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(REVIEW ARTICLE)

The effect of orthodontic treatment with premolar extraction against the temporomandibular joint and masticatory muscles: A review

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Abstract

Temporomandibular joint (TMJ) is a hinge joint that connects the maxillary and mandibular bones between the head of the mandibular condyle and the temporal bone. Removing premolars can cause Temporomandibular Disorder (TMD) which is still debated due to diagnostic errors or errors in mechanotherapy during treatment. Most of the literature states that there is no scientific evidence that premolar removal is a risk for TMD. However, orthodontists should still be aware of anterior tooth contact during orthodontic treatment due to incisor retroclination, deepening of the bite, and incisal interference. The use of low force is still the mainstay for anterior retraction so that there is no decrease in vertical dimension due to loss of anchorage. Achieving the centric relation is the ideal goal of orthodontic treatment, so determining the pre-treatment centric relation is essential. Orthodontic treatment generally tends to improve rather than worsen TMJ conditions.

Purpose: This study aims to describe changes in the TMJ and masticatory muscles after orthodontic treatment with premolar extraction.

Conclusion: Several studies have shown no significant difference in masticatory muscles before and after orthodontic treatment with extraction.

Keywords: Premolar extraction; Temporomandibular joint; Masticatory muscle; Orthodontic treatment; Human & health

1. Introduction

The temporomandibular joint (TMJ) is a joint that connects the temporal bone at the inferior part of the squamous pars with the mandibular condyle. The TMJ is the most complex joint and functions to connect the maxillary and mandibular bones in the physiological movement of the mandible, which opens and closes like a hinge, shifts forward and backward from one side to the other, and has an essential role in the process of mastication, swallowing, and pronunciation [1,2].

One of the most common procedures in orthodontic treatment is premolars extraction [3,4]. Extraction of premolars is often chosen as an alternative in finding space to correct moderate or severe crowding, managing partial malocclusions with impacted canines, anterior open bites, and large overjets [3,5-8]. In addition, premolar extraction is the main alternative chosen in the treatment plan in patients with a protrusive profile. Extraction of premolars is also often

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performed in orthodontic camouflage treatment in skeletal class II and class III malocclusion cases in adult patients. However, several things must still be considered in the choice of extraction as a treatment plan, such as stability and facial esthetics after orthodontic treatment and changes in the temporomandibular joint [8].

Although orthodontic treatment with premolar extraction is often done, some orthodontists still question the existence of changes or negative effects that occur in the TMJ. This thought arose with the notion that premolar extraction followed by retraction would change the position of the mandible and condyle more posteriorly [4]. This narrative study aims to describe changes in the temporomandibular joint and masticatory muscles after orthodontic treatment with premolar extraction.

2. Literature Review

2.1. Temporo-Mandibular Joint (TMJ)

The TMJ plays an essential role in the movement of the jaw during mastication. One of the body's most complicated joints is TMJ, a place where the mandible articulates with the cranium. This articulation allows for joint movement, which is called the ginglymoid joint, and at the same time, there is also a smooth movement classified as an arthrodial joint [1,9]. The temporomandibular joint is formed by the condyle of the mandible, which is located in the mandibular fossa of the temporal bone. The joint plate separates the two bones from their direct articulation [1]. The TMJ is classified as a compound joint. The TMJ consists of hard tissue, soft tissue, ligaments, muscles of mastication and neck, nerves, and blood vessels [1,10,11].

