

CONTINUING EDUCATION ARTICLE

Pain and discomfort during orthodontic treatment: Causative factors and effects on compliance

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Orthodontic patients experience pain and discomfort to a varying degree during the course of treatment. The aims of the present investigation were to follow the progress of adaptation after insertion of new appliances and to study the relationships between the type of appliance worn and pain or discomfort experienced, between pain sensations and attitude toward the treatment and their effects on patients' compliance. Pain and discomfort experienced by 84 patients undergoing orthodontic treatment, their attitude toward the treatment, and compliance were assessed 7 days, 14 days, 6 weeks, 3 months, and 6 months after appliance insertion, using specially designed protocols, questionnaires, and rating scales. Evaluation of the results showed that an adaptation to pain and discomfort occurred during the first 3 to 5 days after placement of the appliance. The severity of pain and discomfort experienced by the patients wearing functional or fixed appliances was significantly higher than by those treated with upper and/or lower removable plates. Patients who had higher personal perception of the severity of their malocclusion and displayed attitudes characteristic for internal control orientation according to the so-called locus of control theory, seemed to adapt faster and have less pain. The results of this study also indicate that acceptance of orthodontic appliances and treatment in general may be predicted by the amount of initial pain and discomfort experienced. (*Am J Orthod Dentofacial Orthop* 1998;114:684-91)

Patients may experience a considerable amount of discomfort from orthodontic treatment, such as feelings of tension, pressure, soreness of teeth, and even pain.¹ For instance, only 15% of the patients wearing intraoral elastics and headgear among those interviewed by Egolf et al² agreed that "braces aren't painful." Oliver and Knappman³ reported that 70% of the subjects in their study had at least some degree of pain, regardless of the type of appliance worn.

Clinical experience and recent research data indicate that patients may adapt to continuous pain and discomfort with the progression of treatment as the sensations cease or at least disappear from their focus of attention.^{4,5} At present, it is not precisely known how much time is needed for such adaptation to occur as only one study so far has dealt with repeated measurements of pain intensity and its gradual decline over the period of

14 days.⁶ The first aim of the present investigation was to study the course of adaptation to orthodontic appliances particularly with regard to intensity of pain and discomfort experienced during short (7 days) and long (14 days to 6 months) periods of appliance wear.

Another issue of potential importance for successful adaptation is the type of orthodontic appliance worn by the patient. The only report³ that considered effects of different appliances indicates that both fixed and removable appliances may cause an equal amount of discomfort. The second aim of our study was to determine the influence of different types of orthodontic appliances on pain sensations associated with appliance wear.

Individual psychological susceptibility is likely to be a significant factor for the intensity of discomfort caused by physical effects of an appliance on oral tissues. Pain experience, for instance, does not seem to be directly related to the magnitude of force exerted by different arch wires⁵ and depends rather on psychological well-being of the individual concerned.⁶ Psychological research has shown that experience of pain and discomfort is influenced by personal values and expectations such as expectations of self-efficacy and treatment outcome.^{7,8} Of relevance to orthodontics are patients' attitudes toward dental esthetics, perceived severity of malocclusion, and expectations from treat-

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ment in the sense of an anticipated orthodontic self-efficacy.^{9,10} Patients' behavior during orthodontic treatment seems to be related to perceived severity of malocclusion¹¹⁻¹³ and to personal control orientation (locus of control theory).¹⁴⁻¹⁶ A further aim of the present study was to elucidate a potential relationship between patient attitude toward treatment and the amount of discomfort perceived, in order to evaluate the role of attitude toward treatment as a predicting factor for the intensity of complaints that may occur during orthodontic treatment.

Discomfort caused by orthodontic appliances may significantly affect patients' compliance with treatment. Pain, functional, and esthetic impairment, and associated complaints are the primary reasons for poor cooperation,^{2,16} for patients' desire to discontinue treatment,³ and for early termination of the latter by the patient.¹⁷ An additional purpose of the present work was to assess the effects of pain and discomfort on treatment compliance.

SUBJECTS AND METHODS

Subjects

Eighty-four patients (39 males, 45 females; mean age, 12.8 ± 4.1 years) undergoing orthodontic treatment participated in the study. Among these patients, 25 were provided with one removable plate, 31 with two removable plates simultaneously for both jaws, 14 received functional appliances, and the other 14 received full bonded fixed appliances. Twenty-seven of the overall 84 subjects received their very first appliance in the course of treatment; the remaining 57 patients had their second or further appliance.

