Treatment with Shockwave Therapy in a Patient with Joint Hypermobility and Temporomandibular Dysfunction

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Abstract

The text addresses the relationship between joint hypermobility (JH), Ehlers-Danlos Syndrome (EDS), and temporomandibular dysfunction (TMD) in patients, discussing the complexity, and comorbidities associated with these conditions. A clinical case is presented, along with the treatment, including focused shockwave therapy as a non-invasive therapeutic approach. The effectiveness of shockwave therapy is discussed in relation to pain relief and musculoskeletal system regeneration, based on studies and scientific evidence.

However, despite the potential benefits, further research is still needed to fully understand the effects of these therapies in patients with specific conditions, such as JH and EDS. The safety and efficacy of shockwave therapy are also discussed, emphasizing the importance of following rigorous protocols to avoid complications.

This summary highlights the relevance of shockwave therapy in the treatment of TMD and other musculoskeletal conditions, providing a comprehensive view of therapeutic approaches and clinical considerations involved.

Keywords: Joint Hypermobility; Ehlers-Danlos Syndrome; Temporomandibular Joint Dysfunction Syndrome, Extracorporeal Shockwave Therapy

Introduction

Joint hypermobility (JH) is often present in hereditary connective tissue disorders and is characterized by joints that exceed the physiological range of motion (ROM) [1]. Temporomandibular dysfunction (TMD) is a condition that commonly causes pain and dysfunction, which can be disabling for patients. Many TMD patients present with psychological comorbidities [2]. The condition results from dysfunction of the masticatory muscles and/or the temporomandibular joint (TMJ), leading to symptoms such as pain, joint noises, and impairment of mandibular function. Diagnostic and treatment methods for TMD do not have a definitive success rate and vary depending on the underlying cause, with conservative approaches recommended before considering surgical interventions. Constantly, new diagnostic and treatment techniques for TMD are being proposed in search of better outcomes for patients [3].

The temporomandibular joint (TMJ) is a complex bilateral synovial joint, located on both sides of the craniofacial complex, playing an essential role in facial expression, chewing, swallowing, speech, and other automatic movements, such as yawning, grinding, or clenching. However, the complete rest of this joint under normal physiological conditions, except for pinching, can be a challenge [4]. Conditions affecting the temporomandibular joint (TMJ) can result in pain and dysfunction in the muscles and joints involved in jaw movement. Recurrent dislocations and subluxations of the TMJ are common and can cause damage to the temporomandibular system, such as injuries to the capsular ligaments and the articular disk, leading to the development of Temporomandibular Dysfunction (TMD) [5]. Bruxism and other parafunctional habits have been identified as factors associated with TMD in the general population. Diagnosis of TMD is based on the diagnostic criteria for temporomandibular disorders, which define criteria for the most common TMJ disorders. The pathophysiology of the TMJ has a significant impact on individuals' ability to perform essential daily activities and vital functions, influenced by a variety of biological, behavioral, emotional, cognitive, environmental, and social factors [6]. Between 2000 and 2500 jaw movements occur daily, highlighting the importance of

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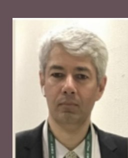

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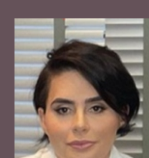

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Figure 1: Nine-point Beighton Scale for joint hypermobility syndrome [8]. Used with permission from the Ehlers-Danlos Society (ehlers-danlos.com).

TMJ health. TMJ dysfunctions are often associated with other health conditions, such as chronic fatigue syndrome, fibromyalgia, and sleep disorders, increasing the physical and emotional suffering of patients [7]. The diagnosis of these dysfunctions is performed by evaluating signs and symptoms, using classification systems such as the diagnostic criteria for temporomandibular disorders and the classification of the American Academy of Orofacial Pain. The treatment of temporomandibular disorders should address the patient holistically, considering the biopsychosocial model of health and involving a specialized multidisciplinary team. Conservative therapeutic approaches, such as physiotherapy, acupuncture, manual therapy, mobilizations, shockwaves, and other techniques, aim to relieve discomfort, improve neuromuscular strength and coordination, and increase joint ROM range of motion [8,9].

