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Patients' anticipation of pain and pain-related side effects, and their perception of pain as a result of orthodontic treatment with fixed appliances

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SUMMARY The aim of this study was to investigate the relationship between (i) the pain and its side effects, anticipated by patients before orthodontic therapy, and (ii) the reported pain and its effects after the placement of initial archwires. Before treatment, 50 adolescent patients (median age 13.6 years, range 8.9–39.3 years, 28 female, 22 male) completed a questionnaire concerning their facial and dental appearance, and their expectations regarding pain, its influence on their daily lives, and changes in their facial and dental appearance as a result of orthodontic treatment. In the week following insertion of the initial archwires the patients completed a series of eight questionnaires, where they reported the level of pain experienced and its influence on their daily lives. In the week after archwire insertion, the maximum pain levels reported did not differ statistically from the anticipated pain levels. Patients significantly under-estimated the changes they would have to make in their diet as a response to pain after archwire insertion. Patients who anticipated a greater effect of pain on their leisure activities and those who had a history of frequent headaches reported higher levels of pain and more disruption of their daily lives as a result of pain. This pattern of response is consistent with a medical model where anxious patients and those with a history of chronic pain reported more pain after surgery.

Introduction

Orthodontic therapy causes significant pain for a large percentage of patients. The prevalence, magnitude, and time course of pain, after insertion of the initial levelling archwire, has previously been reported by several groups of investigators (Jones, 1984; Jones and Richmond, 1985; Sinclair *et al.*, 1986; Feinmann *et al.*, 1987; Kvam *et al.*, 1987, 1989; Ngan *et al.*, 1989; Wilson *et al.*, 1989; Jones and Chan, 1992; Scheurer *et al.*, 1996). Within 4 hours of the insertion of the first archwires, the majority of patients report experiencing some pain. After 24 hours, pain is reported by up to 95 per cent of patients undergoing therapy with fixed appliances (Jones, 1984; Kvam *et al.*, 1987; Scheurer *et al.*, 1996). The levels of pain reported vary, but in one study using a standardized pain questionnaire (the McGill pain questionnaire), mean pain response by adolescents after insertion of archwires was the same as that reported in another study for adult patients seeking treatment for dental pain (Melzack, 1975; Brown and Moerenhout, 1991). The pain within the first 48 hours is so disturbing that approximately 20 per cent of patients report being awakened at night and it causes some patients to take medication (Kvam *et al.*, 1989; Jones and Chan, 1992; Scheurer *et al.*, 1996). Almost all patients reported difficulty with eating as a result of pain (Sinclair *et al.*, 1986; Scheurer *et al.*, 1996). They also reported moderate to extreme difficulty in chewing and biting foods of a firm or hard consistency which caused them to change the consistency of the foods in their diets (Sinclair *et al.*, 1986; Scheurer *et al.*, 1996).

The variations in individual responses to the insertion of orthodontic archwires have led several groups of investigators to look for factors

which could be helpful in predicting which patients will experience the most pain. Investigations into the case attributes, such as initial crowding, and treatment modalities, i.e. type of levelling archwire, have not revealed any significant factors associated with the pain responses of patients undergoing orthodontic therapy (Jones and Richmond, 1985; Jones and Chan, 1992). Some investigators have also examined personal, psychological factors, which would help predict the patient's experience of pain during therapy with fixed appliances (Kidner *et al.*, 1986; Sinclair *et al.*, 1986; Brown and Moerenhout, 1991). Studies of experimental and clinical pain after surgery have presented evidence that anxiety and the context within which tissue trauma occurs has a clinically significant effect on whether or not pain is experienced, the intensity of the pain when it is experienced and the use of narcotics for pain control (Malmo and Shagass, 1949; Beecher, 1956).

The purpose of the present study was, first, to record patients' expectations of pain as a result of orthodontic therapy, secondly, to record the effects they anticipated this pain would have on their lives, and then to compare these expectations with the patients' subsequent reports, after insertion of initial archwires, of pain, and the influence of pain on their daily lives. Further aims were to compare the patients' reports of pain with their pre-treatment evaluation of the appearance of their face, the position of their teeth, the necessity for treatment, and their expectations about the appearance of their face and position of their teeth after treatment. The specific hypotheses were that there were negative correlations (i) between the patients' perception of the adequacy of their dental appearance, or the necessity of treatment and their reports of pain, and (ii) a positive correlation between the anticipated level of pain and the patients' reports of pain.

