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EDITOR

ASSOC. PROF. DR. NESLİHAN YILMAZ ÇIRAKOĞLU

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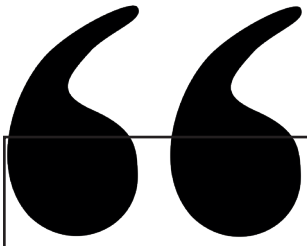
CONTENTS



Chapter 1

CONSERVATIVE OCCLUSAL MANAGEMENT OF TEMPOROMANDIBULAR DISORDERS

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Since the etiology of temporomandibular (TM) disorders is multifactorial and it is not fully known which signs and symptoms will cause more serious problems in the future, it is generally desired that the initial treatments are irreversible. A multidisciplinary approach is required in the conservative treatment of TM disorders (Ardic F et al. 2006; Atsu SS Ayhan-Ardic F, 2006; Okeson JP, 2020). Considering the etiological factors, the patients are informed about the disorder in terms of treatments such as drug therapy, physical therapy, intraoral interocclusal splints (appliance) and occlusion adjustment. The aim of the treatment of TM disorders is similar to the treatment of other orthopedic disorders, to reduce pain, improve function, reduce overloading of the temporomandibular joint (TMJ) region and chewing muscles, and ensure normal daily activities (Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr, 2022; Zhang SH. et al, 2020). It should not be forgotten that the musculoskeletal system has a natural healing capacity in conservative treatment. Although the treatment of simple TM disorders is relatively easy, the treatment of chronic, complex TM disorders requires the assistance of more than one specialist physician, especially if psychological factors are a factor in the etiology (Cleland J & Palmer J, 2004; Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr. (2022). Okeson JP, 2020; Michelotti A, de Wijer A, Steenks M & Farella M, 2005; Miyake R, Ohkubo R, Takehara J & Morita M 2004; Thomas DC, Singer SR. & Markman S, 2023).

Conservative treatment of temporomandibular disorders can be classified as follows:

1. Temporary occlusal treatment

Occlusal splints (occlusal appliance)

2. Permanent occlusal treatment

Orthodontic treatment

Selective grinding

Prosthetic treatment

3. Collateral treatment

Biofeedback

Exercises

Heat therapy

Electrical stimulation

Drug therapy

1. Temporary occlusal treatment

Since the etiology and the relationship between many TM disorders are complex, it is desired that the initial treatments are temporary (Atsü SS, Tekdemir I & Elhan A, 2006; Velly AM, Gornitsky M & Philippe P, 2003; Yap AUJ, Tan KBC, Chua EK & Tan HH, 2002; Yun PY& Kim YK. 2005). Temporary occlusal treatment changes the patient's occlusal condition reversibly through occlusal splints. Occlusal splints also gain importance in terms of diagnosis by allowing the elimination of etiological factors. It is stated that these splints show a clinical success rate of 70-90% (Okeson JP, 2020). The success or failure of occlusal splints depends on the choice of splint, the manufacturing technique, its adaptation to the patient and the cooperation with the patient. The important criterion in the selection of occlusal splints is the elimination of the etiological factor. Therefore, a good anamnesis, clinical examination and the correct diagnosis are very important. Although there are different types of occlusal splints, the most commonly used are stabilization and anterior positioning occlusal splints (Atsu SS & Ayhan-Ardic F, 2006; Jokstad A, Mo A & Krogstad BS, 2005; Okeson JP, 2020).

Stabilization splints: These splints ensure that the temporomandibular joint remains in a more stable or functional position by the forces on the teeth and joint are distributed, the masticatory muscles are relaxed and the teeth are protected from the effects of bruxism (Al-Ani Z, Gray RJ, Davies SJ, Sloan P & Glenny AM, 2005; Okeson JP, 2020). Since stabilization splints are also used to reduce muscle hyperactivity, they are also called muscle relaxing (myorelaxant) splints. Stabilization splints are made in a centric relation position of the mandible and in a way that the occlusal relation is optimum for the patient. The adaptation of the splints is important in eliminating premature contacts and ensuring optimum occlusion at the same time while the condyle is in the most stable position according to the musculoskeletal system (Atsü SS, Tekdemir I & Elhan A, 2006; Okeson JP, 2020). During adaptation, the posterior teeth should be disclused under the guidance of the canine guide. Correct adaptation phase is great importance for the success of the treatment. It is often applied to the upper jaw in a way that covers the entire arch. Although it can also be applied to the lower jaw, it is preferred to be applied to the upper jaw because the upper jaw is more stable, contains more retentive space than the lower jaw, and the desired contacts in all skeletal (Class II and III). When the splints do not cover the entire arch and are used uncontrolled for a long time, complications can be seen in the chewing system with occlusion disorders (Magnusson T, Adiels AM, Nilsson HL & Helkimo M, 2004; Okeson JP, 2020; Turp JC, Komine F & Hugger A, 2004).

The main purpose of these splints is the treatment of muscle hyperactivity (Zhang SH. et al., 2020). Studies show that they also reduce parafunctional activities frequently seen with stress. Stabilization splints are often used in

cases such as muscle hyperactivity, myospasm, myositis and bruxism. Clear (transparent) hard acrylics can be used as construction materials, as well as vacuum-formed materials, and the occlusion can be created with hard acrylic material (Turp JC, Komine F & Hugger A, 2004). The splint should be able to be passively placed and removed without applying force to the teeth. A well-adapted splint should be in equal contact with all teeth on a flat splint surface in centric relation and centric occlusion, and canine guidance should be provided in eccentric movements. If eccentric movements cannot be made comfortably under canine guidance, this may cause an increase in symptoms related to muscle discomfort (Okeson JP, 2020; Wassell RW, Adams N & Kelly PJ, 2004) (Figure 1).

Stabilization splints can be prepared from hard acrylic or they can be prepared from silicone-based material by vacuum forming. The area of use of soft splints is less than hard splints. The effects of hard and soft appliances on muscle activity were compared by using EMG, it was found that splints made of hard acrylic were more effective in reducing muscle activity than soft splints (Okeson JP, 2020). However, in their literature review, Turp et al. (2004) found that there was no difference between hard and soft splints in terms of the treatment of myofascial pain disorders. Soft splints can be used for initial treatment in cases of retrodiscitis, capsulitis or when patients cannot adapt to hard acrylic material. Another area of use for soft splints is to protect teeth during sports activities (Okeson JP, 2020) (Figure 2).

Anterior positioning splints: These splints position the mandible more forward than the centric relation position and provide a more appropriate condyle-disc relation in cases where the disc and condyle are out of harmony. The aim is to provide an optimum condyle-fossa relation and to regain the normal function of the temporomandibular joint (Zhang SH. et al, 2020). In the treatment performed with anterior positioning splints, the position of the mandible is not changed permanently. The aim is to temporarily change the position of the mandible until the appropriate condyle-disc relation is achieved and to provide an environment for the tissue to heal itself in this position (Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H & Rossbach A, 2005; Tecco S, Festa F, Salini V, Epifania E & D'Attilio M, 2004; Williamson EH, 2005). When the symptoms subside and function is regained, the occlusal splint is gradually worn down and the inter-arch relation is restored to its former position. These splints are mainly used in the treatment of disc interference disorders. They can also be used in some acute temporomandibular joint pains and articular inflammation cases (such as retrodiscitis, capsulitis). Another area of use is for the treatment of sounds coming from the temporomandibular joint (single or reciprocal clicking) (Tecco S, Festa F, Salini V, Epifania E & D'Attilio M,2004; Okeson JP, 2020). It is stated that anterior positioning splints reduce the stress on the temporomandibular joint by changing the structural

relationship between the lower and upper jaws and change the localization. In these splints, the mandible is positioned slightly forward of the centric occlusion. This should not exceed 1-2 mm (Okeson JP, 2020; Simmons HC, 2005) (Figure 3). In determining this position, the mandibular position where there is no clicking sound is considered to be the position in which the condylar-disc relationship is optimum. It is also desired that the patient's pain disappears in this position. In some cases, the passing of the clicking sound does not indicate successful reduction of the disc, but it is important in terms of choosing a reference point for treatment. Some researchers have suggested that this position has to be determined by using arthrography or computerized tomography (CT) but also they emphasize the difficulty of determining it and making the appliance. In addition, it should be preferred that the maxilla-mandible relationship determined with anterior positioning splints be as close as possible to the original intercuspal position in order to minimize the irreversible effects of the treatment. During its construction, anterior positioning stops are shaped in the anterior region (right-left canine region) on the splint (Okeson JP, 2020; Simmons HC, 2005). These prevent the mandible from returning to its former position and help it stay more forward than the centric relationship position. While it is preferred to be made on the upper jaw for the reasons mentioned above, the ease of application of the guide ramp to the upper jaw and its greater effectiveness in keeping the mandible forward are other reasons. The construction technique and materials used are the same as the stabilization splint. In order to make a successful anterior positioning splint, it is important to determine the correct anterior position (Kurita H, Ohtsuka A, Kurashina K & Kopp S, 2001; Okeson JP, 2020).

The most effective use period for anterior positioning splints is 2-4 months. It can be recommended to use it only at night, but it should be used for almost 24 hours, especially in acute cases. Studies show that anterior positioning splints are more effective in the short term than stabilization splints in the treatment of disc interference disorders. Correct diagnosis is very important in determining the treatment. If the applied appliance does not reduce the signs and symptoms, it may be an indication that the diagnosis or the splints are not made appropriately (Okeson JP, 2020; Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H & Rossbach A, 2005). The patient's age and health status are factors that affect the success of the treatment. The temporomandibular joint is a tissue that heals slowly. Healing is faster in young patients than in older patients. Systemic diseases of the patient such as diabetes and rheumatoid arthritis are also factors that delay healing. If macrotrauma is the etiological factor, starting treatment immediately after the trauma is important in terms of the effectiveness of the treatment and shortening its duration. If the symptoms return after treatment, it means that the intracapsular tissues have not healed or adapted sufficiently. After treatment, the anterior positioning

splint should be grinding every 2-3 weeks and the mandible should be moved back approximately 1-2 mm (Okeson JP, 2020; Williamson EH, 2005). This procedure repeated until it reaches a stable musculoskeletal position. If the mandible returns to the intercuspal position without any disturbance in occlusion after treatment, there is no need for any occlusal treatment. On the other hand, if the disc interference disorder is caused by occlusion, when the mandible closes in the superior anterior position, the initial contacts on the teeth are not close to the intercuspal position. In this case, the superior-anterior position in the fossa, which is the stable position for the condyle, is not compatible with the intercuspal position of the teeth and requires occlusal rehabilitation as a result of splint treatment. If the malocclusion is not corrected, the patient will return to the old occlusal position and the signs and symptoms of disc interference disorder will recur (McNamara JA Jr, Seligman D & Okeson JP, 1995; Okeson JP, 2020; Seligman DA & Pullinger AG, 1991).

Sometimes, since the healing or adaptation of the retrodiscal tissues is not completed with the withdrawal of the anterior positioning splint, the symptoms will return and in this case, the following applications can be made: The mandible is returned to the anterior position, that is, the position where there are no symptoms, and the occlusion is reshaped according to this position with orthodontic treatment, full mouth restorations or orthognathic surgery (Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr, 2022; Thomas DC, Singer SR. & Markman S, 2023). Since these options require a major change for the entire stomatognathic system, all conservative techniques should be tried before complex treatment methods. Another approach is to apply the treatment for a longer period of time from the beginning, considering that the time required for adaptation and healing of the tissues varies from patient to patient when using an anterior positioning splint. In many patients, 8-10 weeks is not enough for healing and adaptation of the tissues. This approach is a treatment approach that should definitely be tried before surgery and full mouth rehabilitation (Okeson JP, 2020).

