COMPARISON OF TREATMENT OUTCOME OF OCCLUSAL SPLINTS AND PHYSIOTHERAPY REGARDING THEIR EFFECT ON POSTURE: AN IN VIVO PILOT STUDY

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Objectives: The primary objective of the research is to assess occlusal splints and physical exercise effect on posture. The secondary objective is to compare which treatment option has more positive feedback regarding posture adjustment.

Methods: twenty patients with temporomandibular disorders (TMD) were divided into two groups equally, one receiving occlusal splints as a treatment for TMD and the other group receiving physical therapy exercises. They underwent a clinical and postural examination at baseline, after 1 week, after 1 month and after 2 months of treatment. Postural stability was assessed using a force platform (SATEL). Subjects were evaluated in static and dynamic conditions, with open and closed eyes. Surface are and sway length were assessed and compared through stabilometric parameters.

Results: A decrease in sway length for both groups according to time was observed for all positions and eye statuses, however, this decrease was only significant between baseline and 2 months for the two treatment groups in dynamic lateral position when eyes were closed, and in dynamic anteroposterior position when eyes were closed. In dynamic anteroposterior position when eyes were open, the decrease in sway length was only significant between baseline and 2 months in occlusal splint group. For the occlusal splint group, surface area decreased significantly between baseline and 2 months when eyes were open in static, dynamic lateral, and dynamic anteroposterior positions. However, when eyes were closed and in dynamic lateral position, the decrease was significant between baseline and 1 month, but an increase was observed at 2 months. No difference was shown between occlusal splint or physical therapy exercise groups. In the two treatment groups, pain scores have significantly decreased between baseline and 2 months.

Conclusions: the decrease in surface area and sway length indicates an improvement in posture. No difference was shown between occlusal splint or physical therapy exercise groups. Further investigation regarding this topic are needed with a larger sample size.

Clinical significance: Occlusal splint and physical therapy exercise are effective for TMD patients and they may have an effect on postural balance.

Keywords: temporomandibular joint, temporomandibular disorder, force platform, occlusal splint, physical therapy exercise, posture.

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The authors declare no conflicts of interest.

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COMPARAISON DES RESULTATS DES TRAITEMENTS PAR GOUTTIERES OCCLUSALES ET PAR PHYSIOTHÉRAPIE CONCERNANT LEUR EFFET SUR LA POSTURE: UNE ETUDE PILOTE IN VIVO

Objectifs: L'objectif principal de cette recherche est d'évaluer l'effet des gouttières occlusales et des exercices physiques sur la posture. L'objectif secondaire est de comparer la meilleure option thérapeutique en termes d'ajustement postural.

Méthodes: Vingt patients atteints de troubles temporo-mandibulaires (TTM) ont été répartis en deux groupes à parts égales: groupe 1 recevant des gouttières occlusales pour le traitement des TTM, et le groupe 2 des exercices de kinésithérapie. Ils ont subi un examen clinique et postural au début de l'étude, après une semaine, un mois et deux mois de traitement. La stabilité posturale a été évaluée à l'aide d'une plateforme de force (SATEL). Les sujets ont été évalués en conditions statiques et dynamiques, yeux ouverts et fermés. La surface et la longueur de balancement ont été évaluées et comparées grâce à des paramètres stabilométriques.

Résultats: Une diminution de la longueur de balancement a été observée pour les deux groupes en fonction du temps, et ceci pour toutes les positions et tous les statuts oculaires. Cependant, cette diminution n'était significative qu'entre le début et 2 mois pour les deux groupes de traitement en position latérale dynamique lorsque les yeux étaient fermés et en position antéropostérieure dynamique lorsque les yeux étaient fermés.
En position antéropostérieure dynamique lorsque les yeux étaient ouverts, la diminution de la longueur de balancement n'était significative qu'entre le début et 2 mois dans le groupe avec gouttière occlusale. Pour le groupe avec gouttière occlusale, la surface a diminué significativement entre le début et 2 mois lorsque les yeux étaient ouverts en positions statique, latérale dynamique et antéropostérieure dynamique. Cependant, lorsque les yeux étaient fermés et en position latérale dynamique, la diminution était significative entre le début et 1 mois, mais une augmentation a été observée à 2 mois. Aucune différence n'a été observée entre les groupes portant une gouttière occlusale et les exercices de kinésithérapie. Dans les deux groupes de traitement, les scores de douleur ont significativement diminué entre le début et 2 mois.

