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RESEARCH ARTICLE

THE EFFECTIVENESS OF MODIFIED OCCLUSAL SPLINT IN TREATMENT OF OROMANDIBULAR DYSTONIA FOR A SAMPLE OF YEMENI PATIENTS

Mohammed Yahya Mohammed Jahaf [1], Yahya Abdullah Ahmed Alhadi[1], Hassan Abdulwahab Al-Shamahy[2,3]

[1]*Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Republic of Yemen.*
[2]*Department of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.*
[3]*Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University'.*

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***Address for Correspondence:**
Dr. Hassan A. Al-Shamahy, Departement of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.
Tel: +967-1-239551.
E-mail: *alshamahyhassanii@gmail.com*

Abstract

Background and aim: Dystonia is a neurological movement disorder characterized by sustained or periodic muscle contractions, resulting in abnormal, often repetitive, body movements or postures, or both. The movements are typically stereotyped and twisting, and may resemble a tremor. This study was conducted to investigate the effectiveness of a modified occlusal splint (the AL Hadi Modified Occlusal Splint) in the treatment of oromandibular dystonia (OMD).
Methodology: Modified Al-Hadi occlusal splints were fitted to 25 patients (21 males and 4 females) with oromandibular dystonia (OMD) and uncontrolled lateral mandibular deviation. These patients underwent monthly follow-ups for six months. The effectiveness of the modified occlusal splint was assessed by measuring changes in speech, pain, discomfort, involuntary lateral jaw movement, and mastication ability. Scores for each symptom ranged from 0 to 4, with a higher score indicating severe impairment.
Result: The results showed significant improvement in chewing ability starting from the second visit, as well as significant improvement in speech and discomfort (involuntary lateral jaw movement). However, no significant improvement was observed in pain levels. For example, at the six-month follow-up, 8% of patients reported normal chewing ability, 68% could eat anything without significant time-consuming, and 24% could only eat soft foods. Furthermore, no patient found it difficult or time-consuming to eat only soft foods or liquids. Furthermore, 16% of patients reported normal comfort, and no patient reported severe discomfort.
Conclusion: The modified occlusal splint has promise improvement in speech, mastication ability and uncontrolled lateral jaw movement.
Keywords: Lateral deviation dystonia, mastication, occlusal splints, oromandibular dystonia (OMD), pain.

INTRODUCTION

Persistent or sporadic muscular contractions that result in aberrant, frequently repeated body movements, postures, or both are the hallmark of dystonia, a neurological movement condition. The motions may resemble tremor and are typically patterned and twisting. Oromandibular dystonia (OMD), sometimes referred to as cranial dystonia, is a specific form characterized by forceful muscle contractions of the face, jaw, and/or tongue[1-4]. OMD symptoms pose significant challenges for individuals by affecting their speech and eating abilities, causing pain, discomfort, and impacting their overall quality of life[5]. OMD encompasses various subtypes, notably including jaw-closing, jaw- opening, and mixed forms[4]. Jaw-closing dystonia involves involuntary contraction of the jaw muscles, leading to clenching and difficulty opening the mouth, while jaw-opening dystonia results in sustained opening of the jaw. Mixed forms combine features of both, often accompanied by involuntary movements[6,7].

While traditional treatment options for OMD include medications, butox injections, and surgeries, their efficacy remains limited**.** An alternative approach is needed to address the unique needs of patients. Occlusal splints, also known as dental or bite splints, serve as a non-invasive therapeutic option in the treatment of oromandibular dystonia[8].

Current treatment options for oromandibular dystonia are limited, typically consisting of pharmacotherapy, botulinum toxin injections, and physical therapy[1]. While these approaches may provide some relief for symptoms such as jaw clenching and involuntary movements[9]. They often fall short in addressing the complex nature of the condition and may not offer sustained benefits for all patients[10]. Given the challenges of managing oromandibular dystonia effectively, there is a critical need to explore alternative interventions that could offer improved outcomes. Therefore, investigating the effectiveness of modified occlusal splints represents a promising avenue for enhancing the therapeutic options available for individuals with oromandibular dystonia.

