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(REVIEW ARTICLE)

The role of Function Generating Bite (FGB) devices on changes of chewing patterns and muscle activity in deep bite malocclusion

Anis Irmawati [1, *], Beti Ratnasari [2], Noor Faizah Balqis [3], Yassir Ahmad Azzaim [4, 5], Barakat Al-Tayar [5, 6], Aqil Fadhilah Karisma Lady [5] and Ovin Gabriella Notonugroho [7]

[1] *Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[2] *Orthodontic Department, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[3] *Postgraduate Program, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia.*
[4] *Department of Dental Material, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[5] *Magister Program, Dental Health Sciences, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[6] *Department of Orthodontics, School of Stomatology, Lanzhou University, Lanzhou, China.*
[7] *Undergraduate Program, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.*

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Abstract

Background: A malocclusion known as a deep bite occurs when the mandibular incisors are covered by the maxillary incisors by more than the normal value of 30-40% or 2-4 mm. Deep bite is a type of malocclusion that is often found in children and adults, with a prevalence of 23.83% in the Asian population. Patients with a deep bite have a restricted masticatory pattern and have excess function of the mastication muscles. Active muscle training should be recommended to improve jaw bone morphology.

Objective: This review aims to explain the role of the Function Generating Bite (FGB) device on changes in masticatory patterns and muscle activity in deep bite malocclusion.

Methods: The search for literature reviews was conducted using the ScienceDirect, PubMed, and Google Scholar databases. The selected literature was published between 2010 - 2023 in English and Indonesian.

Discussion: Treatment of deep bite in each patient varies depending on the etiology of the malocclusion. One of the functional therapies that can be used to correct malocclusion is FGB. The FGB device has an anchorage system on the muscles, which can regulate and exert pressure intermittently, so as to correct dental malocclusion and functional imbalance.

Conclusion: Treatment with FGB has been shown to significantly improve the lateral component of the masticatory pattern and reduce muscle hyperactivity in deep bite patients during mastication.

Keywords: Deep Bite Malocclusion; Mastication Pattern; Muscle Activity; Function Generating Bite; Good Health and Well Being.

1. Introduction

A malocclusion known as a "deep bite" occurs when the mandibular incisors are covered by the maxillary incisors by more than the normal value of 30-40% or 2-4 mm. One of the most common malocclusions is the deep bite, which affects 46.2% of people in Germany, 41% of people in Italy, 24% of people in the United States, and 21.6% of people in

* Corresponding author: Anis Irmawati

Colombia. Based on population-based studies performed in, Chinese, Indian, Malaysia, Korea, and Middle Eastern countries, the prevalence of deep bite in the Asian population is estimated to be 23.83% [1,2]. According to Alhammadi et al. (2018), prevalence of deep bite in local distribution is 25.83% in permanent teeth and 21.56% in mixed teeth. Deep bite is a type of malocclusion that is often found in children and adults [3]. Patients with deep bite mild usually do not require special treatment, unless the patient wants correction deep bite to improve facial esthetics. The case of severe deep bite if not treated can affect the temporomandibular joint, causing problems in the periodontal tissue, causing tooth wear as a result overlapping excess on the incisor teeth, and causes trauma to the incisor papilla and palatal mucosa, and interferes with the function of mastication [4,5].

Maintenance of deep bite in each patient varies depending on the etiology of malocclusion [4]. Treatment plan for deep bite correction must consider soft tissue, skeletal pattern, interocclusal space, occlusal plane, stability, time of treatment, also the age of the patient. Deep bite correction it will be simpler to achieve and the results will be more stable if it is done on patients in the age of growth and development. Methods for correction of deep bite including intrusion of anterior teeth, extrusion of posterior teeth, combination of extrusion of posterior teeth and intrusion of anterior teeth, and surgery [6].

Patients with deep bite has overfunction of the mastication muscles. Most of the patients with deep bite and open bite indicates dysfunction of the masticatory muscles. The proclination of the incisors and the vertical dimensions of the face can influence the function of the lower lip, with higher activity being seen in these deep bite patients. Active muscle training should be recommended to improve the morphology of the jawbone. It is true that muscle functional training can be used to prevention of jaw deformity [7,8]. Oral functional therapy can be carried out during the child's developmental period through orthodontic appliances, ie Function Generating Bite (FGB). Removable orthodontic appliance is a FGB that can affect malocclusion and improve masticatory function [9]. This study aims to explain the role of FGB device on changes of the pattern of mastication and muscle activity in deep bite malocclusion.