Conclusions: la diminution de la surface et de la longueur de balancement indique une amélioration de la posture. Aucune différence n'a été observée entre les groupes portant une gouttière occlusale et les exercices de kinésithérapie. Des études complémentaires sur ce sujet sont nécessaires avec un échantillon plus large.

Signification clinique: la gouttière occlusale et les exercices de kinésithérapie sont efficaces chez les patients souffrant de troubles de l'ATM et pourraient avoir un effet sur l'équilibre postural.

Mots clés: articulation temporo-mandibulaire, trouble temporo-mandibulaire, plateforme de force, gouttière occlusale, exercices de kinésithérapie, posture.

Introduction

Temporomandibular disorder (TMD) is the second most common musculoskeletal pain, with low back pain being the first. The most common complaint of TMD is pain in the masticatory muscles and/or joint. Pain can be present at any time, even in the absence of any jaw activity. The pain intensity varies from mild to severe. For some patients there may be multiple episodes over weeks or months and the pain can be momentary or constant [1].

Neck or shoulder pain is frequently found in TMD patients. It is reported that TMD patients with neck or shoulder pain tend to present poor body posture, and that neck or shoulder pain is mitigated or disappears with improvement in body posture, as a result of dental and physical treatment for TMD [2].

A study prove that there is evidence that painful TMD is linked to some musculoskeletal problems in the spine, implying that the spine should be checked in these individuals as a potential contributing cause [3]. Furthermore, a substantial link between neck impairment and TMD has been discovered [4].

A systematic review of the literature surveys in 266 publications reporting on a relationship between the masticatory apparatus and disturbances of the spinal column. An inter-relation exists between the masticatory apparatus and head posture according to 216 articles, and an association between pelvic tilting and the oral cavity according to 53 studies. 131 articles conclude that the occlusion affects posture and 171 assert that posture affects occlusion [5].

The link between temporomandibular joint (TMJ), muscle, and posture is still not well understood in the literature, and it is advised that greater sample size, objective posture assessments, and better controlled studies with comprehensive TMD diagnoses are necessary. The intricacy of the contributing elements has left significant gaps in our knowledge of this relationship.

Furthermore, Studies have demonstrated an association between TMDs and posture. Patients with TMD have more noticeable fluctuations to their body's centre of gravity. A number of studies have shown that individuals with TMD often present with an abnormally forward head position, which is accompanied by sternocleidomastoid and posterior cervical extensor muscle shortening [6].

Moreover, because the entire body functions on the principle of compensation, any abnormalities in the upper quadrant, like elevated muscle tension, would cause the spinal region's muscle tension to adjust to force the proper position. All these adaptive modifications take place within the body's tolerance [7].

The cervical lordosis rises to increase the field of view when the head is tilted anteriorly, reducing the field of vision. The anterior location of the head has a similar effect on the centre of gravity, confirming the connection between TMD and posture. Postural alterations in the cervical area can potentially cause TMD by causing the jaw to shift and the head to orient differently. Previous posturography studies have demonstrated a relationship between vision and body posture in subjects with unilaterally anaesthetized trigeminal afferents [8].

TMD refers to a group of conditions that affect the temporomandibular joint, jaw muscles, and surrounding tissues. These conditions can result in pain, discomfort, and functional limitations in the jaw and surrounding areas. If left untreated it can lead to difficulties in jaw movement, including limitations in opening or closing the mouth and significantly impact an individual's quality of life by affecting daily activities and causing discomfort. Since painful TMD have been demonstrated to be biopsychosocial and/or physical disorder, it is extremely improbable that a single aetiology will be found in any individual patient [9].

A study by Baldini et al, postulated that there is a strong correlation between vision and body posture. Their postulation is understandable if we consider that vision is a vital component of the tonic postural system and that its absence inhibits the superior system from controlling the posture [10]. Hence relies the importance of taking into consideration the vision status when recording postural balances as research prove that open and closed eyes plays a role in balance of the body's posture.

