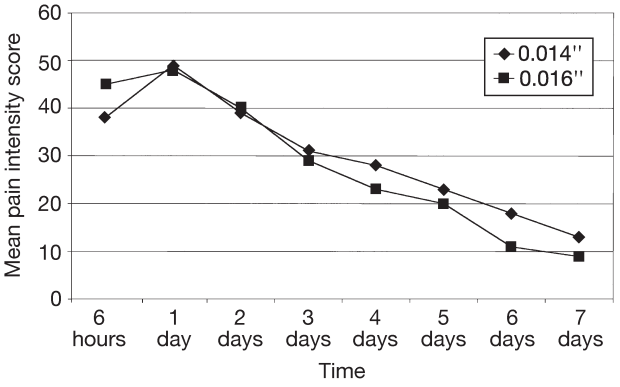

Figure 4 Mean pain intensity scores on the visual analogue scale index of pain periods.

6 ($P < 0.05$) between VAS scores and the consumption of pain relief in the 0.014 inch group. A statistically significant correlation ($P < 0.01$) was also observed in the 0.016 inch group at 6 hours and on days 1, 2, 3 and 4.

Effect of pain on daily life (Table 7)

Although not statistically significant, the most highly affected daily living activity (sports and/or social) was observed at 6 hours, with a rate of 57 per cent (33 patients) in the 0.014 inch group and 50.5 per cent (27 patients) in the 0.016 inch group. In the following days there was a decrease in the number of patients reporting such an effect.

Discussion

This study was performed on 109 patients, who were asked to complete a questionnaire concerning pain perceived

Table 3 Perception of pain at the anterior teeth and mean pain intensity scores versus wire size and time.

Time after insertion	0.014 inch wire				0.016 inch wire			
	%	*n*	Mean pain intensity score	SD	%	*n*	Mean pain intensity score	SD
6 hours	44.6	25	50	30.6	52	28	51	28.3
1 day	39.2	22	44	32.4	49	26	46	25.2
2 days	44.6	25	41	25.3	43	23	43	29.7
3 days	37.5	21	38	15	30	16	39	16
4 days	39.2	22	28	12.3	37	20	24	13.7
5 days	33.9	19	23	12.3	24	13	21	15.2
6 days	28.5	16	20	11	28	15	18	10.7
7 days	33.9	19	11	8.1	25	14	7	6.7

%, percentage of total reporting pain; *n*, number of respondents answering 'yes'; SD, standard deviation.

Table 4 Perception of pain at the posterior teeth and mean pain intensity scores versus wire size and time.

Time after insertion	0.014 inch wire				0.016 inch wire			
	%	*n*	Mean pain intensity score	SD	%	*n*	Mean pain intensity score	SD
6 hours	26.7	15	40	24.5	20	11	38	16.1
1 day	17.8	10	38	15.7	18	10	35	12.7
2 days	21.4	12	35	11.4	26	14	33	11.2
3 days	14.2	8	24	11.4	24	13	21	11.5
4 days	10.7	6	18	11.2	11	6	19	9.7
5 days	8.9	5	15	8.8	13	7	18	7.3
6 days	10.7	6	13	8.3	16	9	9	5.2
7 days	7.4	4	10	6	13	7	7	4.3

%, percentage of total reporting pain; *n*, number of respondents answering 'yes'; SD, standard deviation.

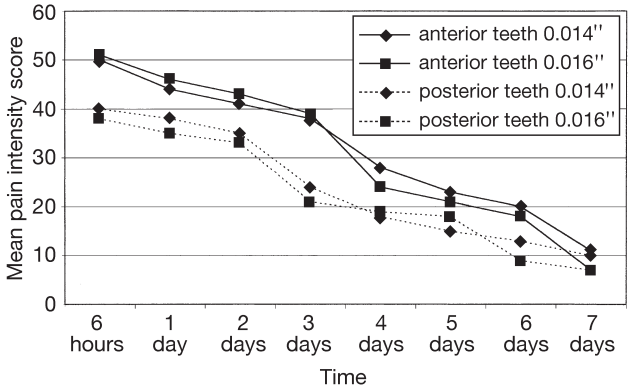

Figure 5 Mean pain intensity scores on the visual analogue scale index of perception of pain at the anterior and posterior teeth.

Table 5 Consumption of pain relief versus wire size and time.

Time after insertion	0.014 inch wire		0.016 inch wire	
	%	*n*	%	*n*
6 hours	58.9	33	49	26
1 day	55	31	32	17
2 days	33	19	16	9
3 days	19	11	7.5	4
4 days	10	6	9.4	5
5 days	3.5	2	–	–
6 days	5.3	3	–	–
7 days	–	–	–	–

%, percentage of total reporting consumption of pain relief;
n, number of respondents.

Table 6 Evaluation of the relationship between mean pain intensity scores and consumption of pain relief using Spearman rank correlation analysis.

