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Prevalence of Temporomandibular Disorders' Signs and Symptoms and Chewing Ability in Patients with Prosthodontic Prostheses

W.M. Al-Omari*, A.A. Al-Hashedi†, M. Marashdeh‡ and G.A. Al-Hrazi§

Abstract - *This study aimed to determine the prevalence of temporomandibular disorders among patients wearing dental prostheses including complete and fixed partial dentures and to evaluate the chewing ability of those patients. Questionnaire and clinical examinations were used to assess those objectives. Fifty six percent of all examined subjects exhibited at least one sign or symptom of temporomandibular disorders while 8.0% had moderate symptoms and 10% had severe symptoms. Patients with fixed partial dentures had a significantly higher prevalence of temporomandibular disorders signs than both complete dentures and dentate. The fixed partial denture group and dentate group exhibited significantly higher chewing ability than did the complete denture group. Therefore, the type of prosthesis correlated significantly with chewing ability.*

KEYWORDS: Prostheses, Complete dentures, Denture quality, Temporomandibular disorders, Chewing ability.

INTRODUCTION

Temporomandibular disorders (TMDs) have been recognized by the American Association of Dental Research (AADR) as a group of musculoskeletal conditions which involve the temporomandibular joint (TMJ) or joints, the masticatory muscles, or both. TMD may lead to difficulties in chewing or other oral functions, acute and/or chronic pain, absence from and impairment of work or social interactions, and overall reduction in the quality of life (Table 1) [1].

Previous epidemiological surveys reported conflicting figures related to the incidence of TMD signs and symptoms [2-11]. It has been reported that 50-70% of the population have signs of a disorder at some stage during their lives[2, 3]. In another survey, an estimated 20-25% of the population had symptoms of a TMD[4]. However, those who sought treatment represent approximately 2-7% of the population[5].

Helkimo descriptive surveys had established that signs and symptoms of masticatory dysfunction are prevalent in all age groups and almost equally in both sexes[6] while population-based studies reported pain in the temporomandibular region is more prevalent among women than men with prevalence being highest among young and middle-aged women[7-11].

A controversy in the prevalence of TMD signs has also been reported in edentulous populations during investigations of signs and symptoms of TMD in complete denture wearers. TMD appears to be almost as prevalent in wearers of complete dentures as in dentate individuals, varying from 15 to 36% [12-15].

* BDS, MDentSci, PhD
† BDS, MDSc
‡ BDS PhD MFDS
§ BDS, MSc, PhD

Previous studies reported that complete denture wearers had a higher prevalence of TMD symptoms than the population with natural dentition[16,17]. However, others reported a higher figure of TMD signs in dentate individuals when compared with edentulous patients [18]; this may be attributed to the low percentage of edentulous patients who complain of TMD [19].

In trying to correlate TMD signs or symptoms to age, it has been reported that signs and symptoms of TMD decrease with increasing age[3,20,21]. While other studies reported that signs and symptoms of TMD increase with age. In another study, a random sample of subjects born in 1904, 1909, and 1914 examined clinically and radiographically at baseline then examinations repeated after 5 years. The study results showed only 4% of this very old population had severe signs of TMD[22].

Controversy has been noticed during investigating the correlation between denture quality and the presence of TMD signs and symptoms. Most studies have found no correlation between signs or symptoms of TMD and factors relating to overall denture quality, including retention, stability, the age of the present denture, the number of sets of dentures and the occlusal status of the dentures[3,12,23-25]. Few studies found that occlusal instability such as incorrect vertical dimension and centric relation records were most frequent contributing factors to the development of TMD among complete denture wearers[17, 26-28].