Addressing TMD early can prevent the progression of symptoms and the development of additional issues. Treatment aims to alleviate pain and improve the individual's overall well-being. Some TMD treatments require surgical intervention that does not always have positive feedback, a treatment option to replace surgical intervention might be tissue engineering by replacing the TMJ. Given the issues with surgical alternatives, tissue engineering continues to be the only natural, long-term, and hopeful treatment for disc replacement. Further studies are needed regarding this treatment option [11].

Other new treatment options of TMD include platelet rich plasma (PRP) and Botulinum toxin injections (BTX). A systematic review published in 2023 by Haddad, Zoghbi et al showed that mandibular range of motion and pain intensity have significantly improved as a result of PRP injections [12]. Moreover, a literature review in 2021 by Haddad et al, showed that Botulinum type A injections are a new chronic pain treatment; patients with severe chronic face pain who have not responded to conventional therapies

may benefit from botulinum type A injections. The standard of evidence, however, is not yet strong enough to provide clinicians with explicit advice [13]. Hence further studies are needed regarding the use of BTX injections to treat TMD.

TMD treatment approaches that are non-invasive and conservative are prefered because the etiology of TMD is not very clear yet. Physical therapy, lifestyle modifications, and oral appliances are often used to manage symptoms, providing effective options without the need for surgical intervention.

Numerous studies have attested to the efficacy of exercise therapy and occlusal splint therapy in alleviating pain and improving mandibular movement for individuals with painful TMD. The occlusal splint is acknowledged as a fundamental, non-invasive therapy option for TMD. Exercise therapy is another conservative approach for those seeking treatment. Its goal is to enhance strength, mobility, coordination, and alleviate pain in the joints and muscles [14-16]. Self exercises are often offered at home and can be done by the patient without supervision.

In presence of occlusal splint and physical therapy treatment for TMD symptoms relief, the question asked is as follows: If occlusal splint and physical therapy are treatment options for TMD, and TMD is believed to affect posture and vice versa, Can occlusal splint and physical therapy affect body posture. And which treatment option is more promising regarding posture adjustment.

Hence, based on the information provided, it's crucial to carry out an in vivo study to investigate the effect of occlusal splints and physical exercise on posture as well as to compare those two treatment options.

The Main objectives of the study are as follows:

- The primary objective of the research is to assess occlusal splints and physical exercise effect on posture.
- The secondary objective is to **compare** which treatment option has more positive feedback regarding posture adjustment and patient satisfaction.

This study is a continuance of an existing line of research in the literature. Nonetheless, there is no enough **studies in the literature** about the comparison between occlusal splint and physiotherapy regarding their effect on posture. Thereby, it is emphasized that the literature needs more studies regarding this topic.

The null hypothesis (H0) investigated in this research is the absence of statistically significant difference in posture after occlusal splints and physiotherapy. H1: There is a statistically significant difference in posture after occlusal splints and physiotherapy.

Materials and methods

Study setting

This study is a clinical prospective pilot study, conducted over a period of 6 months, at Dental Health care center, Faculty of Dentistry, Saint-Joseph University of Beirut (Beirut-Lebanon) and Institute of Physiotherapy, Faculty of Medicine, Saint-Joseph University of Beirut (Beirut-Lebanon). Participants provided their informed consent after the study was authorised by the Saint Joseph University ethical committee. (ref USJ-2022-237)

Inclusion Criteria

- Patient suffering from chronic TMD.
- Bilateral Functional occlusion
- Sleep bruxism

Exclusion Criteria

- history of trauma to the TMJ
- acute TMD
- Medical conditions that might affect the joint and muscles (rheumatoid arthritis, neuromuscular disorder, previous tumor in head and neck)
- Previous surgery in TMJ area

Sample size

In this pilot study, a total of 20 patients from the USJ dental clinic met the inclusion and exclusion criteria and agreed on participating in this study. They were divided into 2 groups. One group consisting of 10 patients received occlusal splint therapy, while the other 10 patients received physical exercises to the TMJ to be done daily by the patient itself. The patient's history and dysfunctions were evaluated using a screening diagnostic form, and the examiners performed a clinical examination. To corroborate the diagnosis of TMD, palpation was performed on the cervical, masticatory, and TMJ muscles. All participants signed a written consent before participation in this study.

