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ORIGINAL ARTICLE

Pain and discomfort perceived during the initial stage of active fixed orthodontic treatment



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KEYWORDS

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Abstract *Background and objectives:* As the most common complication of orthodontic treatment, pain can negatively impact quality of life and cause patients to discontinue treatment. However, few studies have evaluated pain during orthodontic treatment, with controversial findings. This study assessed the intensity and duration of pain and discomfort caused by active orthodontic treatment.

Methods: This descriptive cross-sectional study examined 67 patients (22 men, 45 females; age range: 18–32 years) undergoing fixed orthodontic treatment. Patients were interviewed after the active treatment stage to assess their perceived pain and discomfort at different sites during different activities by a visual analogue scale. Frequency and duration of pain in different areas were analyzed by the chi-squared and chi-squared goodness-of-fit tests ($\alpha = 0.05$).

Results: Among the 67 patients, 65.7% experienced general dentogingival pain or discomfort and 34.3% had localized dentogingival pain or discomfort ($p = 0.010$, chi-squared goodness-of-fit test). Masticating soft foods reduced discomfort ($p = 0.000$, chi-squared) in the tongue, cheeks, and in or around the teeth and gingivae. Pain and discomfort were mostly moderate while masticating sticky, fibrous, and firm foods. Mild pains were mostly reported during tooth brushing and while consuming soft foods ($p < 0.05$, chi-squared). Pain and discomfort tended to last for more than 4 weeks, except in the tongue, where pain and discomfort lasted less than 4 weeks ($p < 0.05$, chi-squared goodness-of-fit test).

Conclusions: Pain and discomfort occur for more than 4 weeks after beginning fixed orthodontic treatment. Changing diets to incorporate softer foods is recommended to alleviate pain.

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1. Introduction

Orthodontic treatment has clear positive effects on a patient's physiological, functional, esthetic, psychological, and social health (Khosravanifard et al., 2012, 2013; Lara-Carrillo et al., 2010; Oshagh et al., 2011). However, it is also associated

with complications, such as root resorption, caries formation, gingival/periodontal problems, allergic stomatitis, systemic metal accumulation, and iatrogenic damage during bracket debonding and bonding removal (Amini et al., 2012a,b; Khosravanifard et al., 2011; Lara-Carrillo et al., 2010; Rakhshan et al., 2012). The most common and problematic sequela of orthodontic treatment is pain and discomfort (Bergius et al., 2002; Erdinc and Dincer, 2004; Firestone et al., 1999; Krishnan, 2007; Miyawaki et al., 1999; Sandhu and Sandhu, 2013; Scheurer et al., 1996; Tecco et al., 2009). The intensity of orthodontic pain is comparable to the greatest intensity of general pain felt with a wasp sting or an ankle sprain (Bergius et al., 2002). Between 87% and 95% of adolescents experience pain during fixed orthodontic treatment, especially during the first 24 h. Moreover, 39–49% experience pain during every step of the treatment or after appliance removal (Bergius et al., 2000, 2002; Erdinc and Dincer, 2004; Firestone et al., 1999; Krishnan, 2007; Miyawaki et al., 1999; Scheurer et al., 1996; Tecco et al., 2009; Xiaoting et al., 2010). Therefore, pain is a major deterrent to orthodontic treatment, a factor that reduces patient compliance during treatment, and a reason that patients discontinue treatment or miss appointments (Bergius et al., 2000, 2002; Erdinc and Dincer, 2004; Krishnan, 2007; Krukemeyer et al., 2009; Miyawaki et al., 1999; Sandhu and Sandhu, 2013; Scott et al., 2008; Sergl et al., 1998; Xiaoting et al., 2010).