2. Methods

The search for literature reviews was conducted using the ScienceDirect, PubMed, and Google Scholar databases. The search was limited to articles focusing on FGB Devices in deep bite malocclusion. The selected literature was published between 2010 - 2023 in English and Indonesian. The selected literature was accessed in full text by selecting the article type in the research and review form. Articles were selected and reviewed according to the inclusion criteria. Then, the selected articles were reviewed and summarized by the author from the relevant previous research results, so the author can make an article based on the study results.

3. Literature Review

3.1. Deep Bite Malocclution

Malocclusion can occur in three planes, namely the sagittal, transverse and vertical planes. Malocclusion that occurs in the vertical plane is deep bite. Deep bite defined as vertival overlapping maxillary incisors covering excess mandibular incisors in centric occlusion position. The normal overbite shows the incisal tip of mandibular anterior teeth contacting the cingulum of maxillary anterior teeth, with a distance between the maxillary and mandibular incisal edges of approximately 1-3 mm, or the maxillary incisors covering one third of the height mandibular incisor clinical crown. Deep bite is a type of malocclusion that is often found in children and adults [1,4]. Deep bite can be divided into several categories, including dentoalveolar deep bite and skeletal deep bite, incomplete deep bite and complete deep bite, true deep bite and pseudo deep bite [6].

3.2. Deep Bite Characteristics

Characteristics of patients with deep bite is a decline gonial angle, curve of Spee deep, decreased posterior maxillary dimensions, downward rotation of the palatal plane, more forward position of the ramus. Deep bite related to facial height lower, especially in the lower third of the facial area, wider anterior and basal alveolar areas, retroclination of the maxillary incisors. Curve of Spee sloping caused by mandibular incisor supraeruption due to adaptation to obtain occlusal contact with maxillary incisors [1,4,6]. Deep bite skeletal is associated with an upward growth pattern of the mandibular condyle and a hypodivergent craniofacial structure; common characteristics of the dentition are incisor supraclusion, molar infraclusion, and increased overjet [2].

Figure 1 Clinical picturedeep bite with supraerupted maxillary anterior teeth [6].

3.3. Deep Bite Etiology

Case treatment of deep bite should be preceded by knowing the cause of deep bite. Overbite excess can be caused by a decrease in the height of the lower face (lower face), overeruption of maxillary anterior teeth, or infraeruption of posterior teeth [10]. The dental or skeletal deep bite can be caused by hereditary factors, environmental, or both combination. Hereditary factors such as skeletal pattern, tooth morphology, pattern of development of malocclusion and development condylar. Environmental factors such as habits lateral tongue thrust, loss of posterior teeth, changes in tooth position, and mastication muscle movements. Anterior deep bite can be caused by infraeruption of posterior teeth or supraeruption of maxillary and/or mandibular incisors. Linear measurements at the alveolar process base were performed using cephalometric analysis to determine the cause of deep bite [6]. According to Varshini et al. (2020), etiology of deep bite classified into inheritent factors consisting of skeletal pattern, tooth morphology, and growth of condylar; and acquired factors consisting of oral habits, changes in the position of the teeth as a result premature loss in primary teeth, also loss of support from posterior teeth [11]. Research by Rodríguez-Olivos et al. (2022) shows that there is a relationship between the occurrence of deep bite with oral habits, namely breathing through the mouth and nose (mixed breathing) [12]. Jabur & Nisayif (2007) stated that children with lip sucking habits indicates an increase overbite [13].

3.4. Deep Bite Mechanism

Anterior deep bite can result from upward or forward rotation of the mandible during growth, or by incisor over-eruption, especially of the mandibular incisors. Generally, the anterior teeth erupt until contact is achieved with the opposing teeth, the palatal mucosa, or the tongue. Deep bite can occur due to skeletal, soft tissue, and dental factors. Deep bite Skeletal occurs as a result of forward mandibular rotation caused by increased vertical posterior facial growth, resulting in a decrease of anterior face height. Soft tissue factors are caused by a higher lower lip in cases of class II division 2 malocclusion, so that the maxillary and mandibular incisors erupt in a retroclinated position. Higher mentalis muscle activity is present in people with impaired lower anterior face height, which can result in retroclination of the maxillary and mandibular incisors and an increase in overbite if the lower lip is positioned higher than normal. If the resting position of the tongue is advanced or the tongue adapts to the lower lip during swallowing, this may occur deep bite incomplete or deep bite complete to the palatal mucosa. Dental factors occur due to mandibular incisor overeruption which is sometimes accompanied by class II malocclusion. Class II division 1 malocclusion with increased overjet, mandibular incisors erupting to contact with the palatal mucosa, or on the tongue in a more forward resting position. Deep bite In class II division 2 malocclusion it is usually caused by retroclination of the maxillary and mandibular incisors. Enhancement overbite also can occur due to overeruption of maxillary incisors [14,15].

