



TEMPOROMANDIBULAR DISORDERS IN CHILDREN

Dental Science

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ABSTRACT

The entity temporomandibular joint (TMJ) disorders, is an umbrella term, which combines a complex set of conditions, manifested by pain in the area of the jaw and associated muscles, and limitations in the ability to make the normal movements of speech, facial expression, eating, chewing, and swallowing. Trauma, general joint and muscle diseases, psychological and psychosocial factors, and certain local and systemic influences can affect the condition of the TMJ. Periodic clinical examination of growing patients along with early diagnosis and treatment of TMJ pathologies prevents further developmental, psychological, functional and esthetical problems in the future. This article describes the etiology, clinical evaluation and diagnosis, classification and treatment of this condition in brief.

KEYWORDS

temporomandibular disorders, children, bruxism, treatment

INTRODUCTION

The Temporomandibular joint, despite its complexity, is one of the most frequently used joints of the human body and its normal functioning is of great importance for the development of the mandible and craniomandibular region.¹ American Academy of Orofacial Pain defines Temporomandibular disorders (TMD's) as a collective term embracing a number of clinical problems that involves the masticatory muscles, the TMJ, and associated structures, or both.² TMD's implies lack of coordinated functioning between the TMJ and its associated musculature, ligaments, teeth and their exquisitely sensitive proprioceptive mechanism. TMJ dysfunction has been generally presumed to be a condition affecting only adults; however the prevalence of signs and symptoms is lower in children.³ The prevalence of TMD signs and symptoms have been noted rarely in 3-5 year-olds whereas 5-9% in 10-15 year olds.⁴ Most data suggests the prevalence of signs and symptoms of TMD increases with age with a higher prevalence of symptoms and greater need for treatment in girls than boys due to the physiologic uniqueness such as hypermobility and hormone influence.⁵ Therapeutic approaches for TMD are undergoing a major evolution away from traditional mechanistic dental concepts of the past to the more current biopsychosocial medical concepts that emphasize multidisciplinary approaches.⁶ Hence, the study of TMJ dysfunction in children could be important in determining whether early problems predispose patients to craniofacial growth abnormalities, TMJ related pain, or mandibular dysfunction in adulthood.

ETIOLOGY:

TMD is considered to have a 'multifactorial etiology.' They have been described as:

Predisposing (risk) factors, Precipitating (initiating) factors, Perpetuating (sustaining) factors.⁷

To simplify how TMD symptoms develop, Okeson has suggested the following formula:

"Normal function + Event > Physiologic tolerance ⇒ TMD symptoms"

Normal function: The masticatory system is designed to carry out the tasks of chewing, swallowing, and speaking.

An event: During normal function of the masticatory system, events can occur that may influence function. These events can be either local or systemic in origin Physiologic tolerance - All individuals do not respond in the same manner to the same event. Each patient has the ability to tolerate certain events without any adverse effect. It is likely that a patient's physiologic tolerance can be influenced by both local and systemic factors.

Several factors responsible for TMJ disorders:

Trauma: A common occurrence in childhood because of falling, chin trauma is reported to be a factor in the development of TMD in pediatric patients. Injuries may also occur due to motor vehicle accidents, sports, physical abuse, forceful intubation, third molar extraction.⁸ Unilateral and bilateral intracapsular or subcondylar fractures are the most common mandibular fractures in children. Closed reduction and prolonged immobilization can result in ankylosis. Indirect trauma such as flexion-extension (whiplash) injuries may alter pain processing and lead to TMD symptoms; however, a direct relationship between TMD and indirect trauma has yet to be established.⁹

Faulty Habits: Poor oral habits can affect the TMJ. Clenching and bruxism are the most obvious of these habits. Excessive use of the telephone, for example, could be an important factor in certain cases. Habits requiring constant use of the joint such as singing or gum chewing may cause or increase symptoms.¹⁰

Malocclusion: A faulty occlusion is probably the most common cause of TMD. A faulty tooth position or cuspal interferences in closing or lateral movements can create muscle imbalances by changing the resting length and function of the masticatory muscles. Clicking and locking disorders caused by disc derangements show a very definite relation to malocclusion.¹⁰ They usually occur when a malocclusion allows the condyle to assume a posterosuperior position in the mandibular fossa. As the intra articular space between the two bones diminishes, the disc has a tendency to be forced forward. This condylar position can also cause the inflammation as the condyle intrudes on the delicate retrodiscal tissue.^{10,11} Factors associated with TMD- skeletal anterior open bite,¹² skeletal class II profile,¹³ class III malocclusion,¹⁴ unilateral posterior crossbite.