In Yemen, there are recent studies on oral and dental diseases, and there is no study of which addressed the effectiveness of an occlusal splint in the treatment of oromandibular dystonia (OMD). However, there were many studies that addressed other topics, such as: the effects of low-level laser in treating myofascial pain dysfunction in the temporomandibular joint in a sample of Yemeni patients[1], the effect of 3D printing in the reconstruction of maxillofacial bone defects[11], the evaluation of fixed prosthetic failure factors in a sample of Yemeni dental patients[12], the sensitivity of *Candida albicans* to antifungal agents isolated from Yemeni patients with denture-associated stomatitis[13], knowledge, attitudes, and practices related to health care ethics among undergraduate students and recent graduates of the Faculty of Dentistry[14], temporomandibular dystonia: prevalence, clinical and demographic data, and results of therapeutic strategies for hundreds of patients[2], the prevalence of signs of temporomandibular joint disorders in healthy, completely edentulous individuals without symptoms, and the effect of dentures on temporomandibular joint disorders[3], and levels of interleukin-1 beta in the human gingival sulcus: rates. Factors affecting its levels in healthy individuals[15], the effect of intermaxillary fixation on biochemical and hematological markers in a sample of Yemeni adults[16], three-dimensional assessment of the shape of the first cervical vertebra in skeletal malocclusion of Class I and III in Yemeni patients, the validity of the Ponnet analysis in a group of Yemeni population, as well as assessment of the anatomical structure of the sinus canal in the anterior maxilla to avoid surgical complications[17,18,19]. Therefore, the primary objective of this study was to study the effectiveness of especially modified occlusal splint in the treatment of OMD in a sample of Yemeni patients.

MATERIALS AND METHODS

Study design: A prospective clinical study was conducted to determine the effect of a specially modified splint in the treatment of temporomandibular joint disease among a sample of the Yemeni population.

Patients: This study was conducted on 25 patients, 21 males and 4 females, with ages 24 to 57 years old. All patients suffered from closed dystonia, with lateral deviation, and varying onset times and severity.

A simple oral appliance, which we refer to in this study as the "Modified Al-Hadi Occlusion Splint", has been developed and used clinically over the past 20 years to treat mandibular dystonia, specifically closed and lateral deviation, by Dr. Yahya Al-Hadi, Associate Professor in the Department of Oral and Maxillofacial Surgery at Sana'a University.

Materials used in the manufacture of Alhadi modified occlusal splint: Alginate impression material: Used to take impressions. Wax sheet: Used to take a bite registration in centric occlusion. Manual virnial for measuring teeth vertical length loss due to attrition: Used to measure the amount of vertical length loss, according this looseness we determine the bite thickness of the splint.

Distone: used to pour the impression immediately.

Hot-cured acrylic: used to create the modified splint.

0.7-gauge wire: to fabricate two Adam clasps, (with\without) labial arch were added by the Laboratory to provide retention for the splint in upper jaw.

Description of Alhadi modified occlusal splint: An acrylic-made splint was adjusted to the hard palate, and retained to the maxillary first molars bilaterally (if present) or to the last posterior tooth bilaterally by two Adam clasp. A biteplate was made over the teeth, with the thickness depending on the vertical loss of the occlusion, ranging from 2 mm to 6mm. This biteplate helps to restore the masticating muscles to their original rest position before attrition. Extension flanges (4-8 mm) downwards with intimate contact with the lingual surface of the lower posterior teeth bilaterally to prevent involuntary lateral deviation of the lower jaw.

Data collection case sheet: To obtain personal information about the patients, information about the general health of the patients, and questions about etiology and severity of their OMD disease. And the following-up questioners were to evaluate the efficiency of the modified splint in the treatment of oromandibular dystonia.

First visit:

During the first visit, the following steps were taken:

Conduct a clinical examination: Gather patient data by using a data collection sheet. Perform a thorough examination of the teeth and surrounding structures. Record the signs and symptoms severity in the case sheet to evaluate the prognosis of each symptom.

Taking impressions and bite registration: Use impression materials to take accurate molds of both jaws. Additionally, record a bite registration to capture the relationship between the upper and lower teeth when the patient bites down.

Cast fabrication: Pour dental stone into the impressions to create casts of the patient's teeth and oral structures. Evaluate the degree of vertical length loss of the occlusion, this done by Assessment the amount of wear or attrition present on the teeth by manual virnial. Which can be measured by comparing

the current tooth length with the expected or ideal tooth length.

Consider the rest position of the masticating muscles (2 mm): The splint aims to restore the masticating muscles to their original rest position before attrition. So the thickness of the splint can be measured by a simple rule, which is Splint thickness = anatomical crown length - clinical crown length + 2 mm send the casts with request paper to the laboratory: Send the casts to the dental laboratory for fabrication of the splint.