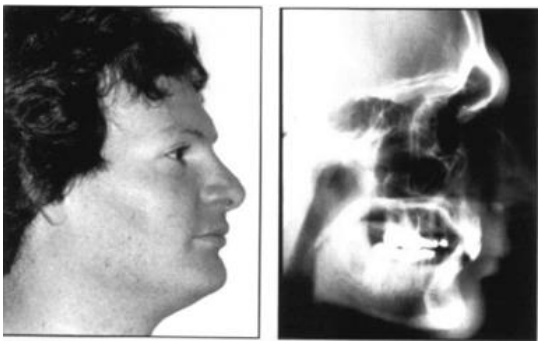

Figure 2 Skeletal lateral view of the deep bite patient. The patient has a concave profile with a anterior face height. Lateral radiograph of the patient in centric relation showsdeep bite caused by retrognathic mandible [14].

3.5. The Impact of Deep Bite

Deep bite left untreated can result in palatal and gingival ulcers, temporomandibular joint disorders, attrition of the mandibular incisors, and impaired mandibular function [16]. Deep bite divided into deep bite complete and incomplete. Deep bite complete covering up to the palatal mucosa of the maxillary incisors is referred to asimpinging overbite, which, when paired with poor oral hygiene, can cause trauma, irritation and discomfort, even causing soft tissue injury. Class II division 2 malocclusion with authenticated at a minimum, retroclinated maxillary incisors may come into contact with the labial gingiva of the mandibular incisors, which when paired with poor oral hygiene can causes gingival recession [15]. Deep bite considered as one of the factors causing pain in the temporomandibular joint and masticatory muscles, especially the medial pterygoid and masseter muscles [17]. Khayat et al. (2021) stated that deep bite the extreme shows a relationship with temporomandibular disorder (TMD) [18]. Alarcon et al. (2000) stated that changes in morphology or occlusal relationships between maxillary and mandibular teeth can lead to differences in muscle and mandibular relationships.condyle-fossa horizontally [19]. Asymmetric masticatory muscle activity can cause pain in TMD.Deep bite can lead to a lack of anterior bite guidance, resulting in excess pressure on the temporomandibular joint and eventually TMD. This can occur in class I, II and III malocclusion [20].

3.6. Therapy of Deep Bite

Therapy of deep bite in each patient varies depending on the etiology of malocclusion. Maintain correction results deep bite is a challenge for orthodontists, because if identification of etiological factors is not carried out properly, patients can experience relapse [4]. Treatment plan for deep bite correction must consider soft tissue, skeletal pattern, interocclusal space, occlusal plane, stability, time of treatment, also the age of the patient. Correction of deep bite it will be easier to achieve and the results will be more stable if it is carried out on patients at a growing age [6].

Deep bite therapy in adult patients is part of temporomandibular joint, restorative, and periodontal therapy. Correction of deep bite include, intrusion of anterior teeth, extrusion of posterior teeth, combination of intrusion of anterior teeth and extrusion of posterior teeth, proclination of anterior teeth, or by surgical methods. Selection of correction method deep bite must benefit the patient or improve patient appearance and functional efficacy. The treatment plan's determination is influenced by various factors, such as vertical dimension and incisor appearance. Treatment with mini screws and segmented arches recommended because the technique can provide an intrusion pressure close to the center of resistance [6,21].

Functional appliances are becoming the treatment of choice for correction deep bite. Functional device for correction of deep bite malocclusion attributed to its ability to modify the potential and direction of jaw growth. Various functional devices have been used for therapy of deep bite, among others: headgear, bionator, twin-block, Frankel II, Herbs, Forsus, a fixed device added with anterior bite plane, and in some severe cases with surgery in combination with orthodontic appliances. The goals of functional treatment are to improve the antero-posterior apical base relationship, promote mandibular growth, and induce desired tooth movement (correction. overjet and overbite) and soft tissue modification [22].