Systemic Diseases: Osteoarthritis, a degenerative joint disease affects the TMJ. Various viruses can also cause TMJ inflammation. Because the synovial membrane is so highly vascularised, infection in the bloodstream easily gains access to the joint. Scleroderma can cause limited jaw opening. Juvenile Rheumatoid Arthritis¹⁵ and hormonal or hereditary disturbances can change growth patterns of the jaw and cause conditions such as mandibular hypoplasia or condylar hyperplasia. Other bony proliferations such as coronoid process overgrowth, chondromas, or calcification of the stylohyoid ligament¹⁶ occasionally occurs. Osteochondritis, usually found in teenaged females is characterized by destruction of the superior condylar surface. Hemophilia^{17, 18} and synovial cysts^{19,20} have been reported as affecting the TMJ. These systemic diseases occur as a result of imbalance of pro-inflammatory cytokines which causes oxidative stress, free radical formation, and ultimately joint damage.²¹

Cervical Dysfunction: The TMJ is in close proximity to the upper part of the cervical spine. Abnormal function or malposition of one of these parts can affect the functioning of TMJ. For example a change in head

position caused by the cervical muscles changes mandibular position. This change affects occlusion and the masticatory muscles and the masticatory muscles then affect the TMJ.^{22,23}

Developmental Abnormalities: Abnormal tooth development or a growth variation of the condyle, coronoid process, or other part of the mandible affects the TMJ. Congenital factors, disease, trauma, mouth breathing or tongue habits can cause these abnormalities.^{3,10}

Psychologic Factors: Psychologic factors can either induce symptoms or worsen TMD.²⁴ Emotional stress predisposes to clenching and bruxism which in turn contribute to orofacial pain. Depression, anxiety, post-traumatic stress disorder, psychologic distress, and sleep dysfunction may influence TMD prognosis.²⁵

Genetic predisposition: Study of catechol-O-methyl-transferase haplotypes found that the presence of one low pain sensitivity haplotype decreased the risk of developing TMD.²⁶

EXAMINATION

It is recommended that each patient who comes to the dental office be screened for these problems.²⁷ A complete history should be taken. While doing so, the clinician should observe the patient for any postural abnormalities, habitual jaw or facial movements, facial asymmetries and expressions of pain. Children with TMD commonly present with a history of preauricular pain that may radiate to the temporal region or the angle of jaw, headache, TMJ sounds, TMJ locking, and ear pain.²⁸

physical examination includes:²⁹

- 1) Examination of the TMJ- examination of active and passive range of mandibular motion, identification of the joint sounds, palpation for tenderness.
- 2) Examination of masticatory and cervical muscles.

DIAGNOSIS

TMJ imaging is considered when there is a recent history of trauma, facial asymmetry, or when abnormal TMJ sounds are noted.³⁰ Imaging should also be considered in patients who have failed to respond to conservative TMD treatment.³¹ There is a wide range of imaging procedures that can be used for patients with TMD, and they vary considerably in cost, availability, and the information that can be obtained from each of them individually.

Hard tissue imaging is generally used:

- To evaluate osseous contours, positional relationship of the condyle with the articular fossa.
- Modalities- Plain (TMJ) radiographs: Transcranial, Transpharyngeal, Transorbital views, Submentovertex projection, Conventional Tomography. Panoramic projection are considered reliable for evaluating condylar head morphology and angulation but does not permit evaluation of the joint space, soft tissues, or condylar motion. Cone-beam computed tomography (CBCT) provides the best view for evaluating the TMJs hard tissues.³²

Soft tissue imaging is generally used:

- To evaluate disc position, morphology and integrity of the disc and abnormalities in muscles and surrounding tissues.

