Republic of Iraq
Ministry of Higher education
And scientific Research
University of Baghdad
College of Dentistry

Pain In Orthodontics

A project submitted to

The College of Dentistry. University of Baghdad, Department ofOrthodontics In partial Fulfilment For the Bachelor of Dental Surgery

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(May,2023)

Certification of the supervisor

I certify that this project entitled " **pain in orthodontics**" was prepared by the fifth-year student **sarah mohammed abdulkhaleq**
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Dedication

I dedicate this graduation project to God who has been with me through my journey. To my father and mother who always support me in my life To my grandfather and grandmother may God have mercy on him/her They always believed in me, I wouldn't have achieved this without them.

Acknowledgement

I would like to extend my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad, **Prof. Dr. Raghad Al-Hashimi**.

My sincere thanks to **Prof. Dr. Dheaa Hussein**, Head of Orthodontics Department, and all professors and seniors in the department for them pleasant cooperation.

My sincere gratitude and heartfelt thanks to my supervisor **lecturer/Dr. Sara M. AL-Mashhadany** for her inspiring personality and for being supportive, advisable, and encouraging continuously in all scientific as well as moral levels.

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Introduction

Pain is a general term that describes uncomfortable sensations in the body. It stems from activation of the nervous system, is a complex experience and often accompanies orthodontic appointments. This, among the most cited negative effects of orthodontic treatment, is of major concern to patients as well as clinicians **(Kluemper *et al.*, 2002)**

Pain can range from annoying to debilitating. It may feel like a sharp stab or dull ache. It may also be described as throbbing, pinching, stinging, burning, or sore.

Pain may be consistent, it may start and stop frequently, or it may occur only under some conditions. It may be acute, developing suddenly and lasting for a short period of time. Or it may be chronic, with ongoing sensations that last or return repeatedly over several months or years. **(Krishnan *et al.*,2007).**

Pain may be localized, affecting a specific part of your body. Or it may be generalized, such as the overall body aches associated with the flu.

Pain lets us know when something is wrong and gives us hints about the cause. Some pain is easy to diagnose and can be managed at home **(Krishnan *et al.*,2007).**

Pain is a subjective response, which shows large individual variations. It is dependent upon factors such as age, gender, individual pain threshold, the magnitude of the force applied, present emotional state and stress, cultural differences, and previous pain experiences **(Ngan *et al.*, 1989).**

Aim of the review

The aim of the present review was to understand the pain definition, mechanism, causes in the treatment of orthodontic approach and to find the management of this pain in many different technique

Chapter one: Review of literature

1.1 Overview of orthodontics pain

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or is described in terms of such damage. With no exception, orthodontic pain is perceived as discomfort, dull pain and hypersensitivity in affected teeth. In most circumstances, pain motivates individuals to withdraw from damaging situations. However, because human beings are well acquainted with the fact that orthodontic pain is a normal adverse effect of tooth movement, orthodontic pain is well accepted by most orthodontic patients. Orthodontic pain is commonly referred to as tooth discomfort induced by orthodontic tooth movement, whereas a broader definition of orthodontic pain refers to any painful sensation ***(*Patel *et al*., 2014).**

1.2 Evaluating pain

There is a well-defined classification system for orthodontic pain proposed by **Burstone *et al* (1962).** It appears to be valid even now and to have stood the test of time.

1.2.1 Classifying pain

There are two ways to classify a painful response to orthodontic mechanics:

one depends on the relationship of force application with pain and the other according to the time of onset. The degree of pain perceived in response to the amount of force application can be divided into three **(Burstone *et al*.,1962)**:

1. First degree: the patient is not aware of pain unless the orthodontist manipulates the teeth to be moved by the appliance, e.g., using instruments such as a band pusher or force gauge.

2. Second degree: pain or discomfort caused during clenching or heavy biting usually occurs within the first week of appliance placement. The patient will be able to masticate a normal diet with this type of pain.