Preparation of the occlusal splint

All patients in the occlusal splint group received an upper occlusal splint. Taking precise impressions is essential to getting a splint that is well fitting, no tooth should be left out of the appliance as it may cause an overeruption of this tooth. After pouring the impressions with plaster, the casts are checked for undercuts in teeth, all undercuts are blocked using wax. After trimming the plaster casts, the casts were prepared for vacuum forming. To create the occlusal splint, the upper model of each patient was vacuum pressed within a 2 mm thermoplastic sheet. The occlusal splints were modified with acrylic resin following border trimming. The patient was led to centric occlusion to allow maximal contact when the acrylic resin was applied on the splint in its plastic condition. The splint was removed once the resin solidified, and adjustments were performed with an acrylic bur placed on a handpiece until each tooth had a single contact that was free of indentations. To verify the occlusion, an articulating paper was used. After that, the splints were polished, and the patient was instructed to wear them overnight.

Patients were advised that TMD is cyclical. They were also educated about the connection between psychological variables, parafunction, and muscle soreness and weariness. The occlusal splints were examined during treatment, and adjustments were made as needed.

Physical exercise therapy

The second group of this study received instructions for home physical exercises to be done at least 2 times in a set of 10 repetitions for each exercise for 2 months. Patients were followed constantly. The exercises were as follows:

- The tongue in resting position: Apply light pressure to the palate by placing the tip of the tongue on the upper palate.
- Gold fish exercise: Put one finger on the chin and one on the TMJ point while maintaining the tongue on the roof of the mouth. Shut the mouth once again after fully dropping the lower jaw.
- Chin tucks: Pull the chin straight back to form a «double chin» while keeping the shoulders back and the chest elevated. Repeat after holding this position for three seconds.
- Resisted mouth opening: With the thumb beneath the chin, slowly open the mouth and press softly on it to provide resistance. After three to six seconds of holding, softly close the mouth.
- Resisted mouth closing: Using one hand, hold the chin with the thumb and index finger. Press lightly on the chin and try to keep the mouth shut while resisting.
- Forward jaw movement: move the mandible forward several times.
- Axial extension of the neck: As though nodding the head, raise and lower the chin.

Stabilometry

Postural balance was assessed using a stabilometry device (SATEL). The patient should stand on the platform barefoot, maintaining their foot placement as marked by the platform. Having their position adjusted based on their habitual position and maintain a fixed gaze. During the test the patient is instructed to remain balanced on the platform without moving the feet or holding on with their hands. Our goal is to figure out how the status with a dental splint and the status with physical exercise differ. The patient's equilibrium is evaluated by the SATEL system in both static and dynamic postures. Both open and closed eyes were used during the test, and it was performed before any treatment, after 1 week, 1 month and 2 months of treatment. The software attached to the platform through a USB cable requires calibration prior to each acquisition. Tests were carried out by the author; the software automatically generates test findings and provides them as a standardised report with the different acquisition parameters listed. The patient was asked to stand on the stabilometer several times. Recordings were made during static posture with open and closed eyes; and during dynamic position (mediolateral and anteroposterior) with open and closed eyes as well.

Visual analogue scale

A visual analogue scale with a range of "1" to "10," where "1" denoted no pain and "10" the worst pain the patient had ever experienced, was used to assess the severity of pain symptoms. Patient were instructed to indicate their pain level at each appointment (baseline, 1 week, 1 month and 2 months)

Statistical analysis

- Data were analyzed using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA).
- Descriptive statistics for the quantitative variables were presented as means (standard deviations) and medians (interquartile ranges).
- The Shapiro-Wilk test was used to determine the normality of distribution of the quantitative variables.
- To compare values between groups at each timepoint, Student's t test or Mann-Whitney U test were used depending on the normality.
- And to compare values for each group between timepoints, repeated-measures ANOVA or Friedman's tests were used, followed by the Bonferroni correction for multiple pairwise comparisons. All tests were two-sided, and the level of significance was set at 5%.