Modalities- Magnetic resonance imaging (MRI)- dependent on the presence of protons in water. Bony and cartilage definitions of TMJ are somewhat compromised because cartilage and cortical bone have minimal quantities of water.³³ Arthrography is usually not recommended for routine diagnostic procedure.³⁴ Ultrasound is a non-invasive, inexpensive, and easily accessible technology for imaging the TMJ.³⁵ Thermography, Arthroscopy can also be used.

American Academy of Orofacial Pain has classified TMD as follows³⁶

- I) TMJ Disorders
 - a) Deviation in form-Articular surface defects, Disc thinning and perforation
 - b) Disc displacements- with and without reduction
 - c) Displacement of disc condyle complex-hypermobility, dislocation
 - d) Inflammatory conditions-capsulitis, synovitis
 - e) Degenerative diseases-osteoarthritis, osteoarthritis
 - f) Ankylosis –fibrous, bony
- II) Masticatory muscle disorders Acute-myositis, reflex muscle

- splinting, muscle spasm Chronic-myofascial pain, muscle contracture, hypertrophy, myalgia Secondary to systemic disease
- III) Congenital and Developmental disorders Condylar hyperplasia, hypoplasia, aplasia, condylosis
- IV) Neoplasms
- V) Fracture (open and closed condylar and sub condylar)

TREATMENT

The literature advocates a large number of potentially reversible conservative therapies to treat TMD patients.

Biobehavioral modalities:³⁷ Biobehavioral interventions are viewed as safe, reversible, and non-invasive, and for the most part they emphasize strategies under the patient's control. Encompasses a large collection of treatment modalities bio-feedback, relaxation, hypnosis, cognitive-behavioral methods, and education.

Biofeedback:³⁸ Assists the patient in regulating bodily functions which are generally controlled unconsciously. It is accomplished by electromyographically monitoring the state of activity or relaxation of the muscles through the surface electrodes placed over the muscles to be monitored.

Cognitive-behavioral therapy:⁴⁰ Develops behavior coping strategies and helps in modifying perceptions about TMD.

Educational modalities:^{39, 40} Educational methods have been demonstrated to be efficacious in the self-management of headache and back pain, using both group and individual approaches to deliver the educational interventions.

Physical therapies:

The goals of treatment for any chronic pain condition are undeniably reduction of pain and improvement of quality of life, which suggests that a treatment should be estimated for its efficacy in reducing the pain and its effectiveness in helping the patient to feel better.^{41,42,43}

Thermal therapies:⁴³ Heat therapy- heat increases circulation to applied area. This creates vasodilatation and reduces the symptoms of myalgia associated with local muscle soreness. Heat is applied by laying a hot moist towel over the symptomatic area. It should remain in place for 10-15 minutes, not to exceed 30 minutes.

Coolant Therapy- Cold encourages the relaxation of the muscles that are in spasm. Ice should be applied to the affected area in a circular motion without pressure, not to exceed more than 5-7 minutes.

The application of cold with exercise is rated as providing significantly greater relief than the application of heat plus exercise or exercise alone, and swelling was also significantly decreased in the group that received the cold therapy.

Low intensity laser: Alternative physical modality in the management of TMD.⁴³

Electrical stimulation: TENS is produced by a continuous stimulation of cutaneous nerve fibers at a sub painful level.⁴³ TENS has been applied clinically in the management of both acute and chronic pain, including pain of myofascial, neurologic, and articular origin.

Manipulation and exercise:⁴³ Manual techniques are hands-on therapies provided by the physical therapist.

Which includes soft tissue mobilization, muscle conditioning, joint distraction. When combined with the short-term effects of cold to decrease pain, passive exercise and stretching may be useful in increasing range of motion, strengthening the muscles, improving function, and reducing pain.