Subjects and methods

The subjects were all patients whose treatment plan included therapy with fixed appliances at the Department of Orthodontics, University of Bern. The patients were being treated by graduate students in the Department and they were selected from subjects of ongoing research on pain as a side effect of therapy with fixed appliances. Because there was a variable delay between the pre-treatment questionnaire and the initiation of treatment, the first 50 subjects in the larger investigation who had completed a pre-treatment questionnaire and returned a series of eight questionnaires after insertion of initial archwires were included in the present investigation. There were 28 females and 22 males in the patient sample. The median age was 13.6 years, range 8.9–39.3 years; the mean age was 15.5 years (± 5.98).

All patients in the study had initially been seen at a screening examination and been informed that fixed appliances would probably be necessary. The pre-treatment questionnaire was administered before the actual treatment plan was presented to the patient and before any treatment was initiated. The subjects were given oral and written instructions on how to fill out the questionnaire, which consisted of 12 questions. The patient was requested to respond to each question by placing a mark along a 10-cm long visual analogue scale (VAS) (Huskisson, 1974). The questions and their endpoints (translated from German) on the VAS were as follows:

1. The appearance of my face now is: horrible/perfect.
2. The appearance of the position of my teeth now is: horrible/perfect.
3. How necessary is a correction of the position of my teeth for my appearance: absolutely necessary/unnecessary.
4. What do I expect from the treatment: no improvement/complete improvement.
5. The appearance of my face after treatment will be: worse/perfect.
6. The appearance of the position of my teeth after treatment will be: worse/perfect.
7. What will the pain be like during treatment: unbearable/unnoticeable.
8. How much will the pain during treatment influence my daily life: completely change/no effect.
9. How much will I have to change my diet because of the pain (e.g. avoid hard foods,

only eat soft foods such as soup, eggs, yoghurt): completely change/no change at all.
10. How strongly will the pain influence my leisure activities (e.g. less sport, less musical instrument, etc.): completely change/no change at all.
11. How strongly will pain influence my social life (e.g. stay at home more, not see my friends as often): completely change/no effect.
12. How often do you have headaches: always/never.

Questions 1–3 were included to elicit the patient's judgement about his/her dental and facial appearance, and the subjective need for treatment and questions 4–6 to determine the patient's expectations about his/her facial appearance as a result of treatment. Questions 7–11 were included to elicit the patient's opinion or expectations concerning the pain anticipated as a result of orthodontic treatment and the effect this might have on daily activities. Results from a previous investigation led us to expect that the patients would experience only minimal disturbance of their daily activities (except for pain-related changes in their diet) as a result of pain from orthodontic therapy (Scheurer *et al.*, 1996). These questions were included as another measure concerning their anxiety over the forthcoming treatment. Chronic pain has been associated with increased response to pain following surgery (Taenzer *et al.*, 1986). Question 12 was therefore included since headache, in the experience of the authors, is the most common chronic pain experienced by Swiss children.

At the appointment where the operator inserted the initial archwires, almost exclusively 0.016-inch 'super-elastic' archwires (Rematitan Lite®, Dentaurum, Pforzheim, Germany), the subject also received a series of eight questionnaires. The subject was instructed how to fill out the questionnaires and requested to return them individually in prepaid envelopes addressed to the Department. A letter containing the instructions also accompanied the questionnaires. A questionnaire was to be filled out 4 hours after the appointment and then at 24-hour intervals after the archwire appointment for the next 7 days. Each questionnaire contained three questions that required a yes/no response: the presence of pain in the immediately preceding period, being awakened by pain, and the use of pain medication. All the other questions concerning pain intensity, location, and two questions concerning the effect of pain on daily life and on changes in diet required responses on a VAS.

For the analysis, means and standard deviations were calculated. The mean and maximum values for the pain response were calculated for each subject for all that subject's pain responses over the 7-day test period. Responses were analysed with the Wilcoxon matched-pairs signed-ranks test, Spearman's correlation coefficient and stepwise regression analysis (SAS Institute Inc., Cary, NC). Statistical significance was set at $P < 0.05$. The inclusion of predictor variables was based on the level of the univariate correlation coefficient. All variables whose two-tailed univariate probability level reached 0.05 were included in the analysis.