Patients' attitude toward treatment was evaluated at the appointment before insertion of a new appliance by means of a questionnaire that contained rating scales regarding perceived severity of malocclusion, treatment expectations, dental esthetics, dental locus of control, and acceptance of treatment as detailed below. After the appliance insertion, the patients were instructed to keep a daily protocol of pain and discomfort for 7 days, as described below. The protocols were collected 14 days after the insertion. In addition, 14 days, 3 months, and 6 months after the insertion date, patients answered questionnaires dealing with appliance acceptance and retrospective assessment of discomfort felt since the last visit. At the 6-month appointment, patients' cooperation during the entire study period was rated by their clinicians.

Rating Scales

The rating scale for perceived severity of malocclusion was a combination of the Fox et al⁹ "Concern for Occlusion Scale" and the Clemmer and Hayes¹⁰ "Per-

ceived Severity Scale." Example items of the scale are: "I am concerned about the way my teeth fit together," and "My teeth need very much to be straightened." Cronbach's alpha-value of 0.8 was calculated for this scale. This value indicates internal consistency, and above 0.7 for individual or 0.5 for group tests confirms validity of a particular test.

Treatment expectations were evaluated using the seven item scale described by Fox et al.⁹ Example entries in this scale are: "Wearing braces on your teeth is no worse than wearing glasses," "Braces probably wouldn't bother me." The calculated Cronbach's alpha-value was 0.88. Perception of dental esthetics was assessed using a modification of the previously described scale¹⁰ (Cronbach's alpha 0.56). Examples: "An attractive smile is important," "When looking at a person's face, I usually notice the teeth first." Dental locus of control was examined by means of the modified "Health Locus of Control Scale"¹¹ (Cronbach's alpha 0.72). For instance: "If I take care of myself I can avoid caries," "People's bad teeth result from their own carelessness."

Acceptance of appliance was rated with the modified "Headgear Scale and General Attitude Scale" described by Clemmer and Hayes¹⁰ (Cronbach's alpha 0.72). Example entries: "I am glad I have started my orthodontic treatment," "I dislike my braces." "General Attitude Scale"¹⁰ was also used for assessment of treatment acceptance (Cronbach's alpha 0.74). For instance: "I am glad I have started my orthodontic treatment."

Patients' cooperation was evaluated by the clinicians with the "Orthodontic Patient Cooperation Scale"¹⁸ with the omission of one item related to parents' compliance (Cronbach's Alpha 0.72). Examples are: "This patient acts withdrawn—shows no interest in treatment," "This patient has poor oral hygiene."

The daily protocol of pain and discomfort contained four entries dealing with effects of appliance on oral tissues including tension, pressure, sensitive teeth, and pain. Entries were answered in the evenings of each of the 7 days on a four point scale: "not at all," "a little," "much," or "very much," to which points 1, 2, 3, and 4, respectively, were ascribed. The same items were included in the questionnaires used for retrospective assessment of discomfort.

The data collected from the protocols of pain and discomfort and those from the rating scales were used to meet the aims of this study as follows. Adaptation to orthodontic appliances was assessed with the scale values obtained from the protocols of pain and discomfort. The influence of different types of appliances on pain sensations was estimated by comparing pain and discomfort reported in the protocols of patients wearing

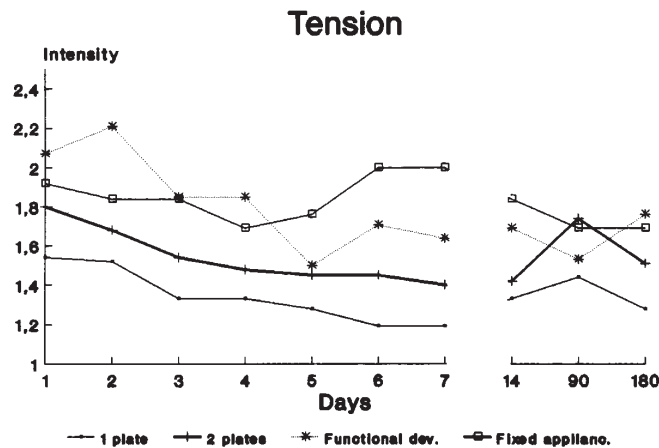


Fig 1. Intensity of tension reported for individual appliance types in self-monitoring daily protocols for the first 7 days and in retrospective assessments carried out 14, 90, and 180 days after insertion of appliances.