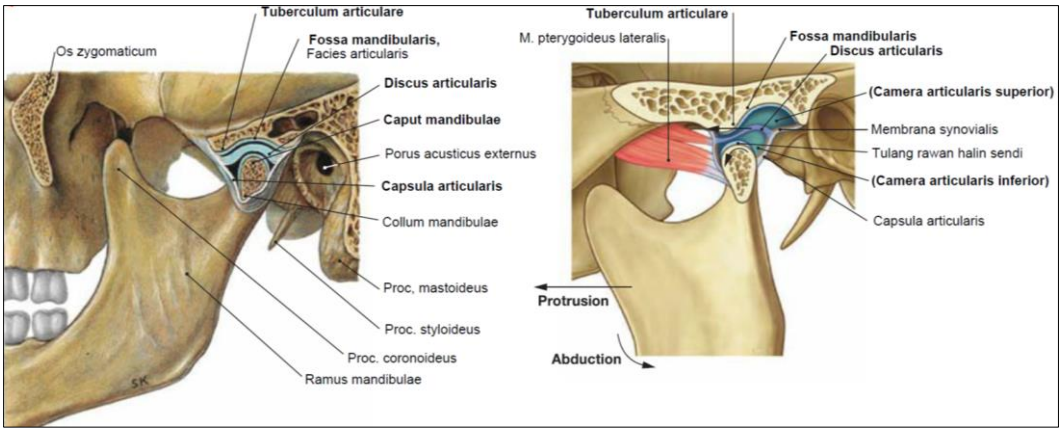

Figure 1 Temporomandibular joint [11].

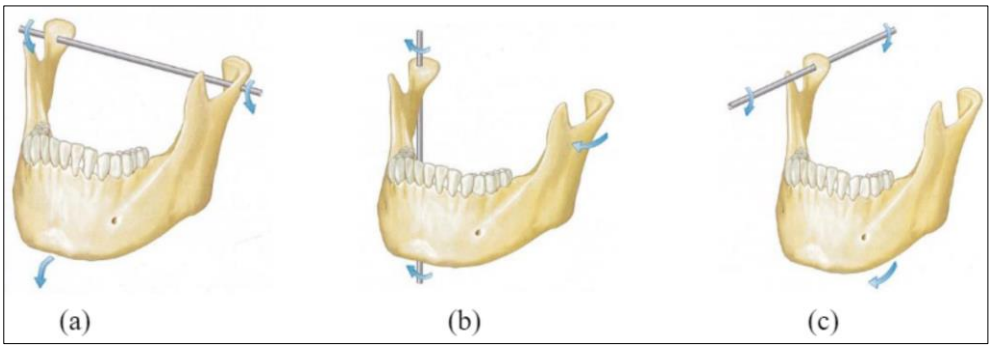

Figure 2 Rotational movement. (a) Horizontal axis's rotation movement. (b) Vertical axis'srotation movement. (c) Sagittal axis's rotation movement [21].

There are two main movements at the TMJ joint (Figure 2 and 3), namely rotation and glide or translational movement. Rotational movement is a rotating motion about its axis that happens between the articular disc's inferior surface and the condyle's superior surface. Based on the axis is divided into: Horizontal, Frontal/vertical, and Sagittal [1]. Glide or translational movement (Figure 4) is a movement in which each object point moves concurrently with the same speed

and direction. Translation happens when the (lower) jaw moves forward, protruding more so that the ramus, condyles, and teeth all move in the same degree and direction of inclination in the masticatory system [1,9,10,12].

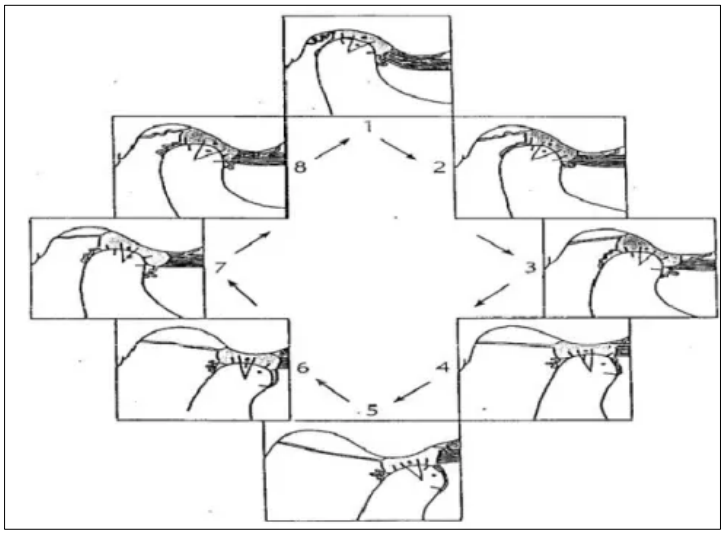

Figure 3 Schematic of the temporomandibular joint on rotational and translational motion when opening and closing the mouth.