Results

The mean and median responses to the pre-treatment questionnaire for all subjects, and for female and male subjects are presented in Table 1. There were no differences between females and males in their evaluation of their facial and dental appearance, and in their expectations concerning the effects of treatment on their appearance, pain as a result of treatment, and the influence of pain on their daily life, with one exception. Males anticipated a significantly smaller influence of pain on their leisure activities (sports, playing a musical instrument, etc.) than females.

The mean, maximum, and median response for pain, and for the influence of pain on daily life and on changes in diet for the 7 days following insertion of the initial archwires are listed in Table 2. The influence of pain on diet was marked. There were no significant differences in the responses between females and males.

Subjects anticipated a significant improvement in the position of their teeth and for the

Table 1 Mean (standard deviation, SD) and median response and interval 75th to 25th percentile (Q3–Q1) to pre-treatment questionnaire.

	All (n = 50)				Females (n = 28)				Males (n = 22)			
	Mean	SD	Median	Q3–Q1	Mean	SD	Median	Q3–Q1	Mean	SD	Median	Q3–Q1
Perceptions												
Face now	61.6	19.3	60	28	63.1	19.2	61	28	59.6	19.7	60	27
Occlusion now	30.5	23.1	30	34	26.9	20.7	23	38	35.0	25.7	33	32
Treatment necessity	22.8	23.7	15	31	21.1	27.5	12.5	23.5	24.9	18.2	25	34
Expectations												
Treatment results	83.8	18.3	88.5	28	84.4	20.3	95.5	25	83.0	15.8	87.5	26
Face after treatment	77.3	15.6	78	23	75.9	15.5	77.5	22	79.1	15.9	80.5	24
Teeth after treatment	85.2	15.4	88	15	87.3	10.5	91	15	82.6	19.9	84.5	14
Pain expected	49.4	23.2	51	38	50.6	24.3	63	41	47.9	22.2	50.5	28
Daily life	31.5	22.8	29	40	33.7	24.4	28	43.5	28.7	20.7	31.5	40
Diet changes	36.8	25.9	34	31	41.1	25.3	43.5	36.5	31.3	26.1	31.5	44
Leisure activities	16.4	19.8	10	25	21.6	21.8	14.5	32.5	9.8	15.0	2	12
Social activities	13.1	16.3	4.5	25	15.8	16.8	14.5	25	9.6	15.4	1.5	7
Headache frequency	27.7	26.1	20	39	29.4	26.7	21	44	25.7	25.8	18	37

Table 2 Mean (standard deviation, SD) and median response and interval 75th to 25th percentile (Q3–Q1) to questions concerning pain, the influence of pain on daily life and the influence of pain on diet following insertion of initial archwires (n = 50).

Response	Pain				Daily life				Diet			
	Mean	SD	Median	Q3–Q1	Mean	SD	Median	Q3–Q1	Mean	SD	Median	Q3–Q1
Mean	27.5	19.2	26.6	23.5	21.5	22.1	15.0	36.3	48.3	26.4	48.2	40.9
Maximum	49.1	27.2	50.0	42	34.4	30.3	26.5	50	69.5	27.4	75.5	37

appearance of their face after treatment, than they noted for their teeth and face before treatment (Table 3). Before treatment they judged their facial appearance to be significantly better than their dental appearance. After treatment, they anticipated that the appearance of their teeth would be better than their facial appearance. The anticipated levels of pain and the anticipated influence of pain on daily life did not differ significantly from the maximum values reported after archwire insertion. The anticipated values were significantly higher than the mean values they reported in the week following insertion of the initial archwires. The reported mean and maximum values for the influence of pain on their diets was significantly higher than the anticipated value.

There was statistically significant positive correlation between responses for pain, influence of pain on daily life and on diet, and the responses to the pre-treatment questionnaire (Table 4). Except for a positive correlation with frequency of headache, there were no significant correlations between the pre-treatment values and the reported influence of pain on diet after archwire insertion (Table 4). Reports of influence of pain on daily life after insertion of archwires were positively correlated with the patients' evaluation

Table 3 Analysis of responses to pre-treatment questionnaire and responses after insertion of first archwires. Wilcoxon matched-pairs signed-ranks test.