Results

Sway length

Table 1. Sway length measured in (mm) in static, dynamic lateral, and dynamic anteroposterior positions, with open and closed eyes, for the two treatment groups, at baseline, one week, one month, and two months after treatments.

Position	Eyes status	Timepoint	Occlusal splint (n=10)	Physiotherapy (n=10)	*p*-value
			Mean (SD)	*Mean (SD)*	
Static	Open	Baseline	393.00 (105.98)	400.90 (122.44)	0.879
		1 week	385.70 (97.32)	389.80 (127.28)	0.936
		1 month	378.10 (97.09)	384.20 (126.66)	0.905
		2 months	370.10 (107.21)	378.40 (119.86)	0.872
		p-value	0.358	0.183	
	Closed	Baseline	447.70 (104.62)	455.70 (140.15)	0.887
		1 week	434.70 (116.73)	445.30 (134.20)	0.853
		1 month	426.00 (89.51)	422.90 (113.37)	0.947
		2 months	413.30 (71.07)	415.90 (110.48)	0.951
		p-value	0.281	0.226	
Dynamic lateral	Open	Baseline	559.70 (95.36)	564.30 (147.23)	0.935
		1 week	544.10 (112.17)	555.30 (136.69)	0.843
		1 month	497.50 (111.15)	517.40 (139.44)	0.728
		2 months	492.80 (76.88)	504.00 (128.16)	0.815
		p-value	0.059	0.126	
	Closed	Baseline	1126.00 (423.83)^{A}	1148.50 (601.57)^{A}	0.631
		1 week	1078.40 (417.10)^{A}	1002.50 (422.60)^{AB}	0.684
		1 month	1027.70 (389.79)^{AB}	1009.70 (410.92)^{AB}	1.000
		2 months	930.10 (337.13)^{B}	887.40 (442.09)^{B}	0.811
		p-value	**<0.001***	**0.003***	
Dynamic antero-posterior	Open	Baseline	558.00 (146.23)^{A}	525.50 (59.61)	0.235
		1 week	545.00 (134.41)^{AB}	502.80 (62.44)	0.385
		1 month	529.50 (130.32)^{AB}	477.00 (71.13)	0.278
		2 months	502.50 (137.62)^{B}	490.10 (90.77)	0.815
		p-value	**0.005***	0.256	
	Closed	Baseline	1205.5 (350.07)^{A}	1105.10 (494.85)^{A}	0.436
		1 week	1120.60 (336.68)^{A}	1043.87 (475.15)^{AB}	0.393
		1 month	1092.90 (310.27)^{AB}	1003.80 (479.98)^{AB}	0.280
		2 months	1036.00 (279.86)^{B}	947.20 (415.35)^{B}	0.582
		p-value	**<0.001***	**0.003***	

*SD = standard deviation; *significant if p<0.05; different uppercase superscript letters indicate statistically significant differences in sway length between timepoints within the same treatment group. Unit of measurement (mm)*

- Interpretation of table 1: no significant differences between groups at all timepoints, positions, and eyes statuses.
- A decrease in sway length for both groups according to time was observed for all positions and eye statuses, however, this decrease was only significant between baseline and 2 months for the two treatment groups in dynamic lateral position when eyes were closed, and in dynamic anteroposterior position when eyes were closed. In dynamic anteroposterior position when eyes were open, the decrease in sway length was only significant between baseline and 2 months in occlusal splint group.

Table 2. Surface area measured in mm2 static, dynamic lateral, and dynamic anteroposterior positions, with open and closed eyes, for the two treatment groups, at baseline, one week, one month, and two months after treatments.