Despite its substantial clinical value, this area has been surprisingly neglected in the literature, educational programs, and practice (Bergius et al., 2000, 2002; Krishnan, 2007; Krukemeyer et al., 2009). Orthodontists usually underestimate the degree of pain caused by treatment and are not well-equipped to assess if and when their patients might need painkillers (Bergius et al., 2000; Krukemeyer et al., 2009). Pain has been assessed in only a handful of studies. All previous studies contained serious flaws. Some studies were of generally poor quality or lacking in research design while others were hampered by understandable experimental limitations. Many studies were negatively affected by small sample sizes ($n = 20$ in Fujita, 1979; $n = 17$ in Sinclair et al., 1986; $n = 70$ in Ngan et al., 1989; $n = 62$ in Scott et al., 2008; and $n = 55$ in Bergius et al., 2002), retrospective designs (Miyawaki et al., 1999; Sinclair et al., 1986), or study durations of only 1 week (Bergius et al., 2002; Erdinc and Dincer, 2004; Ngan et al., 1989; Sandhu and Sandhu, 2013). Furthermore, controversy exists over the rates (Bergius et al., 2000; Tecco et al., 2009; Xiaoting et al., 2010) and duration of orthodontic pain reported in studies of short duration (Bergius et al., 2002; Fujita, 1979; Jones and Chan, 1992; Ngan et al., 1989; Scott et al., 2008; Sergl et al., 1998; Tecco et al., 2009; Xiaoting et al., 2010) compared to the same parameters in studies that examine the entire treatment period or beyond (Lew, 1993; Miyawaki et al., 1999).

The two most important aspects of pain and discomfort in orthodontic treatment are its intensity and duration (Krishnan, 2007). Understanding these has clinical implications to improve patient satisfaction and the quality of oral health (Firestone et al., 1999; Krukemeyer et al., 2009; Tecco et al., 2009). In light of the importance of this mostly overlooked issue, we sought to determine the prevalence and duration of pain and discomfort associated with fixed

orthodontic treatment at different sites and during teeth brushing or eating.

2. Methods

2.1. Patients

Filipino patients undergoing fixed-appliance orthodontic treatment from 2004 to 2008 ($n = 67$) were enrolled. The study population contained 25 original patients and 42 referral patients. There were 22 men and 45 women. Patients were between the ages of 18 and 32 years. Eighteen (26.9%) patients were 18–20 years old, 8 (11.9%) were 21–23 years old, 17 (25.4%) were 24–26 years old, 12 (17.9%) were 27–29 years old, and 12 (17.9%) were 30–32 years old. The study protocol was approved by the institutional review board of the Faculty of the Graduate School at the Manila Central University. Written consent forms were obtained from all participants. Provisions for emergency treatment were put in place if there were any adverse reactions, such as pain, allergies, or irritation of the oral mucosa or gums, during oral examinations. A contact number for the main researcher was provided in case any emergencies occurred.

The inclusion criteria required patients to be willing to participate in the study, generally healthy, nonsmokers, literate, have had less than two extraction sites before enrollment, and have healthy and normal gait and postures. The exclusion criteria were the presence of gingival or periodontal diseases before treatment in the 25 prospective patients, any removable orthodontic appliances, cleft lips or palates, patients wearing obturators or surgically corrected palatal shelves, any dental anomalies that would compromise the duration of leveling and alignment time (e.g., hyperdontia), contraindications for radiography (e.g., anemia), any signs/symptoms of temporomandibular disorders, heavy alcohol consumption, nonsteroidal antiinflammatory drug (NSAID) use, hospitalization, hormone therapy within 6 months before enrollment, pregnant or nursing mothers, or other hormonal conditions (e.g., goiter or hyperthyroidism).

2.2. Orthodontic treatment and pain

The initial phase of orthodontic treatment (leveling and alignment) was performed with fixed appliances alone, by using round frictionless nickel titanium archwires with the least possible force. The amount of force was not standardized between patients, as they had different conditions.