Iontophoresis: It is a process for delivering medications to tissues by means of a low amperage direct current. Delivery of local anaesthetics, anti-inflammatory agents, and vasoconstrictive agents to maintain medicament concentration to the temporomandibular joint and associated musculature, as well as ligaments, tendons, and nerve tissue has been reported to be of therapeutic benefit.⁴⁴

Ultrasound: Therapeutic ultrasound produces thermal and mechanical changes within tissues in the ultrasound field.⁴⁵

Pharmacological modalities:^{46,47} Analgesics, NSAIDs, Opioids, Corticosteroids, Iontophoresis, Intracapsular Injections, Antidepressants, Muscle Relaxants, Sedative-Hypnotics, Anxiolytics, Hypnotics.

Antidepressants have proved to be beneficial, they should be prescribed by a practitioner familiar with pain management.

Occlusal splints: Alter the patient's occlusion temporarily and may be used to decrease parafunctional activity and pain.^{48,49} Occlusal splints may be made of hard or soft acrylic. The stabilization type of splint covers all teeth on either the maxillary or mandibular arch and is balanced so that all teeth are in occlusion when the patient is closed and the jaw is in a musculoskeletally stable position.⁵⁰

Additional therapies: TMJ arthrocentesis, TMJ injections, nerve blocks, acupuncture, trigger point injections, and off-label use of Botulinum toxin A injections.⁵¹

Irreversible therapies include:

Orthodontics: Mandibular positioning devices designed to alter the growth or permanently reposition the mandible (e.g. headgear, functional appliances).

Surgery: The choice of procedure is dependent upon the diagnosis and includes the following:

Arthroscopy- Diagnostic, Operative, Arthroscopy, Disc repositioning and stabilization procedures, Discectomy with or without reconstruction, Eminectomy and eminoplasty, Condylectomy and condylar shave, Condylotomy and vertical-ramus osteotomy, Coronoidectomy, Reconstructive procedures, orthognathic surgery, open joint TMJ surgery. Data suggests surgery is limited in most situations to cases of severe joint degeneration or destruction following trauma or tumor resection.⁵²⁻⁵⁴

FUTURISTIC APPROACH:^{55,56}

Tissue regeneration recapitulates tissue formation- Bone morphogenetic proteins (BMPs). These potent molecules were originally discovered because of their capacity to induce in vivo *de novo* cartilage and bone formation in an ectopic site. Subsequently, it has been demonstrated that they are involved in many developmental processes, such as regulation of epithelial-mesenchymal interactions.

Cartilage-derived morphogenetic proteins: role in skeletal and joint repair: These biologic traits confirm the BMP-like nature of the protein and confirm the potential of CDMP-1 as an agent promoting cartilage and bone differentiation.

The identification and study of the molecular signals guiding tissue morphogenesis and tissue differentiation contribute to the development of new tissue regeneration protocols. The scientific information providing insight into the molecular basis of the development and biologic characteristics of the joint structures, including the TMJ, are still preliminary. The further development of tissue-specific will greatly enhance our capabilities to use the proper precursor cells, morphogens, and delivery systems in future repair protocols. It is possible that the biologic repair of tissues based on this new research will dramatically change surgical approaches in TMD.

CONCLUSION:

Despite the lack of specific data regarding the incidence of temporomandibular joint disorders, much has been learned over the last decade regarding specific pathology and therapy. Mandibular trauma and systemic disease might not directly affect the dentition, but can alter future condylar growth and result in facial asymmetry and skeletal malocclusion. Timely diagnosis can lessen the effect of a TMJ dysfunction or systemic disease on mandibular growth. The absence of guidelines for TMJ in children makes it difficult to apply an evidence-based approach, but it is the dentist's responsibility to examine for and classify TMDs and make the decision to observe, treat, or refer.

REFERENCES:

[1] Dergin, G., & Aktop, S. (2014). Temporomandibular Joint Disorders in Children and Related Comorbidities. *J Arthritis*, 3(1), 1-4.
 [2] Hegde, V. (2005). A review of the disorders of the temporomandibular joint. *The Journal of Indian Prosthodontic Society*, 5(2), 56.
 [3] Thilander, B., Rubio, G., Pena, L., & de Mayorga, C. (2002). Prevalence of temporomandibular dysfunction and its association with malocclusion in children and adolescents: an epidemiologic study related to specified stages of dental development.