Surface area / Position	Eyes status	Timepoint	Occlusal splint (n=10)	Physiotherapy (n=10)	*p*-value
			Mean (SD)	*Mean (SD)*	
Static	Open	Baseline	370.70 (181.89)^{A}	336.90 (130.01)	0.638
		1 week	307.40 (226.85)^{AB}	302.50 (122.04)	0.953
		1 month	325.30 (212.14)^{AB}	296.90 (142.50)	0.853
		2 months	294.90 (205.16)^{B}	293.10 (25.96)	0.529
		p-value	**0.012***	0.140	
	Closed	Baseline	448.20 (235.18)	396.30 (116.26)	0.971
		1 week	405.80 (262.08)	389.30 (117.32)	0.858
		1 month	389.30 (200.30)	338.90 (134.09)	0.517
		2 months	385.30 (215.33)	353.20 (102.03)	0.675
		p-value	0.310	0.123	
Dynamic lateral	Open	Baseline	881.20 (341.26)^{A}	713.80 (254.99)	0.230
		1 week	749.60 (364.98)^{AB}	640.90 (242.52)	0.443
		1 month	725.40 (313.39)^{AB}	660.10 (202.06)	0.587
		2 months	677.70 (309.51)^{B}	663.00 (223.84)	0.904
		p-value	**0.010***	0.265	
	Closed	Baseline	1846.00 (745.42)^{A}	1505.10 (556.00)	0.262
		1 week	1773.80 (766.34)^{AB}	1438.50 (645.22)	0.304
		1 month	1592.50 (667.72)^{B}	1497.00 (582.39)	0.737
		2 months	1673.20 (683.00)^{AB}	1434.70 (545.27)	0.400
		p-value	**0.015***	0.706	
Dynamic antero-posterior	Open	Baseline	798.30 (512.19)^{A}	591.90 (197.96)	0.631
		1 week	743.70 (491.27)^{B}	607.90 (263.87)	0.739
		1 month	707.00 (418.56)^{B}	556.20 (209.10)	0.579
		2 months	664.00 (360.94)^{B}	560.80 (210.11)	0.436
		p-value	**0.006***	0.118	
	Closed	Baseline	1818.30 (702.02)	1540.80 (460.59)	0.310
		1 week	1865.50 (980.06)	1502.40 (525.81)	0.316
		1 month	1614.40 (663.38)	1511.80 (443.79)	0.689
		2 months	1600.20 (623.12)	1363.40 (458.61)	0.346
		p-value	0.218	0.337	

*SD = standard deviation; *Significant if p<0.05; different uppercase superscript letters indicate statistically significant differences in surface area between timepoints within the same treatment group. Unit of measurement (mm^2)*

- Interpretation of table 2: no significant differences between groups at all timepoints, positions, and eyes statuses.
- The decrease in surface area according to time for the physiotherapy group was not statistically significant at all positions and eyes statuses.
- For the occlusal splint group, surface area decreased significantly between baseline and 2 months when eyes were open in static, dynamic lateral, and dynamic anteroposterior positions. However, when eyes were closed and in dynamic lateral position, the decrease was significant between baseline and 1 month, but an increase was observed at 2 month

Table 3. Pain VAS for the two treatment groups, at baseline, one week, one month, and two months after treatments.

Timepoint	Occlusal splint (n=10)		Physiotherapy (n=10)		*p*-value
	Mean (SD)	*Median (IQR)*	*Mean (SD)*	*Median (IQR)*	
Baseline	8.50 (1.18)	8.50 (8.00 – 9.25)^{A}	6.90 (1.79)	7.00 (5.75 – 8.25)^{A}	**0.030***
1 week	3.30 (1.16)	3.00 (2.00 – 4.25)^{AB}	3.80 (2.10)	3.00 (2.00 – 4.75)^{AB}	0.912
1 month	1.70 (0.82)	1.50 (1.00 – 2.25)^{B}	2.30 (1.34)	2.00 (1.00 – 3.25)^{B}	0.353
2 months	1.50 (0.71)	1.00 (1.00 – 2.00)^{B}	1.40 (0.70)	1.00 (1.00 – 2.00)^{C}	0.739
p-value	**<0.001***		**<0.001***		

*SD = standard deviation; *Significant if p<0.05; IQR = interquartile range; different uppercase superscript letters indicate statistically significant differences in VAS between timepoints within the same treatment group.*

- Interpretation of table 3: no significant differences between groups at 1 week, 1 month, and 2 months. However, at baseline, pain scores were significantly greater in occlusal splint group.
- In the two treatment groups, pain scores have significantly decreased between baseline and 2 months.