Extracorporeal shockwave therapy (ESWT) is a non-invasive intervention technique that has been used for over three decades, initially in urology and has evolved to treat various musculoskeletal pathologies [10]. Plantar fasciitis was the first orthopedic condition to receive United States Food and Drug Administration approval for shockwave management. Subsequently, many other indications were added, and in the last decade, there has been a significant expansion of studies on central nervous system application, particularly in degenerative diseases. ESWT is considered a safe therapy, well-tolerated by patients, and its appropriate use is essential to avoid complications. There are two types of technical principals included under the term shockwaves: Radial pressure waves and focused shock waves [11]. Each technology has its specific target depths and surface areas. Focused shockwaves allow for the application of high-energy density waves, penetrating deeper (6 cm–15 cm), while radial pressure waves allow for the application of medium or low-energy density waves with less penetration (2–3 cm) [12].

Focused shockwave generators are widely used in clinical practice, with different generation methods such as electrohydraulic, electromagnetic, and piezoelectric being utilized, each with specific characteristics [13]. Consisting of converging high-energy pressure pulses to a focal point, while radial pressure waves have a more superficial effect, being generated by pneumatic or electromagnetic mechanisms that transmit mechanical energy to tissues in divergent medium to low-energy pressure pulses to a specific point [14]. In fact, radial pressure waves are not shockwaves.

With the two energy propagation mechanisms: direct, which is mechanotransduction, and indirect, the latter caused by the formation of cavitation bubbles, focused shockwaves reach greater depths in body tissues, while radial pressure waves have a more superficial effect [15]. The energy released in the tissues transforms a mechanical effect into a biological effect. There are different phases of tissue reactions, highlighting physical, physicochemical, chemical, and biological aspects [16]. In the physical and physicochemical phases, there is an interaction of shockwaves with tissues, triggering biochemical reactions and release of biomolecules. In the chemical phase, shockwaves modify ionic channels and mobilize calcium in cell membranes. In the biological phase, ESWT modulates processes such as angiogenesis, inflammation, and healing. A study also highlights the ability of ESWT to transform M1 macrophages into M2, influencing the inflamed cellular environment. In addition, the therapy has demonstrated benefits for musculoskeletal conditions, including pain relief and tissue regeneration [17].

Definitions

Joint hypermobility : This is a term used to define a joint that exceeds its physiological ROM, passively and/or actively, taking into consideration age, sex, and race [2]. It is important to understand that JH is a descriptor and not a diagnosis. Although the term JH encompasses some types of hypermobility, for didactic purposes, we will attribute the term JH to those patients with generalized JH (GJH), meaning when JH is observed in multiple joints (five or more), usually involving all four limbs and the axial skeleton [3]. The Beighton score is the most commonly used tool to define GJH (Table 1

Figure 2: Focused shockwaves, piezoelectric device.

Table 1: Beighton's nine-point scale for HAG

Capacity of:	Right	Left
1. Passive dorsoflexion of the fifth metacarpophalangeal >90 °	1	1
2. Oppose the thumb to the volar aspect of the ipsilateral forearm	1	1
3. Hyperextend the elbow >10 °	1	1
4. Hyperextend the knee >10 °	1	1
5. Place your hands flat on the floor without bending your knees	1	1
Scoring: 1 point can be assigned to each side of maneuvers 1-4, so the score for hypermobility will have a maximum of 9 points if all are positive		

and Fig. 1). GJH can be asymptomatic or present with clinical symptoms [3].

Hypermobility spectrum disorder (HSD): This term refers to patients with symptomatic JH who do not meet diagnostic criteria for a specific genetic syndrome, bridging the gap between asymptomatic JH and a genetic diagnosis [3].

Ehlers-Danlos syndrome (EDS), hypermobile subtype (hEDS):

There are 13 subtypes of EDS, with the hypermobile subtype being the most prevalent (other well-known subtypes are classical and vascular). It is inherited in an autosomal dominant manner with variable expressivity [5]. The expression is strongly influenced by gender, with women being more affected than men. In some studies, the ratio between women and men can be as high as 9:1. [7] While collagen and connective tissue are involved, it is challenging to attribute all findings to the collagen alteration itself, and further studies are needed to clarify this fact. While 12 subtypes have a genetic biomarker, the one for hEDS has not yet been identified [2].