Immediately after the first treatment phase (3–6 months after the beginning of treatment), patients were interviewed with questionnaires about the pain and discomfort that they perceived during their treatment period. Pain and discomfort were defined as feelings of pressure, tension, soreness of the teeth, and/or any other oral pains or feelings of disturbance (Krishnan, 2007; Ngan et al., 1989). Pain and discomfort in the tongue, cheeks, teeth, and gingivae, while brushing the teeth, and while chewing various foods (sticky, tough, firm, soft, or fibrous) were recorded on a visual analogue scale (VAS) ranging from “no pain or discomfort” to “intolerable pain or discomfort”. Intolerable pain was defined as a pain that would cause the patient (with any level of tolerance) to

seek emergency treatment or want to stop the orthodontic treatment. The VAS was converted to a 5-point Likert scale, where 0 represented no difficulties or pain, 1 was mild pain or discomfort, 2 was moderate pain or sensory disturbances, 3 was severe pain or discomfort, and 4 was intolerable pain.

Patients were asked whether they had sore mouths and gingival bleeding during the treatment period. The maximum duration of pain or discomfort in or around the teeth, gingivae, tongue, and cheeks, as well as during chewing and hygiene control was also recorded. The maximum duration of pain or discomfort reported by patients was categorized as less than 48 h, 2–7 days, 7–14 days, 14–28 days, or longer than 28 days after treatment initiation. The maximum duration after the treatment initiation where pain or discomfort was felt during eating different types of foods was not assessed because patients could not be restricted to eating only a specific type of food and could not reliably recall the pain duration associated with each type of food.

2.3. Statistical analysis

Descriptive statistics were calculated. Data were analyzed by the chi-squared and chi-squared goodness-of-fit tests. Differences with a *p*-value of less than 0.05 were considered to be statistically significant.

3. Results

All patients felt some pain or discomfort: 23% experienced mild pain, 69% experienced moderate pain, and 8% experienced severe pain. Within the patient group, 65.7% experienced generalized pain or discomfort in or around the teeth and gingivae, compared to 34.3% who had localized dentogingival pain or discomfort ($p = 0.010$ by goodness-of-fit test). All patients experienced sore mouths and bleeding gums to some extent after fitting the brackets, and 76% had difficulty cleaning the brackets.

According to the chi-squared goodness-of-fit test, the severity of pain or discomfort was unevenly distributed across all examined aspects. Pain and discomfort were mostly moderate in the tongue, cheeks, in or around teeth and gingivae, and during the mastication of sticky, fibrous, or firm foods. Brushing the teeth and chewing soft foods mostly induced mild pain and discomfort. General disturbances during chewing however, were mostly severe in nature (Table 1). Masticating soft foods reduced the frequency of pain compared to chewing firm, fibrous, or sticky foods ($p = 0.000$ by the chi-squared test, Table 1). Patients reported greater pain or discomfort in their cheeks than in their tongues ($p = 0.001$; Fig. 1 and Table 1).

The maximum durations of perceived pain in each region were as follows: 2 months in the alveolar bone (women: 2.5 months, men: 1.5 months), 3 months in the tongue (women: 3.5 months, men: 2.5 months), and 4 months in cheeks (women: 5 months, men: 3 months). The maximum duration of perceived pain during mastication was 2 months (women: 2.5 months, men: 1.5 months; Table 2 and Fig. 2). The duration of pain and discomfort was not evenly distributed according to the chi-squared goodness-of-fit test. Perceived pain tended to continue for more than 4 weeks, except in the tongue, where pain and discomfort lasted for less than 4 weeks (Fig. 2 and Table 2).

4. Discussion

The findings of this study indicate that brushing teeth induced primarily mild pain. All patients felt some degree of pain or discomfort while chewing fibrous, sticky, or firm foods, but consuming soft foods significantly reduced pain. According to 90% of patients, orthodontic treatment is painful, and 30% might prematurely cease treatment because of the pain (Krukemeyer et al., 2009; Lew, 1993).