Discussion

This study primary objective is to assess occlusal splints and physical exercise effect on posture. The secondary objective is to compare which treatment option has more positive feedback regarding posture adjustment. The null hypothesis (H0) investigated in this research is the absence of statistically significant difference in posture after occlusal splints and physiotherapy and the H1 is that there is a statistically significant difference in posture after occlusal splints and physiotherapy. This H0 was rejected and H1 accepted regarding sway length in groups in dynamic lateral position when eyes were closed, and in dynamic anteroposterior position when eyes were closed also in dynamic anteroposterior position when eyes were open. Regarding sway surface in the occlusal splint group, the H0 was rejected and H1 accepted when eyes were open in static, dynamic lateral, dynamic anteroposterior positions and when eyes were closed in dynamic lateral position.

Regarding pain relief, both groups showed a significant improvement.

All results in all groups showed a decrease from baseline to 2 months follow-up which translates into an improvement in posture, however this decrease was not interpreted as significantly relevant in all groups this could be due to the small sample size of this study and the heterogenicity of it.

Postural regulation is profoundly dependent on sensory inputs. It is commonly known that vision preferentially stabilises low-frequency sways. When standing quietly, postural control might use other sensory inputs to make up for vision deficiencies [17]. In confirmation with this, we observed that there is a difference in open and closed eyes, although not all times it was significant statistically, but a difference does exist (tables1 and 2). In closed eyes, all results showed an increase in data from the open eyes status. For example, when comparing surface area in occlusal splint in dynamic anteroposterior in open and closed eyes at baseline the mean was 798.30 and 1818.30 respectively. This increase of results in closed eyes conform the results of studies that investigate the effect of eye status on balance [18, 19]. That in conclusion supports the concept that vision is a basic component of the tonic postural system. Hence, one way to confirm the occlusal aetiology of a postural issue is by a differential test comparing closed and open eyes.

Age conditions should be discussed greatly as many studies reveal that age have an influence in body sway and balance. In this study age was not strictly considered, there was a lot of variation between ages of the sample. This might contribute to variability of the results seen. According to Reynard et al. large sway amplitudes are more common in elderly people, in addition in seven of the nine standing activities in this study, age was found to be the most important factor influencing sway amplitudes as well as participants who are younger—those under 25—may exhibit more pronounced postural sways [20]. Furthermore, several researches have revealed that middle-aged adults' balance function deteriorates. One possible explanation is that muscle strength falls more rapidly after the fourth decade of life [21]. Thus, further studies need to emphasize the importance of the age of sample chosen.

Based on existing studies, one could speculate that there may be associations between the

stomatognathic system; yet, because of the sophistication of the contributing variables, the knowledge provided by previous research has significant gaps. Several inves-

tigations have shown a connection between posture and TMD. However, not every research in the literature backs up the notion that posture and the stomatognathic system are related. The vast majority of the literature currently in publication does not support the use of clinical and instrumental methodologies for body posture assessment, mostly due to the significant variability in the measured variables of posture. In exception of stabilometry which is listed as the most common balance measuring instrument [22].

Gelp was the first ever to consider the potential link between TMJs, posture, and muscle function during sports and physical activity; that is, if oral occlusion is inadequate, mandibular posture necessitates persistent muscular adjustment, which can result in postural system abnormalities [23].

The occlusal splint aids in the professional treatment of individuals with TMD and is regarded as a diagnostic tool. In addition to producing a reversible state, this device helps to relieve pain during neuromuscular deprogramming, which leads to muscle relaxation and a decrease in the hyperactivity of the masticatory muscles. Given the complex etiology of TMD, thoughts on the effectiveness of occlusal splints in easing painful symptoms in TMD patients are conflicting [24]. Recent research, however, has demonstrated that its use is appropriate and valid, particularly in situations of bruxism. Based on the data collected using the Visual Analogue Scale, the patients' reported pain significantly decreased after using the occlusal splint as well as patients in the physiotherapy group with a p value < 0,001. The difference between physiotherapy and occlusal splint group was insignificant during follow up which states that regarding pain relief occlusal splints are as effective as physiotherapy.

In the occlusal splint group, posture balance improved which is conform with Zoghbi et al study that is similar to this study in terms of measurement methodology, where 49 patients received occlusal splint treatment and an improvement was noticeable in in patients after 3 months follow up. Zoghbi et al. also proposed that changes to the occlusal balance were thought to affect the subject's morphostatic pattern and proprioceptive distribution of the muscle tonic balance, which in turn could affect the postural balance. Therefore, neck pain and posture may improve in TMD patients who receive orofacial pain therapy [25].

