Original Article

COMPARISON OF DENTAL STATUS AND ORAL FUNCTION BETWEEN THE ELDERLY WITH AND WITHOUT TEMPOROMANDIBULAR DISORDERS

Minh Son Nguyen[1,2a*], Ülle Voog-Oras[1b], Triin Jagomägi[1c], Mare Saag[1d]

[1]Institute of Dentistry, Faculty of Medicine, University of Tartu, Raekoja plats 6, 51003 Tartu, Estonia
[2]Department of Prosthodontics, Faculty of Stomatology, Danang University of Medical Technology and Pharmacy, 99 Hung Vuong, Danang, Vietnam

[a]DDS, PhD, Head of Department
[b]MD, PhD, Associate Professor
[c]DDS, PhD, Associate Professor
[d]DDS, PhD, Professor, Head of Institute

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ABSTRACT

Introduction: Temporomandibular disorders (TMD) are a group of disorders that may cause functional limitations. The aim of the study was to compare the differences in dental status, oral behaviour, and mandibular functional limitations between TMD and non-TMD elderly people in Vietnam.

Methodology: The sample consisted of 146 TMD and 112 non-TMD elderly. The dental and periodontal status were evaluated with DMFT and CPI indices. The participants self-rated frequency of oral behaviour activities (21-item Oral Behaviour Checklist) and mandibular functional limitations (20-item Jaw Functional Limitation Scale).

Results: The mean number of missing teeth in TMD group was 9.6 ± 8.6, while it was 7.6 ± 6.4 in non-TMD group (p = 0.036). Gingival bleeding in TMD group was detected at 18.3 ± 10.2 teeth, which was less than in non-TMD group (21.0 ± 8.7, p = 0.023). The mean number of sextants with a 0–3 mm clinical attachment loss was high for non-TMD group (1.4 ± 2.0, p = 0.021), while the mean number of excluded sextants was high for TMD group (1.3 ± 1.8, p = 0.037). The TMD elderly group reported more frequent instances of "Hold, tighten, or tense muscles" than non-TMD group. No significant differences were found in the self-rated mandibular functional limitations between the two groups.

Conclusion: TMD were associated with missing teeth and periodontal diseases. There was no association between TMD and mandibular functional limitations. The elderly suffering from TMD tended to have increased frequency of holding, tightening, or tensing muscles.

Keywords: dental caries, elderly, mastication, oral function, temporomandibular disorders.

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***Corresponding author:** Dr. Minh Son Nguyen, DDS, PhD Institute of Dentistry, Faculty of Medicine, University of Tartu 6 Raekoja Plats, Tartu 51003, Estonia. Tel: +84983060321, Fax: +372 7319856, e-mail: minhson1883@gmail.com

1. Introduction

Temporomandibular disorders (TMD) are the group of disorders affecting the temporomandibular joint and structure-related joint. The prevalence of TMD in the older adult population varies from 33% to 56.6% [1,2]. TMD often cause orofacial pain, limit the function of the masticatory system, and also impact on quality of life [3].

Multiple factors contribute to the TMD process. Dentition is a part of the masticatory system, and the global burden of dental caries and periodontal diseases can increase the risk of TMD in the older adult population [4]. Our previous studies indicate that more than 50% suffer from TMD [2]. Studies on TMD at the age over 60 years old also reported that 17.5–52.2% of patients had less than 20 teeth, and 10.9–34.3% were edentulousness [5–7]. After dental pain, TMD is the most the common cause of pain in the orofacial area; therefore, dental diseases and TMD may share symptoms and clinical comorbidities.

The parafunctional habits of bruxism and teeth clenching have been regarded as risk factors for TMD pain [8–10]. TMD patients are also limited in their daily activities and have increased frequency of oral parafunction [11,12]. The cumulative risk factors of ageing contribute to the increasing signs of TMD, including limited mouth opening, muscular tenderness, and TMJ sounds, all of which can affect on masticatory performance. Ohrbach et al. [13] and Markiewicz et al. [14] initially developed the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) axis II to determine the presence of parafunctional and functional limitations of the masticatory system. However, norms have not yet been established for those instruments, particularly in the older adult population. Regardless of whether or not elderly with TMD have more limited oral function compared to those free from TMD, because many factors such as dental status, neuromuscular changes, and psychosocial factors can influence oral function of this age group.

Therefore, the aim of the study was to compare the differences in dental status, oral behaviours, and functional limitations of the masticatory system between the TMD and non-TMD elderly people.

2. Materials and methods

The total sample comprised 258 volunteer participants aged 65–74 years in Danang City, Vietnam. Based on clinical examination of TMD according to DC/TMD axis

l [15], our previous study revealed that 56.6% (n = 146) of the total sample were diagnosed with TMD (TMD group) and 43.4% (n = 112) were free of TMD (non-TMD group) [2]. In the current study, the participants of both groups were invited to examine dental status and evaluate oral function.