3. Third degree: if this type of pain appears, the patient might be unable to masticate food of normal consistency.

Based on time of onset, **(Burstone *et al*.,1962)** further classified pain as follows:

1. Immediate: which is associated with sudden placement of heavy forces on the tooth, e.g., hard figure of eight tie between the central incisors to close a midline diastema.

2. Delayed: produced by variety of force values from light to heavy and representing hyperalgaesia of the periodontal membrane. This type of pain response decreases with time i.e., the pain reaction might start as third degree but become second or a first degree with the passage of time.

1.3 Characteristics of orthodontic pain

Orthodontic pain usually starts 4 hours after the application of orthodontic force. After 1 day, it reaches a higher point, and gradually decreases and returns to zero after 3–7 days and 1 month respectively **(Baldini *et al*., 2015)**.

Orthodontic pain exceeds a painful feeling for most patients, it results in a decline in many aspects of the health of patients and hampers masticatory

performance and speech. Soreness of the teeth, feelings of pressure and tension are some of the discomforts experienced by patients who wear orthodontic appliances. Despite the fact that orthodontic pain diminishes in most patients within one week after orthodontic visits, it has been found that about 44% of adolescents sensed orthodontic pain after 1 week, displaying the potential long duration of orthodontic pain **(Bergius *et al.*, 2002)**.

1.4 The basic mechanism of orthodontic pain

Once orthodontic forces are applied on teeth, inflammatory reactions which will stimulate the release of different biochemical mediators in the periodontium and dental pulp, causing the sensation of pain, vascular, cellular, neural and immunological reactions, respond in a coordinated form to eventually result in pain and tooth movement. Tooth movement and orthodontic pain happen to be two biological episodes that are interconnected and dependent with local inflammation being their mode of action **(Sacerdote *et al.*, 2012)**.

During local inflammation, products such as prostaglandin and bradykinin act on sensory endings to promote painful sensations. The basic mechanisms of orthodontic pain are found in periodontal inflammatory responses persuaded by orthodontic forces that involve a network of the following interacting components: vascular, cellular and chemical events **(Neurosci *et al.*,2005).**

1.5 Factors affecting a pain response to orthodontic force

Pain is a response that is subjective and shows variation in individuals. Several factors such as gender, age, emotional state and stress, individual

pain threshold, cultural differences, and preceding pain experiences determine pain **(Berggren *et al*., 2000).**

A. Gender: It is well-known from the literature that females experience pain more than males, this can be explained as females are 'fragile' and sensitive to pain, whilst males are more impassive and can withstand more pain. Some researchers have reported that females are less willing to tolerate pain than males. Contrarily, with regard to pain threshold, others found that between males and females, no differences exist in reporting the feeling of pain **(Ingersoll *et al*., 1989).**

B. Age: There appear to be conflicting findings with regards to age differences in orthodontic pain experience, this may be due to various treatment approaches. Several orthodontic studies reported that the older the patient, the greater the pain reported, the greater the pain sensitivity, and the lower the pain tolerance **(Walsh *et al*., 1989)**.

Age-related changes in psychological measurements of pain and well-being were studied in patients undergoing full fixed appliance orthodontic treatment. A longitudinal series of four questionnaires was used to obtain measurements of these factors after the separation phase of treatment, banding (2 to 7 days after separation), the first adjustment visit (3 to 4 weeks after placement of full fixed appliances), and the second adjustment visit (3–4 months after banding was completed). The results suggest an interaction between the phases of treatment and reported pain and psychological well-being and significant differences in the response profiles of the adolescent age group (14 to 17 years) compared to the preadolescent (11 to 13 years) and adult groups (18 years and older). These findings did not appear to be due simply to group differences in the use of analgesics, class of malocclusion, or type of full fixed appliance used. The profile comparisons

indicated that the adolescent age group generally reported lower levels of psychological well-being and higher levels of pain during the phases of treatment examined. Consistent with these results was the finding that the adolescents differed from the preadolescents and adults in the quality of the pain experience reported during treatment. The results indicate an age difference in adjustment to fixed orthodontic therapy, which suggests that adolescents are more vulnerable to undesirable psychological effects of treatment **(Chan *et al*., 1992).**