Stabilization and anterior positioning splint types should be used according to the patient's diagnosis. While it can be used all day in acute painful positions, it should be preferred to be used at night while sleeping according to the sign and symptoms. Long-term use of it may cause difficulty of speaking and disturbed the occlusion. It is also appropriate to use splints at night in patients with bruxism (Okeson JP, 2020, Simmons HC, 2005; Tecco S, Festa F, Salini V, Epifania E & D'Attilio M, 2004). Although stabilization and anterior positioning splints are frequently used in temporomandibular disorders, pivot, anterior bite plate, posterior bite plate and NTI (nociceptive trigeminal inhibition) splints can also be used in different temporomandibular disorders (Magnusson T, Adiels AM, Nilsson HL & Helkimo M, 2004; Okeson JP, 2020) (Figure 4). Stiesch-Scholz et al. (2005) compared stabilization splints

with pivot splints in cases with non-reduction disc displacement and found no statistical difference between visual analog scale (VAS) and maximum mouth opening at the end of 3 months. In a study conducted by Tecco et al. (2004) on 40 patients with internal derangements, the effectiveness of anterior positioning and stabilization splints on pain intensity and joint noise was compared. The study found that anterior positioning splints were more effective in reducing pain, while there was no significant difference between splint types in reducing joint noise. In another study, Magnusson et al. (2004) compared stabilization splints with NTI splints and showed that stabilization splints were more effective in relieving temporomandibular disorders. When the literature is reviewed, the reasons for the different results regarding splint treatment can be explained as follows: small number of subjects, non-random selection of subjects, insufficient number of control groups, difficulty in creating specific patient groups due to the complex etiology of temporomandibular disorders, and differences in the adaptation capacities of patients (McNeill C, 1997; Okeson JP, 2020).

2. Permanent occlusal treatment

Occlusion modification may be necessary, especially if the cause of TM disorders is premature contact and/or non-suitable restorations (Thomas DC, Singer SR. & Markman S, 2023). The individual's neuromuscular adaptation capacity becomes important in this case. While many occlusal factors may not cause TM disorders, TM disorders signs and symptoms are observed in cases where the individual's neuromuscular adaptation capacity and structural tolerance are exceeded (Okeson JP, 2020). Occlusion is a risk factor that contributes to the development of TM disorders. Although some studies have not found a direct relationship between occlusion and TM disorders, it should be taken into consideration that some factors cannot be eliminated clinically and that a cause-and-effect relationship cannot be fully understood between the investigated parameters (Thomas DC, Singer SR. & Markman S, 2023). However, it is stated that increased open bite (6 mm), overjet greater than 6-7 mm, difference or discrepancy between centric relation and centric occlusion greater than 2 mm, total and partial dentures with excessively high or low vertical dimensions and high restorationsmay affect the disorders (Velly AM, Gornitsky M & Philippe P, 2003). When occlusal therapy is necessary for the treatment of the patient's TM disorders, the patient's pain should be relieved with occlusal splints first and the mandibular movement limits should be provided as much as possible. The occlusal splints may also be used for a kind of diagnostic purpose. During occlusal treatment, in addition to classical occlusion information, occlusal rehabilitation should be performed by fulfilling the structural and physiological requirements of the patient's chewing system (Turp JC, Komine F & Hugger A, 2004).

Selective Grinding: Generally, selective grinding is a type of treatment

performed when the patient's vertical dimension and intercuspal position are suitable. In the treatment, the patients' lower and upper jaw models are examined by taking them to a fully adjustable or semi-adjustable articulator and determining the necessary abrasion points, and this is applied to the patient's mouth with precision. The occlusal plane should be suitable for the patient's chewing system and should reduce signs and symptoms of TM disorders (Koh H & Robinson PG, 2004; Okeson JP, 2020).

Selective grinding can be done in the following order:

1) Elimination of tooth surfaces that prevent occlusion in the centric relation position, 2) Selective grinding of tooth surfaces that interfere with lateral movements,

3) Elimination of posterior tooth surfaces that interfere with protrusive movements,

4) Adjustment of anterior guidance.

Various colored ariculating papers, stone and diamond abrasives, and polishing rubbers can be used during selective grinding. One of the purposes of selective grinding is to ensure that occlusal forces are transmitted along the long axis of the teeth. The BULL rule is followed to eliminate working side conflicts (Buccal upper, lingual lower). Conflicts are eliminated by grinding the buccal cusps in the upper jaw and the lingual cusps in the lower jaw. Mediotrusive side conflicts are resolved by grinding the buccal slopes of the upper lingual cusps and the lingual slopes of the lower buccal cusps. Care should be taken not to grind the cusp tips. This should only be done if necessary by grinding the cusp tips of the teeth in one jaw and the centric relationship should be preserved. However, in order to prevent TM disorders, it is not recommended to eliminate the occlusion disorders with selective grinding before the TM signs and symptoms appear (Koh H, Robinson PG, 2004; Okeson JP, 2020).

Prosthetic treatment: If sufficient functional harmony cannot be achieved with selective grinding and the patient's TM disorders signs and symptoms continue or if the intercuspal position (the position where the teeth are in maximum relation to each other) and the vertical dimension need to be changed, the occlusal plane should be recreated with prosthetic restorations (Okeson JP, 2020). The aim of prosthetic treatment is to provide prosthetic relations between the upper and lower jaws in a previously determined position where the patient's pain symptoms have decreased or disappeared. Prosthetic treatments to be performed considering the indication differences are inlay-onlay, crown, bridge, removable partial dentures, total denture or creation of new anterior guidance with composite resins. In cases where the occlusion is to be completely changed in both jaws or one jaw, fixed temporary restorations should be used for a sufficient period of time before permanent

restoration and their compatibility with the patient's chewing system should be checked (Hammad IA, Nassif NJ & Salameh ZA, 2005; Guttal S& Patil NP, 2005; Di Paolo C, Panti F, Crocitto P & De Luca M, 2004; Chacona RL, 2003; Badel T, Kraljevic S, Panduric J & Marotti M, 2004; Thomas DC, Singer SR. & Markman S, 2023).

The aim of all occlusal treatments performed in TM disorders should be as follows;

1) Ideal jaw relationship determined and intercuspal contacts should show maximum symmetrical distribution,

2) There should be axial or near-axial loading on the teeth,

3) There should be an occlusal plan that is specific and acceptable for each individual, 4) Proper contacts should be provided for mediotrusive, laterotrusive and anterior movement.

5) An acceptable vertical dimension should be provided.

Orthodontic treatment: In cases where intercuspation between the jaws cannot be achieved after the use of anterior positioning splints or when it is diagnosed that the TM disorder is caused by occlusion, orthodontic treatment is needed to ensure stability between occlusion and TMJ. Fixed, removable, functional and extraoral appliances can be used in orthodontic treatment (Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr, 2022; Okeson JP, 2020; Di Paolo C, Panti F, Crocitto P & De Luca M, 2004).

References

Al-Ani Z, Gray RJ, Davies SJ, Sloan P. & Glenny AM. (2005). Stabilization splint therapy for the treatment of temporomandibular myofascial pain: a systematic review. *Journal of Dental Education,* 69, 1242-50.

Ardic F, Gokharman D, Atsü S, Guner S, Yilmaz M. & Yorgancioglu R. (2006). The comprehensive evaluation of temporomandibular disorders seen in rheumatoid arthritis. *Australian Dental Journal*, 51, 23-28

Atsu SS. & Ayhan-Ardic F. (2006). Temporomandibular disorders seen in rheumatology practices: a review. *Rheumatology International*, 26, 1-7.

Atsü SS, Tekdemir I. & Elhan A. (2006). The coexistence of temporomandibular disorders and styloid process fracture: A clinical report. *Journal of Prosthetic Dentistry*, 95, 417-420.

Badel T, Kraljevic S, Panduric J. & Marotti M. (2004). Preprosthetic therapy utilizing a temporary occlusal acrylic splint: a case eport. *Quintessence International*, 35, 401-5.

Chacona RL. (2003). Enamel loss and occlusal vertical dimension. Causes and considerations for treatment. *Dentistry Today*, 22, 92-7.

Cleland J. & Palmer J. (2004). Effectiveness of manual physical therapy, therapeutic exercise, and patient education on bilateral disc displacement without reduction- of the temporomandibular joint: a single-case design. *Journal of Orthopaedic and Sports Physical Therapy,* 34, 535-48.

Di Paolo C, Panti F, Crocitto P. & De Luca M. (2004). Long term follow-up of patients affected by temporomandibular joint dysfunction treated with orthodontic and/or prosthetic occlusal therapy. *Minerva stomatologica*, 53, 555-70.

Guttal S. & Patil NP. (2005). Cast titanium overlay denture for a geriatric patient with a reduced vertical dimension. *Gerodontology*, 22, 242-5.

Hammad IA, Nassif NJ. & Salameh ZA. (2005). Full-mouth rehabilitation following treatment of temporomandibular disorders and teeth-related signs and symptoms. *Cranio* 23, 289-96.

Jokstad A, Mo A. & Krogstad BS. (2005). Clinical comparison between two different splint designs for temporomandibular disorder therapy. *Acta Odontologica Scandinavica*, 3, 218-26.

Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr. (2022). Temporomandibular disorders and orthodontics: What have we learned from 1992-2022?. *American Journal of Orthodontics and Dentofacial Orthopedics,* 161, 769-774.

Koh H. & Robinson PG. (2004). Occlusal adjustment for treating and preventing temporomandibular joint disorders. *Journal of Oral Rehabilitation*, 31, 287-92.

Kurita H, Ohtsuka A, Kurashina K. & Kopp S. (2001). A study of factors for successful splint capture of anteriorly displaced temporomandibular joint disc with disc repositioning appliance. *Journal of Oral Rehabilitation*, 28, 651-7.

Magnusson T, Adiels AM, Nilsson HL. & Helkimo M. (2004). Treatment effect on signs and symptoms of temporomandibular disorders--comparison between stabilisation splint and a new type of splint (NTI). A pilot study. *Swedish Dental Journal*, 28, 11-20.

McNamara JA Jr, Seligman DA. & Okeson JP. (1995). Occlusion, Orthodontic treatment, and temporomandibular disorders: a review. *Journal of Orofacial Pain*, 9, 73-90.

McNeill C. (1997). Management of temporomandibular disorders: concepts and controversies. *Journal of Prosthetic Dentistry*, 77, 510-22.

Michelotti A, de Wijer A, Steenks M. & Farella M. (2005). Home-exercise regimes for the management of non-specific temporomandibular disorders. *Journal of Oral Rehabilitation*, 32, 779-85.

Miyake R, Ohkubo R, Takehara J. & Morita M. (2004). Oral parafunctions and association with symptoms of temporomandibular disorders in Japanese university students. *Journal of Oral Rehabilitation*, 31, 518-523.

Okeson JP, (2020). *Management of Temporomandibular Disorders and Occlusion*.8 th.ed. Chicago: Quintessence Publishing Co.

Seligman DA. & Pullinger AG. (1991). The role of intercuspal occlusal relationships in temporomandibular disorders: a review. *Journal of Craniomandibular Disorders,* 5, 96-106.

Simmons HC. (2005). Board of Directors, American Academy of Craniofacial Pain. Guidelines for anterior repositioning appliance therapy for the management of craniofacial pain and TMD. *Cranio,* 23, 300-5.

Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H. & Rossbach A. (2005). Comparative prospective study on splint therapy of anterior disc displacement without reduction. *Journal of Oral Rehabilitation*, 32, 474-9.

Tecco S, Festa F, Salini V, Epifania E. & D'Attilio M. (2004). Treatment of joint pain and joint noises associated with a recent TMJ internal drangement: a comparison of an anterior repositioning splint, a full-arch maxillary stabilization splint, and an untreated control group. *Cranio*, 22, 209-19.

Thomas DC, Singer SR. & Markman S. (2023). Temporomandibular Disorders and Dental Occlusion: What Do We Know so Far? *Dental Clinics of North America*, 67, 299-308.

Turp JC, Komine F. & Hugger A. (2004). Efficacy of stabilization splints for the management of patients with masticatory muscle pain: a qualitative systematic review. *Clinical Oral Investigations*, 8, 179-95.

Velly AM, Gornitsky M. & Philippe P. (2003). Contributing factors to chronic myofascial pain: a case-control study. *Pain*, 104, 491-499.

Wassell RW, Adams N. & Kelly PJ. (2004). Treatment of temporomandibular disorders by stabilising splints in general dental practice: results after initial treatment. *British Dental Journal*, 197, 35-41.