Written informed consent that explained oral examination procedures was obtained from each participant. This study was registered and approved by the Human Research Ethics Committee of the Danang University of Medical Technology and Pharmacy (No. 523/CN-DHKTYDDN 2014) and was performed in accordance with the World Medical Association's Helsinki Declaration.

2.1. Clinical examination of dental status

The dental status of each participant was examined by using the Decayed Missing Filled Teeth (DMFT) index. The primary caries appeared on the crown or root of a tooth, or secondary carious lesions nest to the restoration was considered a decayed tooth (DT). A missing tooth (MT) was a tooth lost due to caries or any other reason. A filled tooth (FT) was considered with at least one filled surface and without any caries. The DMFT score was the sum of the DT, MT, and FT scores and ranged from 0 to 32.

2.2. Clinical examination of periodontal status

Periodontal status was evaluated using the modified Community Periodontal Index (CPI). The modified CPI records two indicators of periodontal status: gingival bleeding and periodontal pockets. All teeth present were probed (6 sites per tooth) to record any presence of bleeding on probing and periodontal pocket depth (PPD). PPD was scored as follows: score 0 (a PPD of 0-3mm, no pocket), score 1 (a PPD of 4–5mm, shallow pocket), and score 2 (a PPD of ≥ 6mm, deep pocket).

2.3. Clinical examination of clinical attachment loss (CAL)

CAL estimates accumulated lifetime destruction of the periodontal attachment. CAL was measured from the cementoenamel junction to gingival sulcus or pocket at 6 sites per index tooth of each sextant. The CAL severity was recorded based on the highest CAL score of the index tooth as follows: score 0 (CAL 0–3 mm), score 1 (CAL 4–5 mm), score 2 (CAL ≥ 6 mm). The sextant was excluded if there were less than two teeth present.

The first author conducted procedure of dental and periodontal examination according to the WHO's Oral Health Survey guidelines (2013). A pilot study of a group of 25 elderly people was performed to calibrate the examiner before the study was carried out. Ten percent of the participants were re-examined after three days to test the reliability of the examination procedure. The calculated Kappa-values were above 0.85, indicating a high degree of intra-examiner and inter-examination reliability.

2.4. Evaluation of oral function

All participants were interviewed face-to-face on the functional limitations of their masticatory system based on the 20-item Jaw Functional Limitation Scale (JFLS-20) [13] and the frequency of parafunctional behaviours based on the 21-item Oral Behaviour Checklist (OBC-21) [14].

JFLS-20 assesses the limitation of mastication (6 items), mandibular mobility (4 items), verbal and emotional expression communication items (8 items), swallowing, and yawning. Each item was scored on a scale of 0–10 points (10 points = the most limited mandibular function).

OBC-21 determines the frequency of oral parafunctional activities during sleep and waking hours. Each item was scored from 0 (never) to 4 (all the time). In the current study, each item on the JFLS-20 and OBC-21 surveys was categorised as No (score = 0) and Yes (score ≥ 1).

The data was analysed using Version 17.0 of the Statistical Package for Social Sciences software (SPSS Inc., Chicago, Ill., USA). The comparisons of dental status, the frequency of parafunctional behaviours, and functional limitations of the masticatory system between the two groups was performed using Chi-square test and Student's t-test. A confidence level of 95% and a two-sided p-value of < 0.05 were used to reveal significant differences.

Table 1. Comparisons of dental caries status between the TMD and non-TMD elderly participants.

Variable	TMD (n = 146)	Non-TMD (n = 112)	p-value
Sound teeth			
Number of subjects	131	110	
Percent %	89.7	98.2	0.009*[a]
Mean number of teeth	15.5 ± 9.4	17.6 ± 8.7	0.070
Decayed teeth			
Number of subjects	120	108	
Percent %	82.2	96.4	< 0.001*[a]
Mean number of teeth	6.3 ± 5.6	6.5 ± 5.4	0.684
Missing teeth			
Number of subjects	134	106	
Percent %	91.8	94.6	0.463
Mean number of teeth	9.6 ± 8.6	7.6 ± 6.4	0.036*[b]
Filled teeth			
Number of subjects	12	10	
Percent %	8.3	8.9	1.000
Mean number of teeth	0.2 ± 0.9	0.3 ± 1.1	0.710
Caries experience			
Number of subjects	143	111	
Percent %	97.9	99.1	0.635
Mean DMFT	16.0 ± 9.5	14.4 ± 8.7	0.152

[a] Fisher's exact test, [b] Student t-test, * statistically significant
TMD: Temporomandibular disorders, DMFT: Decayed Missing Filled Teeth

3. Results

Prevalence of DMFT was 97.9% in the TMD group and 99.1% in the non-TMD group (p = 0.635). There were significant differences in prevalence between the TMD and the non-TMD groups in terms of sound

Table 2. Comparisons of periodontal status between the TMD and non-TMD elderly.