	Mean difference	SD	Significance
Facial appearance			
After treatment – before	15.8	17.7	0.0001
Dental appearance			
After treatment – before	54.7	33.6	0.0001
Before treatment			
Facial appearance – dental appearance	31.1	23.6	0.0001
After treatment			
Facial appearance – dental appearance	–7.9	22.3	0.0004
Maximum values			
Reported pain – anticipated pain	–0.38	29.7	NS
Maximum values			
Reported daily life – anticipated daily life	2.9	26.2	NS
Maximum values			
Reported change diet – anticipated change diet	32.7	32.4	0.0001
Mean values			
Reported pain – anticipated pain	–22.0	23.1	0.0001
Mean values			
Reported daily life – anticipated daily life	–10.0	21.6	0.001
Mean values			
Reported change diet – anticipated change diet	11.5	34.8	0.048

Table 4 Correlation of pre-treatment questionnaire responses and subject responses (mean and maximum) for pain, influence of pain on daily life and change in diet as a result of pain. Spearman correlation coefficient and *P* value.

Question	Mean reported values			Maximum reported values		
	Pain	Daily life	Diet	Pain	Daily life	Diet
1. Face now	NS	NS	NS	NS	NS	NS
2. Teeth now	NS	NS	NS	NS	0.28 0.048	NS
3. Treatment necessity	NS	NS	NS	NS	NS	NS
4. Improvement	NS	–0.33 0.017	NS	NS	–0.33 0.023	NS
5. Face after	NS	NS	NS	NS	NS	NS
6. Teeth after	NS	NS	NS	NS	–0.29 0.046	NS
7. Pain	0.42 0.003	0.36 0.011	NS	0.34 0.016	0.36 0.011	NS
8. Daily life	0.41 0.004	0.54 0.000	NS	0.40 0.005	0.54 0.000	NS
9. Diet	NS	NS	NS	NS	NS	NS
10. Leisure activities	0.45 0.001	0.40 0.004	NS	0.33 0.023	0.35 0.013	NS
11. Social life	0.36 0.011	0.48 0.001	NS	0.31 0.029	0.46 0.001	NS
12. Headache	NS	0.41 0.004	NS	0.31 0.033	0.39 0.006	0.35 0.015

Table 5 Stepwise regression of maximum values for pain and the influence of pain on daily life after the insertion of initial archwires and values from the pre-treatment questionnaire.

Pre-treatment variables	Partial R^2	Model R^2	Probability
Reported influence of pain on daily life (maximum)			
Influence of pain on daily life	0.27	0.27	0.0001
Headache frequency	0.11	0.39	0.006
Reported pain (maximum)			
Influence of pain on daily life	0.16	0.16	0.0038
Headache frequency	0.11	0.28	0.0106

of the appearance of their teeth before treatment, and negatively correlated with the improvement they anticipated after treatment and the anticipated appearance of their teeth after treatment (Table 4). Reports of pain after archwire insertion were positively correlated with responses to questions 7–12 on the pre-treatment questionnaire.

A correlation of the responses to the questions on the pre-treatment questionnaire with one another revealed that the responses to questions 7–11 were positively correlated with one another (data not shown). Stepwise multiple regression with the mean and maximum responses for pain as the dependent variable, and the responses to questions 7–12 on the pre-treatment questionnaire as the independent variables yielded successful models. In the case of the mean pain responses, the predictor variables were: frequency of headache (partial $R^2 = 0.23$, $P < 0.0004$), anticipated influence of pain on daily life (partial $R^2 = 0.16$, $P < 0.0012$), and anticipated pain during treatment (partial $R^2 = 0.03$, $P < 0.1441$). In the case of the maximum pain response, the predictor variables were (Table 5): anticipated influence of pain on daily life (partial $R^2 = 0.16$, $P < 0.0038$), frequency of headache (partial $R^2 = 0.11$, $P < 0.0106$). Models with all significant pre-treatment variables were developed with reports of influence of pain on daily life as the dependent variable; the independent values for both mean and maximum (Table 5) values were anticipated effect of pain on daily life and frequency of headaches.