Although all studies agree that pain occurs during orthodontic treatment, there are large variations between reported prevalence rates, intensities, and durations of pain (Bergius et al., 2000, 2002; Erdinc and Dincer, 2004; Firestone et al., 1999; Fujita, 1979; Jones and Chan, 1992; Jones, 1984; Jones and Richmond, 1985; Krishnan, 2007; Krukemeyer et al., 2009; Lew, 1993; Miyawaki et al., 1999; Ngan et al., 1989; Scheurer et al., 1996; Scott et al., 2008; Sergl et al., 1998; Tecco et al., 2009; Xiaoting et al., 2010). As pain is subjective by nature, it is extremely difficult to measure (Bergius et al., 2000, 2002; Erdinc and Dincer, 2004; Krishnan, 2007; Krukemeyer et al., 2009; Xiaoting et al., 2010), especially because it varies considerably from case to case and depends on several interindividual variations, such as age, gender, the magnitude of the force applied, pain thresholds, stress, current emotional state, cultural differences, social class, and past pain experiences (Bergius et al., 2000, 2002; Firestone et al., 1999; Haraji and Rakhshan, 2014; Haraji et al., 2013; Krishnan, 2007; Krukemeyer et al., 2009; Tecco et al., 2009; Xiaoting et al., 2010). The relatively high frequency of pain in this sample was consistent with other studies (Bergius et al., 2002; Erdinc and Dincer, 2004; Krukemeyer et al., 2009; Miyawaki et al., 1999; Scheurer et al., 1996; Tecco et al., 2009). Apart from the alveolar pain, soft tissue lesions and wounds caused by orthodontic appliances might as well induce pain (Bergius et al., 2000).

Table 1 Frequency distribution (%) of the presence and intensity of pain and discomfort felt in different areas or during brushing or masticating, or specifically masticating sticky, fibrous, firm (SFF), or soft foods.

Pain/discomfort source	<i>n</i>	Presence (%)		<i>n</i>	Intensity (%)			<i>p</i>
		Yes	No		Mild	Moderate	Severe	
Tongue	67	59.7	40.3	40	32.5	50.0	17.5	0.042
Cheeks	67	85.1	14.9	57	15.8	80.7	3.5	0.000
Dentogingival discomfort	67	68.7	31.3	46	26.1	58.7	15.2	0.001
Masticating problems	67	100.0	0.0	67	19.4	34.3	46.3	0.026
Problems in chewing SFF foods	67	100.0	0.0	67	10.4	47.8	41.8	0.000
Problems in chewing Soft foods	67	61.2	38.8	41	61.0	31.7	7.3	0.000
Hygiene control	67	100.0	0.0	67	61.2	31.3	7.5	0.000

The *p* value is calculated using the chi-square goodness-of-fit test.