Variable	TMD (n = 146)	Non-TMD (n = 112)	p-value
Gingival bleeding			
Number of participants (%)	135 (92.5)	110 (98.2)	0.467
Mean number of teeth	18.3 ± 10.2	21.0 ± 8.7	0.023*c
Prevalence of participants having highest score of PPD			
PPD 0–3 mm	15 (10.7)	15 (13.4)	0.514
PPD 4–5 mm	46 (32.9)	50 (44.6)	0.056
PPD ≥ 6 mm	78 (55.7)	47 (42.0)	0.030*a
Mean number of teeth present with PPD			
PPD 0 –3 mm	12.3 ± 10.2	14.4 ± 9.7	0.085
PPD 4–5 mm	7.3 ± 7.9	8.3 ± 8.1	0.342
PPD ≥ 6 mm	1.0 ± 3.6	0.6 ± 1.7	0.210
Prevalence of participants having highest score of CAL			
CAL 0–3 mm	2 (1.4)	12 (10.7)	0.001*b
CAL 4–5 mm	38 (26.0)	42 (37.5)	0.048*a
CAL ≥ 6 mm	45 (30.8)	25 (22.3)	0.128
Excluded sextants	61 (41.8)	33 (29.5)	0.042*a
Mean number of sextants with CAL and excluded sextants			
CAL 0–3 mm	0.9 ± 1.4	1.5 ± 2.0	0.021*c
CAL 4–5 mm	2.4 ± 2.0	2.7 ± 2.2	0.184
CAL ≥ 6 mm	1.5 ± 1.7	1.0 ± 1.7	0.100
Excluded sextants	1.2 ± 1.8	0.8 ± 1.4	0.037*c

[a] Chi-square test, [b] Fisher's exact test, [c] Student's to-test, * statistically significant.
PPD: Periodontal pocket depth; CAL: Clinical attachment loss.

teeth (89.7% and 98.2%, p = 0.009) and decayed teeth (82.2% and 96.4%, p < 0.001). The number of missing teeth was statistically higher in the TMD group (9.6 ± 8.6 teeth) than in the non-TMD group (7.6 ± 6.4, p = 0.036, Table 1).

Regarding periodontal status, gingival bleeding was detected at 18.3 ± 10.2 teeth in the TMD group, which was lower than 21.0 ± 8.7 teeth in the non-TMD group (p = 0.023). The prevalence of older adults with PPD ≥ 6 mm was higher in the TMD group (55.7%) than in the non-TMD group (42%, p = 0.030). Concerning clinical attachment loss, occurrences of CAL 4–5 mm was 37.5% for the non-TMD group and 26.0% for the TMD group (p = 0.048); whereas, a high prevalence of excluded sextants was significantly related to the TMD group (41.8%, p = 0.042). The mean number of sextants with CAL 0–3 mm was 0.9 ± 1.4 in the non-TMD group, which was statistically lower than 1.5 ± 2.0 sextants of the non-TMD group (p = 0.021); however, the TMD group had more excluded sextants (1.3 ± 1.8) than the non-TMD group (0.7 ± 1.4, p = 0.037).

Comparing the functional limitations of mastication revealed no differences between the TMD and non-TMD group. Most participants in the TMD elderly group had masticatory limitations related to chewing tough food (82.2%), followed by chewing chicken (69.2%), and chewing hard bread (66.4%); the results for the non-TMD group were 75.9%, 64.3%, and 56.3%, respectively. The mean score (standard error) of each

Table 3. Comparisons of functional limitations of masticatory system between the TMD and non-TMD elderly.