C. Ethnicity: Some dimensions of pain are universal but others are learned. Behavior and stoical attitudes are encouraged by some cultures. In some other cultures, individuals are encouraged to openly express their responses and receive sympathy and attention for this behavior. Social factors, such as differences in socioeconomic status can influence access to health care so that some ethnic groups do not receive adequate pain relief due to inadequate medical treatment. With regard to pain and its response, the family as well as the surroundings are among the most important sources to be considered during early learning **(Edwards *et al*., 2001).**

D. Anxiety: and Fear Dental anxiety or previous negative dental experiences can increase the risk of reporting pain and psychological factors such as anxiety and dental fear have been found to be associated with more pain during dental procedures. It has been shown that dental anxiety can lower pain threshold and lead to the perception of generally non-painful stimuli as painful and that a high level of dental anxiety mirrors a strong effect of fear of both specific and general painful things and conditions **(Staud R *et al*., 2009).**

D. Pain: Sensitivity At any phase of treatment, individual variation can potentially happen in pain processing ranging from the peripheral nociceptor,

through pain-regulating mechanisms in the brainstem and spinal cord to the psychological and cognitive processes involved in interpreting and experiencing pain **(Polat *et al*., 2005).**

There is no doubt that the physiological and psychological susceptibility of the individuals is considered as a momentous aspect in the intensity of tissue pain caused by the physical effects of appliances. Studies reported that there was no direct relation existed between pain experienced by the patient and the magnitude of forces applied **(Polat *et al*., 2005).**

1.6 The relation between orthodontic pain and patient compliance and daily activities

Several studies in the literature approve the fact that orthodontic pain has a clear effect on obedience and daily activities of patients. Functional and aesthetic impairments during wearing of appliance are considered the major reasons affecting patient compliance. Most orthodontic patients change the texture of their food due to the difficulty in chewing and biting solid foods. Data support the assumption that discomfort from the use orthodontic appliances can be an important factor affecting compliance by patients **(O'Connor *et al*.,2000)**.

Pain, aesthetic and functional impairment caused by appliances are some of the major causes of early termination or discontinuation of treatment. During the 6-months period that follows appliance placement, researchers have found a significant correlation between patients' co-operation and complaints **(Sergl *et al*.,1998).**

The literature advocated that during the diagnostic phase, the preliminary attitude of patients towards orthodontics should be understood and

discussed with them in all its reality. In psychology, this procedure is termed as 'rational restructuring' **(Christersson *et al*., 1992).**

Brown and Moerenhout *et al* in 1991 reported that the influence of the pain from orthodontic treatment on the daily activities of patients is definite. The pain experienced during the first 48hours is considered to be so disturbing and results in sleepless nights and the use of medication. Although statistically insignificant results found, it has been reported that about50 percent of patients had troubles with their daily activities at 6 hours and on days 1 and 2 and there was a reduction in the severity of discomfort also the quantity of patients experiencing it from day 3 onwards **(Erdinç *et al*., 2004).**

1.7 Causes of orthodontic pain

All orthodontic procedures such as separator placement, arch wire placement and activations, application of orthopaedic forces and debonding produce pain in patients. It is also clear that fixed appliances produce more pain than removable or functional appliances and there exists little correlation between applied force magnitude and pain experienced **(Bondemark *et al.*, 2004).**

The various discomforts experienced by patients after appliance placement are often described by them as feelings of pressure, tension, soreness of the teeth, and pain as such

The two most important parts of orthodontic pain its duration and intensity are often ignored **(Ngan *et al.*, 1989).**

1.7.1 Orthodontic separation

Creating space mesially and distally to teeth, which are to be banded, forms the initial step in fixed orthodontic mechanotherapy. It is well-known that placement of orthodontic separators (brass wire, elastomeric, spring type steel separators, and latex elastics) results in a painful experience for almost all patients. Two controlled clinical trials performed by **(Ngan *et al.*, 1994)** concluded that there was discomfort associated with separator placement, which usually starts within 4 hours of insertion. The level of discomfort increases over the next 24 hours and decreases to pre-placement level within 7 days. A recent report has also addressed this issue. They evaluated and compared the separation effect and patient perception of pain and discomfort to two types of orthodontic separators (elastomeric and spring type) but found no statistically significant difference between the discomforts caused by the two types of separators. They reported that the worst pain was experienced at day 2 and subsided almost completely by day 5 **(Bondemark *et al.*, 2004)**.