Discussion

Standardized psychometric measures of pain and anxiety were not used in the present study (Eysenck and Eysenck, 1975; Melzack, 1975; Spielberger *et al.*, 1977). Although such standardized measures have the advantage of being widely used in the analysis of psychological factors and of allowing a comparison across investigations, they also have certain disadvantages. Some more complicated pain measures, it has been suggested, may encourage children to fill out the questionnaire in concert with a parent, but this would tend to invalidate the results (Brown and Moerenhout, 1991). The instrument for recording pain in the present study, the VAS, is admittedly undifferentiated in comparison with the McGill pain questionnaire, but it is a valid and reliable instrument, which can be quickly filled out by subjects. Furthermore, it is easily understood even by young children who can respond without adult help (Huskisson, 1974; Melzack, 1975; Seymour *et al.*, 1985a).

One of the aims of this study was to investigate patients' expectations concerning pain and the pain-related side effects accompanying orthodontic therapy, as well as an evaluation of their appearance and their expectations about the results of therapy. It is informative to note that subjects clearly distinguished between their dental and facial appearance, and not surprisingly for patients in an orthodontic clinic, rated their dental appearance significantly lower than their general facial appearance (Table 3).

The subjects expected significant improvement in their dental appearance and for this to have a modest, but significantly positive effect on their general facial appearance (Table 3). The subjects expected that, after treatment, their dental appearance would more closely approach perfection than their facial appearance. These expectations are informative about patients' confidence in the skill of the orthodontist. Patient expectations concerning improvement in facial/dental appearance as the primary reason for seeking orthodontic therapy has been noted by other investigators (Tulloch *et al.*, 1984; Breece and Nieberg, 1986).

There was no correlation between the responses regarding facial and dental appearance on the pre-treatment questionnaire, and pain values after archwire insertion (Table 4). During war, soldiers in a hospital viewed their injuries as a relief from the intense anxiety of the battlefield and as a reason for being returned home, and they reported less pain and required less analgesics than civilians after similar surgery (Beecher, 1956). In general, the significance of the surgical wound has an effect on patients' reports of post-surgical pain and analgesic use (Beecher, 1956; Chapman and Cox, 1977). However, in the present study, the subjects did not experience less pain because they perceived their dental appearance as poor or because they perceived the treatment which caused the pain as necessary. It is suggested that the range of malocclusions represented in the present study was not large enough to have a significant effect on the subjects' perceptions after archwire insertion. The malocclusions of the majority of patients treated in this clinic are moderate, the mean pre-treatment Peer Assessment Rating score is approximately 25 (Firestone *et al.*, 1999). In the present study, the subjects' responses about their facial appearance indicated general satisfaction, even while they were dissatisfied with their dental appearance. Indeed, the range of malocclusions in the average practice may generally be too narrow for the differentiation of pain responses reported after surgery (Beecher, 1956; Chapman and Cox, 1977). In support of this, one set of investigators found that there was no relationship between the severity of a prospective orthodontic patient's malocclusion and their body image and self-concept (Klima *et al.*, 1979).

There was a positive correlation between anticipated pain and its consequences, and reported pain. There were no statistical differences between the scores for anticipated pain and anticipated disturbance in daily life, and the maximum scores for pain and disturbance in daily life. At first glance, it appears that subjects had reasonably accurate knowledge about the pain that they would experience and the effect this would have on their personal lives. The one exception was the major, unexpected change in diet as a result of pain following the insertion of the first archwires. Therefore, in the opinion of the authors, it is unlikely that subjects could accurately anticipate the discomfort they would experience due to their knowledge of the side effects of orthodontic therapy. In support of this, it is evident that subjects were clearly uninformed of the effect of pain on diet, a consistent and major side effect of orthodontic therapy (Sinclair *et al.*, 1986; Scheurer *et al.*, 1996). The question then remains as to why there was a correlation between the anticipated levels of pain and their side effects, on the one hand, and the reported pain plus its side effects, on the other.

There is evidence that post-operative pain after oral surgery is not directly related to the operator or to the extent of surgical trauma (Seymour *et al.*, 1985b). Research on pain following surgery, including oral surgery, has fairly consistently shown that among others, psychological factors, such as neuroticism, anxiety, and fear modify post-surgical pain, mood, and analgesic requirements (Parbrook *et al.*, 1973; Chapman and Cox, 1977; Taenzer *et al.*, 1986; Feinmann *et al.*, 1987). Investigators have linked pain perception following surgery with the patient's typical emotional reactivity, as well as with the patient's pre-operative emotional state (Taenzer *et al.*, 1986). Emotional traits such as extroversion, anxiety, and depression were components of models, which could predict approximately half of the variability in post-operative outcome measures including pain (Taenzer *et al.*, 1986). Pre-operative anxiety has been correlated with post-operative VAS pain

scores (Chapman and Cox, 1977; Lim *et al.*, 1983; Feinmann *et al.*, 1987).