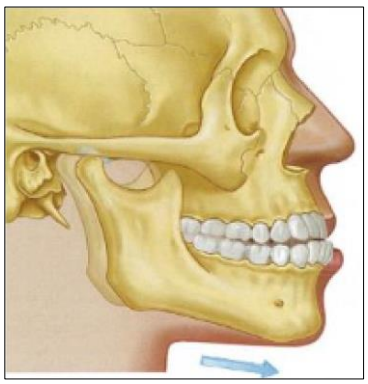

Figure 4 Translation Movement

TMJ function depends on the harmony of hard tissue structures such as condyle bone, mandibular fossa, articular eminence, and soft tissue: articular disc, ligaments in the form of collateral, capsular, temporomandibular, sphenomandibular, stylomandibular, masticatory muscles such as temporalis, masseter, medial pterygoid, and pterygoid lateralis and neck muscles (digastric), but in the presence of initiating factors (trauma, excessive chewing load), predisposing (anatomy, occlusion, bad habits, systemic, psychological conditions), perpetuation (hormonal and psychosocial factors), allows the occurrence of functional abnormalities of the TMJ because the TMJ system is complex so that changes in the components of the system will cause TMJ abnormalities [1,2,13-15].

Based on Singh (2007), Temporomandibular joint disorders' symptoms and signs are: joint sound, feeling sore/tired in masticatory muscles, limited mouth opening, disturbances in mandibular movement, which include deviation and deflection of the jaw, cute malocclusion due to disorders of masticatory muscles, tooth wear, facial pain, headache, disorders of the ear [16].

2.2. Classification of Angle Malocclusion

For more than a century, the Classification of occlusion has attracted the attention of dentistry. It may be claimed that the most accepted and largely used occlusal classification system is the Angle classification [1,2]. The relationship of the first molar and canines the maxilla to the mandible provides a reasonably good assessment of the anteroposterior jaw relationship, provided that the teeth are positioned correctly in the dental arch.

Angle divides malocclusion into three classes, according to the occlusal relationship of the first molar (Figure 5): (a) class I malocclusion: the relationship of the molar is normal, but the wrong line of occlusion is due to malpositioned teeth, rotation, or other causes; (b) class II malocclusion: the position of lower molars is distally relative to the upper molars, the occlusion line is not defined; (c) class III malocclusion: the position of lower molars is mesially relative to upper molars, the occlusion line is not defined [1,17-20].

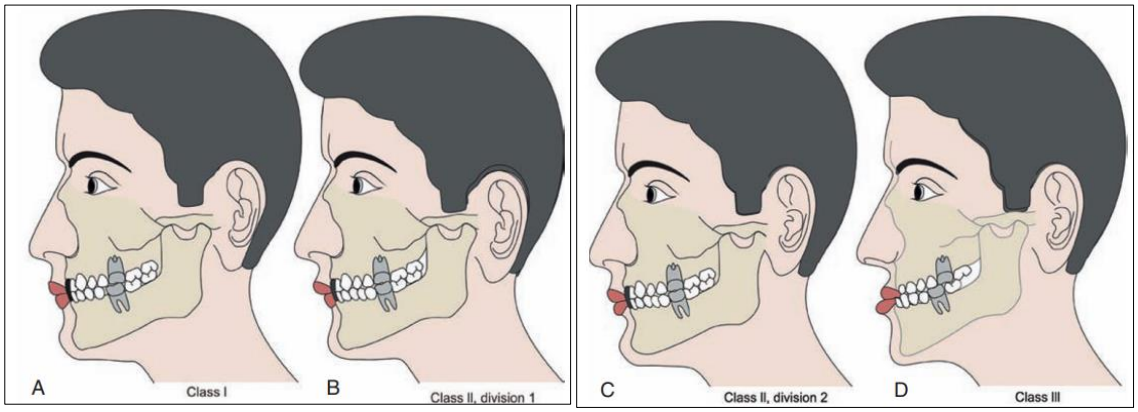

Figure 5 Types of malocclusion based on Angle classification. A: Class I malocclusion. B: Division 1 of class II malocclusion. C: Division 2 of class II malocclusion. D: Class III malocclusion [19]