An electromyography study**,** performed to evaluate the motor and sensory changes associated with separator placement, showed a decrease in motor output as well as pressure pain threshold in muscles of mastication. They suggested this to be a protective mechanism against further damage to the injured part of the masticatory system. It is clear that pain is associated with the process of orthodontic separation and starts within 4 hours of its placement with a peak level at day 2 that might last for 7 days.(Figure **1.7.1**)(**Michelotti *et al.*, 1999)**

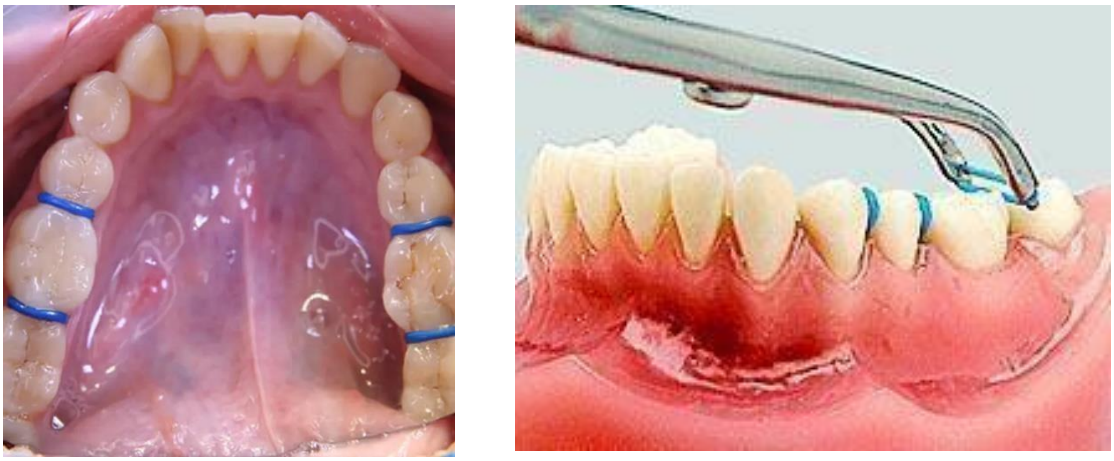

Figure 1.7.1: placement of Orthodontic separation **(Bondemark *et al.*, 2004).**

1.7.2 Arch wire placement and activation

Pain associated with initial arch wire placement has been previously researched.

Jones *et al* (1984) reported that pain is experienced by the majority of patients 4 hours after arch wire placement, which will peak at 24 hours and then decline. Various authors, who performed the same research in other racial and ethnic groups, confirmed these findings stated that pain from arch wire placement can be worse in some patients and could even be more than that experienced after tooth extraction. They observed a diurnal variation in pain experienced by patients with evening and nights showing the highest scores. The pain will usually last for 2–3 days and will gradually decrease in its intensity by fifth or sixth day (Figure 1.7.2) .**(Jones and Chan, 1992a, b), (Ngan *et al*., 1989).**

Figure 1.7.2 placement of arch wire **(*Ngan et al,.1989)***

Comparing various arch wires to determine differences in pain perception showed no statistically significant results. No difference in the intensity, prevalence, or duration of pain between different arch wires was found **(Fernandes *et al.*, 1998).**

In agreement with others, found that patients reported more pain experience in anterior than in posterior teeth because of the differences in root surface area, increased involvement of anterior teeth during levelling, and greater use of anterior teeth for biting. (**Scheurer *et al.*, 1996).**

some reported that after 11 hours of force application, a higher pain perception was experienced in the lower than in the upper arch. **(Fernandes *et al*.,1998)**