Laboratory procedures: The casts were mounted in a simple articulator with the correct occlusion relationship, and the splint was made according to doctor request.

Second visit:

The splint was modified and secured to the maxilla using a bilateral Adam clip. The patient received motivational instructions on how to insert and remove the splint. Motivational instructions were also provided, emphasizing the importance of wearing the splint throughout the day and removing it during meals and for cleaning purposes. The patient was also informed that "the effectiveness of the splint depends on adherence to instructions".

Follow up visits:

Patients underwent monthly interview follow up to evaluate the prognosis of the symptoms.

Speech

- Score of 4: Inaudible, with more than 50% of speech affected.
- Score of 3: Still inaudible, but to a lesser extent, with less than 50% of speech affected.
- Score of 2: Audible, but difficult to comprehend.
- Score of 1: Hard to speak clearly.
- Score of 0: Normal speech with no issues.

Pain

- Score of 4: Severe pain (radiated sever continuously pain)
- Score of 3: Moderate to severe pain (radiated, interrupted pain)
- Score of 2: Mild to moderate pain (localized, continuous pain and need to analgesic to be relieved)
- Score of 1: Mild, intermittent pain (localized, interrupted pain which subsides spontaneously without the need for analgesic)
- Score of 0: No pain.

Masticating ability

- Score of 4: Can only consume liquids.
- Score of 3: Difficult and time-consuming to eat soft food.
- Score of 2: Can only eat soft food.
- Score of 1: Able to eat anything, but it takes a long time.
- Score of 0: Normal masticating ability.

Discomfort (uncontrolled involuntary movement)

- Score of 4: Severe discomfort not (sever closed mouth not more than 1 finger which absolutely interrupt the jaw function).
- Score of 3: Moderate to severe discomfort (noticeable abnormal jaw movements which interfere with jaw functions).
- Score of 2: Mild to moderate discomfort (abnormal movement which is noticeable by others but don't interfere with normal function of the jaw)
- Score of 1: Mild discomfort slightly abnormal jaw movement which is not noticeable by other people and not effect in the normal functions)
- Score of 0: Normal comfort with no discomfort (full control for mouth movement)

Evaluation of effect:

One week after fitting the Alhadi modified occlusal splint, each patient was interviewed to check their physical fitness and adaptation to the appliance, and to collect signs and symptoms. At the monthly visit, the patient was interviewed to measure the number of scores (speech scale, pain scale, discomfort scale (uncontrolled movement), and chewing scale) related to TMJ dystonia. The assessment focused on the most significant symptoms associated with the disease. The assessment included changes in speech, pain, discomfort, and chewing ability. These changes were recorded using the aforementioned rating scale used in a previous study [10].

Inclusion criteria

Participants diagnosed with closed and lateral deviation oromandibular dystonia. Patients age above 18 years old) of any gender. Participants with a stable medical condition and not currently undergoing any major dental or maxillofacial treatment. Individuals who are able to understand and comply with the study requirements. Participants who are willing to use the especially modified occlusal splint 6. Participants who have not undergone any previous treatment with any type of occlusal splints to treat oromandibular dystonia.

Exclusion criteria

Patient with allergic reaction to the splint component (metal or acrylic). Patients under the age of 18. Patients with severe cognitive impairment or an inability to understand and follow study instructions. Individuals with history of significant trauma or injury to the oral cavity or jaw region. Patients with psychiatric disorders. Individuals unable or unwilling to give informed consent to participate in the study. Participants who have previously used an occlusal splint for the treatment of oromandibular dystonia or resaving any type of dystonia treatment.

Ethical considerations

This study was approved from the Ethical Committee of the Faculty of Medicine and Health Sciences Sana'a University, Yemen. Each patient who participated in this study signed consent no (2) in the appendix.

Statistical analysis

By using Epi Info statistical program version 6 (CDC, Atlanta, USA), the analysis of the data was performed. Expressing the quantitative data as mean values, or standard deviation (SD), when the data was normally distributed. Expressing the qualitative data as percentages. Associated factors were calculated by 2X2 tables to find, X^2 and p value.