The Angle Orthodontist, 72(2), 146-154.
 [4] KÖhler, A. A., Helkimo, A. N., Magnusson, T., & Hugoson, A. (2009). Prevalence of symptoms and signs indicative of temporomandibular disorders in children and adolescents. A cross-sectional epidemiological investigation covering two decades. *European archives of paediatric dentistry*, 10(1), 16-25.
 [5] Karthik, R., Hafila, M. F., Saravanan, C., Vivek, N., Priyadarsini, P., & Ashwath, B. (2017). Assessing prevalence of temporomandibular disorders among university students: a questionnaire study. *Journal of International Society of Preventive & Community Dentistry*, 7(Suppl 1), S24.
 [6] Alamoudi, N., Farsi, N., Salako, N. O., & Feteih, R. (1998). Temporomandibular disorders among school children. *The Journal of clinical pediatric dentistry*, 22(4), 323-328.
 [7] Howard, J. A. (2013). Temporomandibular joint disorders in children. *Dental Clinics*, 57(1), 99-127.
 [8] Greco, C. M., Rudy, T. E., Turk, D. C., Herlich, A., & Zaki, H. H. (1997). Traumatic onset of temporomandibular disorders: positive effects of a standardized conservative treatment program. *The Clinical journal of pain*, 13(4), 337-347.
 [9] DeLeeuw, R. (2018). *Klasser. Differential Diagnosis and Management of TMDs. Orofacial Pain: Guidelines, Assessment, Diagnosis, and Management*. 6th ed. Hannover Park, Ill.: Quintessence Publishing, 144-207.
 [10] Gelb, H. (1971). A review correlating the medical-dental relationship in the craniomandibular syndrome. *The New York journal of dentistry*, 41(5), 163-175.
 [11] Farrar, W. B., & McCarty, W. L. (1979). Inferior joint space arthrography and characteristics of condylar paths in internal derangements of the TMJ. *Journal of Prosthetic Dentistry*, 41(5), 548-555.
 [12] Bilgic, F., & Gelgör, İ. E. (2017). Prevalence of temporomandibular dysfunction and its association with malocclusion in children: an epidemiologic study. *Journal of Clinical Pediatric Dentistry*, 41(2), 161-165.
 [13] Manfredini, D., Segù, M., Arveda, N., Lombardo, L., Sciliani, G., Rossi, A., & Guardanardi, L. (2016). Temporomandibular joint disorders in patients with different facial morphology. A systematic review of the literature. *Journal of Oral and Maxillofacial Surgery*, 74(1), 29-46.
 [14] Nilsson, I. M. (2007). Reliability, validity, incidence and impact of temporomandibular pain disorders in adolescents. *Swedish dental journal. Supplement*, (183), 7-86.
 [15] Engel, M. B., Richmond, J., & Brodie, A. G. (1949). Mandibular growth disturbance in rheumatoid arthritis of childhood. *American Journal of Diseases of Children*, 78(5), 728-743.
 [16] Rasmussen, O. C., & Bakke, M. (1982). Psoriatic arthritis of the temporomandibular joint. *Oral Surgery, Oral Medicine, Oral Pathology*, 53(4), 351-357.
 [17] Sanders, B. (1975). Temporomandibular joint ankylosis secondary to Marie-Strümpell disease. *Journal of oral surgery (American Dental Association)*: 1965, 33(10), 784-786.
 [18] Kreutziger, K. L., & Mahan, P. E. (1975). Temporomandibular degenerative joint disease: Part I. Anatomy, pathophysiology, and clinical description. *Oral Surgery, Oral Medicine, Oral Pathology*, 40(2), 165-182.
 [19] Kameda, T. (1979). Hemarthrosis of the temporomandibular joint in a patient with hemophilia B: report of case.
 [20] Janecka, I. P., & Conley, J. J. (1978). Synovial cyst of temporo-mandibular joint imitating a parotid tumour. *Journal of maxillofacial surgery*, 6, 154-156.
 [21] Milam, S. B., Zardeneta, G., & Schmitz, J. P. (1998). Oxidative stress and degenerative temporomandibular joint disease: a proposed hypothesis. *Journal of oral and maxillofacial surgery*, 56(2), 214-223.
 [22] Robinson, M. J. (1966). The influence of head position on temporomandibular joint dysfunction. *Journal of Prosthetic Dentistry*, 16(1), 169-172.