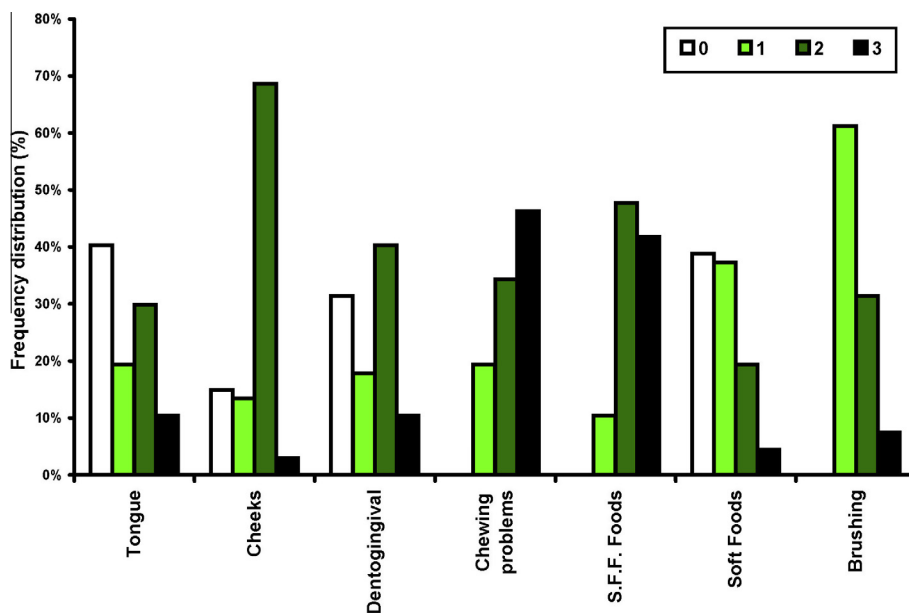


Figure 1 Frequency distribution (% , $n = 67$) of the 0-3 Likert-scale scores of pain/discomfort at different sites or during different activities.

Table 2 Frequency distributions (%) of the *maximum* duration of pain and discomfort.

Pain/discomfort source	<i>n</i>	< 2 D	2-7 D	7-14 D	14-28 D	> 28 D	<i>p</i>
Tongue	40	5.0	12.5	30.0	37.5	15.0	0.007
Cheeks	57	0.0	3.5	15.8	29.8	52.6	0.000
Dentogingival discomfort	46	0.0	10.9	23.9	28.3	37.0	0.001
Masticating problems	67	0.0	4.5	11.9	26.9	56.7	0.000

The *p* value is calculated using the chi-square goodness-of-fit test.
D, days.

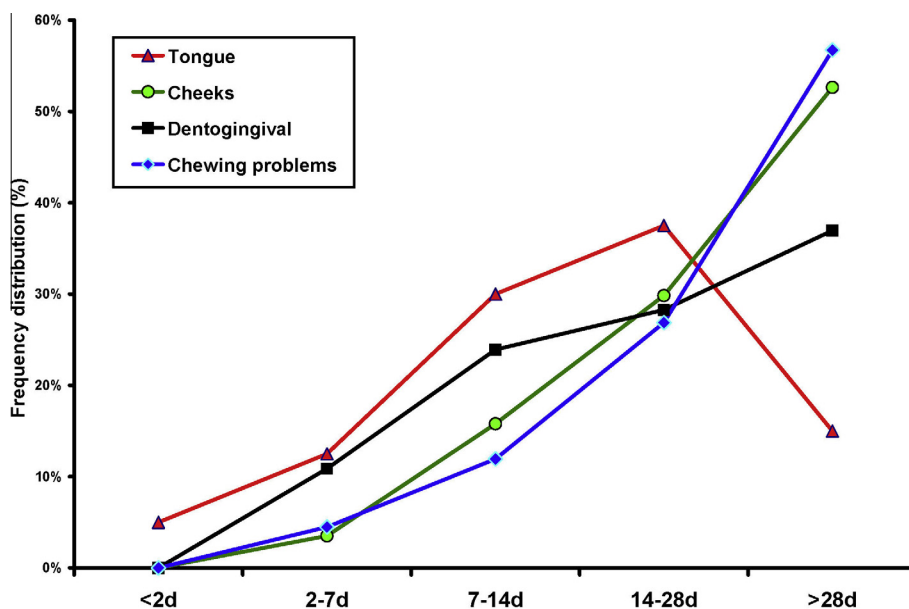


Figure 2 Frequency distribution (%) of the *maximum* duration of persisting pain at different sites or during brushing.