Relationship between JH and TMD

EDS leads to significant gingival and periodontal changes with excessive inflammation compared to the amount of present bacterial plaque, extensive gingival recessions, and early loss of dentition in 98% of cases. In the other EDS subtypes, periodontal changes are less frequent [18, 19]. Associations exist between some EDS subtypes and dental irregularities, such as variations in the number, shape, and size of teeth, defects in enamel, and crown constitution [20]. However, due to the rarity of some EDS subtypes where these irregularities are observed, and the predominance of research based on isolated clinical cases, generalizing the results is complicated. Recently, the strongest association between EDS and dental irregularities is linked to vascular EDS; showing pulpal changes such as decreased pulp volume, deformed pulp chambers, and root anomalies, especially in mandibular molars. Pulp calcifications and root hypoplasia are common in the classic subtype of EDS [21,22].

EDS affects connective tissues, including ligaments and cartilage that support the TMJ. Scientific studies have consistently pointed out that individuals with EDS are more likely to develop TMJ dysfunctions [20,23,24].

Case report

A 40-year-old woman, a secretary, diagnosed with hypermobile EDS, started experiencing pain in the TMJ at the age of 30. She underwent orthognathic surgery, which worsened the pain. Since then, she has been using an oral muscle relaxant splint. She developed cervical pain, a mild burning sensation of 3/10 intensity, worsening in the morning and by the end of the day. She has been under medical follow-up with us since August 2022, bringing previous imaging exams.

Imaging exams

The magnetic resonance imaging (MRI) of the TMJ (2020) presented degenerative process in the mandibular condyles probably caused by subchondral sclerosis, while the MRI of the cervical spine (2021) showed left facet osteoarthritis at C2-C3, bilateral at C3-C4, and right at C5-C6; mild disc degeneration at C4-C5, and C5-C6, small broad-based posterior disc protrusion at C5-C6. The MRI of the skull (2020) result was normal.

Past medical history

The previous drug-induced hepatitis, prior drug-induced erythema, endometriosis, Hashimoto's thyroiditis, and lactose intolerance.

Continuous use of the following medications: CBD-THC Full Spectrum, Amitriptyline, Pregabalin, and Botulinum Toxin Type A every 6 months. Frequent chiropractic care was performed.

Electroneuromyography Studies:

Facial and upper limb electroneuromyography was performed in August, 2022.

The electroneuromyography showed pre-ganglionic motor, axonal, and chronic impairment in the C6-C7 myotomes to the right, without signs of active denervation. No changes suggestive of a disorder at the postsynaptic junction were observed.

Conduct:

It was proposed to the patient four sessions of focused shockwave therapy with a weekly interval and dry needling (DN) with electrostimulation.

Protocol:

Focused shockwave therapy, piezoelectric device, manufacturer BTL, at the following myofascial points:

- Bilateral trapezius – 1,500 shots per side
- Bilateral masseter – 800 shots per side
- Bilateral cervical region – 700 shots per side.

*Intensity 0.08 mj/mm2, frequency of 8Hz, and 6,000 shots.

In May 23, 2024 the patient attended a follow-up appointment reporting an improvement in pain by around 80%, although she still mentioned pain at the base of the occipitals.

Discussion

TMD has a diverse characteristic, associated with atypical habits, pressure, and teeth grinding, local or systemic conditions, and psychosocial factors such as distress [25, 26]. The TMJ and the knee joint have similarities; they are diarthrodial joints essential for many daily movements. The knee, composed of the tibiofemoral and patellofemoral joints, is crucial for walking and running, supporting greater forces than the TMJ, which facilitate chewing, speaking, and breathing. Biomechanically, the knee deals with higher compression and shear forces, while the TMJ withstands traction loads. Biochemically, the knee meniscus has variations of collagen Type I and II, and the TMJ disc consists mostly of collagen Type I. Both joints can develop pathologies, resulting in pain and dysfunction. Although the knee joint and the TMJ have a similar incidence of cartilage diseases, treatment options for the knee are more effective. Both are among the most utilized joints in the body [27]. Musculoskeletal disorder known as myofascial pain is complex and manifests through trigger points. These points, located in areas of muscle tension, are sensitive to touch and often cause pain when pressed. These trigger points or nodules can cause various changes in individuals, from muscle shortening, hypersensitivity, and weakness, vascular changes, dizziness, and hyperirritability. Trigger points involved in myofascial dysfunction have high concentrations of various substances, such as acetylcholine production or release at muscle nerve endings, resulting in prolonged depolarization of the cell membrane and release of intracellular calcium. This leads to muscle ischemia and the release of sensitizing substances such as Substance P, CGRP, bradykinin, prostaglandins, serotonin, tumor necrosis factor α (TNFα), and interleukins (IL-1β, IL-6, IL-8) [26].