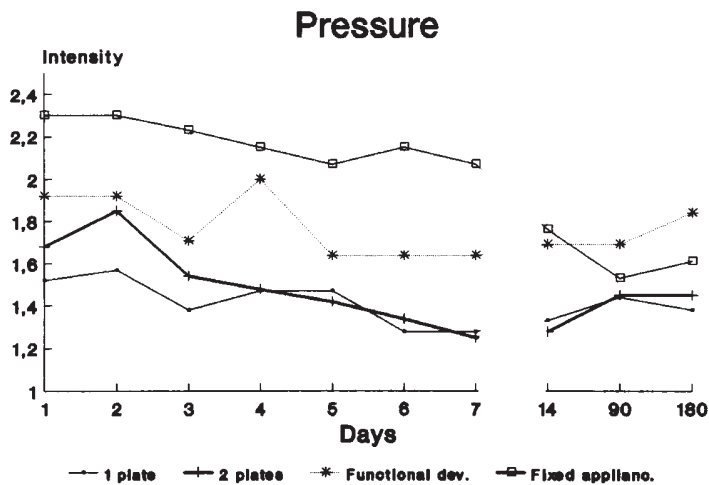


Fig 2. Intensity of pressure reported for individual appliance types in self-monitoring daily protocols for the first 7 days and in retrospective assessments carried out 14, 90, and 180 days after insertion of appliances.

removable plates on one hand with the reports of patients treated with fixed or functional appliances on the other. Potential relationships between patients' attitude toward treatment and the intensity of pain and discomfort perceived were tested by calculating correlations between patients' attitudes before appliance insertion, as evaluated by means of the above rating scales, and the intensity of complaints recorded in the protocols. The effects of pain and discomfort perceived during treatment on patients' compliance was examined by calculating correlations between the intensity of complaints reported in the protocols and acceptance of appliance and treatment as shown by the rating scales, and patients' compliance as assessed by their clinicians.

RESULTS

Longitudinal Analysis of Adaptation

The changes in perception of pain and discomfort after appliance insertion are shown separately for each type of appliance in Figs 1 to 4. The period of 1 to 7 days on the x-axis refers to the results obtained from the daily protocols of pain and discomfort; days 14, 90, and 180 are ascribed to the retrospective assessment of discomfort carried out 14 days, 3 months, and 6 months after appliance insertion. Inspection of the graphs in Figs 1 to 4 reveals a mild generalized trend in declining intensity of complaints detectable over the short-term course of 7 days in contrast to the long-term events. The changes in intensities over the time course

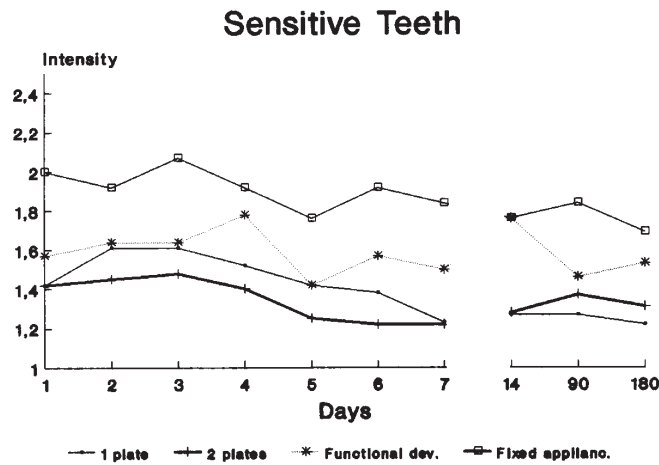


Fig 3. Intensity of sensitivity of teeth reported for individual appliance types in self-monitoring daily protocols for the first 7 days and in retrospective assessments carried out 14, 90, and 180 days after insertion of appliances.

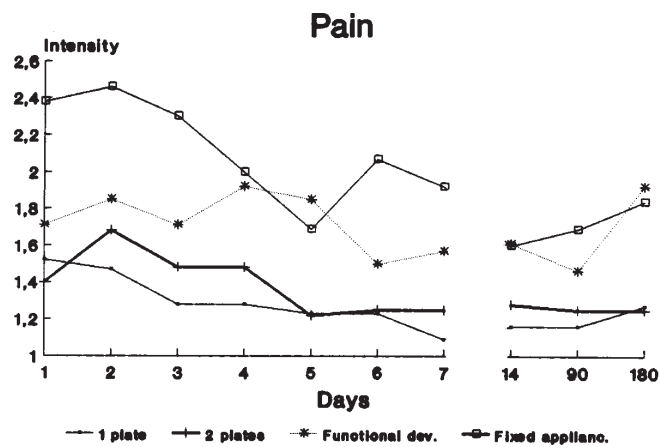


Fig 4. Intensity of pain reported for individual appliance types in self-monitoring daily protocols for the first 7 days and in retrospective assessment carried out 14, 90, and 180 days after insertion of appliances.