Some authors reported that the conditioned and/or nociceptive reflexes elicited as a result of orthodontic arch wire activation often leads to avoidance of chewing hard foods by the patients. **(Gianelly *et al*.,1971).** and others through their different experiments, evaluated the effect of orthodontic arch wire activation on the masseter muscle ,They observed a reduction in masseter muscle activity and attributed this to the noxious stimuli emulating from the periodontal membrane or para dental receptors triggering a reflex mechanism, which caused inhibition of jaw-closing muscles (EMG activity during induced

pain has been shown to increase when jaw-closing muscles act as antagonists, (**Lund *et al*., 1983).**

In brief, both arch wire placement as well as activation will cause pain and might affect dietary habits as well as the daily life activities of patients **(Fernandes *et al.*,1998).**

1.7.3 Appliance type

The effect of different appliances (fixed and removable) on pain experience has been evaluated**.** (Figure 1.7.3).

There is no difference in the level of discomfort produced by fixed or removable appliances **(Oliver and Knapmann *et al*., 1985)**.

Another author contradicted this finding and stated that fixed and functional appliances produced a higher intensity of discomfort than removable appliances. Patients wearing fixed appliances reported higher values for intensities of pressure, tension, pain, and sensitivity to teeth **(Sergl *et al*., 1998).**

Their findings were in agreement with **(Stewart *et al*., 1997)** that fixed appliances create more pain when compared with removable appliances.

(a) (b)

Figure 1.7.3: (a) removable appliance. (b) fixed appliance **(Mosby *et al*,.2012*).***

1.7.4 Initial tooth positions and force levels

The concept of light forces producing more physiological and less painful tooth movement is a matter of debate.

Hixon *et al* (1969) who favored application of heavier forces for canine retraction, stated that higher forces per unit area increased the rate of biological response.

Gianelly *et al* (1971) argued that large forces caused greater periodontal compression and thus more pain. They stated that some pain accompanies every orthodontic appointment.

Another author evaluated the relationship between initial tooth positions, applied force levels, and experienced pain but observed no statistically significant correlation among the three parameters. Those authors suggested that the degree of displacement of the tooth from the arch wire to indicate the level of applied force and thereby discomfort experienced by the patient should not be considered. **(Richmond *et al.*, 1985)**

All these assumptions and findings point to the fact that malocclusions, however severe, when undergoing orthodontic treatment will elicit a painful response, and little correlation exists between the degree of pain response and applied force magnitude.

1.7.5 Orthopaedic forces and sutural strain

Craniofacial orthopaedics utilizes mechanical forces of a high magnitude, which when applied are absorbed and transmitted to the craniofacial complex. These forces will produce a series of reactions characterized by tissue displacement, deformation, and development of internal stress **(Mao *et al.*, 2003).**

Ten Cate *et al* (1977) after exerting a sagittal expansion force in rats, observed traumatic tears, exudates, death of fibroblasts, disruption of collagen fibers, and acute inflammation. As part of the inflammatory process, the patient perceives a painful sensation, which is often expressed in the whole craniofacial region. There are reports in the literature that demonstrate painful experiences after application of expansive force with rapid palatal expanders **(Needleman *et al.*, 2000).**

Concluded that vast majority of children undergoing rapid palatal expansion experience pain, which occurs during the initial phase and diminishes thereafter. **Egolf *et al in* 1990** found that approximately 28 per cent of patients reported pain as the factor which prevented them from wearing headgear or elastics. Patients often experience discomfort after 24 hours of headgear wear and there is a sharp decline in pain after 3 days

Ngan *et al* in 1997 Evaluated the discomfort levels associated with combination therapy, headgear, and a Transpalatal arch (TPA).

They suggested that wearing of a headgear and a TPA should never be started together and that headgear wear should precede TPA wear by at least 1 week. **Ngan *et al in* 1997** concluded that protraction headgear does not induce muscle pain or produce an increase in muscle activity. It is clear that the pain associated with orthopaedic devices is not of a muscular nature but a part of the acute inflammatory reaction occurring at the sutural regions.