Time after insertion	0.014 inch wire	0.016 inch wire
6 hours	0.551**	0.766**
1 day	0.709**	0.817**
2 days	0.612**	0.724**
3 days	0.698**	0.513**
4 days	0.632**	0.686**
5 days	0.370*	–
6 days	0.493**	–
7 days	–	–

*$P < 0.05$; **$P < 0.01$.

after insertion of fixed orthodontic appliances. The form was given to the patients at the first appointment after insertion of the archwires and returned at the next appointment. The system of measuring discomfort by VAS was found to be appropriate, with even young children able to understand the concept and respond to the questions.

Table 7 Effect of pain on daily life versus wire size and time.

Time after insertion	0.014 inch wire		0.016 inch wire	
	%	*n*	%	*n*
6 hours	57	33	50.5	27
1 day	48	27	47	25
2 days	44	25	37	20
3 days	35	20	45	24
4 days	30	17	37	20
5 days	25	14	26	14
6 days	32	18	24	13
7 days	28.5	16	30	16

%, percentage of total reporting an effect on daily life;
n, number of respondents.

Space analysis was not included in the assessment as no correlation has been found between pain and severity of crowding (Jones and Richmond, 1985).

Feinmann *et al.* (1987) reported that pain is related to gender and social class. In this study, no significant difference was found between pain and gender, which is in agreement with the findings of Jones and Chan (1992). Gender discrimination was therefore excluded and boys and girls were evaluated together.

Following ligation of the archwires, the patients started to feel uncomfortable and perceived pain. Clinically and statistically, it was expected that there would be a difference between the pain perceived by those in whom different sized wires were inserted. However, no statistically significant difference was found between the initial pain reported by the 0.014 and 0.016 inch groups. Jones (1984), in a study of pain perceived following insertion of initial archwires, reported that some patients had great discomfort for the first few days, with adults affected more than adolescents. In this study, although not statistically significant, pain peaked at 24 hours in both groups following archwire ligation. This finding is in agreement with Scheurer *et al.* (1996) and Wilson *et al.* (1989).

Again, while not statistically significant, pain started to decrease after day 3 and the mean pain intensity score was between 0 and 60, indicating that the pain perceived was moderate (Table 2).

As can be seen from Tables 3 and 4, although not statistically significant, the data show higher pain scores for the anterior than for the posterior teeth, in agreement with the results of other investigators (Ngan *et al.*, 1989; Scheurer *et al.*, 1996). This may be explained by the fact that during the levelling phase the anterior teeth are often more involved and incisors have smaller root surfaces than molars. In addition to this, biting while eating might be the reason for the higher pain perceived in the anterior teeth.

At 24 hours, the consumption of pain relief was higher in the 0.014 than in the 0.016 inch group; this was

statistically significant (Table 5). However, no statistically significant difference was observed as regards perception of pain between the 0.014 and 0.016 inch groups. Self-medication was statistically significantly higher in the 0.014 inch group compared with the 0.016 inch group. A possible explanation is that the patients in the 0.014 inch group consumed more pain relief on a preventive basis with the anxiety of probable pain.

In contrast to Feinmann *et al.* (1987), who found no correlation between pain experience and analgesic consumption, a correlation between pain intensity scores and the consumption of pain relief was observed in the present study, which is in agreement with the findings of Scheurer *et al.* (1996). The results are also in agreement with Jones (1984), who reported a correlation between perceived discomfort and analgesic consumption. Scheurer *et al.* (1996) claimed that perceived pain and the consumption of pain relief would decrease if the patient was efficiently informed about the discomfort that would be experienced.

Brown and Moerenhout (1991) reported that pain from appliances and its influence on daily life are seen as major causes of discontinuance of treatment. In the present study, although not statistically significant, it was observed that the daily lives of 50 per cent of the patients were influenced by the orthodontic wire at 6 hours and on days 1 and 2. However, there was a significant decrease in the number of patients whose daily lives were affected starting from day 3 until day 7 (Table 7).

Sergl *et al.* (1998) reported that patients who are aware of the severity of their orthodontic irregularities and can control their emotions perceive a less intense feeling of discomfort. Before commencing orthodontic treatment, patients should be motivated by informing them of the nature and extent of the malocclusion. Because psychological factors during orthodontic treatment influence patient adaptation to discomfort and pain (Brown and Moerenhout, 1991; Jones and Chan, 1992), the possibility of physiological adaptation by patient distraction techniques is also feasible.

Conclusions

No gender discrimination was found for perception of pain in the two different archwire groups. No significant correlation was found for the time at which initial pain was perceived after insertion of the two initial archwires of different sizes. In both groups, initial pain was perceived at 2 hours. Although not statistically significant, pain reached a peak in both groups on day 1, started to decrease on day 3 and was perceived as being greater at the anterior than the posterior teeth. The consumption of pain relief was highest at 6 hours after archwire insertion and gradually decreased on the following days. The consumption of pain relief was greater in the 0.014 than the 0.016 inch group on day 1, which was statistically significant.

The results of this study show that pain was perceived after insertion of the two wires of different sizes used for initial alignment. Either of these can therefore be chosen as the initial archwire depending on the mechanics used by the orthodontist.

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