Shockwave therapy is a non-invasive treatment modality that uses acoustic waves to produce physical effects and transforms them into biological actions in tissues, stimulating angiogenesis, vasculogenesis, lymphangiogenesis, and neoangiogenesis, improving perfusion, and altering tissue ischemic pain sensitization. Studies have indicated that the masseter and temporal muscles are often affected by active trigger points in patients with TMD [27]. A recent study showed that both DN and shockwave therapy can be effective in treating myofascial trigger point (MTrP) symptoms in the upper trapezius muscle in patients with chronic non-specific neck pain. The results indicated no significant difference between the interventions in trigger point pain intensity and cervical mobility [28].

The use of low-intensity therapeutic ultrasound once daily for 2 weeks has been shown to be effective in relieving bilateral myofascial pain associated with TMD [29]. This approach also resulted in improvements in the mandibular functions of the studied patients [29]. A study demonstrated that treatment with DN in MTrPs of the trapezius muscle reduced pain and increased pressure pain threshold in three sessions. The research indicated that DN can stretch local sarcomeres and activate neurons that reduce pain. In addition, the treatment can affect microcirculation and the chemical properties of MTrPs. In other studies, the focal shockwave therapy significantly improved pain, quality of life, and anxiety in patients with MTrPs in the trapezius [30].

Application of radial pressure waves has been shown to be more efficient than ultrashort wave (uw) in the treatment of TMD, resulting in improvements in pain scores Visual Analog Scale, jaw movement range (MMO), and TMD function [31].

The TMD process occurs through a proinflammatory process, with the release of cytokines such as IL-1, IL-6, and TNF-α, M-1 macrophages involved in synovial inflammation, leading to joint cartilage degradation and excessive apoptosis of chondrocytes in the soft tissue of bone and joints, as a result of increased nitric oxide content, substance P, calcitonin gene-related peptide, and local metabolism imbalance in the joint. Shockwaves can reduce the nitric oxide content in joint fluid, decrease chondrocyte apoptosis, stimulate articular cartilage proliferation, repair cartilage defects, inhibit the secretion of inflammatory cytokines, regulate M-1 macrophage polarization to M-2, leading to tissue regeneration.[32] Tissues with low vascularization, when subjected to shockwaves, can promote revascularization through local release of growth factors, mobilize stem cells, and stimulate exosome production, resulting in increased blood flow to the tissue [32].

The previous studies indicated that these mechanisms could also contribute to reducing muscle tone in spasticity cases and have a stimulating effect on lubricin expression in fasciae and tendon sheaths [28-30]. It has been demonstrated that lubricin induces improved tendon sliding in vivo [33]. Furthermore, shockwaves can have an analgesic effect during therapy, blocking the activation and transmission of pain signals through non-invasive stimulation of cell membranes and nerve endings, especially C fibers [34].

The study investigated the effects of ESWT on in vitro cells, examining the relationship between shockwave intensity and biological outcomes. The results showed that low-energy ESWT improved angiogenic factor expression and reduced apoptotic cytokines, while high energy had the opposite effects. An energy flux density of 0.10–0.13 mJ/mm2 with 200–300 pulses was considered ideal for stimulating cell proliferation and suppressing inflammation and apoptosis. Shockwave therapy exhibited varied effects on different cytokines, including increased expression of eNOS, Ang-1, and Ang-2, and suppression of inflammatory mediators. The results highlight ESWT potential in regulating biological processes, suggesting the need for future investigations to fully understand the in vivo effects [35]. In a meta-analysis, the multimodal therapy outcome consisting of occlusal splints and counseling therapy may offer improvement for patients with TMD [36]. Radial pressure waves are generally applied to superficial injuries and large treatment areas, while focal shockwaves are often used to treat deeper injuries, bone edema, and calcifications. Studies have shown that multimodal treatment and repeated shockwave applications result in better therapeutic outcomes in TMD [37, 38].