RESULTS

Masticating ability scale: Table 1 presents data of the masticating ability scale with (time monthly) visits for

patients using modified splints. The masticating ability scale is ranked into five categories: normal masticating ability, able to eat anything but takes a long time, can only eat soft food, difficult and time-consuming to eat soft food, and can only consume liquids. In the first visit, immediately before splint insertion, no patients reported normal masticating ability. The majority of patients, 14 (56.0%), found it difficult and time-consuming to eat soft food, followed by 9 patients (36.0%) who could only eat soft food, and 2 patients (8.0%) who reported being able to eat anything, but it takes a long time. No patients reported being able to eat or consume only liquids. In the second visit, the first month of follow-up, no patients reported normal masticating ability.

The majority of patients, 14 (56.0%), found it difficult and time-consuming to eat soft food, followed by 9 patients (36.0%) who could only eat soft food, and 2 patients (8.0%) who reported being able to eat anything, but it takes a long time.

Table 1: Effectiveness of the modified occlusal splint on the masticatory capacity scale in treating oromandibular dystonia.

Follow up	Masticating Ability scale										X^2	*p*
	Normal masticating ability		Able to eat anything, but it takes a longtime		Can only eat soft food		Difficult and time-consuming to eat soft food		Can only consume liquids			
	N	%	N	%	N	%	N	%	N	%		
Based	0	0.0	2	8.0	9	36.0	14	56.0	0	0.0		
1st month	0	0.0	2	8.0	9	36.0	14	56.0	0	0.0		
2nd month	0	0.0	4	16.	15	60	6	24	0	0.0		
3rd month	2	8.0	7	28	14	56	2	8.0	0	0.0	74.87	0.000*
4th month	2	8.0	14	56	9	36	0	0.0	0	0.0		
5th month	2	8.0	17	68	6	24	0	0.0	0	0.0		
6th month	2	8.0	17	68	6	24	0	0.0	0	0.0		

No patients reported being able to eat or consume only liquids. In the third visit, the second month of follow-up, 2 patients (8.0%) reported normal masticating ability. The majority of patients, 14 (56.0%), could only eat soft food. 2 patients (8.0%) who found it difficult and time-consuming to eat soft food. 7 patients (28.0%) reported being able to eat anything, but it takes a long time, and no patients reported being able to eat and consume only liquids. In the fourth visit, the third month of follow-up, 2 patients (8.0%) reported normal masticating ability, and 14 patients (56.0%) could only eat soft food. 2 patients (8%) found it difficult and time-consuming to eat soft food. Total 7 patients (28.0%) reported being able to eat anything, but it takes a long time, and no patients reported being able to consume only liquids. In the fifth visit, the fourth month of follow-up, 2 patients (8.0%) reported normal masticating ability. The majority of patients, 14 (56.0%), reported being able to eat anything, but it takes a long time, followed by 9 patients (36.0%) who could only eat soft food. No patients reported it difficult and time-consuming to eat soft food or to be able to eat and consume only liquids. In the sixth visit, which is the fifth month of follow-up, 2 patients (8.0%) reported normal masticating ability. The majority of patients, 17 (68.0%), reported being able to eat anything, but it takes a long time, followed by 6 patients (24.0%) who could only eat soft food. No patient reported that it was difficult and time-consuming to eat soft food or to be able to eat and consume only liquids. In the seventh visit, the sixth month of follow-up, 2 patients (8.0%) reported normal masticating ability. The majority of patients, 17 (68.0%), reported being able to eat anything, but it takes a long time, followed by 6 patients (24.0%) who could only eat soft food. No patient reported that it was difficult and time-consuming to eat soft food or to be able to eat and consume only liquids.

Discomfort scale (involuntary or uncontrollable lateral jaw movement): Table 2 presents data of the discomfort scale per visit for patients using splints. The discomfort scale consists of five categories: normal comfort with no discomfort, mild discomfort with slightly abnormal jaw movement, mild to moderate discomfort, moderate to severe discomfort, and severe discomfort.