were tested for statistical significance with the Wilcoxon test used for dependent samples. To do this, intensities were pooled for each individual complaint on each individual day without reference to different appliance types, and the intensities of each day were tested against the intensity of the first day. An exception was made for the complaint “sensitive teeth” so that the intensity of the second day was chosen as the reference group against which the intensities of subsequent days were tested, because the mean intensity reported for this complaint on the second day markedly exceeded the value of the first day.

Tables I and II show the results of the statistical evaluation of the short-term and long-term data,

respectively. It can be seen from Table I that a statistically significant decline of tension started on day 3 and continued until day 7 as shown by the numbers of patients reporting higher or lower tension felt throughout the time course compared with day 1. Perception of pressure, sensitive teeth, and pain also decreased significantly between days 5 and 7 compared with the corresponding reference values as reflected by the numbers of subjects reporting higher or lower intensity of complaints throughout this period compared with day 1. Analysis of retrospective long-term changes (Table II) showed no statistically significant differences between the numbers of patients reporting higher or lower complaint intensities compared with day 14,

Table I. Numbers of subjects reporting higher (↑) or lower (↓) intensities of perceived tension, pressure, sensitive teeth, or pain within 7 days after appliance insertion

	<i>Tension</i>			<i>Pressure</i>			<i>Sensitive teeth</i>			<i>Pain</i>		
	↓	↑	Z	↓	↑	Z	↓	↑	Z	↓	↑	Z
Day 2	8	10	0.54	15	10	1.07				19	10	1.58
Day 3	7	23	2.45*	10	19	1.78	8	7	0.62	13	15	0.45
Day 4	8	27	2.93**	13	21	1.17	10	13	0.34	15	19	0.49
Day 5	6	31	3.48***	10	25	2.30*	7	23	2.38*	8	23	2.37*
Day 6	6	27	3.10**	7	28	3.03**	5	20	2.15*	9	24	2.06*
Day 7	8	32	3.09**	8	32	3.46***	6	23	2.70**	7	23	2.91**

Z-values and corresponding significance levels (* $P < .05$, ** $P < .01$, *** $p < .001$) obtained from Wilcoxon test are also shown.

Significance was tested comparing values for each individual day with the values for day 1, except for "sensitive teeth" where day 2 was chosen as the reference value.

Table II. Numbers of subjects reporting higher (↑) or lower (↓) intensities of perceived tension, pressure, sensitive teeth, or pain over the long period

	<i>Tension</i>			<i>Pressure</i>			<i>Sensitive teeth</i>			<i>Pain</i>		
	↓	↑	Z	↓	↑	Z	↓	↑	Z	↓	↑	Z
Day 90	21	18	1.06	16	13	0.59	12	13	0.14	14	15	0.31
Day 180	15	13	0.11	10	19	1.78	10	15	0.55	20	16	0.83

Z-values obtained from Wilcoxon test are also shown. Significance was tested comparing values for days 90 and 180 with the values for day 14. No statistically significant difference was found.

Table III. Mean ranks, Z-values and corresponding significance levels

	<i>One or two plates</i>	<i>Functional or fixed appliance</i>	Z
Short term			
Tension	36	53	2.94**
Pressure	36	54	3.25**
Sensitive teeth	37	50	2.41*
Pain	34	57	4.10***
Long term			
Tension	36	47	2.11*
Pressure	36	47	2.13*
Sensitive teeth	34	51	3.33**
Pain	32	54	4.26***

* $P < .05$, ** $P < .01$, *** $P < .001$) obtained from Mann-Whitney's U-test.

Groups of complaint intensities over short (1 to 7 days) or long (14, 90, 180 days) periods were built for one and two removable plates and compared with the values for functional and fixed appliances.

although a substantial variation in reported intensities of each individual complaint was recorded (Figs 1-4).