Laser therapy and ESWT have immediate analgesic effects, acting to decrease ATP production in dorsal root ganglion neurons. Laser acts by stimulation of endogenous opioid release, an increasing pain threshold with changes in bradykinin and histamine release [39]. The reapplication of shockwaves triggers repeated chemical reactions, stimulating normal molecular and cellular functions, promoting biological regeneration, and restoring tissue physiological homeostasis without causing damage. This effect is achieved through mechanotransduction and cavitation. It is important to note that focal shockwaves offer greater penetration in musculoskeletal disorder treatment and present fewer restrictions in indications for various pathologies [40]. Increasing evidence indicates that ESWT is safe and effective in treating various musculoskeletal disorders. The most common complications after ESWT include local pain, skin erythema, soft-tissue swelling, hematoma formation, and syncope [41].

The occurrence of these complications is usually related to energy flow density, with high-energy ESWT more likely to cause local complications compared to low-energy ESWT. Isolated cases of more severe side effects have also been documented, including two reported cases of osteonecrosis [41]. However, there is still controversy about the ideal treatment frequency, requiring further research. While fewer complications have been reported, it is essential to follow strict protocols to avoid potential complications in clinical applications [42].

Furthermore, ESWT can stimulate neovascularization and growth factor secretion, which has great potential to enhance chondrocyte viability and cartilage repair mechanisms. Animal studies have shown that ESWT offers benefits such as cartilage protection, anti-inflammatory effects, neovascularization, prevention of cell apoptosis, and tissue regeneration, which may be relevant for joint treatment [43].

Conclusion

The use of shockwaves as part of TMD treatment, along with other therapies, is seen as a promising alternative approach. These methods can play a significant role in pain relief and musculoskeletal system regeneration. However, there is a significant gap in the scientific literature regarding the impact of these therapies on patients with JH, EDS, and TMD. Future research is essential to further investigate the effects of these treatments on such specific clinical conditions.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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References

1. Malek S, Reinhold EJ, Pearce GS. The Beighton Score as a measure of generalised joint hypermobility. Rheumatol Int. 2021 Oct;41(10):1707-1716. doi: 10.1007/s00296-021-04832-4. Epub 2021 Mar 18. PMID: 33738549; PMCID: PMC8390395

2. Martin VT, Neilson D. Joint hypermobility and headache: the glue that binds the two together--part 2. Headache. 2014 Sep;54(8):1403-11. doi: 10.1111/head.12417. Epub 2014 Jun 23. PMID: 24958300.

3. Castori M, Tinkle B, Levy H, Grahame R, Malfait F, Hakim A. A framework for the classification of joint hypermobility and related conditions. Am J Med Genet C Semin Med Genet. 2017 Mar;175(1):148-157. doi: 10.1002/ajmg.c.31539. Epub 2017 Feb 1. PMID: 28145606.

4. P. Beighton, L. Solomon, C. L. Soskolne. Articular mobility in an African population. Ann Rheum Dis 1973;32:413.

5. Malfait F, Francomano C, Byers P, Belmont J, Berglund B, Black J, et al. The 2017 international classification of the Ehlers-Danlos syndromes. Am J Med Genet C Semin Med Genet. 2017 Mar;175(1):8-26. doi: 10.1002/ajmg.c.31552. PMID: 28306229.

6. Castori M, Camerota F, Celletti C, Grammatico P, Padua L. Ehlers-Danlos syndrome hypermobility type and the excess of affected females: possible mechanisms and perspectives. Am J Med Genet A. 2010 Sep;152A(9):2406-8. doi: 10.1002/ajmg.a.33585. PMID: 20684008.

7. Castori M. Ehlers-danlos syndrome, hypermobility type: an underdiagnosed hereditary connective tissue disorder with mucocutaneous, articular, and systemic manifestations. ISRN Dermatol. 2012;2012:751768. doi: 10.5402/2012/751768. Epub 2012 Nov 22. PMID: 23227356; PMCID: PMC3512326.