4. Discussion

Deep bite or deep overbite is defined as the amount of centric occlusion that overlaps between the mandibular and maxillary incisors. Patient with deep bite has overfunction of the muscles of mastication. The masticatory muscles, especially the cross of medial pterygoid and masseter, have an important role in the morphology of the mandible; Furthermore, neuromuscular and environmental factors are one of the etiologies of dentofacial deformities [4,8].

One of the characteristics of patients with deep bite is curve of Spee steep or deep. The anteroposterior curve is referred to as curve of Spee is defined as the anatomical curve formed by the occlusal arrangement of the teeth projecting into the median plane, starting from the tip of the mandibular canine cusp to the tip of the buccal cusp of the premolars and molars, continuing to the anterior line of the mandibular ramus and ending at the anterior aspect of the mandibular condyle. Curve of Spee performs a biomechanical function during mastication by efficiency of occlusal forces and enhacing the friction ratio between posterior teeth. Arch of the curve of Spee that deeper are usually found in dental malocclusions with deep bite due to the presence of extruded mandibular anterior teeth. Curve of Spee with normal curvature is necessary for an efficient masticatory system. Arch of the curve of Spee that are too deep can change the balance of the muscles, and cause impaired occlusion function [4,23].

Patients with deep bite has overfunction of the mastication muscles. The masticatory muscles, especially the medial pterygoid and masseter crosses, have an important role in mandibular morphology. Masseter muscle strength (occlusal forces) alone is greater in patients with deep bite compared to patients with open bite, and muscle weakness on the

mastication muscles can cause dilation of the mandibular angle [8]. Differences in craniofacial morphology can causes differences in neuromuscular activity and volume, also orientation of the are across-sectional. Occlusal pressure and Electromyograph (EMG) activity of the masticatory muscles when carrying out their functions are related to the vertical craniofacial morphology, i.e. in facial height. Various characteristics that can affect the amount of occlusal pressure and pattern of muscle activity are gender, age, height, body weight. Individuals with facial height lower, for example in patients with deep bite, has a higher EMG activation. This indicates that there are muscular differences in the stomatognathic system caused by differences in the morphology of the craniomandibular complex. Clinically, this shows that a patient's facial analysis is necessary to determine the treatment plan [24,25]

Maintenance of deep bite in each patient varies depending on the etiology of malocclusion. Correction of deep bite, include posterior tooth extrusion, incisor intrusion, or both [4,21]. Functional devices are the treatment of choice for cases deep bite, especially in patients of growing age. Functional devices work by exploiting, eliminating, or guiding stress from muscle function, tooth eruption and development for the correction of malocclusion [26] When the appliance is used, the mandible experiences a downward and forward movement, causing soft tissue and muscle stretching, and a myotatic reflex occurs [27]

One of the functional therapies that can be used to correct malocclusion is FGB. Removable orthodontic appliance is a FGB that can affect malocclusion and improve masticatory function. FGB is a functional appliance individually manufactured from acrylic resin with characteristics posterior bite enhancer made of metal. This device is also known as gnatological tool. FGB is not only used for the dental malocclusions correction, but it is also used for the abnormal chewing patterns correction with significant results [9].

Research by Pinancino et al. (2022) performed involving 81 deep bite malocclusion patients who were given treatment with functional therapy using FGB devices, and the mastication patterns and activity of the masticatory muscles were recorded with Electromyography (EMG) before and after treatment. The results showed that the ability of patients with deep bite to apply pressure when mastication is no different from that of a normal subject. Deep bite patient can adapt the chewing pattern to the consistency of the bolus (food), although muscular activation during mastication is significantly increased. Analysis of the masticatory cycle indicates inhibition of the lateral components of mastication during the closing movement due to malocclusion, causing the masticatory pattern to be more vertical. Analysis of the masticatory cycle after treatment showed that treatment for deep bite using the FGB can significantly improve the lateral component of the masticatory pattern. The results of this study indicate that functional therapy with FGB can significantly reduce muscle hyperactivity in deep bite patients during mastication. This indicates that correction of malocclusion at the occlusal level can alter neuromuscular coordination [2].