The prevalence of TMD signs and symptoms in partially edentulous patients restored with maxillary and/or mandibular fixed partial dentures has not been well-documented in the literature. However, it has been reported that clicking, locking and inter-articular disc displacement have been found in patients wearing over-contoured crowns or restorations with excessive occlusal curvatures[29]. Moreover, Hagag and co-workers have reported prosthodontic replacement of missing teeth may create an acute morpho-

Table 1. *Signs and symptoms of TMD* [20]

Signs of TMD	*Symptoms of TMD*
1- Deviation of mandible on opening or closing.	1- History of head, face, or ear pain.
Presence of shifting of the mandible which can be observed during opening and/or closing of the mouth.	Pain often begins in or around the ear then it spreads to the face, neck and sometimes to teeth.
2- TMJ sound/noise.	2- Pain on palpation of TMJ and musculature.
The presence of joint sound or noise which can be objectively determined with high accuracy on clinical examination by asking the patient to open and close his/her mouth several times.	Pain in any joint including TMJ is called arthralgia which is manifested as sharp, sudden and intense pain that is closely associated with joint movement. Patients also may feel tenderness in the muscles of jaw, head and neck on palpation.
3- Limitation of mouth opening.	3- Subjective symptoms of joint dysfunction:
This sign has been used frequently in the epidemiologic studies to determine TMJ dysfunction which is evaluated by measuring the interincisal distance.	Patients may note a sudden, major change in the way the upper and lower teeth fit together Difficulties in opening one's mouth or jaws that get stuck, lock, or go out. Feeling of fatigue of the jaws. Feeling of stiffness of the jaws on awakening or on movement of the lower jaws.
4- Locking and /or Luxation.	4- Pain on function.
	Pain maybe brought on by yawning, chewing, opening the mouth widely or during lateral movement of jaw from side to side

logical change of occlusal conditions which consequently may interfere with the established functional equilibrium and timing of jaw muscles contraction[30]. Since the improvement of masticatory function is usually a major concern in restoring posterior teeth, many studies have reported on different methodologies to evaluate chewing ability of patients wearing various prostheses [31-34].

Assessment of masticatory function can be carried out using subjective or objective methods. Objective methods are more accurate; however, more time consuming and require special facilities that make them sometimes expensive and difficult to use [35-37]. Therefore, researchers have differentiated masticatory ability from masticatory efficiency depending on the assessment method. Masticatory ability is considered a patient's subjective response relative to chewing and his or her objective capacity to chew so it can be evaluated by questionnaires or personal interviews. Masticatory efficiency and performance are considered a patient's clinical subjective capacity to chew which should be evaluated by clinical mastication tests [32,34,38,39].

In general, chewing performance of edentulous individuals wearing complete dentures is significantly less than dentate individuals [40-43]. Furthermore, complete denture wearers experienced more difficulty in chewing hard food than dentate subjects and thus a group of subjects with intact dentition had a greater masticatory performance index value[44]. By contrast, it was reported that chewing ability in subjects with cross-arch fixed partial dentures was almost as good as in subjects with complete, healthy dentitions and superior to that of complete denture wearers[45]. In addition, Nagasawa and Tsuru found the masticatory performance, the number of chewing strokes, and chewing time until swallowing were similar with the removable and fixed partial dentures[46].

Many epidemiological studies have reported on the signs and symptoms of masticatory dysfunction regarding: prevalence, frequency and severity. However, the influence of dental prostheses especially, fixed partial denture, on the prevalence of TMD and on chewing efficiency is still unclear and recent relevant studies are scarce[15]. Therefore, it would appear worthwhile to conduct this cross-sectional study to investigate these conditions and other relevant variables among a Jordanian Subpopulation. The purpose of this study was to assess clinically the oro-facial sequels of wearing fixed partial or removable complete dentures through:

- Determining the prevalence of TMDs among patients wearing fixed partial or complete dentures.
- Determining the prevalence of TMDs in a control group of dentate subjects.
- Evaluating chewing ability in patients wearing various fixed and removable prostheses and compare them to the control group.
- Investigating the possible correlation between TMD and chewing ability.

MATERIALS AND METHODS

A total of 150 subjects including 67 males (44.7%) and 83 females (55.3%), were recruited from routine follow up patients who attended the prosthodontic, conservative and periodontology clinics of the Dental Teaching Centre, Jordan University of Science and Technology between March 2007 and May 2007. The age range of subjects was 21 to 82 years (Mean = 46.9 years). Subjects were divided equally into three groups (I) Complete denture group, subjects wearing maxillary and mandibular complete dentures (CDs). (II) Fixed partial denture group (FPD), subjects who

had fixed partial dentures replacing the second premolar and/or first molar teeth. (III) Dentate group, subjects with full natural dentitions with no dental prostheses (FD). This study was approved by the ethics committee of Jordan University Science and Technology. Each subject received a written and verbal description of the study and informed consent was obtained prior to enrolment into the study.