Pain experienced by this study population was mostly moderate, except for minor pain and discomfort experienced while brushing teeth, and severe pain and discomfort during mastication. In most cases, pain (except pain felt in the tongue) lasted at least for more than 1 month after treatment began, which it was consistent with previous results (Lew, 1993; Miyawaki et al., 1999). Most earlier studies agree that the pain peaks in the first 24 h and does not last long thereafter (Bergius et al., 2000; Erdinc and Dincer, 2004; Fujita, 1979; Jones and Chan, 1992; Ngan et al., 1989; Scott et al., 2008; Sergl et al., 1998; Tecco et al., 2009; Xiaoting et al., 2010). However, other studies found that it might persist even after appliance removal (Miyawaki et al., 1999). The differences might be attributed to different pain measurement scales, anatomical sites assessed, or study durations, as many studies assessed the pain only for 1 week and focused only on severe pain during that time (Bergius et al., 2002; Erdinc and Dincer, 2004; Ngan et al., 1989; Scott et al., 2008). Additionally, some authors considered mild pain as no pain and statistically insignificant decreases in pain level as considerable (Erdinc and Dincer, 2004).

The mechanisms underlying orthodontic pain are not fully understood (Bergius et al., 2000; Erdinc and Dincer, 2004; Scheurer et al., 1996). Orthodontic pain appears to be caused primarily by the compression of the periodontal ligament (PDL) under orthodontic forces, especially during the initial stages of tooth movement. Leveling and alignment of the teeth by orthodontic forces induces both immediate and delayed responses from the teeth and alveolar bone structures (Bergius et al., 2000; Krishnan, 2007; Scott et al., 2008; Tecco et al., 2009). Immediate responses occur after placing the archwires and are characterized by ischemia and PDL compression. Delayed responses, mainly PDL hyperalgesia, begin several hours later. During this response, released prostaglandins can increase the sensitivity of the pain receptors to noxious agents, such as bradykinin, serotonin, acetylcholine, substance P, and histamine. This phase continues with neurogenic inflammation, osteoblastic and osteoclastic activity, periodontal vasodilatation, and pain (Bergius et al., 2000; Erdinc and Dincer, 2004; Fujita, 1979; Krishnan, 2007; Scheurer et al., 1996; Scott et al., 2008; Tecco et al., 2009).

Lighter forces are less traumatic and painful and are thought to be ideal for orthodontic treatment (Scott et al., 2008), but this recommendation is controversial (Krishnan, 2007). Crowded teeth will be actively engaged with the archwire, which results in substantial forces depending on the level of crowding. Therefore, extreme forces are likely unavoidable at the beginning of treatment (Scott et al., 2008) and will produce pain that peaks around 24 h after treatment and reduces slightly after the second or third day (Bergius et al., 2000, 2002; Fujita, 1979; Jones and Chan, 1992; Ngan et al., 1989; Scott et al., 2008; Sergl et al., 1998; Tecco et al., 2009; Xiaoting et al., 2010).

Awareness of pain by healthcare providers and attention to a patient's psychological well-being can improve pain tolerance and decrease perceived pain (Erdinc and Dincer, 2004; Krishnan, 2007; Krukemeyer et al., 2009; Sergl et al., 1998). Thus, communication between the clinician and patient regarding the pain could improve felt pain and compliance (Erdinc and Dincer, 2004; Krukemeyer et al., 2009; Scheurer et al., 1996), especially as many patients are not well-informed (Scheurer et al., 1996). Medications, such as NSAIDs (especially pre- and postprocedural doses) and low-level laser

therapy, might also be useful to reduce pain (Bergius et al., 2002; Krishnan, 2007; Krukemeyer et al., 2009; Xiaoting et al., 2010). However, over-the-counter doses of many NSAIDs cannot necessarily relieve pain and, at the same time, might potentially disrupt tooth movement due to prostaglandin antagonism (Krukemeyer et al., 2009).

This study showed that brushing teeth could cause pain. Although mostly mild, pain was experienced in a large proportion of the sample. This result is consistent with other available studies suggesting that orthodontic pain might negatively affect oral hygiene efforts (Krukemeyer et al., 2009; Sergl et al., 1998). To avoid or relieve discomfort, instruction on brushing with small narrow-headed brushes and explanations of how to use plastic bumper sleeves or soft wax immediately after bonding is recommended (Miyawaki et al., 1999).