Table 2: Effectiveness of the modified occlusal splint on the discomfort scale in treating oromandibular dystonia

Follow up	Discomfort scale										X^2	*p*
	Normal Comfort with no discomfort		Mild discomfort slightly abnormal jaw movement		Mild to moderate discomfort		Moderate to severe discomfort		Severe discomfort			
	N	%	N	%	N	%	N	%	N	%		
First visit	0	0.0	0	0.0	3	12	17	68	5	20.0		
1st month	0	0.0	0	0.0%	8	32	14	56	3	12.0		
2nd month	0	0.0	3	12.0	12	48.0	7	28	3	12		
3rd month	2	8.0	9	36.0	9	36	5	20	0	0.0	79.53	<0.0001*
4th month	2	8.0	12	48.	8	32	3	12.	0	0.0		
5th month	3	12	15	60	4	16	3	12	0	0.0		
6th month	4	16	15	60	3	12	3	12	0	0.0		

At the first visit, just before splint insertion, no patients reported normal comfort with no discomfort or mild discomfort. Instead, 3 patients (12.0%) experienced mild to moderate discomfort, 17 patients (68.0%) had moderate to severe discomfort, and 5 patients (20.0%) reported severe discomfort. At the second visit, the first month of follow-up, none of the patients reported normal comfort or mild discomfort. Most patients, 14 (56.0%), experienced moderate to severe discomfort, followed by 8 patients (32.0%) who showed mild to moderate discomfort and 3 patients (12.0%) with severe discomfort. In the third visit, the second month of follow-up, no patients reported normal comfort. 3 patients (12.0%) experienced mild discomfort, 12 patients (48.0%) had mild to moderate discomfort, 7 patients (28.0%) had moderate to severe discomfort, and 3 patients (12.0%) reported severe discomfort. In the fourth visit, the third month of follow-up, 2 patients (8.0%) reported normal comfort. 9 patients (36.0%) had mild discomfort, 9 patients (36.0%) had mild to moderate discomfort, 5 patients (20.0%) had moderate to severe discomfort, and no patient reported severe discomfort.

In the fifth visit, the fourth month of follow-up, 2 patients (8.0%) reported normal comfort. The majority of patients, 12 (48.0%), experienced mild discomfort, followed by 8 patients (32.0%) with mild to moderate discomfort. Three patients (12.0%) with moderate to severe discomfort. No patients reported severe discomfort. In the sixth visit, the fifth month of follow-up, 3 patients (12.0%) reported normal comfort, and 15 patients (60.0%) had mild discomfort, 4 patients (16.0%) had mild to moderate discomfort, 3 patients (12.0%) had moderate to severe discomfort. No patients reported severe discomfort. In the seventh visit, the sixth month of follow-up, 4 patients (16.0%) reported normal comfort. Total 15 patients (60.0%) had mild discomfort, 3 patients (12.0%) had mild to moderate discomfort, 3 patients (12.0%) had moderate to severe discomfort, and no patients reported severe discomfort. The chi-square test was employed to analyze the association between the discomfort scale and time (monthly visits). *p*-value=0.000* suggests a statistically significant relationship between the discomfort scale and time (monthly visits).

Speech scale: Table 3 displays the results of the effects of the study's modified splint on speech abilities for the six-month follow-up period. The participants were categorized into five groups based on their speech ability: normal speech with no issues, hard to speak clearly, audible but difficult to comprehend, inaudible with less than 50% of speech affected, and completely inaudible with more than 50% of speech affected. During the first visit, 2 patients (8.0%) had normal speech with no issues, while the majority (64.0%) had audible speech that was difficult to comprehend.

Table 3: Effectiveness of the modified occlusal splint on the speech scale in treating oromandibular dystonia.

Follow up	Speech Scale										X^2	*p*
	Normal speech with no issues		Hard to speak clearly		Audible, but difficult to comprehend		Still in audible, but to a lesser extent, with less than 50% of speech affected		Inaudible, with more than 50% of speech affected			
	N	%	N	%	N	%	N	%	N	%		
Based	2	8.0	0	0.0	16	64	5	20	2	8		
1st month	2	8	10	40	11	44	2	8	0	0.0		
2nd month	3	12	12	48	8	32	2	8	0	0.0		
3rd month	4	16	13	52	8	32	0	0.0	0	0.0	71.95	<0.0001*
4th month	8	32	12	48	5	20	0	0.0	0	0.0		
5th month	13	52	8	32	4	16	0	0.0	0	0.0		
6th month	13	52	8	32	4	16	0	0.0	0	0.0		