Inclusion and exclusion criteria were established as follows: for the three groups, subjects who were diagnosed or previously treated for TMD were excluded. Subjects who took any medication that interfere with the examination such as analgesics were also excluded. For the first group of subjects wearing complete dentures, only those who didn't visit their dentists for the last three months were included. However, any subject from the second group, with fixed partial dentures, who had seen his /her dentist within the last week to deal with complaints related to the prostheses, was excluded to avoid the potential interference of other symptoms with TMD symptoms. Fixed partial dentures subjects included in the study were only those with 3-4 unit fixed-fixed FPDs replacing the second premolar and /or first molar teeth. Cantilevered FPDs were excluded. For third full dentate group, extracted or missing third molars were not counted as missing teeth during the clinical examinations. No drugs or medications were given nor were any treatment procedures accomplished by the examiners. Finally, Denture quality, retention and stability, was evaluated by the same method performed by Kapur [47] and Demers et al [48] and should be acceptable by patients and examiners before the test performed. Furthermore, only patients with dental prostheses who reported not having symptoms relevant to TMD prior to replacement of missing teeth were included in the study.

Clinical examination of the patients and prostheses was performed by one examiner to ensure the continuity of interpretation of the answers provided by the subjects. However, the examiner was calibrated with an experienced prosthodontist.

Clinical Assessment of Temporomandibular Disorder

All patients were required to complete an examiner-administered questionnaire in which all demographic data, past medical and dental history, reported symptoms of TMD were recorded. All subjects then underwent clinical examinations to register Helkimo's index. This index consisted of three indices for the evaluation of masticatory system function; clinical dysfunction index, anamnestic dysfunction index and occlusal index[49].

Clinical Dysfunction Index (Di) was used for the clinical evaluation of the functional state of the masticatory system through evaluation of five groups of symptoms:

1. Impaired range of movement of the mandible: Assessed by measurement of maximal opening of the mouth, maximal lateral movements and maximal protrusion.
2. Impaired function of TMJ: It evaluates the pattern or pathway of mandibular opening Straight or deviated path of mandibular movement during opening and closing with or without palpable TMJ sounds, or clinically demonstrable locking and/or luxation of the TMJ when the patient performed various movements of the mandible.
3. Pain on movement of the mandible: it was said to be present if pain could be elicited when the patients asked to perform different mandibular movements systematically and reporting any pain during such movements.
4. Pain in the temporomandibular joint: Muscle tenderness was recorded if the subject described the palpation of masticatory muscles as painful. All muscles were palpated bilaterally
5. Pain in the masticatory muscles: joint tenderness was determined by bilateral digital palpation posteriorly via the external auditory meatus and laterally over the condyle in the immediate peri-auricular region. As for palpation of muscles a clear reaction of the patients were recorded as symptoms.

Anamnestic Dysfunction Index (Ai) was based on gathering data from a list of questions by interviewing patients for symptoms of TMD. All subjects in the three groups were requested to report any symptoms of dysfunction of the masticatory system such as: TMJ tenderness, limitation and/or deviation of mandibular movement, joint sounds (e.g., clicking or crepitus), and masticatory muscle tenderness, that they had at any time before clinical examination. The results were recorded.

Occlusal Index (Oi) was used for evaluation of the occlusion of the subjects with respect to: number of teeth, number of occluding teeth, interferences on occlusion and articulation in the FD and FPD groups by a thorough clinical examination of centric and eccentric jaw movements and by observing and recording the contacts between the opposing teeth using articulating foil.

Assessment of Chewing Ability

All subjects were requested to complete the Chewing Ability Questionnaire prepared according to the method described by Stellingsma et al[50]. Based on this questionnaire, all subjects in each group were requested to report whether they were satisfied or dissatisfied with their chewing ability. Subjects reported their perceptions about their abilities to chew nine different kinds of food on a 3-point rating scale (0 = good, 1 = moderate, 2 = bad). The items were grouped into three categories (a) Soft food group including; boiled vegetables, potatoes, crust-less bread, and minced meat. (b) Tough food group including; crusty bread, steak and Gouda cheese. (c) Hard food group including; apple, carrot and peanuts. Each group final score was calculated as the mean of the item score which ranged from 0 to 2. Chewing ability was determined descriptively according to the final score as good = 0, moderate = 1 or bad =2.