1.7.6 Debonding

An author evaluated the threshold level for patient discomfort at debonding and concluded that tooth mobility and force application were the two important influencing factors. They found intrusive forces to produce less pain at debonding in comparison with forces applied in a mesial, distal,

facial, lingual, or extrusive direction. They suggested applying finger pressure or asking the patient to bite on a piece of cotton roll to minimize pain while debondingn **(*Williams et al.*,1992).**

1.8 Management of pain during orthodontics treatment:

1.8.1 Pharmacological approach

Non-steroidal anti-inflammatory drugs are still the most preferred method for pain control during orthodontics for decades. They are useful in relieving orthodontic pain, but on the other hand, they can reduce the rate of tooth movement which is still being debated, for that reason, NSAIDs are not consistently used to control pain in orthodontic practice Painful sensations are initiated by prostaglandins when they bind to sensory endings an aid tooth movement through bone remodeling stimulation **(Anbuslevan *et a*l., 2012)**.

Studies have shown that the production of prostaglandi is made possible by COX enzymes and that the activity of COX enzymes is inhibited by NSAIDs

By hampering the release of prostaglandin, orthodontic pain is alleviated by NSAIDs. Consequently, bone remodeling and local inflammation are promoted by prostaglandin, and reduced levels of prostaglandin resulting from NSAID intake could hinder osteoclasts activity and reduce the rate of tooth movement **(Hägg *et al*.,1997)**.

Different types of NASIDs are available like Acetaminophen, Ibuprofen, Celecoxib, Misoprostol and Naproxan sodium. The effectiveness of the use of NASIDs in avoiding impeding tooth movement is different among various studies (Figure 1.8.1). **(Shetty *et al.,2013).***

Figure 1.8.1: Ibuprofen tablet **(Kaci Durbin *et al*,.2022)**

Anaesthetic gels are safer alternatives to analgesics in reducing the pain which results from orthodontic procedures. they may be of use when orthodontic procedures are performed, such as band placement and cementation, archwire ligation, and band/bracket removal. The advantage of this system is its delivery method, which simply introduces the gel into the gingival crevice and makes it entirely painless **(Keim et al,.2004).**

1.8.2 Mechanical approach

Different mechanical ways have been suggested for pain reduction during orthodontic treatment and these include vibration, chewing gums, biting wafers and acupuncture **(Saloom *et al*,. 2012)**

The management of orthodontic pain through vibratory stimulation involves the application of vibration to patients' teeth by placing a vibrating device in their mouths. Orthodontic pain can be alleviated by directing patients to use chewing gums and bite wafers. The mode of action of vibration, chewing gums and biting wafers can be related to the fact that mechanical stimuli initiate mechanoreceptors that transmit tactile signals while suppressing the transmission of painful signals. Besides that, orthodontic forces squeeze periodontal vascular vessels and cause local ischemia and ensuing local inflammation. Vibrations re-establish normal circulation

and hence decrease pain in spite of controversies present for the effectiveness of vibration in relieving orthodontic pain Due to a lack of evidence, there is need for proof of the effective use of chewing gum and biting. Acupuncture has been found to be effective in relieving orthodontic pain their mechanisms of action for the relieve of orthodontic pain remain unknown **(Marie *et al*.,2003).**

1.8.3 Behavioral approach

Different behavioral approaches are used to reduce orthodontic pain. They include: physical activity, cognitive behavioral therapy and music therapy **(Feliciano *et al*.,2014).**

Reassurance and attention confusion are the common features shared by these procedures. Anxiety and stress have been reported to accompany orthodontic pain, and a quick follow-up could decrease the levels of orthodontic pain significantly. This means that by reassuring orthodontic patients, orthodontic pain may be controlled. One pattern of psychotherapy is cognitive behavioral therapy using to correct the negative attitudes of the patients and reduce their anxiety. Increased anxiety aggravates pain sensations in patients via the limbic system-mediated neural pathways. It has been shown in clinical practice that lowering of patients' anxiety through CBT is an effective way of reducing orthodontic pain. Other modalities such as music therapy and physical activity can relieve orthodontic pain in clinical practice throughout distracting the patients' attention via the insular cortex mediated neural pathways **(Zhang *et al*.,2013).**