Orthodontics was no longer just about the alignment of irregular teeth due to the establishment of the concept of normal occlusion and a classification scheme that incorporates the occlusion lines in the early 1900s. Instead, it has developed into the malocclusion treatment, defined as any deviation from the ideal occlusal scheme described by Angle. Maintaining entire teeth is an essential aim of orthodontic treatment since a clearly established connection needs wholeness of the teeth in both arches. Angle and his followers were adamant in their opposition to extraction for orthodontic procedures. However, in order to emphasize the importance of following dental occlusion, face proportions and esthetics were taken into consideration. Angle stopped using extraoral force since he realized it wasn't required for a good occlusal connection. Only by postulating that the finest esthetics are constantly earned when the patient has optimal occlusion did he overcome the dilemma of dental and facial attractiveness [18].

Table 1 Priority table of orthodontic treatment goals according to Angle and its comparison with the soft tissue paradigm [18].

Parameter	**Angle Paradigm**	**Soft Tissue Paradigm**
Primary treatment goal	Ideal dental occlusion	Normal soft tissue proportion and adaptations
Secondary goal	Ideal jaw relationship	Functional occlusion
Hard and soft tissue relation	Ideal hard tissue proportions produce ideal soft tissues	Ideal soft tissue proportions define ideal hard tissues
Diagnostic emphasis	Dental cast, cephalometric radiographs	Clinical examination of intraoral and facial soft tissues
Treatment approach	Obtain ideal dental and skeletal relationships, assume the soft tissues will be all right	Plan ideal soft tissue relationships and then place teeth and jaws as needed to achieve this
Function emphasis	TMJ in relation to dental occlusion	Soft tissue movement in relation to display of teeth
Stability of result	Related primarily to dental occlusion	Related primarily to soft tissue pressure and equilibrium effects
TMJ, Temporomandibular joint		

It became obvious over time that even great occlusion might be unsatisfying if it was obtained at the price of correct face proportions. It is not just an aesthetic issue, but it is sometimes hard to maintain the occlusal connection created by using strong elastics to force the teeth together for lengthy periods of time, as proposed by Angle and his followers. In the 1940s and 1950s, tooth extraction was introduced into orthodontics under the guidance of Raymond Begg in Australia and Charles Tweed in the United States (who had both studied with Angle), to enhance face esthetics and attain more good occlusal stability [18].

2.3. Relationship of malocclusion and temporomandibular joint disorders

Malocclusion is caused by a misalignment of the teeth's position and size and the growth. Malocclusion can cause a decrease in the health value of the individual. In addition, malocclusion is significantly associated with the development of temporomandibular dysfunction. Some studies suggest that certain types of malocclusion can cause temporomandibular joint disorders. Class II angle of malocclusion, class III angel of malocclusion, crossbite, and open bite are examples of the type of malocclusion [18].

2.4. Camouflage treatment with tooth extraction

Camouflage treatment through anteroposterior movement by utilizing the extraction space can be done by extracting the maxillary first premolars or extracting the maxillary and mandibular premolars. With maxillary first premolar extraction, the treatment objective was to maintain the proper molar relationship and close the extraction space by retracting the protruding anterior teeth. The maxillary arch extraction chamber is used to reduce overjet and overbite and correct dental irregularities. Treatment with tooth extraction can also cause mandibular rotation and affect the facial profile, so it is contraindicated in patients with short facial height [18,21].

2.5. Effects of premolar extraction on the orthodontic treatment of the temporomandibular joint (TMJ)

The position of the condyle can be affected by orthodontic treatment, while the position of the condyle itself is closely related to the position of the articular disc. Orthodontic treatment is said to have a risk of TMD if there is an obstruction of occlusion that can spur the displacement of the condyle to the posterior during orthodontic treatment with premolar extraction [22].

Costen first proposed the relationship between occlusal factors and TMD symptoms in 1934 [23-25]. Costen recommended a variety of orthodontic treatments, including occlusal modifications, to address malocclusion and reduce TMD symptoms. TMD may be caused by both functional and structural malocclusions, and the main purpose of TMD therapy is to alleviate discomfort and dysfunction [24,25].