Assessment of Denture Quality

All CDs were carefully examined by the same examiner for support, retention, stability, occlusion, vertical dimension of occlusion and freeway space. The denture quality (retention and stability) was evaluated by the same method performed by Kapur and Demers et al[48, 49]. In this method; each denture base was scored separately for its stability and retention on a 3- and 4-point scale respectively (Table 2). A sum score of less than six identified clinically poor dentures; six to eight identified clinically fair dentures

and a score greater than eight characterized clinically well made dentures [47, 48].

Reliability tests were carried out on ten subjects from the sample to determine both inter and intra examiner agreement. Reliability was measured by using percent of exact agreement test. The examiner was calibrated with an experienced prosthodontist before proceeding with the examination of the subjects.

The data were statistically analyzed using Statistical Package for Social Science (SPSS, Version 12) computer software (SPSS Inc., Chicago, USA). For each group means and standard deviations were calculated. Comparison of results from the three groups was carried out using Kruskal–Wallis one way ANOVA and Chi square tests. A significant difference was assured to exist among the groups if the probability of such a difference or a greater difference was found to be less than five percent ($P<0.05$).

Data Analysis

Table 2. *Classification of complete denture retention and stability (Kapur, 1967).*

Score	*Retention Criterion*	*Stability Criterion*
0	No retention. When the denture is seated in its place, it displaces itself	No stability. When a denture base demonstrates extreme rocking on its supporting structures under pressure
1	Minimum retention. When a denture offers slight resistance to vertical pull and little or no resistance to lateral force.	Some stability. When a denture base demonstrates moderate rocking on its supporting structures under pressure.
2	Moderate retention. When a denture offers moderate resistance to vertical pull and little or no resistance to lateral force.	Sufficient stability. When a denture base demonstrates slight or no rocking on its supporting structures under pressure.
3	Good retention. When a denture offers maximum resistance to vertical pull and sufficient resistance to lateral force.	

Table 3. *Distribution of the study subjects based on gender and age groups*

Age group (years)	*Male No. (%) 67 (44.7 %)*	*Female No. (%) 83 (55.3 %)*	*Total No. (%) 150 (100%)*
20-30	7 (10.4%)	4 (4.8%)	11 (7.3%)
31-40	19 (28.4%)	33 (39.8%)	52 (34.7%)
41-50	9 (13.4%)	27 (32.5%)	36 (24.0%)
51-60	19 (28.4%)	9 (10.8%)	28 (18.7%)
61-70	12 (17.9%)	6 (7.2%)	18 (12.0%)
71-80	1 (1.5%)	3 (3.6%)	4 (2.7%)
> 80	0 (0%)	1 (1.2%)	1 (0.7%)

Table 4. *Distribution of study subjects based on prosthesis type and age groups.*

Type of prosthesis	*Age groups*						
	20-30	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*> 80*
Complete denture (CD)	0 0%	2 4%	2 4%	24 48%	17 34%	4 8%	1 2%
Fixed bridges(FPD)	6 12%	16 32%	24 48%	3 6%	1 2%	0 0%	0 0%
Full dentate (FD)	5 10%	34 68%	10 20%	1 2%	0 0%	0 0%	0 0%
Total	11 7.3%	52 34.7%	36 24%	28 18.7%	18 12%	4 2.7%	1 0.7%

RESULTS

Age and sex distribution of the patients are shown in (Table 3, 4)

Clinical Temporomandibular Disorder

The frequency and distribution of clinical signs of TMD among the entire sample of subjects were recorded. More than half of the subjects (56.0%) had mild clinical signs of TMD. Eight percent of the subjects had clinical signs of moderate TMD and 10% had severe clinical signs of TMD (Table 5). Dental status failed to show a significant effect on the frequency and distribution of clinical signs.

Reported symptoms of TMD as obtained from the anamnestic dysfunction index were also recorded (Table 6). The majority of subjects reported the presence of mild symptoms of TMD, of which the FPD group represented the highest percentage while the CD group showed the lowest. As shown by Chi square test, the difference between the three groups was statistically significant (P= 0.001).