Influence of Type of Appliance

Visual inspection of Figs 1-4 suggests that there was a substantial difference in intensity of complaints

subject to the type of appliance worn. The graphs in Figs 1-4 indicate that on one hand the experience of patients wearing two removable plates paralleled that of patients treated with one plate; on the other hand, similarities were disclosed between fixed and functional appliances in respect to complaint intensities and course of adaptation. Based on this observation, the results were assembled in two groups, and the differences between the two groups were tested for statistical significance using Mann-Whitney *U* test for independent samples (Table III). Patients treated with fixed or functional appliances reported significantly more tension, pressure, sensitive teeth, or pain than the patients wearing one or two removable plates over both short-term and long-term courses.

Attitude Toward Treatment and Intensity of Complaints

Associations between patients' attitudes before appliance insertion and the intensity of complaints recorded within 7 days after the insertion were tested by calculating Spearman correlation coefficients (Table IV). Subjects who perceived their malocclusion as severe reported less pressure, sensitive teeth, and pain over the time course tested. Although positive expectations of treatment and concern with their own dental

Table IV. Spearman correlations between intensities of complaints perceived within 7 days after appliance insertion and attitudes toward orthodontic treatment such as perceived severity of malocclusion, expectations from treatment, concern with dental esthetics, and internal dental locus of control

	<i>Tension</i>	<i>Pressure</i>	<i>Sensitive teeth</i>	<i>Pain</i>
Perceived severity	-0.12	-0.19*	-0.30**	-0.20*
Treatment expectations	-0.14	-0.15	-0.01	-0.13
Dental esthetics	0.05	0.03	0.03	0.03
Internal locus of control	-0.35	-0.26*	-0.28*	-0.13

Significance levels, * $P < .05$, ** $P < .01$, *** $P < .001$.

esthetic appearance showed no correlation with the reported intensity of complaints, characteristics of internal dental locus of control were related to the intensity of tension, pressure, and sensitive teeth.

Discomfort and Compliance

Pearson correlation coefficients between total intensity of complaints and acceptance of appliance, treatment, and compliance are shown in Table V. It can be seen that complaints from daily protocols and retrospective reports after 3 months showed a significant negative correlation with acceptance of the appliance. Total discomfort scores obtained after 6 months had a significant negative correlation with all three measurements of cooperation. These correlations indicate that acceptance of the appliance and treatment, as well as compliance, improve with decreasing intensity of complaints.

DISCUSSION

The aims of the present investigation were to follow up the progress of adaptation after insertion of new appliances and to study the relationships between the type of appliance worn and pain or discomfort experienced, between pain sensations and attitudes toward the treatment and their effects on patients' compliance. In this study, data were collected with self-monitoring daily protocols that are regarded as useful and valid methods to study patients' experience and behavior during treatment.¹⁹ Furthermore, we used established rating scales to assess several behavioral aspects that may be relevant to adaptation to treatment and compliance.^{9-11,18}

The results of this study imply that an adaptation to new appliances took place within the first 7 days after appliance insertion, which is earlier than the 14 days reported by Brown and Moerenhout.⁶ This conclusion is supported by the significant reduction of intensity of pressure, sensitive teeth, and pain reported within 5 days and the significant decrease of perceived tension as early as 3 days after appliance insertion (Table I, Figs 1-4), as well as by the fact that no statistically significant changes of complaints were revealed in retrospective

Table V. Pearson correlations between total intensities of complaints reported over short and long time courses and acceptance of appliance and treatment as rated by the patients themselves and patients' compliance as rated by the clinicians

	<i>Appliance acceptance</i>	<i>Treatment acceptance</i>	<i>Compliance</i>
Total complaint intensity			
Days 1-7	-0.26*	-0.16	-0.05
2 Weeks	-0.19	-0.07	-0.08
3 Months	-0.21*	-0.07	-0.20
6 Months	-0.44**	-0.45**	-0.27*

Significance levels, * $P < .05$, ** $P < .01$.

reports 14 days, 3 months, and 6 months later (Table II, Figs 1-4). As forces exerted by the appliances during the first 7 days presumably remained stable or at least did not increase, the adaptation may be ascribed to changes of patients' perceptions of adverse stimulation.

The majority of the subjects received their second or a further appliance during the period studied and might presumably have been influenced by their experience with the previous appliances regarding the intensity of complaints and acceptance of the appliance. Such influence was, however, negligible as demonstrated by statistical comparison (results not shown here) of the intensities of complaints reported by this group of patients with the reports of those who received their first appliance. Similarly, no difference was found between perceptions of male and female participants. Therefore, these two variables were excluded from further data evaluation. We have also disregarded the type of malocclusion treated and prescription of extractions as part of treatment as their potential influence on the subject of the present study seemed very unlikely.