Williamson EH. (2005). Temporomandibular dysfunction and repositioning splint therapy. *Progress in Orthodontics*, 6, 206-13.

Yap AUJ, Tan KBC, Chua EK. & Tan HH. (2002). Depression and somatization in patients with temporomandibular disorders. *Journal of Prosthetic Dentistry,* 88, 479-484.

Yun PY. & Kim YK. (2005). The role of facial trauma as a possible etiologic factor in temporomandibular joint disorder. *Journal of Oral and Maxillofacial Surgery*, 63, 1576-83.

Zhang SH, He KX, Lin CJ, Liu XD, Wu L, Chen J. & Rausch-Fan X. (2020). Efficacy of occlusal splints in the treatment of temporomandibular disorders: a systematic review of randomized controlled trials. *Acta Odontologica Scandinavica,* 78, 580-589.

Figures

Figure 1. *Stabilization (Muscle relaxant) splint. Equal occlusal contacts should be provided in centric relation on the flat surface of the stabilization splint.*

Figure 2. Soft (made of silicone material) splints.

Figure 3. Anterior positioning splint.

Figure 4. Pivot splints. It is thought that exercises performed with these splints for 5 minutes three times a day create a distraction effect in the TMJ region.

Chapter 2

ANKYLOGLOSSIA: ETIOLOGY, CLINICAL FINDINGS AND TREATMENT OPTIONS

***Gizem KARAGÖZ DOĞAN*[1]**

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The lingual frenulum is a dense fibrous connective tissue with a multi-layered structure, composed of mucous membranes, fasciae, or upper fibres of the genioglossus muscle. It connects the underside of the tongue to the floor of the mouth and the mandibular bone. Its development begins in the fourth week of pregnancy, when the first, second, and third pharyngeal arches give rise to the tongue. Anatomical differences in these layers can result in an embryological disorder known as ankyloglossia (from the Greek "ankylos" meaning bound, and "glossa" meaning tongue), characterised by a thick and tight frenulum or its placement restricting the mobility of the tongue. Ankyloglossia is most commonly characterised by a heart-shaped tongue or a small notch at the tip of the tongue. (Tomara, Toli, Vasilopoulou, Sarantopoulos, & Papadopoulou, 2023) (Olivi, Signore, Olivi, & Genovese, 2012) (Klockars, & Pitkäranta, 2009a) (Hill, Lee, & Pados 2021) (Reddy, Reddy, Bindu, Ramya, & Ramesh, 2014). Ankyloglossia, a congenital anomaly, can result not only from a short frenulum but also from shortening of the genioglossus muscle, either alone or in conjunction with a short frenulum (Hill, Lee, & Pados, 2021) (Tsaousoglou, Topouzelis, Vouros, & Sculean, 2016).

A panel of ankyloglossia experts in the United States has suggested that while ankyloglossia can lead to functional or behavioral disorders, it can also be considered as an anatomical structure. A lingual frenulum that can be observed or felt by touch from birth up to 6 months is considered normal and commonly seen; therefore, as long as it does not affect function, the lingual frenulum should not be considered ankyloglossia (Salt, Mehendale, Dhanda, & Khemani, 2020).

Ankyloglossia can affect many aspects of a child's life, and it may therefore be helpful to involve professionals from various specialties in clinical practice and management. It would be remiss of me not to mention the invaluable input of other professionals, including otolaryngologists, paediatricians, speech therapists, paediatric surgeons, lactation consultants, dentists and orthodontists. Each of these professionals approaches ankyloglossia from a unique perspective. The literature on ankyloglossia contains a variety of opinions, which is understandable given the diversity of perspectives involved. (Tomara, Toli, Vasilopoulou, Sarantopoulos, & Papadopoulou, 2023).

Etiology and Hereditary Transmission of Ankyloglossia

It seems that there may be some evidence indicating that ankyloglossia might be a genetically transmitted pathology. However, it is not yet clear what the specific genetic components are that regulate the phenotype and penetration in affected patients. Further research would be beneficial to clarify the precise etiopathogenesis of ankyloglossia. (Reddy et al., 2014). Ankyloglossia can present as an isolated anomaly or in conjunction with other craniofacial anomalies. It has been reported that 82% of ankyloglossia

cases appear as isolated anomalies without other associated anomalies or diseases. Nevertheless, some studies have indicated that this condition may be linked to syndromes associated with the X chromosome, including cleft palate syndrome, Ehlers-Danlos syndrome, inverse epidermolysis bullosa, Smith-Lemli-Opitz syndrome, Kindler syndrome, Beckwith-Wiedemann syndrome, Van der Woude syndrome, Simpson-Golabi-Behmel syndrome and Opitz syndrome. It has been suggested that ankyloglossia may potentially result from mutations in T-box genes or exposure to teratogenic substances during pregnancy. A significant portion of ankyloglossia is hereditary, showing particularly autosomal dominant traits. There are two reports that isolated ankyloglossia is hereditary as an autosomal dominant trait. Additionally, studies have indicated that cocaine use by the mother during pregnancy can increase the risk of ankyloglossia in the baby by more than three times (Tsaousoglou et al., 2016) (Harris, Friend, & Tolley, 1992) (Costa-Romero, Rivero-Calle, & Martinón-Torres, 2021).

Classification of Ankyloglossia

There is no single standardized diagnostic grading system for defining ankyloglossia (Klockars, & Pitkäranta, 2009a). A few studies have proposed classification standards for ankyloglossia using anatomical and/or functional criteria, but these standards vary in their measurements (Ruffoli, 2005). The term "free tongue distance" refers to the space between the attachment of the lingual frenulum at the base of the tongue and the tip of the tongue. A clinically acceptable normal free tongue distance is greater than 16 mm. Based on Kotlow's observations, ankyloglossia can be classified into four types, each defined by the clinical length of the free tongue, which is the distance the tongue can be extended outward. Kotlow's Classification of Ankyloglossia: (Kotlow, 1999).

- Class I: Mild ankyloglossia (12-16 mm)
- Class II: Moderate ankyloglossia (8-11 mm)
- Class III: Severe ankyloglossia (3-7 mm)
- Class IV**:** Complete ankyloglossia (<3 mm).

In addition to Kotlow's classification, there are a number of other tools for assessing ankyloglossia, including the Hazelbaker Assessment Tool for Lingual Frenulum Function (HATLFF), the Bristol Tongue Assessment Tool (BTAT), which has since been renamed TABBY (Tongue-tie and Breastfed Baby), and the Coryllos classification. A systematic review conducted in 2022 revealed that the HATLFF and Coryllos classifications are widely used. However, data from the HATLFF classification is not publicly accessible, while the Coryllos classification criteria are shown below: (Coryllos, Genna, & Salloum, 2004).

Type 1: The frenulum attaches at the tip of the tongue.

Type 2: The frenulum attaches 2-4 mm behind the tip of the tongue.

Type 3: The frenulum attaches at the mid-tongue.

Type 4: The frenulum attaches at the base of the tongue.

Incidence of Ankyloglossia

Ankyloglossia is an anatomical malformation that is more prevalent in males than in females, with a ratio of approximately 3:1. This is primarily due to X-linked genetic traits caused by mutations in the TBX22 gene (Gonzalez Garrido, Andreu, & Vazquez, 2022) (Klockars, & Pitkäranta, 2009b). The prevalence of ankyloglossia has not been precisely determined and is reported in various studies to range from as low as 0.3% to as high as 16%. It would appear that the prevalence is higher in studies investigating newborns (2% to 10%) compared to those examining children, adolescents, or adults (0.1% to 2.08%). Ankyloglossia is more commonly seen as an isolated condition in newborns (Hill et al., 2021), Reddy et al., 2014) (Zhao, He, & Wang, 2022) (Mezzapesa, Fiorella, Del Vecchio, Parisi, & Vicenti, 2020).

In recent years, the number of patients diagnosed with ankyloglossia has risen. This increase can be attributed to several factors. Firstly, there has been a heightened emphasis on the benefits of breastfeeding. Secondly, there has been greater awareness of the negative impact ankyloglossia can have on breastfeeding. Thirdly, there has been an increase in the number of social media and website content about tongue-ties. Fourthly, there has been a growing number of lactation consultants who can identify potential cases. Fifthly, there has been an increase in the number of medical professionals, particularly dentists, who treat ankyloglossia. (Messner et al., 2020).

Functional Problems Related to Ankyloglossia

Ankyloglossia can be observed in individuals ranging from newborns to infants, children, and adolescents. However, in some people, it may go undiagnosed despite causing anatomical or functional problems. Depending on the severity of ankyloglossia, it may be asymptomatic; it can regress spontaneously with development, or individuals affected by ankyloglossia may learn to adequately compensate for the reduced mobility of the tongue over time (Reddy et al., 2014). Ankyloglossia can cause issues in various functions such as sucking, swallowing, chewing, and speaking. It can also lead to mechanical problems (such as difficulty licking lips, licking an ice cream cone, or playing a wind instrument), orthodontic and orthopedic anomalies, and issues related to joint movements. Therefore, particularly at birth or during early childhood, whether or not there are restrictions in tongue movements, early detection of a thick or very tight frenulum is crucial (Tomara et al., 2023) (Tsaousoglou et al., 2016) (Mezzapesa et al., 2020).

There are numerous studies in the literature examining the relationship between ankyloglossia and breastfeeding difficulties. These studies indicate that babies with ankyloglossia often have problems such as difficulty latching onto the nipple, which can lead to persistent issues for nursing mothers, including prolonged nipple pain or conditions like mastitis. It has been observed that continuous nipple pain in women breastfeeding babies with ankyloglossia can occur at rates ranging from 36% to 80% (Hill et al., 2021) (Tsaousoglou et al., 2016)

Costa-Romero and colleagues (2021) in their review reported that babies with moderate ankyloglossia, which does not severely affect tongue movements, can compensate for this condition and improve their sucking skills (Costa-Romero et al., 2021). Campanha et al. have stated that newborns with ankyloglossia are more likely to encounter breastfeeding difficulties, particularly in terms of sucking skills, with a probability as high as 36.07% (Campanha, Martinelli, & Palhares, 2019). Risken and colleagues emphasized that babies with ankyloglossia, regardless of whether the lingual frenulum is anterior or posterior, are more likely to experience breastfeeding difficulties in the first 30 days of life (Riskin et al,. 2014). Other studies on breastfeeding have argued that ankyloglossia rarely or never impedes feeding. Messner and colleagues have observed that professionals who hold this view are usually pediatric specialists and otolaryngologists (Messner, Lalakea, Aby, Macmahon, & Bair, 2000).

Prior to the decision to proceed with surgical intervention for ankyloglossia-related breastfeeding difficulties, it is essential to exclude other anomalies that could also be the cause of such difficulties. In particular, comprehensive intraoral examinations, including the assessment of tongue function, should be conducted in newborns presenting with sucking difficulties. (Rowan-Legg, 2015). During this examination, it is of great importance to allow the infant to suck on the gloved finger of the examiner, as this allows for the assessment of tongue movement and function, as well as the checking of the shape and position of the movement. Additionally, palpating the lingual frenulum, observing its flexibility and tissue length, and examining the relationship of the frenulum to the tongue and floor of the mouth are necessary for diagnosis. Furthermore, health professionals should assess the range of tongue elevation relative to the floor of the mouth during an oral examination. Variations in the length, position, and flexibility of the lingual frenulum can affect a baby's ability to suck, and thus, should be considered. Following a detailed intraoral examination, a discussion should be held with the mother about breastfeeding (nipple pain, mastitis, etc.) and any observed feeding issues. Should difficulties be identified, it is recommended that a referral be made to a health professional with expertise in breastfeeding support. (Tomara et al., 2021) (Rowan-Legg, 2015). Despite these efforts, if complaints persist, lingual

frenotomy is recommended. The benefits after frenotomy reported include better nipple grasp by the baby, resulting in reduced nipple pain for the mother and the continuation of breastfeeding practices without interruption (Olivi et al., 2012) (Martinelli, Marchesan, Lauris, Honório, & Gusmão, 2015).