8. Sanches SH, Osório Fde L, Udina M, Martín-Santos R, Crippa JA. Anxiety and joint hypermobility association: a systematic review. Braz J Psychiatry. 2012 Jun;34 Suppl 1:S53-60. English, Portuguese. doi: 10.1590/s1516-44462012000500005. PMID: 22729449.

9. Bielajew BJ, Donahue RP, Espinosa MG, Arzi B, Wang D, Hatcher DC et al. Knee orthopedics as a template for the temporomandibular joint. Cell Rep Med. 2021 Apr 14;2(5):100241. doi: 10.1016/j.xcrm.2021.100241. PMID: 34095872; PMCID: PMC8149366.

10. Schmitz C, Császár NB, Milz S, Schieker M, Maffulli N, Rompe JD, et al. Efficacy and safety of extracorporeal shock wave therapy for orthopedic conditions: a systematic review on studies listed in the PEDro database. Br Med Bull. 2015;116(1):115-38. doi: 10.1093/bmb/ldv047. Epub 2015 Nov 18. PMID: 26585999; PMCID: PMC4674007.

11. Contaldo C, Högger DC, Khorrami Borozadi M, Stotz M, Platz U, Forster N et al. Radial pressure waves mediate apoptosis and functional angiogenesis during wound repair in ApoE deficient mice. Microvasc Res. 2012 Jul;84(1):24-33. doi: 10.1016/j.mvr.2012.03.006. Epub 2012 Mar 29. PMID: 22504489.

12. Simplicio C, Purita J, Murrell W, Santos GS, Dos Santos RG, Lana JF. Extracorporeal shock wave therapy mechanisms in musculoskeletal regenerative medicine. J Clin Orthop Trauma 2020;11:S309-18.

13. Rompe JD, Kirkpatrick CJ, Küllmer K, Schwitalle M, Krischek O. Dose-related effects of shock waves on rabbit tendo Achillis. A sonographic and histological study. J Bone

Joint Surg Br. 1998 May;80(3):546-52. doi: 10.1302/0301-620x.80b3.8434. PMID: 9619954.

14. Simplício CL, SMBTOC. Tratado de Ondas de Choque. Abu Dhabi: Sociedade Médica Brasileira de Tratamento por Ondas de Choque, Alef; 2022.

15. Gollmann-Tepeköylü C, Pölzl L, Graber M, Hirsch J, Nägele F, Lobenwein D, et al. miR-19a-3p containing exosomes improve function of ischaemic myocardium upon shock wave therapy. Cardiovasc Res. 2020 May 1;116(6):1226-1236. doi: 10.1093/cvr/cvz209. PMID: 31410448.

16. Simplicio C, Santos G, Shinzato GT, De Barros GA, Imamura M, Neto AD, et al. Extracorporeal shockwave treatment for low back pain: A descriptive of the literature. Biol Orthop J 2022;4:e96-105. DOI https://doi.org/10.22374/boj.v4iSP1.46

17. Sukubo NG, Tibalt E, Respizzi S, Locati M, d'Agostino MC. Effect of shock waves on macrophages: A possible role in tissue regeneration and remodeling. Int J Surg. 2015 Dec;24(Pt B):124-30. doi: 10.1016/j.ijsu.2015.07.719. Epub 2015 Aug 18. PMID: 26291028.

18. Kapferer-Seebacher I, Lundberg P, Malfait F, Zschocke J. Periodontal manifestations of Ehlers-Danlos syndromes: A systematic review. J Clin Periodontol. 2017 Nov;44(11):1088-1100. doi: 10.1111/jcpe.12807. Epub 2017 Sep 25. PMID: 28836281.

19. Carvalho TG. Síndrome De Ehlers-Danlos. Espondiloartrite e Manifestações Orofaciais-Um Caso Clínico. Porto: Universidade Fernando Pessoa, Faculdade de Ciências da Saúde; 2023. Available in: https://bdigital.ufp.pt/bitstream/10284/12064/1/PPG_33477.pdf

20. Kapferer-Seebacher I, Schnabl D, Zschocke J, Pope FM. Dental Manifestations of Ehlers-Danlos Syndromes: A Systematic Review. Acta Derm Venereol. 2020 Mar 25;100(7):adv00092. doi: 10.2340/00015555-3428. PMID: 32147746; PMCID: PMC9128968.