Kirveskari and Alanen's study of 521 patients with loss of 1 to 14 teeth stated a significant relationship between upper premolar loss and TMD without explaining the process [25]. Premolar extraction is hypothesized to cause mandibular distalization, posterior displacement of the condyles, depth of the bite, and TMD by causing a decrease in vertical dimension, retroclination of the upper incisors, and interference of the anterior teeth. Interference in the incisor area, such as in a deep bite, can trigger joint dislocation because the mandible is pushed posteriorly when closing the mouth [27].

Research by Artun et al. 1992 concluded that posterior displacement of the condyle is more likely to occur in division 1 of class II malocclusion upper premolar extraction only. The impact of premolar extraction on division 1 of class II malocclusion was investigated by Lueke and Johnston. They stated that after a mean maxillary incisor retraction of 5 mm, seventy percent of patients showed forward displacement of the maxillary basal bone. Significant condylar changes were not associated with incisor retraction but with occlusion of the buccal segment and maxillary development. Thirty percent of patients experienced distal condylar displacement, especially in adult patients with moderate lower anchor loss and less upper anchor loss [4].

According to Wyatt (1988), anterior and premolar retraction in division 1 of class II malocclusion can result in posterior condyle displacement and anterior disc displacement [28]. Farrar and McCarty stated that orthodontic treatment with premolar extraction did not have good stability related to excessive maxillary incisor retraction, which could cause the mandible to shift posteriorly. A posterior shift of the mandible can cause the disc to slip and shift its position more anteriorly and cause internal derangement [22]. Internal derangement is a common cause of pain in the TMJ that occurs due to disruption of the normal anatomical relationship between the disc and the condyle, resulting in impaired joint movement. The pain is caused by compression of the condyle against the retrodiscal tissue, a tissue that has many nerves, in the glenoid fossa [29,30].

Internal dearrangement occurs in 3 stages; the first stage is the painless incoordination phase, in which a catching sensation or the joint stops is moving for a moment that occurs when opening the mouth; the second stage is anterior disc displacement with reduction on mouth opening, which is characterized by clicking or popping (Fig. 7A); the third stage is anterior disc displacement without reduction, when trying to open the mouth, which is characterized by jaw movement inhibition or locking (Fig. 7A) [4].

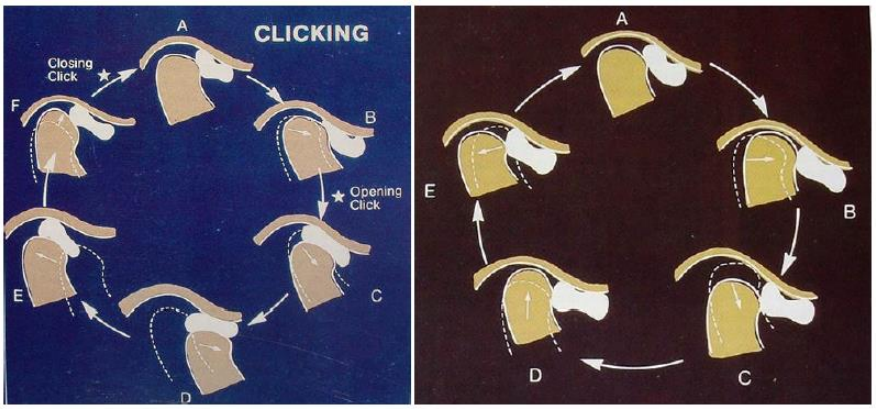

Figure 6 A. Condyle and disc movement in anterior disc displacement with reduction. B. Condyle and disc movement in anterior disc displacement without reduction (taken from http://www.occlusion.dent.chula.ac.th)

Nielsen L et al. stated that several orthodontic mechanics have a negative effect on the stomatognathic system because of the creation of new occlusal patterns, one of which is premolar retraction and incisal retraction because it causes displacement of the condyle to the posterior and additional load on the pain-sensitive area. Actions that can affect the TMJ and exacerbate existing TMD, namely the use of class II elastics, elastics for midline correction, headgear, and chin cups because they can change the position of the TMJ posteriorly. Nielsen et al. compared the palpation of post-orthodontic patients with controls in order to assess the influence of orthodontic treatment on the masticatory system, and found that the prevalence of muscle and TMJ discomfort was higher in the group. Still, there was no difference in the prevalence of joint sounds [31]. Witzig and Spahl recommend extraction of the second molar in search of space compared to the extraction of premolars because it provides a better esthetic impact and a healthy TMJ. However, there will be an increase in vertical dimensions [32].