Clinical signs of TMD as obtained from the clinical dysfunction index showed a highly significant association with reported symptoms of TMD as obtained from the anamnestic dysfunction index in all subjects. This association represented by Pearson correlation test (correlation coefficient =0.53, P<0.0001).

The occlusal index used to evaluate the occlusion of subjects in the FPD and FD groups demonstrated that the majority of the subjects (65.0%) were suffering from moderate disturbances in occlusion or articulation (Table 7). Thirty six percent of the subjects were wearing fixed prostheses; 29.0% were dentate. The Chi square test demonstrated statistically significant difference between the groups and (P = 0.007).

Chewing ability

Chewing ability scores were recorded in each group according to Stellingsma *et al.*[50] The highest mean score (less ability) for chewing ability (Mean 0.6120, SD 0.50) was reported for the CD group which was interpreted by the authors as moderate chewing ability. However, both FPD and FD subjects had lower mean scores (0.3 and 0.1 respectively) which indicated higher chewing ability (Table 8). The Kruskal–Wallis one way ANOVA test revealed a statistically significant difference between the CD group and the other two groups (P < 0.01); while no statistically significant difference was noted between FD group and FPD group (P = 0.18).

Denture quality

Complete denture group was classified into three groups regarding denture quality according to Kapur scale: poor,

Table 5. *Distribution of subjects basd on clinical dysfunction index*

Group	*Severity of Clinical TMD*			
	No TMD	*Mild TMD*	*Moderate TMD*	*Severe TMD*
CD	19 (12.7%)	24 (16.0%)	5 (3.3%)	2 (1.3%)
FPD	8 (5.3%)	33 (22.0%)	3 (2.0%)	6 (4.0%)
FD	12 (8.0%)	27 (18.0%)	4 (2.7%)	7 (4.7%)
Total	39 (26.0%)	84 (56.0%)	12 (8.0%)	15 (10.0%)

Table 6. *Distribution of sample subjects based on anamnestic dysfunction index*

Variables		*Anamnestic dysfunction index*		
		Symptoms free	*Mild symptoms of TMD*	*Severe symptoms of TMD*
Type of prosthesis	CD	29 (19.3%)	13 (8.7%)	8 (5.3%)
	FPD	12 (8.0%)	26 (17.3%)	12 (8.0%)
	FD	12 (8.0%)	22 (14.7%)	16 (10.7%)
Total		53 (35.3%)	61 (40.7%)	36 (24.0%)

Table 7. *Distribution of subjects based on occlusal index (Oi)*

Variables		*Occlusal index*		
		No disturbance in occlusion or articulation	*Moderate disturbances in occlusion or articulation*	*Severe disturbances in occlusion or articulation*
Type of prosthesis	FPD	0 (0.0%)	36 (36.0%)	14 (14.0%)
	FD	9 (9.0%)	29 (29.0%)	12 (12.0%)
Total		9 (9.0%)	65 (65.0%)	26 (26.0%)

fair and well made dentures. In this study poor dentures represented 36% of the CD sample, well made denture quality represented only 8% of the sample; the majority of the sample (56%) had fair dentures. The quality of complete dentures failed to show significant association with the severity of clinical temporomandibular dysfunction.

Chewing ability and denture quality

The highest mean score was reported for the group that had fair denture quality (0.702). This indicated moderate chewing ability. The lowest mean score was noted in the group with well made or high denture quality (0.466). This indicated high levels of chewing ability (Table 9). However, the quality of complete dentures failed to show significant effect on chewing ability (correlation coefficient =0.036, P =0.80).

Clinical temporomandibular disorder and chewing ability

The Kruskal-Wallis test was used to find the significance, if any, of the association between severity of clinical dysfunction and chewing ability (Table 10). The highest mean score was noted for the group who had moderate clinical dysfunction so this group had a poor level of chewing ability while the group with mild clinical dysfunction had the lowest mean and thus had a high level of good chewing ability. The difference was found to be statistically significant (P = 0.03).