Beyond breastfeeding difficulties, it is suggested that ankyloglossia may lead to respiratory issues in later years due to the forward displacement of the epiglottis and larynx (Tsaousoglou et al., 2016). The tongue is a fundamental organ for swallowing, and a short lingual frenulum can hinder its proper function. Swallowing involves complex neuromuscular activity, starting with the advancement of the tongue's apex to the retroincisal-palatal point, followed by the mid-posterior part of the tongue making contact with the hard and then the soft palate. Everyone with ankyloglossia experiences some degree of difficulty in swallowing because a tongue with ankyloglossia cannot fully perform the movements described above. The inability to elevate the tongue against the palatal tissue prevents the development of adult-type swallowing and perpetuates infantile swallowing patterns, which can lead to an open bite over time. One of the symptoms is a tendency towards mouth breathing due to an open bite. The absence of upward and backward movement of the tongue can result in excessive pressure being exerted on the anterior part of the mandible, which may subsequently lead to mandibular prognathism and the formation of a diastema between the lower incisor teeth. (Olivi et al., 2012) (Reddy et al., 2014).

While most discussions about feeding difficulties related to ankyloglossia focus on breastfeeding, a study involving 37 children with ankyloglossia reported that surgical intervention to correct the tongue-tie improved their feeding skills by 83% (Baxter, Merkel-Walsh, Baxter, Lashley, & Rendell, 2020). The challenges in feeding include increased oral transit time for food, reduced bolus mobility within the mouth, choking, gagging, involuntary expulsion of food during chewing, frustration related to eating, and selectivity in diet (Baxter, Merkel-Walsh, Baxter, Lashley, & Rendell, 2020) (Merkel-Walsh, & Overland, 2018) (Bahr, 2018).

In cases of ankyloglossia, while some children are reported to develop normal speech, others are noted to develop speech deficiencies due to articulation errors or difficulties. This discrepancy has led to a lack of consensus among paediatricians regarding the potential impact of ankyloglossia on speech development. A 2016 study by Tsaousoglou and colleagues found that only 23% of paediatricians acknowledged this association (Tsaousoglou et al., 2016). Similarly, a 2022 study by Wang and colleagues reported that only 25% of paediatricians were aware of the potential impact of ankyloglossia on speech development (Wang, Zhao, Liu, Shen, & Wu, 2022). In accordance with the findings of Meissner's research, 71% of young children with ankyloglossia exhibit speech abnormalities associated with limited tongue mobility

(Messner & Lalakea, 2002). The prevalence of speech disorders in individuals with ankyloglossia varies depending on the specialty of the authors reporting such incidences. In children with ankyloglossia, speech problems are typically identified as articulation disorders resulting from restricted tongue tip movement. Speech sounds that can be adversely affected by limited tongue tip mobility include the following: "t, d, n, l, s, r, z, and th." (Ito, Shimizu, Nakamura, & Yamanaka, 2015).

In the literature, speech problems are the most common reason, accounting for 64%, for surgically correcting the frenulum. Daggumati et al. in their retrospective review found no significant improvement in speech quality after surgical frenulum correction in children with ankyloglossia compared to those who did not receive treatment (Daggumati et al., 2019). In contrast, many studies claim that patients' speech and articulation improve post-procedure as tongue mobility is enhanced. Due to this discrepancy in the literature, the effect of surgical intervention on speech improvement in patients with ankyloglossia remains controversial and calls for further research (Zhao et al., 2022) (Messner, & Lalakea, 2002) (Walls et al., 2014).

Ankyloglossia has been linked to sleep difficulties and sleep apnea in both children and adults. In individuals with ankyloglossia, the tongue does not make firm contact with the palate, which particularly during sleep can lead to the tongue falling back into the pharynx, restricting or obstructing the airway. A recent systematic review reported that myofunctional therapy could retrain the tongue to properly adhere to the palate and prevent airway blockage. This therapy has been shown to reduce the apnea-hypopnea index (AHI) by 62% in children and by 50% in adults. While myofunctional therapy often assists with sleep difficulties in cases of ankyloglossia, its effectiveness can be limited in severe cases due to insufficient tongue mobility (Camacho et al., 2015).

Ankyloglossia is often associated with a higher and more anterior position of the hyoid bone. This association is due to the hypertonicity of the extrinsic and suprahyoid lingual muscles (attached to the jaw and skull) and consequently results in the tension of the subhyoid muscles, which are connected through the cervical mid-fascia to the sternum, clavicle, scapula, larynx, pericardium, and mediastinum (Olivi et al., 2012).

Treatment of Ankyloglossia

The literature indicates that a short frenulum is not always associated with tightness or fibrosis. In some cases, despite its reduced length, the frenulum allows for normal lingual mobility. Furthermore, the elasticity of the floor of the mouth can mitigate the effects of ankyloglossia and assist in tongue movement. In such cases, surgical intervention is deemed unnecessary and is not recommended. However, if the anomaly is relatively severe, particularly

if it causes breastfeeding problems, early surgical intervention of the short frenulum is recommended. Messner et al., in their study, have reached a consensus that intervention for a baby with symptomatic ankyloglossia should occur within the first month of life (Messner et al., 2020). Supporting Messner et al.'s findings, Emond et al. reported that mothers in the control group could not endure more than five days without medical assistance and supplementation, and they agreed that surgical intervention should ideally take place at an average of 11 days old (ranging from 8-16 days) (Emond et al., 2014). After the surgical procedure, the necessity of prompt speech therapy for the rehabilitation of the lingual muscles is emphasized (Olivi et al., 2012) (Gonzalez Garrido et al., 2022).

Breastfeeding Difficulties
Speech Difficulties
Inability to lick the upper and/or lower lips
Limited ability of the tongue to reach the palatal retroincisal point when the mouth is wide open, and a distorted shape or invagination at the tip of the tongue when extended outside the mouth.

Table 1: Clinical and Functional Criteria for Surgical Indication of a Short Frenulum (Olivi et al., 2012)

Regardless of the indications leading to the decision to correct the frenulum surgically, frenotomy is the primary surgical treatment option; surgical interventions can be classified as simple loosening (frenotomy, frenulotomy, or frenectomy) and sutured surgery (frenuloplasty) (Wang et al., 2022). There are also differing opinions regarding the timing of surgical treatment for ankyloglossia. Some researchers argue that surgical intervention should not be performed until the child is older than four years, and then only if there are significant speech problems, while others advocate for completing the intervention between the ages of 4 and 8, noting that a child's speech development is intertwined with auditory functions, linguistic environment, and intellectual growth. It is well known that ages 2 to 5 are a critical period for the development of a child's vocal system. An untreated short or tight lingual frenulum can limit the motor function of the tongue, seriously affecting the growth and development of the lingual system and inevitably leading to permanent speech disorders in children. Therefore, accurate intervention measures and optimal timing are crucial for infants and young children with speech problems caused by ankyloglossia. Consequently, many studies have reached a consensus that the ideal time for surgical intervention for ankyloglossia is during infancy (Zhao et al., 2022) (Berry, Griffiths, & Westcott, 2012) (Buryk, Bloom, & Shope, 2011).

To perform a frenotomy, the baby should be swaddled with the head positioned towards the practitioner. An assistant should gently pull down on the chin to keep the baby's mouth open. The practitioner should lift the tongue with a

grooved director or fingers to better visualize the frenulum. Using iris scissors, a precise incision of about 2 mm should be made in the central mucous membrane, ensuring that the base of the tongue (due to its vascularization) and Wharton's duct are not harmed. After making the incision, pressure should be applied to the area to control bleeding (Costa-Romero et al., 2021). After the frenotomy, there are several recommendations to help reduce the regeneration rate of the tissue. The first is to breastfeed the baby immediately after the frenotomy to help prevent bleeding. Secondly, post-frenotomy exercises should be performed, which involve carefully applying pressure and massaging the parts of the frenulum. Additionally, the functional mobility of the tongue should be enhanced by encouraging the baby to lift the tongue to the palate and move it sideways. It is recommended that these exercises be performed four to six times a day (Tomara et al., 2023). The complication rate following frenotomy is approximately 9%. The most common complications include bleeding (3-5%, depending on the study), recurrence (5%), injury to the lips or salivary glands, infections, damage to the lingual nerve, formation of mucosal retention cysts, pain, and a failure to improve breastfeeding (1.30%). A less frequent but more severe complication is damage to Wharton's duct. Consequently, it is of paramount importance that the procedure be carried out by a trained professional (Costa-Romero et al., 2021). The traditional frenectomy procedure is a surgical operation performed under local anaesthesia, involving precise incisions. In contrast, frenuloplasty entails the complete removal of the frenulum. This procedure is more invasive and complex than a frenotomy and is conducted under general anaesthesia or anaesthesia of the lingual nerve. Both procedures require suturing and demand surgical expertise, particularly skills in working with young patients, which can make traditional frenotomy techniques challenging. Laser technology offers an excellent alternative to traditional frenotomy. It is simple and quick to apply and is generally well-tolerated by patients. Additionally, the procedure requires minimal anesthesia and usually presents no symptoms post-operation. Various wavelengths can be utilized in the laser technique, and it is essential to ensure that the energy applied is at the lowest and most effective level possible. Lower energy application minimizes damage to the targeted tissue and promotes a faster healing process. The Er-YAG laser is often preferred for this procedure (Olivi et al., 2012) (Costa-Romero et al., 2021).

It is imperative that appropriate analgesia be provided for surgical interventions. However, comprehensive data on effective analgesia is lacking in the literature. Case reports have indicated the use of acetaminophen, lidocaine, and sucrose for analgesia, yet none of these have been subjected to comprehensive study. Among anesthetic preparations, benzocaine has been subjected to a randomized controlled trial, which demonstrated that it is ineffective when compared to a placebo. (Olivi et al., 2012).

In patients with ankyloglossia, physical therapy is recommended both before and after surgery to improve prognosis. Techniques used include speech exercises, awareness of oral cavity morphology, stretching exercises, and myofunctional therapy that includes extra-buccal and intra-buccal massages. It is also noted that myofunctional therapy can lead to the release of the tongue tie through intraoral and extraoral stimulation without the need for surgical intervention (Gonzalez Garrido et al., 2022).

Conclusion

In conclusion, ankyloglossia is an anatomical disorder that can affect individuals from newborns to adults, but the existing published studies on ankyloglossia are controversial in many aspects. This underscores the importance of comprehensive research, as well as educational and training programs, for lactating mothers, babies with tongue-ties, and professionals who support individuals with ankyloglossia.

REFERENCES

1. Tomara, E., Toli, A., Vasilopoulou, K., Sarantopoulos, A., & Papadopoulou, P. (2023). Ankyloglossia as a barrier to breastfeeding: A literature review. Children, 10(12), 1902.
2. Olivi, G., Signore, A., Olivi, M., & Genovese, M. D. (2012). Lingual frenectomy: Functional evaluation and new therapeutical approach. European Journal of Paediatric Dentistry, 13(2), 101-106.
3. Klockars, T., & Pitkäranta, A. (2009). Pediatric tongue-tie division: Indications, techniques and patient satisfaction. International Journal of Pediatric Otorhinolaryngology, 73(10), 1399-1401.
4. Hill, R. R., Lee, C. S., & Pados, B. F. (2021). The prevalence of ankyloglossia in children aged <1 year: A systematic review and meta-analysis. Pediatric Research, 90(2), 259-266.
5. Reddy, N. R., Reddy, R. S., Bindu, M. H., Ramya, K. S., & Ramesh, T. (2014). Clipping the (tongue) tie. Journal of Indian Society of Periodontology, 18(3), 395.
6. Tsaousoglou, P., Topouzelis, N., Vouros, I., & Sculean, A. (2016). Diagnosis and treatment of ankyloglossia: A narrative review and a report of three cases. Quintessence International, 47(6).
7. Salt, H., Mehendale, F. V., Dhanda, J., & Khemani, S. (2020). Speech production in young children with tongue-tie. International Journal of Pediatric Otorhinolaryngology, 134, 110035.
8. Harris, E. F., Friend, G. W., & Tolley, E. A. (1992). Enhanced prevalence of ankyloglossia with maternal cocaine use. The Cleft Palate-Craniofacial Journal, 29(1), 72-76.
9. Costa-Romero, M., Rivero-Calle, I., & Martinón-Torres, F. (2021). Ankyloglossia in breastfeeding infants: An update. Archivos Argentinos de Pediatria, 119(6), e600-e609.
10. Ruffoli, R., Giambelluca, M. A., Scavuzzo, M. C., Strambi, M., Corti, P., & Genitori, L. (2005). Ankyloglossia: A morphofunctional investigation in children. Oral Diseases, 11(3), 170-174.
11. Kotlow, L. A. (1999). Ankyloglossia (tongue-tie): A diagnostic and treatment quandary. Quintessence International, 30(4), 259-262.
12. Coryllos, E., Genna, C. W., & Salloum, A. C. (2004). Congenital tongue-tie and its impact on breastfeeding. American Academy of Pediatrics, 1–6.
13. Gonzalez Garrido, M. D. P., Andreu, A. L., & Vazquez, R. M. (2022). Effectiveness of myofunctional therapy in ankyloglossia: A systematic review. International Journal of Environmental Research and Public Health, 19(19), 12347.
14. Klockars, T., & Pitkäranta, A. (2009). Inheritance of ankyloglossia (tongue-tie).