Mastication function therapy utilizes a movements variation (exercise) to gain strength awareness, coordination, and displacement and resistance of the jaw, tongue, lips, and cheeks. This action involves active muscle training, passive exercise, muscle stretching, and sensory stimulation [9]. Recent studies suggest that the kinematic mastication cycle in young adult patients with deep bite showed less inferior excursion and greater posterior excursion during the opening movement, as well as decreased closing velocity [2]. Changes in muscle activity can be assessed quantitatively by EMG. EMG is the most objective method for measuring changes in masticatory muscle electrical activity, so that it can detect the effectiveness of orthodontic procedures applied to patients. Surface EMG allows the dentist to evaluate the masticatory muscles non-invasively [28]. The EMG amplitude of the masticatory muscles increases during mastication in individuals with deep bite, and decreased after functional treatment. Changes in the masticatory cycle and increased EMG activity in the masticatory muscles were found in these patients deep bite with mixed dentition, and found changes after treatment with functional FGB devices. The FGB device has an anchorage system in the muscles, which can regulate and exert pressure in an efficient manner intermittent, so as to correct dental malocclusion and functional imbalance [2]. FGB causes the repositioning of the teeth in accordance with the physiological conditions of the temporomandibular joint and avoids cup-to-cup contact position errors on the teeth. This action is caused by a stainless steel bite block positioned in the posterior occlusion region which plays a role in opening the mandible and adjusting the mandible position of the in three planes (sagittal, transverse, vertical) during orthodontic movements [9].

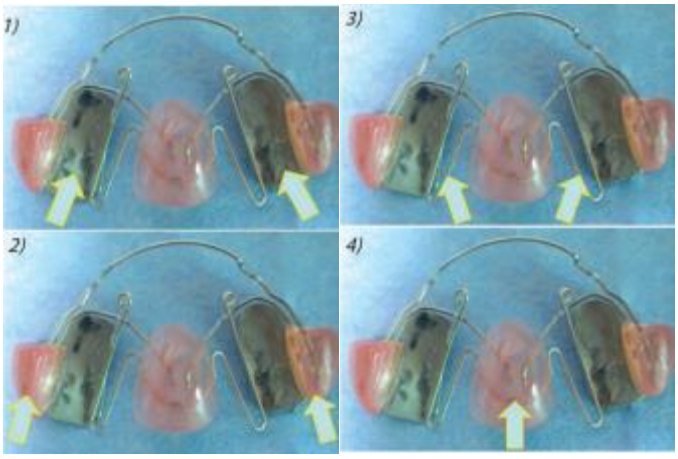

Figure 3 Components on the FGB device: (1)Stainless steel bite block, (2) Buccal shield, (3) Expansion coil, (4) Palatal button.

Therapy deep bite using FGB can significantly reduce muscle hyperactivity during mastication, which is also found in therapy with other removable functional appliances. Nonetheless, individuals with strong masticatory muscles are more prone to relapse after orthodontic treatment involving extrusion of posterior teeth, which then leads to anterior recurrence.deep bite [2]. This is supported by Senthil & Tamizharas (2012) which states that muscle hyperactivation can reappear and then lead to recurrence of malocclusions. The patient should be warned about the risk of relapse, so that the patient can seek treatment immediately [23]. Recurrence of malocclusion can lead to deterioration of the teeth and other structures of the stomatognathic system, which may be irreversible [2].

One of the factors that can affect an individual's response to treatment with functional devices is the masticatory musculature system and its functional capacity [29]. The capacity of the masticatory muscles as measured by bite force and masseter muscle thickness varies from individual to individual, and the characteristics of the muscles are determined by genetic factors. The use of functional devices can affect the thickness of the masseter muscle because the masseter muscles will be active when using functional devices. Orofacial musculature influences facial morphology and dentoalveolar position. The muscles that attached to the mandible include: the temporalis, masseter, medial and lateral pterygoid, and suprahyoid muscle. These muscles can affect dentoskeletal morphology and can cause relapse after orthodontic treatment [30,31].

5. Conclusion

Deep bite malocclusion is not limited to dental malocclusion nalone. Deep bite malocclusion can affect masticatory function, and must be kept in mind during the growth period to prevent worsening of the stomatognathic system. Patients with deep bite have a masticatory cycle with disturbance of the lateral components of mastication during the closing motion resulting in a more vertical masticatory pattern. Patients with deep bite also has hyperactivity of the muscles of mastication. Treatment with Functional Generating Bite (FGB) has been shown to significantly improve the lateral component of masticatory patterns and reduce muscle hyperactivity in patients deep bite during mastication. Choice of treatment for deep bite should be based on the etiology of the malocclusion and may vary from patient to patient.

Compliance with ethical standards

Disclosure of Conflict of interest

No Conflict of interest to be disclosed.

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