A smaller portion (20.0%) had inaudible speech with less than 50% of their speech affected, and two participants (8.0%) had completely inaudible speech. In the first month of follow-up, 2 patients (8.0%) had normal speech, while 40.0% had difficulty speaking clearly, 44.0% had audible speech that was difficult to comprehend, and 8.0% had inaudible speech with less than 50% of speech affected. No participants were completely inaudible. In the second month, 3 patients (12.0%) had normal speech, while 48.0% had difficulty speaking clearly, 32.0% had audible speech that was difficult to comprehend, and 8.0% had inaudible speech with less than 50% of speech affected. No participants were completely inaudible. The third month showed 4 patients (16.0%) had normal speech, while 52.0% had difficulty speaking clearly, 32.0% had audible speech that was difficult to comprehend, and no patients had inaudible speech with less than 50% of speech affected. No participants were completely inaudible. By the fourth month, the number of participants with normal speech increased to 32.0%, while the majority still had some difficulty speaking clearly or had audible speech that was difficult to comprehend. This trend continued in the fifth and sixth months, with the number of individuals with normal speech increasing to 52.0%. The chi-square statistic showed significant differences with time. Overall, the findings suggest that the modified splint had a positive effect on speech abilities, as the number of participants with normal speech increased over time, although a significant portion still experienced speech difficulties.

Pain scale: The following table shows the relationship between the pain scale and time (monthly visits) for patients with splint use. During the initial visit, 14 patients (56.0%) reported no pain, while 4 patients (16.0%) reported mild intermittent pain. Additionally, 2 patients (8.0%) reported mild to moderate pain, 4 patients (16.0%) reported moderate to severe pain, and

1 patient (4.0%) reported severe pain. In the second visit, there was a shift in the distribution of pain scale categories. The number of patients reporting mild intermittent pain increased substantially to 12 patients (48.0%), making it the most frequently reported category. Meanwhile, the number of patients reporting no pain decreased to 5 patients (20.0%). The distribution of other categories remained relatively stable compared to the first visit. Moving to the third visit, the distribution of pain scale categories resembled that of the first visit. Once again, the majority of patients (56.0%) reported no pain, while the remaining patients reported varying levels of discomfort, with mild intermittent pain being the next most common category. In the fourth visit, a similar pattern to the first and third visits emerged. The majority of patients (60.0%) reported no pain. However, there was a decrease in the number of patients reporting mild to moderate and moderate to severe pain compared to earlier visits.

Table 4: Effectiveness of the modified occlusal splint on the pain scale in treating oromandibular dystonia by six months follow up.

Follow up	Pain scale										X^2	*p*
	No pain		Mild intermittent pain		Mild to moderate pain		Moderate to severe pain		Severe pain			
	N	%	N	%	N	%	N	%	N	%		
Based	14	56	4	16	2	8.0	4	16	1	4		
1st month	5	20	12	48	4	16	3	12	1	4		
2nd month	14	56	5	20	3	12	2	8.0	1	4		
3rd month	15	60	2	8.0	4	16	1	4.0	0	0.0	27.11	0.29
4th month	15	60	5	20	5	20	0	0.0	0	0.0		
5th month	15	60	6	24	4	16	0	0.0	0	0.0		
6th month	15	60	8	32	2	8	0	0.0	0	0.0		

During the fifth visit, the distribution of pain scale categories shifted once more. The number of patients reporting mild to moderate and moderate to severe pain increased slightly compared to the previous visit, although the majority still reported no pain. The distribution of pain scale categories in the sixth visit mirrored that of previous visits, with the majority of patients (60.0%) reporting no pain. There were minor fluctuations in the number of patients reporting mild intermittent and mild to moderate pain. In the final visit, a similar pattern persisted, with the majority of patients (60.0%) reporting no pain. However, there was a notable increase in the number of patients reporting mild intermittent pain compared to earlier visits. The chi-square statistic used to analyze the relationship between the pain scale and time (monthly visits) was 27.11, with a *p*-value of 0.299. These results indicate that there is no significant association between the pain scale and the number of visits during this month.

Table 5: Vertical dimension loss of patients.

Vertical dimension loss	N	%
No loss of vertical dimension	5	20
1 mm loss of vertical dimension	3	12
2 mm loss of vertical dimension	7	28
3 mm loss of vertical dimension	6	24
4 mm loss of vertical dimension	4	16
Total	25	100

Vertical dimension loss: The result of the vertical dimension loss distribution in Table 5 illustrates that the greatest number of patients, 7 (loss of 2 mm from vertical dimension), represents 28.0% of the total number of patients. Then 6 patients 'lost 3 mm from the vertical dimension, the vertical dimension representing 24.0% of the total patients. Five patients, or 20%, have no loss of vertical dimension. The last vertical dimension loss group had 1 mm loss of vertical dimension in 3 patients, which represents 12% of the total patients.