Clinical Genetics, 75(1), 98-99.

15. Zhao, H., He, X., & Wang, J. (2022). Efficacy of infants' release of ankyloglossia on speech articulation: A randomized trial. Ear, Nose & Throat Journal, 01455613221087946.

16. Mezzapesa, P. P., Fiorella, M. L., Del Vecchio, A., Parisi, D., & Vicenti, A. (2020). Clinical outcomes of diode laser treatment of ankyloglossia in children and young adults: A report of two cases. Cureus, 12(3).

17. Messner, A. H., Walsh, J., Rosenfeld, R. M., Schwartz, S. R., Ishman, S. L., Baldassari, C., Brietzke, S. E., Darrow, D. H., Goldstein, N., Levi, J., ... & Chan, K. H. (2020). Clinical consensus statement: Ankyloglossia in children. Otolaryngology–Head and Neck Surgery, 162(5), 597-611.

18. Campanha, S. M. A., Martinelli, R. L. C., & Palhares, D. B. (2019). Association between ankyloglossia and breastfeeding. Codas, 31, e20170264.

19. Riskin, A., Mansovsky, M., Coler-Botzer, T., Kugelman, A., Shaoul, R., Hemo, M., Wolff, L., Harpaz, S., Olchov, Z., & Bader, D. (2014). Tongue-tie and breastfeeding in newborns-mothers' perspective. Breastfeeding Medicine, 9(9), 430–437.

20. Messner, A. H., Lalakea, M. L., Aby, J., Macmahon, J., & Bair, E. (2000). Ankyloglossia: Incidence and associated feeding difficulties. Archives of Otolaryngology–Head & Neck Surgery, 126(1), 36-39.

21. Rowan-Legg, A., Canadian Paediatric Society, & Community Paediatrics Committee. (2015). Ankyloglossia and breastfeeding. Paediatrics & Child Health, 20(4), 209-213.

22. Martinelli, R. L. C., Marchesan, I. Q., Lauris, J. R. P., Honório, H. M., & Gusmão, R. J. (2015). The effects of frenotomy on breastfeeding. Journal of Applied Oral Science, 23(2), 153-157.

23. Baxter, R., Merkel-Walsh, R., Baxter, B. S., Lashley, A., & Rendell, N. (2020). Functional improvements of speech, feeding, and sleep after lingual frenectomy tongue-tie release: A prospective cohort study. Clinical Pediatrics, 59(9-10), 885-892.

24. Merkel-Walsh, R., & Overland, L. (2018). Functional assessment and remediation of TOTs (tethered oral tissues). TalkTools.

25. Bahr, D. (2018). Feed your baby and toddler right: Early eating and drinking skills encourage the best development. Future Horizons.

26. Wang, J., Zhao, H., Liu, D., Shen, Y., & Wu, Y. (2022). The effect of ankyloglossia and tongue-tie division on speech articulation: A systematic review. International Journal of Paediatric Dentistry, 32(2), 144-156.

27. Messner, A. H., & Lalakea, M. L. (2002). The effect of ankyloglossia on speech in children. Otolaryngology–Head and Neck Surgery, 127(6), 539-545.

28. Ito, Y., Shimizu, T., Nakamura, T., & Yamanaka, Y. (2015). Effectiveness of tongue-tie division for speech disorder in children. Pediatrics International, 57(2),

222-226.

29. Daggumati, S., Cohn, J. E., Brennan, M. J., Evarts, M., McKinnon, B. J., & Terk, A. R. (2019). Speech and language outcomes in patients with ankyloglossia undergoing frenulectomy: a retrospective pilot study. *OTO open*, *3*(1), 2473974X19826943.

30. Walls, A., Pierce, M., Wang, H., Steehler, A., Steehler, M., & Harley, E. H. Jr. (2014). Parental perception of speech and tongue mobility in three-year olds after neonatal frenotomy. International Journal of Pediatric Otorhinolaryngology, 78(1), 128-131.

31. Camacho, M., Certal, V., Abdullatif, J., et al. (2015). Myofunctional therapy to treat obstructive sleep apnea: A systematic review and meta-analysis. Sleep, 38(5), 669-675.

32. Emond, A., Ingram, J., Johnson, D., Blair, P., et al. (2014). Randomised controlled trial of early frenotomy in breastfed infants with mild-moderate tongue-tie. Archives of Disease in Childhood - Fetal and Neonatal Edition, 99(3), F189-95.

33. Berry, J., Griffiths, M., & Westcott, C. (2012). A double-blind, randomized, controlled trial of tongue-tie division and its immediate effect on breastfeeding. Breastfeeding Medicine, 7(3), 189-193.

34. Buryk, M., Bloom, D., & Shope, T. (2011). Efficacy of neonatal release of ankyloglossia: A randomized trial. Pediatrics, 128(2), 280-288.

Chapter 3

THE EFFECTS OF RADIATION ON OUR LIFE AND HEALTH

Serap DUMAN[1]

1 This book chapter is extracted from my master thesis dissertation entitled "Dentistry students' knowledge and behavior regarding radiation: Cross-Sectional and Qualitative Mixed Study", supervised by Nilüfer Ersan (Master's Thesis, Yeditepe University, Istanbul, Türkiye, 2022).

"Primum non nocere" (do not harm first) : Although this sentence in the Hippocratic oath is the starting point and basis of health practices, it is a sentence that can be a principle in every area of life and in every profession. First of all, everyone who does their profession, especially health professionals who provide human health services, has the responsibility to perform their duties in the best way by avoiding risks without harming the society and themselves. One of the negative effects that many people may experience while doing their jobs is ionizing radiation. Since the 1945s, when scientists began to study and understand the nucleus of the atom, which was a nuclear energy source, they have opened doors that provide great benefits to humanity in this regard (Şeker & Çerezci, 1997). In addition, it is understood that it has negative effects as well as benefits (Şeker & Çerezci, 1997), (Whaites, 2003). Radiation-emitting devices are increasingly used in many fields from industry to health. For example, some healthcare professionals have been using X-ray imaging devices that produce radiation throughout their professional lives since their students. In industry, shipyards, energy production and various imaging areas, devices that emit ionizing radiation at an increasing rate are exposed to speed and usage areas. The biological effects of radiation can be deterministic or stochastic; deterministic effects are dose-dependent, while stochastic effects are dose independent (Şeker & Çerezci, 1997), (Whaites, 2003). Despite the fact that radiation emitting devices emit low-dose radiation, the accumulation of radiation in the human body over time may pose a risk to health in the long term (stochastic risk) (Şeker & Çerezci, 1997), (Whaites, 2003). The most important precaution that can be taken against this risk is to learn how to protect yourself with education and not to compromise in practice. Because the number of people exposed to low-dose radiation in societies is increasing. No matter which method is used, the radiation emitted from the devices used in the imaging fields in every radiological photography or industry has the potential to cause harm. For this reason, it is considered that it should be applied using the lowest possible dose, no matter what process is used, by following the principle of ALARA (As Low As Reasonably Achievable) (Whaites, 2003). As a result of the examination of literature scans and other studies, it is thought that the education, knowledge and behaviors of the people in the business lines where all these devices are used, primarily health sector employees, should be complete in order to protect everyone related to ionizing radiation. (Whaites, 2003). Thus, it is thought that unnecessary radiation exposure for the whole society will be prevented and health will be positively affected.

WHAT IS RADIATION?

Radiation is the release or transfer of energy emitted from a source in the form of an electromagnetic wave or particle. This energy is propagated in the form of particles, electromagnetic waves and photons. Radiation can be natural or artificial (Şeker & Çerezci, 1997), (Whaites, 2003).

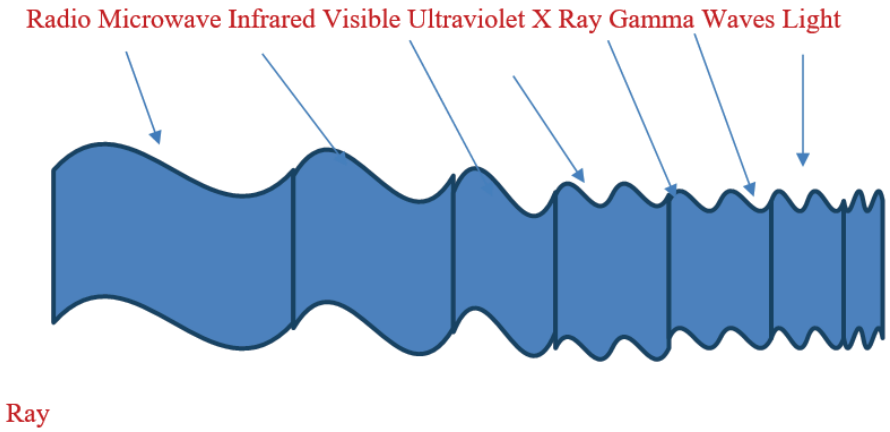

Figure 2.1. Electromagnetic spectrum

IONIZING AND NON-IONIZING RADIATION

Radiation can be classified in different ways. One of them is the Classification of Ionizing and Non-Ionizing Radiation (Figure 2.2). Radiation, which has energy on the binding energy of the electron to the atom, breaks an electron from the atom and causes ionization. Radiation lower than the electron to the atom's binding energy cannot make the atom ionize. Therefore, it is also described as non-ionizing radiation. As radiation passes through the substance, it transfers energy to the substance it passes through. This energy can cause ionization within the cell. Accordingly, those whose energy can ionize the atom when it interacts with the substance are described as "ionizing radiation" and those who cannot ionize it as "non-ionizing radiation". If ionization occurs, chemical changes occur that cause harmful biological effects. Ionizing radiation is also of two types: Particle type and wave type. We can give alpha and beta particles, neutrons as examples of particle type; gamma rays and X-rays as examples of wave-type ionization. Examples of non-ionizing radiation include ultraviolet light, visible light, infrared light and radiofrequency (Şeker & Çerezci, 1997), (Whaites, 2003).