 [23] Cohen, S. (1957). A cephalometric study of rest position in edentulous persons: influence of variations in head position. *Journal of Prosthetic Dentistry*, 7(4), 467-472.
 [24] Schwartz, L. L. (1956). A temporomandibular joint pain-dysfunction syndrome. *Journal of chronic diseases*, 3(3), 284-293.
 [25] De Luca Canto, G., Singh, V., Conti, P., Dick, B. D., Gozal, D., Major, P. W., & Flores-Mir, C. (2015). Association between sleep bruxism and psychosocial factors in children and adolescents: a systematic review. *Clinical Pediatrics*, 54(5), 469-478.
 [26] Fillingim, R. B., Ohrbach, R., Greenspan, J. D., Knott, C., Dubner, R., Bair, E., ... & Maixner, W. (2011). Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. *The Journal of Pain*, 12(11), T46-T60.
 [27] Klineberg, I. (1991). Craniomandibular disorders and orofacial pain: diagnosis and management. John Wright.
 [28] De Coster, P. J., Van den Bergh, L. I., & Martens, L. C. (2005). Generalized joint hypermobility and temporomandibular disorders: inherited connective tissue disease as a model with maximum expression. *Journal of orofacial pain*, 19(1).
 [29] Talley, R. L., Murphy, G. J., Smith, S. D., Baylin, M. A., & Haden, J. L. (1990). Standards for the history, examination, diagnosis, and treatment of temporomandibular disorders (TMD): a position paper. *CRANIO®*, 8(1), 60-77.
 [30] Hammer, M. R., & Kanaan, Y. (2018). Imaging of the pediatric temporomandibular joint. *Oral and Maxillofacial Surgery Clinics*, 30(1), 25-34.
 [31] Dym, H., & Israel, H. (2012). Diagnosis and treatment of temporomandibular disorders. *Dental Clinics*, 56(1), 149-161.
 [32] Qureshy, F. A., Savell, T. A., & Palomo, J. M. (2008). Applications of cone beam computed tomography in the practice of oral and maxillofacial surgery. *Journal of oral and maxillofacial surgery*, 66(4), 791-796.
 [33] Kopp, S., Nilner, M., Pettersson, A., & Rohlin, M. (1988). Relationship between clinical and radiologic findings of the temporomandibular joint in rheumatoid arthritis. *Oral surgery, oral medicine, oral pathology*, 66(6), 639-643.
 [34] Brooks, S. L., Brand, J. W., Gibbs, S. J., Hollender, L., Lurie, A. G., Ommell, K. Å., ... & White, S. C. (1997). Imaging of the temporomandibular joint: a position paper of the American Academy of Oral and Maxillofacial Radiology. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 83(5), 609-618.
 [35] Hussain, A. M., Packota, G., Major, P. W., & Flores-Mir, C. (2008). Role of different imaging modalities in assessment of temporomandibular joint erosions and osteophytes: a systematic review. *Dentomaxillofacial Radiology*, 37(2), 63-71.
 [36] Truelove, E. L., Sommers, E. E., LeResche, L., Dworkin, S. F., & Von Korff, M. (1992). Clinical diagnostic criteria for TMD New classification permits multiple diagnoses. *The Journal of the American Dental Association*, 123(4), 47-54.
 [37] Orlando, B., Manfredini, D., Salvetti, G., & Bosco, M. (2007). Evaluation of the effectiveness of biobehavioral therapy in the treatment of temporomandibular disorders: a literature review. *Behavioral medicine*, 33(3), 101-118.
 [38] Mohl, N. D., Ohrbach, R. K., Crow, H. C., & Gross, A. J. (1990). Devices for the diagnosis and treatment of temporomandibular disorders. Part III: Thermography, ultrasound, electrical stimulation, and electromyographic biofeedback. *The Journal of prosthetic dentistry*, 63(4), 472-477.
 [39] Crider, A. B., & Glaros, A. G. (1999). A meta-analysis of EMG biofeedback treatment of temporomandibular disorders. *Journal of Orofacial Pain*, 13(1).
 [40] Scrivani, S. J., Khawaja, S. N., & Bavia, P. F. (2018). Nonsurgical management of pediatric temporomandibular joint dysfunction. *Oral and Maxillofacial Surgery Clinics*, 30(1), 35-45.