All patients experienced pain or discomfort while chewing fibrous, sticky, or firm foods, but consuming soft foods significantly reduced pain frequency. This finding was consistent with results of other investigators (Miyawaki et al., 1999) and suggests that patients should alter their diets to provide some relief (Krishnan, 2007; Krukemeyer et al., 2009; Scheurer et al., 1996). Eating soft foods instead of sharp, hot, spicy, firm, or fibrous foods is recommended unless the hard or fibrous foods are eaten in small bites (Miyawaki et al., 1999). However, patients tend to underestimate or ignore advice regarding dietary changes (Firestone et al., 1999). Our results were somewhat consistent with the literature. Fujita (1979) studied 20 orthodontic patients and observed tongue soreness and difficulty with speech and hygiene maintenance in some patients within the first months of treatment. Sinclair et al. (1986) retrospectively studied 17 orthodontic patients and reported increases in plaque index, speech difficulty, and tongue soreness. Miyawaki et al. (1999) retrospectively evaluated 111 patients and found that 57–76% of patients had tongue soreness, phonetic problems, difficulty in chewing fibrous food, and difficulty in brushing teeth after bonding.

This descriptive study was limited in some aspects. The subjective nature of pain and the broad range of interindividual differences, even to standard stimuli, make pain difficult to measure (Bergius et al., 2000, 2002; Erdinc and Dincer, 2004; Haraji and Rakhshan, 2014; Haraji et al., 2013; Krishnan, 2007; Krukemeyer et al., 2009; Xiaoting et al., 2010). Therefore, the VAS system was used because it is understood by most patients, is reliable, is sensitive to small changes, and has good reproducibility (Bergius et al., 2000; Erdinc and Dincer, 2004; Scott et al., 2008; Xiaoting et al., 2010). Another limitation was that patients had been asked to fill out the VAS retrospectively (after 6 months). Therefore, the accuracy of pain perception is questionable. Future studies could require patients to record a pain journal, which would be more accurate. Moreover, further statistical analyses are necessary to verify the role of associated factors. The sample sizes of future studies should be determined by power calculations.

Another limitation was the broad age range because of potential differences in pain perception across age groups. A narrower age range could allow better assessment of the roles of other factors. On the other hand, the inclusion of various ages helps to elucidate the issue across the entire clinical population and favors the generalizability. Age-wise comparisons could further clarify the results. The role of age in pain remains poorly understood, in part because measurement methods are

different (Scheurer et al., 1996) and correlations are not clear (Krishnan, 2007). Some studies have reported higher levels of pain in older subjects (Bergius et al., 2000; Jones, 1984; Scheurer et al., 1996), while some others have found no correlations between pain and age (Ngan et al., 1989; Scott et al., 2008). For instance, adolescents tend to experience higher levels of pain compared to preadolescents and adults (Krishnan, 2007). The controversy can be attributed to methodological differences and the sample age range (Bergius et al., 2000). Although a linear negative correlation has been observed between age and general pain until the age 25 years (Bergius et al., 2000), in orthodontics, the relationship is not linear and the most sensitive age seems to be between 13 to 16 years (Bergius et al., 2000; Krishnan, 2007).

Another limitation was the differences between treatment plans (Scheurer et al., 1996). For example, if bands were used with lingual cleats, a higher incidence of pain reported in the tongue would be expected than if buccal tubes were bonded and there were no lingual attachments. Nevertheless, all orthodontic treatments can produce pain (Bergius et al., 2000, 2002; Krukemeyer et al., 2009; Ngan et al., 1989; Scheurer et al., 1996) and several treatment plans were excluded from this design.

5. Conclusion

Discomfort and pain caused in the initial stage of fixed orthodontic treatment can be moderate to severe and might last for more than 1 month. Generalized dentogingival discomfort is more prevalent than localized discomfort. Brushing teeth might cause mild discomfort and consuming soft foods can minimize pain.

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Conflict of interest

The authors declare no conflicts of interest.

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