21. Buryk-Iggers S, Mittal N, Santa Mina D, Adams SC, Englesakis M, Rachinsky M, et al. Exercise and Rehabilitation in People With Ehlers-Danlos Syndrome: A Systematic Review. Arch Rehabil Res Clin Transl. 2022 Mar 4;4(2):100189. doi: 10.1016/j.arrct.2022.100189. PMID: 35756986; PMCID: PMC9214343.

22. Kapferer-Seebacher I, van Dijk FS, Zschocke J. Periodontal Ehlers-Danlos Syndrome. 2021 Jul 29. In: Adam MP, Feldman J, Mirzaa GM, et al., editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK572429/.

23. Kosho T, Mizumoto S, Watanabe T, Yoshizawa T, Miyake N, Yamada S. Recent Advances in the Pathophysiology of Musculocontractural Ehlers-Danlos Syndrome. Genes (Basel). 2019 Dec 29;11(1):43. doi: 10.3390/genes11010043. PMID: 31905796; PMCID: PMC7017038.

24. Lepperdinger U, Zschocke J, Kapferer-Seebacher I. Oral manifestations of Ehlers-Danlos syndromes. Am J Med Genet C Semin Med Genet. 2021 Dec;187(4):520-526. doi: 10.1002/ajmg.c.31941. Epub 2021 Nov 6. PMID: 34741498; PMCID: PMC9298068.

25. Song B, Yeh P, Nguyen D, Ikpeama U, Epstein M, Harrell J. Ehlers-Danlos Syndrome: An Analysis of the Current Treatment Options. Pain Physician. 2020 Jul;23(4):429-438. PMID: 32709178.

26. Yoshizawa T, Kosho T. Mouse Models of Musculocontractural Ehlers-Danlos Syndrome. Genes (Basel). 2023 Feb 8;14(2):436. doi: 10.3390/genes14020436. PMID: 36833362; PMCID: PMC9957544.

27. Tian Y, Cui S, Guo Y, Zhao N, Gan Y, Zhou Y, et al. Similarities and differences of estrogen in the regulation of temporomandibular joint osteoarthritis and knee osteoarthritis. Histol Histopathol. 2022 May;37(5):415-422. doi: 10.14670/HH-18-442. Epub 2022 Feb 23. PMID: 35194774.

28. Urits I, Charipova K, Gress K, Schaaf AL, Gupta S, Kiernan HC, et al.. Treatment and management of myofascial pain syndrome. Best Pract Res Clin Anaesthesiol. 2020 Sep;34(3):427-448. doi: 10.1016/j.bpa.2020.08.003. Epub 2020 Aug 8. PMID: 33004157.

29. Ba S, Zhou P, Yu M. Ultrasound is Effective to Treat Temporomandibular Joint Disorder. J Pain Res. 2021 Jun 10;14:1667-1673. doi: 10.2147/JPR.S314342. PMID: 34140803; PMCID: PMC8203600.

30. Sabeti-Aschraf M, Dorotka R, Goll A, Trieb K. Extracorporeal shock wave therapy in the treatment of calcific tendinitis of the rotator cuff. Am J Sports Med. 2005 Sep;33(9):1365-8. doi: 10.1177/0363546504273052. Epub 2005 Jul 7. PMID: 16002492.

31. Li W, Wu J. Treatment of Temporomandibular Joint Disorders by Ultrashort Wave and Extracorporeal Shock Wave: A Comparative Study. Med Sci Monit. 2020 Jun 21;26:e923461. doi: 10.12659/MSM.923461. PMID: 32564051; PMCID: PMC7328499.

32. Kim YH, Bang JI, Son HJ, Kim Y, Kim JH, Bae H, et al. Protective effects of extracorporeal shockwave on rat chondrocytes and temporomandibular joint osteoarthritis; preclinical evaluation with in vivo99mTc-HDP SPECT ex vivo micro-CT. Osteoarthritis Cartilage 2019;27:1692-701. DOI: 10.1016/j.joca.2019.07.008

33. Hazan-Molina H, Reznick AZ, Kaufman H, Aizenbud D. Assessment of IL-1β and VEGF concentration in a rat model during orthodontic tooth movement and extracorporeal shock wave therapy. Arch Oral Biol. 2013 Feb;58(2):142-50. doi: 10.1016/j.archoralbio.2012.09.012. Epub 2012 Oct 22. PMID: 23088789.