Henrikson et al. used a history of clinical evaluation and a questionnaire before, during, and after therapy, as well as one year following treatment, to state several things. According to Henrikson et al., there was a decrease in the prevalence of muscular soreness on palpation, as well as a decrease in symptoms during and after therapy [33]. Janson and Hasund studied 60 patients with various premolar extractions and found that orthodontic therapy, even in severe malocclusion, had no risk of developing TMD. Gianelly, 1988, and Kendinger, 1991, stated that there was no difference in the position of the condyles in both controls and patients after orthodontic treatment with extraction [27,33]. Sadowsky used audiovisual evaluation to examine clicking noises in 160 patients and found no significant change in TMJ sounds before and after therapy in both non-extraction and extraction procedures. Reciprocal clicking noises were discovered before orthodontic treatment [34].

McNamara and Bennett stated that malocclusion would result in impaired masticatory performance. Tome et al. investigated the effect of extraction on the TMJ by looking at changes in mandibular trajectory and smoothness of mandibular movement by calculating the jerk-cost, which was identical to the change in acceleration. The smaller the mandibular trajectory variation and the smaller the difference in the acceleration of mandibular movement, the more effective the kinematic ability of mandibular movement. The presence of malocclusion will reduce the kinematic effectiveness of mandibular movement, whereas better occlusion, one of which is through orthodontic treatment, will increase the kinematic effectiveness of mandibular movement [35].

There was no significant relationship between signs and symptoms with orthodontic treatment caused by tooth extraction and symptoms and signs of TMD, according to a 20-year study by Dibbets and Van Der Weele on the evaluation of orthodontic treatment with tooth extraction and signs and symptoms of TMD [36]. Research by Kremenak et al. using the TMD index stated similarly that 90% of the sample showed the TMD index value remained or even improved, while 2% of the sample showed an increase of 5 points on the Helkimo scale [37].

2.6. Effect of premolar extraction on orthodontic treatment on the muscles of mastication

One of the etiological causes for malocclusion is the force of the masticatory muscles. Changes in the masticatory muscles are feared to disrupt the long-term stability of orthodontic treatment results. Kundinger's study, 1991, using EMG to calculate masticatory muscle contractions during clenching, stated that there was no significant difference between the masticatory muscle contraction ratio values in control and post-orthodontic treatment patients with extractions.'One of the etiological causes for malocclusion is the force of the masticatory muscles [4].

Tongue thrusting is a division 1 of class II malocclusion hallmark, which generally has excessive overjet. It stimulates the perioral muscles to make lips contact, and the tongue will move forward to close the oral cavity during swallowing. This pattern aims to create a negative intraoral pressure which plays an important role in swallowing. When compared to normal occlusion, muscle tension in the premolar region during swallowing is two times higher in division 1 of class II malocclusion. Under normal conditions, the anterior third of the tongue is in contact with the incisor papillae and the palate next to the upper incisors during swallowing. At the same time, the lips remain closed [38].

At resting, more than half of patients with division 1 of class II malocclusion show an adjustable tongue position. Because of the big overjet, the tongue's form is adjusted to the shape of the dental arch; the tongue is more forward and between the dental arches. In the Souza study sample, the anterior section of the tongue contacted the lingual region of the upper incisors in 47 percent of individuals with division 1 of class II malocclusion. 70% of division 1 of class II malocclusion patients have an adapted tongue position after upper incisor retraction. The rising proportion of patients with adapted tongue posture suggests that premolar extraction in division 1 of class II malocclusion therapy may not improve tongue posture; in fact, it may encourage the normal tongue to adapt to a new position that is further forward, reducing post-treatment stability [38].

The suprahyoid and mylohyoid muscles are part of the stomatognathic system that plays a major role in swallowing. Contraction of the suprahyoid muscles stimulates contraction of the floor of the mouth and pushes the tongue toward the palate. The mylohyoid muscle functions a lot during chewing, sucking, and in the early stages of swallowing. There are various swallowing patterns, and the masticatory muscles need to adapt to new patterns after retraction [38].