Both self-monitoring daily protocols and long-term retrospective reports evaluated in this investigation indicate that the type of appliance may have an effect on the intensity of discomfort experienced by the

patient. This finding is in contrast to the conclusion of another study.³ According to the complaints reported by the subjects in our study, fixed and functional appliances produced higher intensity of discomfort than removable plates (Table III). The comparison of fixed and functional appliances on one hand with one or two removable plates on the other was implemented essentially for statistical reasons. It is recognized, however, that there are fundamental differences between fixed and functional appliances regarding their general character, mode of action, and probably sensations perceived by patients. As shown in Figs 1-4, higher values of the intensities of pressure, tension, pain, and sensitivity of teeth were reported by the subjects treated with fixed appliances in contrast to those wearing functional appliances. Tentatively, the high level of discomfort caused by fixed appliances and the relatively high degree of discomfort associated with functional appliances are based on different experiential qualities. In the case of fixed appliances, they are probably based on adverse sensations in the periodontal ligament and its surrounding structures, whereas unfavorable effects of functional appliances are more likely to arise from pressure and tension in muscles and mucosa. In any event, however, it is not our intention to advocate or oppose use of a particular type of orthodontic appliance merely on the basis of wearing comfort.

Elucidation of the relationship between patients' attitudes toward orthodontic treatment and the intensity of discomfort felt after the insertion of appliance showed a distinct correlation between these factors. Subjects with higher concern about the severity of their malocclusion and attitudes characteristic for internal control orientation perceived lower intensity of discomfort (Table IV). Internal locus of control implies that patients attribute treatment outcome to their personal efforts without relying primarily on chance or endeavors of others.⁸ It has been previously suggested^{5,6} that psychological factors may influence patients' adaptation to pain and discomfort during orthodontic treatment. Our study provides novel information supporting this suggestion.

Appliance and treatment acceptance on one hand and compliance on the other were assessed as factors thought to represent patients' and clinicians' viewpoints, respectively, on patients' cooperation during treatment. Their relationship to the intensity of discomfort was tested. A significant correlation was established between cooperation and the complaints reported 6 months after appliance insertion. This correlation is in accord with the conclusion of another study³ that there is an association between pain and patients' wish for premature termination of orthodontic treatment.

The construct of patient cooperation is understood as a complex of different tasks for patients to accomplish during orthodontic treatment, such as appointment keeping, appliance care, interest in treatment, and adequate oral hygiene.¹⁸ The results of the present study support the conclusions of previous reports^{2,16} that discomfort caused by orthodontic appliances may affect treatment compliance. In this respect, it is interesting that many patients consider initial lack of information about possible discomfort during treatment as the primary reason for premature termination of treatment.¹⁷ To prevent such unwanted outcome of treatment, it may be recommended for clinical situations that patient's initial attitude toward orthodontics always be considered, discussed with the patient, and its realistic contents examined. Tedesco et al²⁰ have termed this procedure, applied in preventive dentistry, as *rational restructuring*. Sufficient time should be allowed to explain the severity of malocclusion to the patient and to use the treatment need as a motivating stimulus. Potential effects of poor cooperation on the existing dental condition should be discussed to help the patient in establishing a sense of personal control. Furthermore, patients should be prepared for encountering discomfort during treatment and their psychological adaptation strengthened by stressing that discomfort may be counteracted by diverting one's attention from it.

CONCLUSION

Taken together, the results of this study imply that patient attitude may predict the amount of discomfort occurring during treatment, which in turn, may predict patient acceptance of appliance and treatment on the whole and his/her compliance.

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AAO MEETING CALENDAR

- 1999 — San Diego, Calif, May 15 to 19, San Diego Convention Center
2000 — Chicago, Ill, April 29 to May 3, McCormick Place Convention Center (*5th IOC and 2nd Meeting of WFO*)
2001 — Toronto, Ontario, Canada, May 5 to 9, Toronto Convention Center
2002 — Baltimore, Md, April 20 to 24, Baltimore Convention Center
2003 — Hawaiian Islands, May 2 to 9, Hawaii Convention Center
2004 — Orlando, Fla, May 1 to 5, Orlando Convention Center
2005 — San Francisco, Calif, May 21 to 26, Moscone Convention Center
2006 — New Orleans, La, April 29 to May 3, Ernest N. Morial Convention Center