Table 8. *Means and standard deviations of chewing ability scores for each group of study population*

Type of prosthesis	*N*	*Mean*	*Std. Deviation*
CD	50	0.61	0.50
FPD	50	0.26	0.37
FD	50	0.12	0.36
Total	150	0.33	0.04

Table 9. *Association between denture quality and chewing ability*

Denture quality	*N*	*Mean*	*Std. Deviation*
< 6 = poor denture	18	0.50	0.51
6-8 = fair denture	28	0.70	0.49
> 8 =good denture	4	0.47	0.54
Total	50	0.61	0.50

Reliability

Reliability was measured by using the percent of exact agreement test. The percent of exact agreement between both examiners was 85% for denture quality index. However, the percent when used to observe the reliability and consistency between examinations was 80-90%.

Inter-item correlation

Inter-item correlation for the three groups of food (soft, tough and hard) was tested using analysis of variance. Inter-item correlation was 0.58 for soft foods (reliability according to Cronbach's $\alpha = 0.7696$), 0.76 for tough foods (Cronbach's $\alpha = 0.8980$) and 0.82 for hard foods (Cronbach's $\alpha = 0.9215$). The reliability test results indicated high significant level of inter-item correlation and consistency between the answers of the subjects regarding the chewing ability for the various items within each food group.

DISCUSSION

This study was based on randomized groups of patients attending the Dental Teaching Centre of Jordan University of Science and Technology (JUST). Patients were recruited from the prosthetic, conservative and periodontal clinics. The power of this study was 78% and the sample size was 150 subjects. This was considered acceptable compared to previous literature reports [21,51-54]. However, a larger sample size would have increased the power of the study by minimizing the more confounding effect that results from variations between small size sample subjects. Additionally, due to recruitment of subjects attending a dental teaching institute, and the inclusion and exclusion criteria, this study population may not be adequately representative to predict results for a larger, more general population.

The current study was originally designed to include subjects wearing removable partial dentures (RPD) but unfortunately the authors were not capable of reviewing considerable number of subjects within the allocated time for the investigation, in addition to the fact that there were only few RPD subjects available, and therefore they were excluded.

The exclusion criteria in the current study were adopted to avoid any false positive diagnosis of TMD signs and symptoms and any influence on the study outcome, such as taking analgesics, history of previous treatment of TMD, any relevant medications that may interfere with examination and complete denture patients seen in the last 3 months for denture adjustment. Fixed partial Denture replacing single or two teeth only were included as cross arch or longer span FPD may have an effect on the study

Table 10. *Mean scores of chewing ability and standard deviation in subjects with different levels of TMDs*

Severity of Clinical TMD	*N*	*Mean*	*Std .Deviation*	*Std. Error*
No TMD	39	0.39	0.45	0.07
Mild TMD	84	0.27	0.43	0.05
Moderate TMD	12	0.56	0.42	0.12
Severe TMD	15	0.40	0.43	0.11
Total	150	0.33	0.44	0.04

outcome. This has to be further investigated and was considered beyond the scope of the current study. Additionally, Patients with positive history of any TMD symptoms prior to prosthetic replacement were excluded. This was necessary to exclude correlating historic symptoms from those of the current status.

Despite the fact that one calibrated examiner examined all the subjects to reduce variations between different examiners which demonstrated high level of inter-examiner and intra-examiner reliability, it is believed that total bias could not be completely eliminated. However, this bias was assumed to be significantly minimized. A single examiner might be more consistent and examination outcome would have been less biased. Nevertheless, it might be considered good practice to have one examiner collect data on some study variables and a different examiner other variables. Therefore, in the current study, the reliance on single examiner for data collection might have introduced some inaccuracies.

Clinical assessment of Temporomandibular disorder

In population-based studies, TMD indices have proven to be valuable to provide comparisons either between groups or between various studies. Therefore, in studies depending on clinical examination such as the current study, it became obvious that a simplified and time-saving TMD index would be necessary[22].

Helkimo's index was designed to make an estimate of the presence or absence of symptoms of TMD, such as the presence or absence of pain. Some symptoms in this index were to some extent quantified.[49] Moreover, Helkimo's index was designed in such a way that the distinctions between dysfunction groups 1 and 2 are more diffuse than between 2 and 3 and thus, a single or isolated severe symptom could never give the individual a high index value, The highest value can be given only for the coexistence of two or more severe symptoms [48].