Patients with division 1 of class II malocclusion showed synergy of the right and left suprahyoid muscles after orthodontic treatment, although their myoelectric activity remained significantly different from that of class I malocclusion patients. There was no increase in perioral muscle strength after treatment while the tongue posture tended to move forward so that the probability of relapse was greater. According to Anderson et al., the risk of recurrence in division 1 of class II malocclusion therapy with premolar extraction and anterior retraction is similarly linked to the size of the dental arch following extraction [39].

3. Discussion

TMJ is a joint which connects the temporal bone at the inferior part of the squamous pars with the mandibular condyle. The TMJ is the most complex joint and functions to connect the maxillary and mandibular bones in the physiological movement of the mandible, which opens and closes like a hinge, shifts forward and backward from one side to the other, and has an important role in the process of mastication, swallowing, and swallowing and pronunciation [1,2].

One of the most popular treatments in orthodontic therapy is premolar extraction [3,4]. Extraction of premolars is often chosen as an alternative in searching for space to correct moderate or severe crowding, management of partial malocclusions with impacted canines, anterior open bites, and large overjets [3,5-8]. In addition, premolar extraction is the main alternative chosen in the treatment plan in patients with a protrusive profile. Adult patients with skeletal class II and class III malocclusions frequently have their premolars removed as part of their orthodontic camouflage therapy. However, several things must still be considered in the choice of extraction as a treatment plan, such as stability and facial esthetics after orthodontic treatment and changes in the temporomandibular joint [8].

Any changes or negative effects that occur in the TMJ. This thought arose with the notion that premolar retraction followed by retraction would change the position of the mandible and condyle more posteriorly [4]. This narrative study aims to describe changes in the TMJ and masticatory muscles after orthodontic treatment with premolar extraction.

Malocclusion is caused by a misalignment of growth with tooth position and size. A person's health value might be lowered as a result of malocclusion. In addition, malocclusion is significantly associated with the development of temporomandibular dysfunction. Some studies suggest that certain types of malocclusion can cause

temporomandibular joint disorders. Angle class II and class III malocclusions, crossbite, and open bite are examples of the type of malocclusion in issue [18].

Camouflage treatment through anteroposterior movement by utilizing the extraction space can be done by extracting the maxillary first premolars or extracting the maxillary and mandibular premolars. With maxillary first premolar extraction, the treatment objective was to maintain the proper molar relationship and close the extraction space by retracting the protruding anterior teeth. The maxillary arch extraction chamber is used to reduce overjet and overbite and correct dental irregularities. Treatment with tooth extraction can also cause mandibular rotation and affect the facial profile, so it is contraindicated in patients with short facial height [18,21].

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One of the etiological causes for malocclusion is the force of the masticatory muscles. Changes in the masticatory muscles are feared to disrupt the long-term stability of orthodontic treatment results. Kendinger's study, 1991, using EMG to calculate masticatory muscle contractions during clenching, stated that there was no significant difference between the masticatory muscle contraction ratio values in control and post-orthodontic treatment patients with extractions. The calculated ratio indicates the value of the anterior masseter and temporalis muscles' contribution to the maximal voluntary biting force [4].

Patients with division 1 of class II malocclusion showed synergy of the right and left suprahyoid muscles after orthodontic treatment, although their myoelectric activity remained significantly different from that of class I malocclusion patients. There was no increase in perioral muscle strength after treatment while the tongue posture tended to move forward so that the probability of relapse was greater. Anderson et al. explained that reduced dental arch size following extraction is similarly linked to the probability of recurrence in division 1 of class II malocclusion therapy with premolar extraction and anterior retraction [39].

4. Conclusion

The orthodontic treatment with premolar extraction has no effect to the temporomandibular joint and masticatory muscles. There is no scientific proof that premolar removal causes temporomandibular disease. During orthodontic treatment, however, orthodontists should be cautious of anterior tooth contact, which can develop owing to incisor retroclination, bite deepening, and incisal interference. The use of low force is still the mainstay for anterior retraction so that there is no decrease in vertical dimension due to loss of anchorage.

Compliance with ethical standards

Disclosure of Conflict of interest

No Conflict of interest to be disclosed.

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