RADIATION TYPES

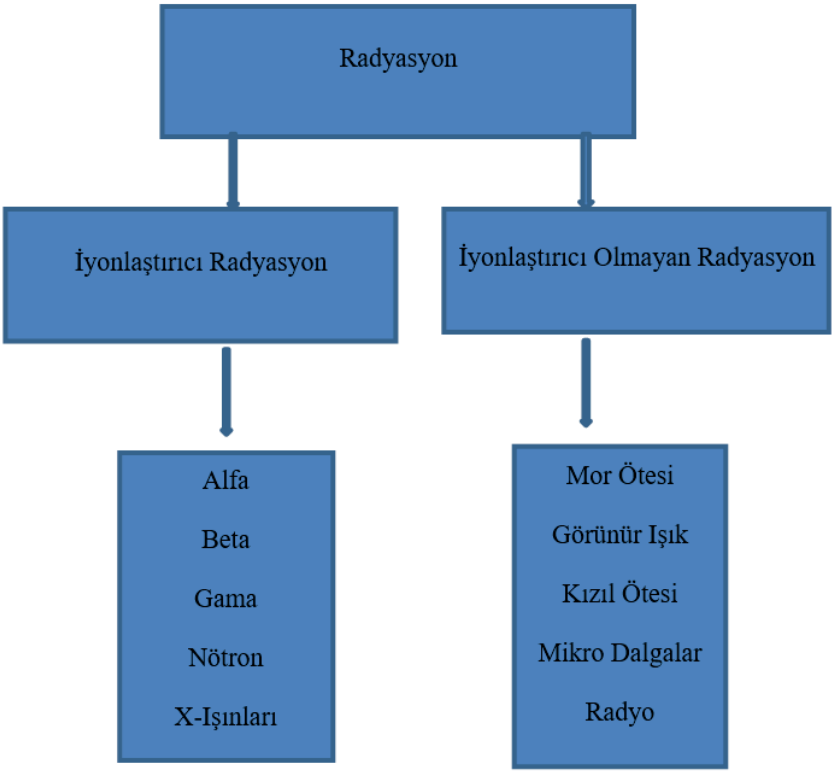

Figure 2.2: Radiation Types According to Energy (14)

RADIATION DOSES

UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation), which publishes the radiation doses received by humans from all sources, published the average annual dose total according to the world's population as approximately 2.8 mSv (milli Sievert) in the results of its examination conducted in 2000. More than 85 percent of this is natural radiation sources and is inevitable, and half of this 85 percent is due to radon decay. 14 percent of the total rate is medical irradiation, and artificial resources (radioactive sprinkler, consumer products, occupational irradiation and emissions from the nuclear industry) account for less than 1 percent. UNSCEAR 2000 Report on Sources and Effects of Ionizing Radiation to the General Assembly, United Nations, Vienna 2000).

To determine dose limits, CNSC has largely adopted the recommendations of the International Committee for Radiological Protection (ICRP). According to the ICRP, the highest radiation dose in which a professional radiation

person is allowed to receive a certain time interval is called the maximum permission dose (MPD) and this dose should not exceed an average of 20 mSv in the following 5 years, provided that it does not exceed 50 mSv in any given year. It should not exceed 2 mSv per month (UNSCEAR 2000 Report on Sources and Effects of Ionizing Radiation to the General Assembly, United Nations, Vienna 2000).

CONTRIBUTIONS OF ARTIFICIAL RADIATION SOURCES TO PERSONAL DOSE

Considering all artificial radiation sources; 97% of the total radiation affecting humans is due to medical applications, the largest share among medical irradiation is diagnostic radiological examinations. Radiological examination, 37 million nuclear medicine and 7.5 million radiotherapy are performed annually for 3.6 billion people worldwide (Neuberger, Brownson & Morantz, 1989). X-ray devices that emit X-rays are used for diagnostic purposes in dentistry. The average annual effective dose in dentistry is 0.06 mSv published in 1990-1994 data in UNSCEAR 2000 volume 1, annex-E. The most common film-drawn areas of the body are chest, arms, legs and teeth, accounting for approximately 25 percent of the total examinations (Turkish Atomic Energy Agency [TAEK], Radiation Safety Guide for Applications with Dental X-ray Devices RSGD-KLV-018), (UNSCEAR, 2000).

HARMFUL EFFECTS OF RADIATION

It is suggested that there is a relationship between low-dose X-rays and goiter, chest, lung cancer and leukemia, but the mechanism of action of the dose of ionizing radiation taken on the formation of these cancers cannot be fully predicted (Şeker & Çerezci, 1997), (Whaites, 2003). In the study of Preston et al., they found that female radiology workers had an increased risk of breast cancer as a result of low dose radiation exposure (Preston et al., 2016). In a different study, it was found that low-dose radiation harms eye health and increases the formation of cataracts (National Radiological Protection Board, 2001). Many more studies have shown that although the dose of ionizing radiation is low, it causes various health problems in health workers, for example, it has been determined that exposure of radiology workers to ionizing and non-ionizing radiation has the effect of lowering bone mineral density and serum ALP levels. Another study points out that exposure to ionizing radiation in lower doses than previously thought causes not only cancer but also non-cancerous diseases. For example, cardiovascular diseases and cataracts are given (Baselet et al. 2016).

X-RAYS

Each form of radiation has a range of wavelengths. X-rays have short and long wavelengths. The short wavelength form of X-rays is high frequency

electromagnetic (EM) radiation. They carry high energy due to their high frequency. They are the short X-rays with the most effective and efficient power in imaging. The most commonly used devices in dentistry are Periapical Dental X-ray Device and Panoramic Dental X-ray Device. These devices that emit X-rays can make some changes in the cell (Preston et al. 1983-2008). X-rays were discovered in 1895. It was used for diagnostic purposes in medicine just 6 months after it was discovered. Although the benefits of radiation use were detected very early, the harms were understood in the early 1900s with the unknowing exposure of doctors and surgeons to high doses of X-rays. By 1905, it has been proven that excess radiation dose causes cancer with articles published in many medical journals. There is less dose exposure in dentistry compared to other occupational groups studied with radiation. Despite this, dentists whose hands were exposed to radiation many times at that time caught fatal skin cancer and many radiologists died from this type of skin cancer. In fact, X-rays can be seen as the cause of blood cancer, which is the cause of death in both of the Curie couple (Balsak, 2014), (Kaya, Adapınar & Özkan 1997), (Coşkun, 2011). In the 1910s, when high doses were applied, it was seen that results close to surgery were obtained, but patients were lost due to acute reactions in a short time (Tuğrul, 2012), (Pusey,1903). The International Agency for Research on Cancer (IARC) and the World Health Organization (WHO) have accepted that X-rays carry cancer risks for humans (UNSCEAR, Vienna 2000), (Daşdağ, 2010). The cancer rate due to X-ray applications has been reported at the level of 0.6% in the UK, 0.09% in the USA, 1.3% in Germany and 2.9% in Japan, unfortunately, no statistics have been found on this subject in our country (Kurtman & Çelebioğlu, 2000).

DETERMINISTIC AND STOCHASTIC EFFECTS OF RADIATION

The effects of radiation on living things can be examined in two classes as Deterministic and Stochastic Effects (Şeker & Çerezci, 1997), (Whaites, 2003), (Kunt & Dayıoğlu, 2011). Deterministic Effects: In order to see this effect, a certain radiation dose must be exceeded, that is, there is a threshold dose. When a cell's DNA or other critical fragments receive a very high dose of radiation, which is normally transmitted over a short period of time, the cell can die or be damaged irreparably. If this kills a sufficient number of cells in a tissue or organ, early radiation effects may occur. These are called deterministic effects and the severity of the effects varies according to the radiation dose taken. They can include acute radiation syndrome, skin burns, hair loss, and death in extreme cases. Most of the deterministic effects occur shortly after exposure and above the dose thresholds specific to each tissue exposed (Şeker & Çerezci, 1997), (Whaites, 2003), (Kunt & Dayıoğlu, 2011). Stochastic Effects: These are the effects that occur without the need to exceed any threshold dose in the received radiation. A safe dose interval cannot be determined to be protected from the stochastic, that is, dose-independent harmful effects of radiation.

For this reason, it is essential to fully apply radiation protection measures in every case where radiation is studied. The risks that may be caused by the stochastic effect are leukemia, cancer, genetic mutations. Genetic mutation and cancers that occur with a stochastic effect are no different from those with other causes (Şeker & Çerezci, 1997), (Whaites, 2003), (Kunt & Dayıoğlu, 2011). In a cohort study with 27,000 diagnostic x-ray workers in China, the risk of diagnostic x-ray workers developing cancer was found to be 50% higher than other experts; a significantly increased risk for leukemia, breast and thyroid cancers was observed among cancers. The authors stated that this high difference observed was mainly due to findings from workers employed before 1960 (and for ≥ 10 years) when exposure to radiation in China was high (Wang et al., 1950-1985), (Wang et al., 1988). A cohort study with the participation of x-ray technicians in the US showed some evidence that the risk of thyroid cancer increased in technicians exposed to higher radiation (Preston et al., 2016). A similar study was conducted in China (Wang et al., 1988). Following the publication of another study conducted by Hujoel et al. (2004), there was an important debate about the possible effects of low-dose radiation, suggesting a relationship between dental radiography and low birth weight babies, especially during pregnancy. These studies on diagnostic x-ray workers, including dentists, suggest that a large number of low-dose radiation exposures may be important in the etiology of thyroid cancer. In the study conducted by Memon et al. (2009), it has been seen that exposure to relatively higher lifetime dental x-rays in recent years is one of the reasons for thyroid cancer increase reports in many countries.

RESULTS OF RADIATION AFFECTING CELLS

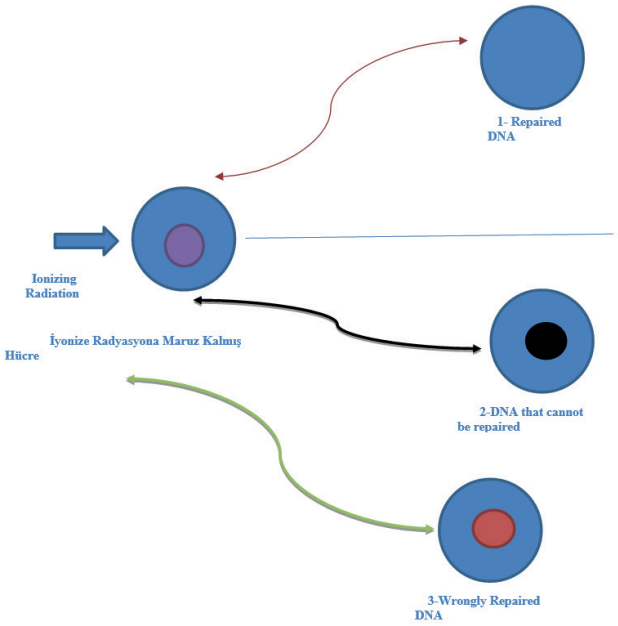

Figure 2.3. A radiation beam that breaks the double helix of the DNA chain and causes DNA damage

As seen in Figure 2.3, ionizing radiation has a three-way effect on the cell. The first of these is that the DNA is properly repaired and continued to function normally. DNA fracture normally occurs every second of the day, and cells have a natural ability to repair this damage. The second possibility is that DNA damage is very severe and the cell dies (deterministic effects). The third possibility is that the cell repairs itself incorrectly, but continues to live (stochastic effects) (Whaites, 2003), UNSCEAR, Vienna 2000), (Stewart et al., 2012).

INTERNATIONAL AND NATIONAL RADIATION PROTECTION INSTITUTIONS

We take advantage of national and international laws to protect ourselves from radiation. Each country has its own laws, statutes and regulations that provide radiation safety for radiation workers and the public. Some of them are:

ICRP (International Commission on Radiological Protection): It is an independent, international non-governmental organization with the mission of providing advice and guidance on radiation protection. Based on the results of the researches on radiation and its biological effects around the world, it

publishes laws, statutes and regulations that are advisory from time to time in order to make radiation protection more effective. Other institutions are:

UNSCEAR (United Nations Scientific Committee On The Effects Of Atomic Radiation): Founded in Vienna in 1955. Publishes important public reports on the sources and effects of ionizing radiation.

IAEA (International Atomic Energy Agency): Founded in Vienna in 1957. It serves as a governmental forum for scientific and technical cooperation in the peaceful use of nuclear technology and nuclear power worldwide.

EURATOM (European Atomic Energy Community): Founded in 1957.

ICRU (International Commission On Radiation Units and Measurements) is a standardization committee established in 1925.

WHO (World Health Organization): Founded in Geneva in 1948. Its goal is that all people reach the highest possible health levels. Turkey also became a member of this organization in 1949.

ISO (International Organization For Standardization): Develops and publishes technical, industrial and commercial standards worldwide.