- [41] Haug, R. H., & Foss, J. (2000). Maxillofacial injuries in the pediatric patient. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 90(2), 126-134.
- [42] McNeill, C. (1997). Management of temporomandibular disorders: concepts and controversies. *The Journal of prosthetic dentistry*, 77(5), 510-522.
- [43] Selby, A. (1985). Physiotherapy in the management of temporomandibular disorders. *Australian dental journal*, 30(4), 273-280.
- [44] Lark, M. R., & Gangarosa Sr, L. P. (1990). Iontophoresis: an effective modality for the treatment of inflammatory disorders of the temporomandibular joint and myofascial pain. *CRANIO®*, 8(2), 108-119.
- [45] Melis, M., Secci, S., & Ceneviz, C. (2007). Use of ultrasonography for the diagnosis of temporomandibular joint disorders: a review. *Am J Dent*, 20(2), 73-78.
- [46] List, T., Axelsson, S., & Leijon, G. (2003). Pharmacologic interventions in the treatment of temporomandibular disorders, atypical facial pain, and burning mouth syndrome. A qualitative systematic review. *Journal of orofacial pain*, 17(4).
- [47] Hersh, E. V., Balasubramaniam, R., & Pinto, A. (2008). Pharmacologic management of temporomandibular disorders. *Oral and maxillofacial surgery clinics of North America*, 20(2), 197-210.
- [48] Fujii, T., Torisu, T., & Nakamura, S. (2005). A change of occlusal conditions after splint therapy for bruxers with and without pain in the masticatory muscles. *CRANIO®*, 23(2), 113-118.
- [49] Okeson, J. P. (2014). *Psychologic factors and oral and facial pain*. *Bell's oral and facial pain* 7th ed.
- [50] Olsen-Bergem, H., & Bjornland, T. (2014). A cohort study of patients with JIA and arthritis of the TMJ: Outcome of arthrocentesis with and without the use of steroids. *Int J Oral Maxillofac Surg*, 43(8), 990-5.
- [51] Dimitroulis, G. (2005). The role of surgery in the management of disorders of the temporomandibular joint: a critical review of the literature: Part 2. *International journal of oral and maxillofacial surgery*, 34(3), 231-237.
- [52] Nitzan, D. W., Dolwick, M. F., & Martinez, G. A. (1991). Temporomandibular joint arthrocentesis: a simplified treatment for severe, limited mouth opening. *Journal of Oral and Maxillofacial Surgery*, 49(11), 1163-1167.
- [53] McCain, J. P. (1996). *Principles and practice of temporomandibular joint arthroscopy*. Mosby-Year Book.
- [54] Tarro, A. W. (1989). Arthroscopic treatment of anterior disc displacement: a preliminary report. *Journal of oral and maxillofacial surgery*, 47(4), 353-358.
- [55] Luyten, F. P. (1995). Cartilage-derived morphogenetic proteins Key regulators in chondrocyte differentiation?. *Acta Orthopaedica Scandinavica*, 66(sup266), 51-54.
- [56] Langer, R. (2007). Tissue engineering: perspectives, challenges, and future directions. *Tissue engineering*, 13(1), 1-2.