Thus, the Helkimo index has been described as an epidemiologic instrument and considered to be a simple index. It has been therefore used in many studies to estimate the functional status of the masticatory system [14, 22, 49, 54-56].

In this study, Helkimo's clinical dysfunction index was used to determine the prevalence of TMD among a study population. It should be noted that these results were consistent with the Helkimo's anamnestic dysfunction index outcome and also with results of Pullinger *et al* study[56]. The latter study reported the prevalence of TMJ signs and symptoms. It was demonstrated that two thirds of the study sample reported only mild or early symptoms, 17% reported moderate symptoms and only 3% reported severe symptoms[56]. The current study results were also consistent with epidemiological surveys that reported 50-70% of the populations studied had signs of a disorder at some stage during their lives[2,3]. Within the limitation of the current study, the findings were consistent with some previous investigations and confirmed the lack of consensus on the prevalence of TMD. However, comparing the prevalence of TMD in the current investigation with previous epidemiological studies should be done with caution due to differences in methodology, study population, and sample size.

Current results showed a highly significant correlation between clinical signs of TMD that were evaluated by using clinical dysfunction index and the reported symptoms of TMD evaluated by using the anamnestic dysfunction index ($P<0.001$). This result was in agreement with that of Magnusson *et al* study that reported a significant correlation between subjective symptoms of TMD and the clinical dysfunction index on all follow-up examinations[54].

In comparing the prevalence of TMD between study groups, the results were strongly supported by results of some studies which stated TMDs are almost as prevalent in wearers of complete dentures as in dentate individuals, varying from 15 to 25% [12, 13, 18, 57]. The prevalence of TMD signs in edentulous denture wearing populations appeared to range between 12 and 80% [20]. The comparatively low percentage of signs and symptoms of TMD among denture wearers in this study and other similar studies may be explained as CD wearers who experienced discomfort with their dentures usually adapted to impaired oral function without any complaint or accept it as being the result of the normal process of ageing[16, 58]. While other studies reported that patients wearing CDs suffered from more TMD signs or symptoms than dentate populations. The results were explained by the fact that patients of older age groups might be expected to demonstrate a higher incidence of osteoarthritis[17] and the prevalence of TMDs was demonstrated in the literature to be high in patients with osteoarthritis. One of the supportive studies is the study by Yamakawa et al who compared dentition status and temporomandibular joint (TMJ) disorders in subjects with rheumatoid arthritis (RA) and in subjects of similar age without RA. Study results showed that the prevalence of TMJ disorders was higher in RA group (67.6%) in comparison to the non-RA group (32.9%)[59]. Another study observed the presence of signs and symptoms of TMD in patients with rheumatoid arthritis. From the study results, authors concluded that by using an important measurement tool such as the scale of limited mandibular function, a significant incidence of signs and symptoms of TMJ involvement in patients with rheumatoid arthritis had been demonstrated[60].

The high percentage of TMD among patients having fixed partial dentures may be attributed to long term losing of molar support which considered an important etiological factor for TMD. Or it could be caused by poor occlusal form of the fixed partial dentures[61]. Due to the fact that some subjects could not exactly recall the period elapsed from the time of extractions and replacement of the missing teeth with fixed partial dentures, the influence of this variable could not be conclusively determined. This was considered as one of the limitations of the current study and should be investigated in future studies.

The assessment of TMD of patients with dental prostheses in the current study was based on the fact that the patients have reported not having symptoms relevant to TMD prior to replacement of missing teeth. The studied subjects were therefore assumed free of TMD symptoms prior to treatment. Hence, a conclusive direct causal relationship between provision of dental prostheses (FPDs and CDs) and TMD should be interpreted with caution and can not be conclusive unless a longitudinal study is conducted. Further future studies are required to determine the prevalence of TMD among patients attending a hospital, institution or private practice.

Assessment of chewing ability

Impairment of chewing ability has been documented by many studies as a usual consequence of losing natural teeth regardless of their replacement with dental prostheses[12, 13, 16-18] .