Several investigations of predictors of pain have indicated that anxiety before surgery is positively correlated with reports of pain after surgery (Martinez-Urrutia, 1975; Chapman and Cox, 1977; Lim *et al.*, 1983; Scott *et al.*, 1983; Taenzer *et al.*, 1986; Feinmann *et al.*, 1987). In these investigations, which employed standardized measures of psychological characteristics, there is a lack of unanimity about the relative importance of situational reactions to stress, which are specific to a particular set of circumstances or 'states', i.e. state anxiety and more generalized predispositions to react strongly to stressful situations or 'traits', i.e. trait anxiety (Wolfer and Davis, 1970; Bruegel, 1971; Martinez-Urrutia, 1975; Chapman and Cox, 1977; Lim *et al.*, 1983; Scott *et al.*, 1983; Taenzer *et al.*, 1986; Feinmann *et al.*, 1987). It has been shown that when anxiety is monitored on a VAS labelled 'no anxiety' to 'extreme anxiety', the responses pre-operatively positively correlate with post-operative pain, and mirror the responses to more detailed measures of anxiety and depression (Feinmann *et al.*, 1987). We therefore employed several common descriptors of anticipated influence of pain on daily life as indicators of anxiety. The correlation of the responses to questions 7–11 on the pre-treatment questionnaire indicates an underlying factor influencing all responses about anticipated pain and its side effects. Thus, in the present investigation, we interpret responses of how much pain and other side effects are anticipated as a result of orthodontic therapy as reflecting a general measure of anxiety. VAS pain scores after insertion of archwires in the present study are equivalent to the post-surgical pain scores recorded in other studies. It is hypothesized that in the present study, correlation between maximum reported pain and anticipated pain, and the anticipated influence of pain on daily life, leisure and social activities is the correlation between pre-treatment anxiety concerning the orthodontic treatment and the 'post-operative' pain after insertion of the archwire.

It is further hypothesized that the inclusion of frequency of headache in the models for prediction of pain and for prediction of the influence of pain on daily life is an indication that frequent headaches presensitize a patient to pain. Frequent headaches we consider to be a form of chronic pain and chronic pain has been linked to increased pain responses after surgery (Taenzer *et al.*, 1986). An alternative interpretation is that there may be some other, unknown variable, which connects headache frequency and pain response after treatment.

The clinical implications of the results of the present investigation would seem to be for the dentist to undertake measures to reduce the patient's anxiety. Some investigators have reported success in using mental processes pre-surgically to influence post-surgical experiences (Roe, 1963; Kendall *et al.*, 1979; Croog *et al.*, 1994). However, the extent of success reported is often modest. In one study, there were no differences in post-operative anxiety and only anxiety during cardiac catheterization was significantly reduced compared with the placebo control group (Kendall *et al.*, 1979). In another study, only after the second episode of periodontal surgery did the techniques significantly reduce pain, although other pre-operative counselling procedures have reported 90 per cent reductions in post-operative narcotic use after general surgery (Roe, 1963). Thus, at the present time, although careful explanation of the procedures to be employed and of the time course of the pain after archwire insertion and of its significant effect on diet are indicated, it may be expedient to remind patients and their parents that exercise and analgesics are effective in reducing pain (White, 1984; Hwang *et al.*, 1994; Ngan *et al.*, 1994).

Conclusions

In summary, there were no effects on pain reported after archwire insertion associated with the subjects' evaluation of their own dental and facial appearance, or of their evaluation of the necessity of treatment to improve their appearance. Subjects' expectations concerning pain levels and the effects of pain on their daily lives did not differ from the maximum values they reported during the week following insertion of initial archwires. Subjects significantly under-estimated the

changes they would need to make in their diet as a response to pain after insertion of initial archwires. These results are consistent with a model including anxiety as a major factor determining whether patients experience post-operative pain and the level of pain that they experience.

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