In our country, the Turkish Atomic Energy Agency (TAEK), with its new name is the Turkish Energy, Nuclear and Mineral Research Institute (TENMAK), is our institution that is obliged to make laws and regulations regarding radiation protection.

REFERENCES

1) Şeker Ş.S., Çerezci O., Radiation and Protection Methods Around Us. İstanbul: Boğaziçi University Printing House; 1997

2) Whaites E., Essentials of Dental Radiography and Radiology. (3rd ed.), Edinburgh: Churchill Livingston, 2003

3) Fidancı İ. , Tekin O. , Demirel A.H. , Arslan İ. , Dilber S. , Eren Ş.Ü. , Gümüş E. Evaluation of the Relationship Between Radiation Producing Device Use and Thyroid Cancer Ankara, Ankara Training and Research Hospital, Family Medicine Clinic; 20144) Başaran M. , Bozdemir E. Evaluation of Radiation Protection and Biological Effects of Radiation Awareness of Dentistry Specialization and Senior Students Article, Düzce University Journal of Health Sciences Institute 2021; 11(2): 165-17

4) Preston-Martin S, Mack W, Henderson BE. Risk factors for gliomas and meningiomas in males in Los Angeles County. Res 1989;49:6137–43. Access 17.4.2021, https://pubmed.ncbi.nlm.nih.gov/2790826/

5) Neuberger JS, Brownson RC, Morantz RA, Chin TD. Brain cancer's relationship with dental x-rays and profession in Missouri1991;15:31–4. Access 17.4.2021, https://pubmed.ncbi.nlm.nih.gov/1646072/

6) Wang JX, Inskip PD, Boice JD Jr, Li BX, Zhang JY, Fraumeni JF Jr. Cancer incidence among medical diagnostic x-ray workers in China. 1950-1985. Int J Cancer 1990;45: 889–95. Access 21.5.2021, https://pubmed.ncbi.nlm.nih.gov/2335392/

7) Wang JX, Boice JD Jr, Li BX, Zhang JY, Fraumeni JF Jr. Cancer among medical diagnostic x-ray workers in China. J Natl Cancer Institute.1988;80:344–50. Access 21.5.2021, https://pubmed.ncbi.nlm.nih.gov/3357200/

8) Hujoel PP, Bollen, Noonan CJ, del Aguila MA. Antepartum Dental Radiography and Low Birth Weight. JAMA 2004;291:1987–93. Access 21.5.2021, https://pubmed.ncbi.nlm.nih.gov/15113817/

9) Memon A, Godward S, Williams D, Siddique I, Al-Saleh K. Risk of dental x-rays and thyroid cancer: a case-control study. Acta Oncol. 2010 May;49(4):447-53. Access 21.5.2021. https://doi.org/10.3109/02841861003705778.

10) Manavgat Sakaoğlu S., Mandıracıoğlu A. Professional Ionizing Radiation Risk Perception of Employees Carrying Personal Dosimeters. TTB Journal of Occupational Health and Safety. 2012. 12: p.34-43.

11) Radiation Safety Guide For Applications Made With Dental X-Ray Devices RSGD-KLV-018 Turkish Atomic Energy Agency

12) UNSCEAR 2000 Report on the Sources and Effects of Ionizing Radiation to the General Assembly (2 Volumes), United Nations, Vienna 2000.

13) Dasdag S. Ionizing Radiation and Cancer, Journal of Dicle Medicine, 2010; 2: p. 177-185.

14) Preston, D.L., Kitahara, C.M., Freedman, D.M., Sigurdson, A.J., Simon, S.L., Little, M.P., ... & Doody, M.M. (2016). Breast Cancer Risk and Long-Term Low-to-Moderate Dose Occupational Radiation Exposure in the U.S. Radiologic Technologists Cohort, 1983-2008. 10.1038/bjc.2016.292. Epub September 13, 2016. Accessed: April 20, 2021. [http://www.ncbi.nlm.nih.gov/pmc/articles/pmc5117787/] (http://www.ncbi.nlm.nih.gov/pmc/articles/pmc5117787/)

15) National Radiological Protection Board. (2001) Radiologist Protection Bulletin No: 231, Chilton, Didcot, Oxon OX11 0RQ:2001 ;95(2):135- Access: 16.4.2021 138.http://www.ncbi.nlm.nih.gov/pmc/articles/pmc4930038/

16) Baselet B., Rombouts C., Benotmane A.M., Baatout S. and Aerts A. (2016). Cardiovascular Diseases Related To Ionizing Radiation: Risk Of Low Dose Exposure. 8(6):1623-1641 Access: 16.4.2021 http://www.ncbi.nlm.nih.gov/pmc/articles/pmc5117755/

17) Kunt H., Dayıoğlu H. (2011). Radyasyonun Kullandıkları Cihaza Bağlı Olarak Radyoloji Çalışanlarının Kemik Mineral Yoğunluğu Üzerindeki Etkisi. Avrupa Genel Tıp Dergisi 2011; 8(4):318-322 Erişim: 20.5.2021 https://www.ejgm.co.uk/download/the-effects-of-radiation-on-bone-mineral-density-of-radiology-workers-depending-on-the-device-they-6926.pdf

18) Stewart, F., Akleyev, A., Hauer-Jensen, M., Hendry, J., Kleiman, N., Macvittie, T., Wallace, W. ICRP Publication 118: ICRP Statement on Tissue Reactions and Early and Late Effects of Radiation in Normal Tissues and Organs - Threshold Doses for Tissue Reactions in a Radiation Protection Context. Annals of the ICRP, 2012; 41(1-2), 1–322.

19) Tuğrul, A. B. (2012) Radiation Physics Lecture Notes. ITU Energy Institute.

20) Pusey W.A. The Practical Application of Rontgen Rays in Therapeutics and Diagnosis. W.W.Saunders Comp.1903.

21) Kurtman C., Çelebioğlu B. Ankara University Dikimevi Health Services Vocational School Yearboar Volume 1 Issue 1. 2000

22) Balsak H. Knowledge, Attitudes and Behaviors of Radiology Employees About the Harmful Effects of Radiation Used for Diagnostic Purposes. Malatya, İnönü University, 2014.

23) Kaya T., Adapinar B., Ozkan R. (1997). Basic Radiology Technique. İstanbul: Nobel Publishing Distribution.

24) Coşkun Ö. (2011). Biological Effects of Ionizing Radiation, Süleyman Demirel University Journal of Technical Sciences, 1 (2) 13-17.

Chapter 4

MANANGEMENT OF TEMPOROMANDIBULAR DISORDERS

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Manangement of temporomandibular disorders (TM) is generally be classified into 2 types as primary treatment and supportive treatment. While the primary treatment is aimed at controlling or eliminating the etiological factor that causes the disorder, supportive treatment is aimed at reducing the patient's symptoms (Okeson JP, 2020).

I. Disorders of the Masticatory Muscles

A common complaint in patients with masticatory muscle disorders is muscle pain (myalgia). There may be a restriction in mandibular movements due to pain. The anamnesis taken from the patient is important in determining the patient's treatment plan. This disorder can be classified into 4 subgroups and their treatments are listed below (Garstka AA, et al. 2023; Okeson JP, 2020).

• Muscle hyperactivity

The primary treatment: The etiology of this disorder can be long-lasting dental treatments or a sudden injury caused by any trauma. the patient's signs and symptoms will disappear with the elimination of the trauma. Other treatment is not needed. If the cause is an inappropriate restoration (a high crown or filling), the patient's symptoms will disappear by correcting the restoration and making it compatible with the current occlusion (Beaumont S, Garg K, Gokhale A. & Heaphy N, 2020; Thomas DC, Singer SR. & Markman S, 2023).

Supportive therapy: The patient is advised to limit jaw movements without pain and to eat soft foods. Depending on the severity of the pain, muscle relaxants may be given to the patient (Okeson JP, 2020).

• Myospasm:

The main treatment: The cause of myospasm may be the factor causing muscle hyperactivity. If this is not eliminated, the event may turn into myospasm after 2-3 days. Increased psychological stress or deep pain may cause myospasm with a central stimulating effect. The origin of deep pain may be the temporomandibular joint or teeth, as well as cervical pain. The pain from these sources occurs as pain reflected in the chewing muscles (Okeson JP, 2020). In the treatment, the patient is advised to keep jaw movements within painless limits and to eat soft foods. In addition, the patient is advised to not clench their teeth except function (swallowing and eating). If the patient has bruxism, stabilization (muscle relaxing) splint is applied to ensure equal distribution of the loads in occlusion on the teeth (Al-Ani Z, Gray RJ, Davies SJ, Sloan P. & Glenny AM, 2005). If the source is not in the muscle but pulpal origin and causes secondary myospasm in the masseter muscle, the source should be eliminated with the necessary treatment.

Supportive treatment: The most preferred supportive treatment for myospasm is physical therapy (heat applications and gentle massage to the painful muscle area will cause relaxation in the muscles) (Asquini G, Pitance L, Michelotti A. & Falla D, 2022).

• Myositis:

Unlike muscle hyperactivity and myospasm, while the treatment of myospasm takes 7-10 days, the treatment of myositis can take weeks and sometimes months.

The main treatment: The patient is advised to limit chewing movements, consume soft foods and, if possible, not to move the jaw lead to pain. Anti-inflammatory drugs and stabilization splint are recomended due to inflammation in the local muscle tissue (Garstka AA, et al. 2023; Atsü SS, Tekdemir I. & Elhan A, 2006).

Supportive treatment: After the acute symptoms have subsided, passive stretching movements are used to help gradually activate the muscles. In many cases, heat therapy, which will be applied carefully, will help reduce the symptoms. If pain occurs after heat application or passive exercises, these procedures should be reduced as they can increase the pain (Garstka AA, et al. 2023; Michelotti A, de Wijer A, Steenks M. & Farella M, 2005).

• Myofacial trigger point pain:

Myofascial trigger points originate from local hypersensitive areas within the muscle tissue. These areas or points are overloaded by the muscles, constant deep pain (constant deep pain) or increased psychological stress. Upper respiratory tract infections and viral infections can activate them (Okeson JP, 2020).

Main treatment: The most effective treatment for myofascial trigger point pain is stretching the trigger points. The vapocoolant spray is used on the muscle and trigger point and then the muscle is stretched. This spray reduces nerve stimulation in this area and temporarily reduces pain. Another technique is to massage in a way that does not cause pain. Physical therapy and injecting local anesthetic into the trigger point and ensuring muscle stretching are other techniques used (Okeson JP, 2020).

II. Treatment of Disc Interference Disorders

Disc interference disorders are caused by the disruption of the relationship between the condyle-disc complex and the mandibular fossa. It is characterized by intracapsular symptoms. Many cases are chronic and asymptomatic. Such patients notice their discomfort when warned by their physicians. The treatments for these disorders can be done as follows (Cleland J. & Palmer J, 2004; Okeson JP, 2020).

• Degeneration of the condyle-disc complex:

Degeneration occurs with the extension of the supporting ligaments of the condyle-disc complex and the thinning of the disc. These structural changes allow the disc to move out of its normal relationship with the condyle. The cause is usually trauma, more often microtrauma. The source of microtrauma may be chronic malocclusion, or restorations that may cause muscle hyperactivity, Class II anterior deep bite, overjet greater than 6-7 mm. Degeneration of the condyle-disc complex can be examined under the following 3 headings; Disc displacement, disc dislocation with reduction, and disc dislocation without reduction (Okeson JP, 2020).

a. Disc displacement and disc dislocation with reduction: The main purpose in degeneration of the condyle-disc complex is to re-establish the normal condyle-disc relationship. If this is achieved, the symptoms usually resolve. If occlusal factors are the main etiological factor, occlusion rehabilitation is necessary. If occlusion is not the etiological factor, normal condyle-disc relationship should be re-established and sufficient time should be given for the tissues to heal themselves. It is usually difficult to find the exact etiological factor in these disorders. It is required to provide normal condyle-disc relationship, to give sufficient time for the tissues to heal themselves and adapt, and then to reconsider the situation for permanent dental treatment (Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr, 2022; Manfredini D, Ercoli C, Poggio CE, Carboncini F. & Ferrari M, 2023).