DISCUSSION

Current study by using Y Al-Hadi modified splints showed a significant increase in the percentage of speech improvement with no issues, from 8% to 52% across seven months. This is in line with Yoshida, who found a benefit in 32% of patients by using standard splints[10]. The occlusal splints play a vital role in the speech treatment of patients with OMD may be due to several important benefits. First, they aid in muscle relaxation, reducing tension and spasms in the muscles involved in speech production. Second, splints provide alignment and stability, ensuring improved coordination and control of the articulatory organs for clearer speech. Third, the splints enhance sensory feedback, allowing OMD patients to better monitor and control their articulatory movements during speech, thereby improving speech accuracy. Fourth, the rigidity of the splint inhibits the bite desire; finally, the down extension flanges block the uncontrolled lateral jaw movement that will return normal jaw movement control with time. Overall, these modified occlusal splints offer significant support in managing OMD-related speech difficulties, which demonstrates the effectiveness of this novel occlusal splint in improving speech in patients with OMD.

The present study showed a significant effect in the treatment of discomfort symptoms (involuntary jaw movement), this is in line with a case report by Khan, which supported the concept of neurosensory tricks (splints) to reduce dystonic activity. After four weeks of using a dental splint, they observed a 40% temporary reduction in involuntary movements[20]. However, the positive effects were temporary, which may explain the lack of significant improvement in discomfort scales in his study. In contrast with current

study which showed significant improvement. This difference is due to presence of bilateral downward extension to the lingual surface of lower posterior teeth in current study that inhibits unfavorable lateral movements of the jaw, which restore the original jaw control movement memories of patients before the OMD, so we can say that the Alhadi splint has positive effect in treatment of OMD symptoms centrally.

The present study demonstrated a significant improvement in masticating ability. Although there are no previous studies specifically addressing this symptom, most studies confirm a general improvement in the symptoms of oromandibular dystonia. The reason for this enhancement may be attributed to noticeable relief in the chewing muscles, leading to increased efficiency in chewing[1,4]. Current study did not indicate a significant improvement in the pain symptom. Additionally, there are no previous studies addressing this specific symptom. However, a slight improvement was observed due to the reduction in muscle tension, resulting in pain relief. For patients who did not experience pain relief, it is possible that Oromandibular dystonia is a complex condition with varying degrees of severity and individual responses to treatment. Some patients may be need longer therapy to see improvements in pain management. The different levels of pain severity among patients could have affected treatment outcomes, with those experiencing more severe pain potentially requiring more intensive or prolonged intervention. While the study suggests some relief for certain patients, further research with longer follow-up periods and stratified analyses based on pain severity is recommended for a better understanding of the efficacy of therapy for oromandibular dystonia by this modified occlusal splint (Alhadi splint).

The study observed that the majority of OMD patients had significant vertical dimension loss (80%). This finding aligns with Chidiac[21] in which he found that vertical dimension loss is a contributing factor in oromandibular dystonia. The exact mechanisms underlying this loss are not fully understood but may involve abnormal muscle activation patterns and altered jaw movement control[21].

Limitations of the study

One limitation in this area is the lack of qualified technicians. Due to the novelty of the device and the technicians' insufficient knowledge of maxillofacial surgery, there is a scarcity of technicians skilled in manufacturing this device. Also, some patients were unwilling to stop chewing khat during the treatment period. As a result, these patients had to be excluded from the study. A second limitation is the difficulty in finding suitable cases. It was a challenge to locate cases that met the specific criteria for the study. This scarcity of suitable cases prolonged the research period, potentially affecting the timely completion of the study. A third limitation was the irregular follow-up of some patients: some patients from remote locations failed to adhere to regular monthly follow-up visits. As a result, these patients had to be excluded from the study.

CONCLUSIONS

The present study result introduces a novel invention, of modified occlusal splint, that demonstrates significant improvement in speech, discomfort, and masticating ability scales. However, there was no significant improvement in the pain scale. Since this is a new invention, there have been no previous similar studies conducted.

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AUTHOR'S CONTRIBUTIONS

Jahaf MYM: writing the original draft, methodology, investigation. **Alhadi YAA**: design and supervision of clinical work. **Al-Shamahy HA**: formal analysis, data processing. Final manuscript was checked and approved by all authors.

DATA AVAILABILITY

The empirical data used to support the study's results can be obtained upon request from the corresponding author.

CONFLICT OF INTEREST

None to declare.

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