Some studies have shown that the use of questionnaire or patients-based measure to evaluate the chewing ability was one of the best predictors of treatment's choices. The authors used this reasoning in designing this study as the principal measures of masticatory performance should be based on the patients' perceptions rather than on a particular physiologic test which may be highly efficient, but difficult to use[34-37].

In this study, the perception by individuals of their masticatory performance was measured by a chewing ability questionnaire. Subjects were asked to report their perception to chew different foods of various textures and hardness. The foods covered the full scale from 'very easy' to 'very difficult' and were divided into three groups; soft; tough; and hard foods.

The current study demonstrated that the CD group reported moderate chewing ability (Mean 0.6120, SD 0.50); while both the FPD and FD groups reported higher chewing abilities (Means 0.3 and 0.1 respectively). This result was consistent with previous study that specifically studied the correlation between chewing performance and the number of remaining teeth. [31] Their results showed that masticatory performance was significantly influenced by amount of dentition. Hence, subjects with reduced number of remaining dentition had reduced masticatory performances. They used more chewing strokes to prepare food for swallowing than subjects with complete natural dentitions[32, 40, 41].

The lack of significant differences between the FD and FPD groups could be explained in relation to numbers of occlusal contacts since this is likely to be very similar in both groups and therefore it is hardly surprising that the masticatory ability of the two groups are similar. Previous study suggested that the biggest number of occlusal contacts were recorded for the small span fixed appliances compared to long span fixed and fixed-removable prosthodontic appliances, and the removable complete denture per the tooth in the posterior region.[62] And because the number and localisation of occlusal contacts are directly related to chewing efficiency[63], the difference between FPD and CD subjects could be expected. However, the number of occlusal contacts was not investigated in the current study.

Previous studies also supported the findings of this study when they reported a reduced chewing performance in subjects with complete dentures [42, 64].

Chewing ability and denture quality

Although an association was observed between denture quality (retention/ stability) and masticatory ability, denture quality did not provide a satisfactory prediction of the chewing ability. The association was not statistically significant (correlation coefficient= 0.036, P> 0.05). This result was in agreement with Heath's study results. He found that maxillary denture quality as measured by the same Kapur index correlated poorly with mastication and increasing denture base retention with denture base adhesives, failed to improve the masticatory ability of the denture wearers[47, 65]. This low correlation between the two variables may be attributed to an adaptation process in which individuals wearing ill-fitting dentures modify their chewing habits to optimize masticatory ability with their dentures.

The study finding also supported the results of studies which reported that clinically measurable retention loss induced by the peripheral reduction of well-fitting denture bases did not significantly affect masticatory performance. In some instances, subjects with ill-fitting dentures and no denture adhesive did better than those with well-fitting dentures. This could be attributed to efficient manipulation of food during chewing [47] .

Clinical temporomandibular disorder and chewing ability

Subjects with moderate TMD demonstrated lower chewing ability than those with mild TMD. The correlation was statistically significant (P=0.03). This result was consistent with those shown in previous studies as patients suffering from masticatory muscle pain often complain of aggravation of pain during chewing. [66-67] Clark *et al* found patients suffering from masticatory muscle pain to have a lower maximum voluntary bite force level and a shorter endurance time compared to normal subjects.[68] While Dao *et al* found a 3-minute chewing test increased pain in most myofacial pain patients, particularly in those with low pain scores at rest[67].

Treatment of TMDs was also reported to positively affect masticatory function and endurance time increased significantly after treatment [69].

CONCLUSIONS

From the results of this study, the authors concluded that:

The prevalence of TMD was high among the study population but of mild character according to both Helkimo's clinical and anamnestic dysfunction indices.

Dental prostheses failed to show significant effect on the severity of TMD signs and symptoms.

Chewing ability was influenced by the type of prosthesis since subjects in both the dentate and fixed partial denture groups reported higher chewing ability in comparison to subjects in the complete denture group.

There was no significant association between denture quality and chewing ability.

Subjects with moderate TMD had lower chewing abilities than those subjects with mild TMD. The correlation between TMD and chewing ability was statistically significant.

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ADDRESS FOR CORRESPONDENCE

Dr. Wael M Al-Omari, Associate Professor of Restorative Dentistry and Prosthodontics, Department of Prosthodontics, Jordan University of Science and Technology, Irbid, Jordan. Email: womari@just.edu.jo

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