Main treatment: Anterior positioning splints, stabilization splints and oral exercises are used to provide optimum condyle-disc relationship (Shimada A. et. al. 2019; Simmons HC, 2005). Systemic diseases of the patient such as diabetes and rheumatoid arthritis are factors that delay healing If macrotrauma is the etiological factor, it is important to start treatment immediately after the trauma in terms of the effectiveness of the treatment and shortening its duration (Ardıç F, 2006; Atsu SS. & Ayhan-Ardic F, 2006).

b. Disc dislocation without reduction: In the treatment of disc dislocation without reduction, unlike the reduced disc location, the aim is to first move the disc that is anterior to the condyle by manipulation, to slide posteriorly and to capture (recapture) it on the condyle side. While performing these procedures, the superior lateral pterygoid muscle and the masseter muscle should not be contracted. If necessary, a local anesthetic can be injected into the superior lateral pterygoid muscle to relax it (Poluha RL et al. 2019; Okeson JP, 2020).

Main treatment: First, functional manipulation should be performed to reduce the disc or to have the condyle capture the disc (Nagata K. et. al. 2019). In the procedure, the patient is asked to move the mandible as far forward as possible and the jaw is opened. If this fails, the physician grasps the mandible

by placing his thumb at the level of the 2nd molar on the affected side and applies force downward, upward and to the opposite side to ensure that the condyle moves downward and forward in the fossa. When the lateral and anterior movement is completed, the patient is told to stay like this for 20-30 seconds. Then, the patient is asked to move the mandible as far forward as possible and waited for a few seconds. Then the mouth is opened as much as possible. If the disc can be reduced, anterior the positioning splint is performed consecutively and applied to the patient. The subsequent treatment is the same as in the treatment of reduced disc dislocation (Okeson JP, 2020). If the disc cannot be reduced, the muscle-induced overload on the temporomandibular joint is reduced with stabilization splints. This contributes to the reduction of pain by increasing the adaptation of retrodiscal tissues. Anterior positioning and exercise splints can also be used for treatment purposes in this position (Nagata K, et al. 2019; Okeson JP, 2020; Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H. & Rossbach A, 2005).

Supportive treatment: Supportive treatment in disc interference disorders should aim to eliminate pain and secondary myospasm. In disc dislocations, pain may occur with central stimulating effects. Increased spasm in the mouth-opening muscles increases intra-articular pressure and makes joint movements difficult. Therefore, drug therapy and physical therapy (such as heat, ultrasound) are recommended as supportive treatment (Cleland J. & Palmer J, 2004; Garstka AA, et al. 2023).

• Structural incompatibilities

It originates from structural disorders of the articular surface and prevents normal jaw movements. Structural incompatibilities may be in the form of adhesion and differentiation in form. Sometimes adhesion can be temporary and allow mandibular movements. It is usually associated with bruxism, which causes long-term static loading in the temporomandibular joint. Stabilization splints are used in the treatment of this disorder because they change the relationship here and reduce interarticular pressure. In cases where adhesion is permanent, arthroscopic surgery is indicated (Zhang SH, et al. 2020; Okeson JP, 2020).

Supportive treatment: Passive stretching and ultrasound are used as supportive treatment (Michelotti A, de Wijer A, Steenks M. & Farella M, 2005).

• Subluxation:

Subluxation usually originates from the anatomical form of the fossa. In cases where the short slope of the articular eminence in the posterior continues with a straight and long slope in the anterior, the frequency of subluxation increases in individuals.

Main treatment: It is surgically change the form of the temporomandibular joint (Tran C, Ghahreman K, Huppa C. & Gallagher JE, 2022).

Supportive treatment: Supportive treatment begins with explaining the cause of the patient's discomfort and the ways to protect it. The patient must learn to open his mouth limitedly so that the mandible does not translate. If this situation cannot be resolved by patient control, orthodontic bands are placed on the teeth and mouth movements are restricted intraorally. Such applications can also be made in patients using dentures, or it may be preferred to increase the slope of the eminence surgically (Okeson JP, 2020; Tran C, Ghahreman K, Huppa C. & Gallagher JE, 2022).

III. Treatment of inflammatory disorders of the temporomandibular joint:

Inflammatory disorders of the temporomandibular joint are characterized by constant pain in the joint area, especially increasing with function. Since the pain is constant, this results in secondary central stimulatory effects such as myospasm and referred pain. They can be examined in 4 groups. These are capsulitis and synovitis, retrodiscitis, degenerative joint diseases and inflammatory arthritis (Atsu SS. & Ayhan-Ardic F, 2006; Okeson JP, 2020).

• Capsulitis (synovitis):

Trauma or other inflammatory disorders often cause capsulitis or synovitis.

Main treatment: Since macro trauma is eliminated, it is important in the main treatment not to expose the joint to another trauma (Okeson JP, 2020).

Supportive treatment: It is recommended that the patient limit mandibular movements, avoid painful movements and eat soft foods. Thermotherapy and analgesics applied to the joint area reduce pain. Muscle hyperactivity may be seen together with these disorders, in which case the use of a stabilization splint is important for treatment as it will reduce intra-articular pressure and reduce muscle contraction (Zhang SH, et al. 2020). If the cause of capsulitis or synovitis is secondary inflammation and originates from adjacent tissues, the main treatment begins with the use of appropriate antibiotics. If the cause is arthritic, arthritis is treated If capsulitis has developed secondary to disc interference disorders, the patient's disc dislocation should be treated (Ardıç F. et al, 2006; Atsu SS. & Ayhan-Ardic F, 2006).

• Retrodiscitis:

The cause is usually trauma. As a result of the trauma, the condyle is pushed posteriorly towards the retrodiscal tissues. The response of the retrodiscal tissues to trauma is usually inflammation, and the retrodiscal tissues push the condyle forward, causing malocclusion (Okeson JP, 2020).

Main treatment: Removal of the trauma.

Supportive treatment: If the patient does not have acute malocclusion, analgesics are given and the patient is told to eat soft foods and limit jaw movements. Thermotherapy is recommended as it will reduce pain. After the pain decreases, the patient is told to perform normal jaw movements. If acute malocclusion has developed, a stabilization splint should be applied as the contact of the teeth will increase the pain even more. The appliance is regularly worn until the retrodiscal tissues heal (Okeson JP, 2020).

•Degenerative joint diseases and inflammatory arthritis

Retrodiscitis also occurs as a result of intrinsic trauma in retrodiscal tissues when the disc is displaced anteriorly. When the disc is positioned anteriorly, the condyle is positioned more posteriorly and presses on the retrodiscal tissues. In many cases, since the tissues cannot withstand this pressure, inflammation develops in the tissue as a result of trauma (Yun PY & Kim YK, 2005).

Main treatment: The aim is to eliminate the trauma again. If the cause of retrodiscitis is anterior displacement or dislocation of the disc, anterior positioning splints are applied to ensure proper condyle-disc relationship. After the pain and other symptoms subside, the splint is worn and the mandible is placed in centric occlusion position (Atsu SS. & Ayhan-Ardic F. (2006).

Supportive treatment: The patient should restrict mandibular movements in a way that does not cause pain. Analgesics and thermotherapy may be recommended until the anterior positioning splint shows its effect and reduces the pain.

References

Al-Ani Z, Gray RJ, Davies SJ, Sloan P. & Glenny AM. (2005). Stabilization splint therapy for the treatment of temporomandibular myofascial pain: a systematic review. *Journal of Dental Education,* 69, 1242-50.

Ardic F, Gokharman D, Atsü S, Guner S, Yilmaz M. & Yorgancioglu R. (2006). The comprehensive evaluation of temporomandibular disorders seen in rheumatoid arthritis. *Australian Dental Journal*, 51, 23-28.

Asquini G, Pitance L, Michelotti A. & Falla D. (2022). Effectiveness of manual therapy applied to craniomandibular structures in temporomandibular disorders: A systematic review. *Journal of Oral Rehabilitation*, 49, 442-455.

Atsu SS. & Ayhan-Ardic F. (2006). Temporomandibular disorders seen in rheumatology practices: a review. *Rheumatology International*, 26, 1-7.

Atsü SS, Tekdemir I. & Elhan A. (2006). The coexistence of temporomandibular disorders and styloid process fracture: A clinical report. *Journal of Prosthetic Dentistry*, 95, 417-420.

Beaumont S, Garg K, Gokhale A. & Heaphy N. (2020). Temporomandibular Disorder: a practical guide for dental practitioners in diagnosis and management. *Australian Dental Journal,* 65, 172-180.

Cleland J. & Palmer J. (2004). Effectiveness of manual physical therapy, therapeutic exercise, and patient education on bilateral disc displacement without reduction- of the temporomandibular joint: a single-case design. *Journal of Orthopaedic and Sports Physical Therapy,* 34, 535-48.

Garstka AA, Kozowska L, Kijak K, Brzózka M, Gronwald H, Skomro P. & Lietz-Kijak D. (2023). Accurate Diagnosis and Treatment of Painful Temporomandibular Disorders: A Literature Review Supplemented by Own Clinical Experience. *Pain Research and Management,* 31, 1002235.

Kandasamy S, Rinchuse DJ, Greene CS. & Johnston LE Jr. (2022). Temporomandibular disorders and orthodontics: What have we learned from 1992-2022?. *American Journal of Orthodontics and Dentofacial Orthopedics,* 161, 769-774.

Manfredini D, Ercoli C, Poggio CE, Carboncini F. & Ferrari M. (2023). Centric relation-A biological perspective of a technical concept. *Journal of Oral Rehabilitation,* 50, 1355-1361.

Michelotti A, de Wijer A, Steenks M. & Farella M. (2005). Home-exercise regimes for the management of non-specific temporomandibular disorders. *Journal of Oral Rehabilitation*, 32, 779-85.

Nagata K, Hori S, Mizuhashi R, Yokoe T, Atsumi Y, Nagai W. & Goto M. (2019). Efficacy of mandibular manipulation technique for temporomandibular disorders patients with mouth opening limitation: a randomized controlled trial for comparison with improved multimodal therapy. *Journal of Prosthodontic Research*, 63, 202-209.

Okeson JP, (2020). *Management of Temporomandibular Disorders and Occlusion*.8 th.ed. Chicago: Quintessence Publishing Co.

Poluha RL, Canales GT, Costa YM, Grossmann E, Bonjardim LR. & Conti PCR. (2019). Temporomandibular joint disc displacement with reduction: a review of mechanisms and clinical presentation. *Journal of Applied Oral Science*, 21, e20180433.

Shimada A, Ishigaki S, Matsuka Y, Komiyama O, Torisu T, Oono Y, Sato H, Naganawa T, Mine A, Yamazaki Y, Okura K, Sakuma Y & Sasaki K. (2019). Effects of exercise therapy on painful temporomandibular disorders. *Journal of Oral Rehabilitation*, 46, 475-481.

Simmons HC. (2005). Board of Directors, American Academy of Craniofacial Pain. Guidelines for anterior repositioning appliance therapy for the management of craniofacial pain and TMD. *Cranio,* 23, 300-5.

Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H. & Rossbach A. (2005). Comparative prospective study on splint therapy of anterior disc displacement without reduction. *Journal of Oral Rehabilitation*, 32, 474-9.

Thomas DC, Singer SR. & Markman S. (2023). Temporomandibular Disorders and Dental Occlusion: What Do We Know so Far? *Dental Clinics of North America*, 67, 299-308.

Tran C, Ghahreman K, Huppa C. & Gallagher JE. (2022). Management of temporomandibular disorders: a rapid review of systematic reviews and guidelines. *International Journal of Oral and Maxillofacial Surgery*, 51, 1211-1225.

Yun PY. & Kim YK. (2005). The role of facial trauma as a possible etiologic factor in temporomandibular joint disorder. *Journal of Oral and Maxillofacial Surgery*, 63, 1576-83.

Zhang SH, He KX, Lin CJ, Liu XD, Wu L, Chen J. & Rausch-Fan X. (2020). Efficacy of occlusal splints in the treatment of temporomandibular disorders: a systematic review of randomized controlled trials. *Acta Odontologica Scandinavica,* 78, 580-589.