1.8.4 Low-level laser therapy

Low-level laser therapy has been widely used for pain alleviation in both medical and dental practice. Pain relief during orthodontic treatment has been achieved by using it. Low-level laser therapy involves the application of laser

irradiation to the entire dental arch. Evidence exist to confirm the effective use of low-level laser therapy in orthodontic pain relief, however, other study had disproved its effectiveness. Different irradiation dosages and durations may be responsible for these disagreements. As a result, the protocols of irradiation should be explained and further verification of their influence is required. (Figure 1.8.4)

Figure 1.8.4: low laser therapy and laser device **(Williams *et al.*,1992).**

1.8.5 Gene therapy

Gene therapy refers to a method of moving DNA sequences or genes to target cells with a view to alter the biological functions of the target cells. When endogenous opioid genes are moved into neurons, the alleviation of pain could be achieved. In a clinical trial of humans, gene therapy was used to alleviate cancer pain and satisfactory results were obtained. Different types of viral vectors have been employed for conveying concerned genes into target cells, including herpes simplex virus . Neurotropism of herpes simplex virus makes it to be useful in gene therapy for disorders of the nervous system including pain. Furthermore, endogenous opioid genes or RNA interference sequences can be transferred into the trigeminal ganglia against pro-inflammatory genes like Calcitonin gene-related

peptide (CGRP) by using herpes simplex virus to alleviate orthodontic pain. Nowadays, in clinical practice, gene therapy usage is restricted due to biosafety reasons. However, gene therapy may become an applicable treatment method for the alleviation of orthodontic pain if its biosafety complicity is looked into in the near future. **(Collen et al,. 2003).**

Chapter two: Discussion

Pain and discomfort are a common complication during active orthodontic treatment with fixed appliances. Pain relatively starts within four hours, increases over the next 24 hours, and decreases within seven days after initial bonding and placement of separators. (**Koritsánszky *et al.*,2011).**

Pain intensity can also be affected by the type of appliance. Patients with fixed appliances report significantly greater pain intensity than those with removable ones According to the reviewed articles, both pharmacological and non-pharmacological methods were introduced in orthodontic pain management. However, orthodontists must use their best professional judgment to assess each case individually and select an appropriate treatment modality based on pain threshold level of an individual **(Marques *et al.*,2014)**

Non-steroidal anti-inflammatory drugs (NSAIDs) are still the most preferred method for pain control during orthodontics for decades. They are useful in relieving orthodontic pain, but on the other hand, they can reduce the rate of tooth movement which is still being debated so Anaesthetic gels are safer alternatives to analgesics in reducing the pain which results from orthodontic procedures (**Fujiyama *et al.*,2014).**

Other treatment modalities in orthodontic treatment include chewing gum and biting on wafers **(Krasny *et al*.,2013).**

Low-level laser therapy had been introduced earlier as another treatment modality for orthodontic pain control. Besides its analgesic effect, low laser therapy enhances tissue recovery and accelerates tooth movement **(McGrath *et al*,.2015).**

Analgesics and laser irradiation remained effective in the management of orthodontic pain at its peak intensity among all used interventions. However, further research is required to improve the quality of evidence **(Sonesson *et al*,.2016).**

Chapter three: 3.1 Conclusion

- Orthodontists must use their best professional judgment to assess the pain threshold level of each patient individually.
- Effective orthodontist-patient communication and targeted nutritional guidance may help in preventing pain and discomfort experienced by the patients to some extent.
- However, based on the available literature, analgesics remained the effective and routine methodology of pain management.
- Moreover, while prescribing analgesics, orthodontists must be aware of the pharmacological action as well as the pros and cons related to each drug.
- A maximum recommended dose should be taken into consideration for each patient.

3.2 Suggestions

Nevertheless, pain management is a complex phenomenon. Therefore, further investigations combining different methods of orthodontic pain control with appropriate study designs and large sample sizes are required.

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