There is an apparent correlation between cervical spine and posture, as well as TMJ movements. Further systematic assessment of the functional connections between the two regions is required. When assessing physical exercise results; one can determine that even though not all differences were statistically significant but decrease in sway length and surface area was noticeable. The results seem to coincide with those of Wänman et al. who demonstrated a considerable amelioration in pain and jaw function among individuals undergoing physiotherapy [16].

Physical exercises for TMD corrects dysfunctions and shifts the center of gravity, which affects limb stability and spine mobility [26]. Research has demonstrated that a mandible in the myocentric position enhances postural balance [27, 28]. It is therefore hypothesised that treatments targeted at the relaxing of these muscles may impact the afference from receptors of the stomatognathic system, thereby influencing postural control, as TMD can change the activity of the masticatory muscles. TMDs can cause imbalances and discordant movement patterns by interfering with the synchronisation of the masticatory muscles used for chewing and jaw function. By use of focused coordination of physiotherapeutic exercices targeting TMJ muscles, participants can retrain their muscles to cooperate harmoniously, enhancing jaw function and minimising muscle imbalances [29]. Additionally, proprioceptive awareness is enhanced by stretching and coordination exercises, which improves jaw movement control and coordination. Thus, a more stable and aligned TMJ is encouraged. TMDs are frequently accompanied by abnormal muscular activation patterns and trouble regulating the jaw muscles. This rehabilitation procedure by physical therapeutic exercises helps to lessen TMD symptoms and enhance jaw function.

According to Nota et al., a significant difference in the amplitude of the sway area and sway velocity postural parameters in maximum intercuspidation and rest positions, with eyes open existed between TMD participants and healthy participant [6]. The current study has already demonstrated an improvement in posture with the use of occlusal splint and therapeutic exercises in subjects with TMD, for 2 months. An overall decrease in sway length and surface area that was significant only for the occlusal splint group in surface area between baseline and 2 months when eyes were open in static, dynamic lateral, and dynamic anteroposterior positions and a decrease in sway length was only significant between baseline and 2 months for the two treatment groups in dynamic lateral position when eyes were closed, and in dynamic anteroposterior position when eyes were closed. In dynamic anteroposterior position when eyes were open, the decrease in sway length was only significant between baseline and 2 months in occlusal splint group. This decrease can be regarded as an attempt to adjust posture.

Limitations of this study are as follows

The first limitation is that this study is a pilot study with a small sample size, which reduces the statistical comparisons' power. Second limitation is analysis by age was impossible due to limit of sample size, which increases the variability in the study results, as proven before, age subgroups should be considered in further studies as age effect on result is important.

When considering the management of TMD, the choice between an occlusal splint and physiotherapy necessitates a nuanced evaluation of individual needs and underlying factors. Occlusal splints, primarily designed for managing TMJ disorders, can inadvertently influence posture by addressing issues related to jaw alignment. However, their efficacy in addressing broader postural concerns remains a subject of debate. On the other hand, physiotherapy adopts a holistic approach, targeting musculoskeletal imbalances and promoting overall body alignment. Through exercises and manual techniques, physiotherapy aims to enhance strength, flexibility, and proprioception, contributing to improved posture. The comparison between occlusal splints and physiotherapy underscores the importance of a comprehensive assessment, recognizing that addressing posture involves not only the oral and maxillofacial aspects but also the intricate interplay of musculoskeletal and neuromuscular components throughout the body.

Conclusion

Based on the findings, we may draw the conclusion that the use of occlusal splints and physiotherapeutic exercises as a non-invasive therapeutic strategy for TMD patients is well accepted in the scientific literature.

Now, the question is whether or not postural balance will continue to alter (or even revert to its initial state), or if these results only represent a transient shift in how the body is seen. Furthermore, another question arises: if these results would have been significant statistically in all statuses and all groups if sample size was bigger. To answer this, a study examining the individuals' use of the occlusal splint and therapeutic exercises with a longer follow up period and a larger sample size is required.

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