34. Manafnezhad J, Salahzadeh Z, Salimi M, Ghaderi F, Ghojazadeh M. The effects of shock wave and dry needling on active trigger points of upper trapezius muscle in patients with non-specific neck pain: A randomized clinical trial. J Back Musculoskelet Rehabil. 2019;32(5):811-818. doi: 10.3233/BMR-181289. PMID: 30883334.

35. Zhang X, Yan X, Wang C, Tang T, Chai Y. The dose-effect relationship in extracorporeal shock wave therapy: the optimal parameter for extracorporeal shock wave therapy. J Surg Res. 2014 Jan;186(1):484-92. doi: 10.1016/j.jss.2013.08.013. Epub 2013 Sep 3. PMID: 24035231.

36. Al-Moraissi EA, Farea R, Qasem KA, Al-Wadeai MS, Al-Sabahi ME, Al-Iryani GM. Effectiveness of occlusal splint therapy in the management of temporomandibular disorders: network meta-analysis of randomized controlled trials. Int J Oral Maxillofac Surg. 2020 Aug;49(8):1042-1056. doi: 10.1016/j.ijom.2020.01.004. Epub 2020 Jan 22. PMID: 31982236.

37. Wang CJ, Wang FS, Yang KD, Weng LH, Hsu CC, Huang CS, et al. Shock wave therapy induces neovascularization at the tendon-bone junction. A study in rabbits. J Orthop Res. 2003 Nov;21(6):984-9. doi: 10.1016/S0736-0266(03)00104-9. PMID: 14554209.

38. Moya D, Ramón S, Schaden W, Wang CJ, Guiloff L, Cheng JH. The Role of Extracorporeal Shockwave Treatment in Musculoskeletal Disorders. J Bone Joint Surg Am. 2018 Feb 7;100(3):251-263. doi: 10.2106/JBJS.17.00661. PMID: 29406349.

39. Király, M., Bender, T., & Hodosi, K. (2018). Comparative study of shockwave therapy and low-level laser therapy effects in patients with myofascial pain syndrome of the trapezius. Rheumatology International. doi:10.1007/s00296-018-4134-x 10.1007/s00296-018-4134-x

40. Poenaru D, Sandulescu MI, Cinteza D. Biological effects of extracorporeal shockwave therapy in tendons: A systematic review. Biomed Rep. 2022 Dec 29;18(2):15. doi: 10.3892/br.2022.1597. PMID: 36684664; PMCID: PMC9845689..

41. Moya D, Ramón S, Guiloff L, Terán P, Eid J, Serrano E. Malos resultados y complicaciones en el uso de ondas de choque focales y ondas de presión radial en patología musculoesquelética [Poor results and complications in the use of focused shockwaves and radial pressure waves in musculoskeletal pathology]. Rehabilitacion (Madr). 2022 Jan-Mar;56(1):64-73. Spanish. doi: 10.1016/j.rh.2021.02.007. Epub 2021 Apr 5. PMID: 33832759.

42. Zhang X, Yan X, Wang C, Tang T, Chai Y. The dose-effect relationship in extracorporeal shock wave therapy: the optimal parameter for extracorporeal shock wave therapy. J Surg Res. 2014 Jan;186(1):484-92. doi: 10.1016/j.jss.2013.08.013. Epub 2013 Sep 3. PMID: 24035231.

43. Lu CC, Chou SH, Shen PC, Chou PH, Ho ML, Tien YC. Extracorporeal shock wave promotes activation of anterior cruciate ligament remnant cells and their paracrine regulation of bone marrow stromal cells' proliferation, migration, collagen synthesis, and differentiation. Bone Joint Res. 2020 Aug 11;9(8):458-468. doi: 10.1302/2046-3758.98.BJR-2019-0365.R1. PMID: 32832074; PMCID: PMC7418778.

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