	Functional limitation	TMD (n = 146)		Non-TMD (n = 112)		p-value[a]
		No.	%	No.	%	
Mastication	Chew tough food	120	82.2	85	75.9	0.215
	Chew hard bread	97	66.4	63	56.3	0.095
	Chew chicken	101	69.2	72	64.3	0.407
	Chew crackers	62	42.5	46	41.1	0.822
	Chew soft food	35	24.0	27	24.1	0.980
	Eat soft food requiring no chewing	17	11.6	15	13.4	0.673
	Number of limitation items (maximum = 6)[b]	3.0 ± 1.9		2.8 ± 2.1		0.400
	Mean score of each item (SE)[b]	2.55 (0.17)		2.26 (0.19)		0.264
Mandibular mobility	Open wide enough to bite from a whole apple	26	17.8	18	16.1	0.713
	Open wide enough to bite into a sandwich	34	23.3	26	23.2	0.989
	Open wide enough to talk	27	18.5	21	18.8	0.958
	Open wide enough to drink from a cup	26	17.8	19	17.0	0.859
	Number of limitation items (maximum = 4)[b]	0.8 ± 1.5		0.8 ± 1.4		0.896
	Mean score of each item (SE)[b]	0.49 (0.09)		0.43 (0.08)		0.659
Verbal and emotional expression	Talk	11	7.5	11	9.8	0.514
	Sing	25	17.1	19	17.0	0.973
	Putting on a happy face	12	8.2	11	9.8	0.654
	Putting on an angry face	12	8.2	12	10.7	0.494
	Frown	15	10.3	13	11.6	0.733
	Kiss	14	9.6	10	8.9	0.856
	Smile	23	15.8	17	15.2	0.899
	Laugh	15	10.3	14	12.5	0.575
	Number of limitation items (maximum = 8)[b]	± 2.1		1.0 ± 2.2		0.752
	Mean number of each item (SE)[b]	0.23 (0.05)		0.21 (0.05)		0.774
	Swallow	19	13.0	14	12.5	0.903
	Yawn	22	15.1	17	15.2	0.980
	Number of limitation items in JFLS-20[b]	4.9 ± 4.9		4.7 ± 5.4		0.815
	Total score of JFLS-20 ± SD[b]	19.8 ± 18.6		17.6 ± 17.6		0.348

[a] Chi-square test, [b] Student's t-test. TMD: Temporomandibular disorders, SE: standard error, JFLS-20: 20-item Jaw Functional Limitation Scale.

of the masticatory items was 2.55 (0.17) for the TMD group, compared to 2.26 (0.19) for the non-TMD group (p = 0.260). The prevalence of limitations of mandibular mobility ranged from 17.8% to 23.3% in the TMD group, which were similar with the variation of 16.1% to 23.2% in the non-TMD group (p > 0.05). There were no significant differences between the two groups regarding limitations of verbal and emotional expression. The total score of JFLS-20 was 19.8 ± 18.6 in the TMD group and 17.6 ± 17.6 in the non-TMD group (p = 0.348, Table 3).

There were significant differences in the prevalence of parafunctional activities between the TMD and non-TMD groups in terms of "Hold, tighten, or tense

muscles without clenching" (7.5% and 1.8%, p = 0.036) and "Eating between meals that food requires chewing" (43.2% and 57.1%, p = 0.026). The TMD group also tended to have more prevalent parafunctions of "Press tongue forcibly against teeth" and "Place tongue between teeth" (p = 0.067 and p = 0.079, respectively) compared to the non-TMD group. No significant differences were found in the mean number of parafunctional items between the two groups (p = 0.928, Table 4).

4. Discussion

The current study highlighted a different dental status between the TMD elderly and non-TMD elderly groups. Our TMD elderly group lost an average of 9.6 ± 8.6 teeth and were higher than the non-TMD group; in other words, our study was in accordance with previous findings indicating that there was association of TMD with missing teeth [16–18]. When individuals lose many teeth, their chewing pattern can be changed and have impact on masticatory performance. Numerous studies indicated that chronic unilateral chewing increases the risk of TMD [18,19]. In addition, tooth loss causes social limitations, psychological disorders, and reduces the quality of life, all of which have been regarded as factors contributing to TMD.

The main finding of our study was that periodontal diseases have influence on TMD. PPD ≥ 4 mm indicates periodontal tissue destruction due to inflammation, while the CAL measurement estimates lifetime accumulated destruction of the periodontal attachment. These measures permit comparisons the severity of periodontal diseases between population groups. Our finding indicated that PPD and CAL were worse in the TMD group than in the non-TMD group. More than half of the TMD group had PPD ≥ 6 mm and over 70% of those had the CAL ≥ 6 mm and excluded sextants. All these numbers were comparatively high compared to 42% and 51.8%, respectively, in the non-TMD group. In the elderly population, periodontal diseases are the most frequent cause of tooth loss; therefore, TMD was significantly associated with both periodontal diseases and tooth loss in the current study.

Gingival bleeding does not affect single tooth but can affect many remaining teeth in the mouth, but the TMD group had more missing teeth than the non-TMD. Therefore, the number of teeth with gingival bleeding was observed less in the TMD group in our study. Periodontal inflammation has been considered a potential risk factor for other diseases. Proinflammatory cytokines enhance the pathogenesis of periodontal diseases. Interleukin (IL-1) and tumour necrosis factor alpha (TNF-α) represent proinflammatory cytokines that stimulate a number of events which occur during infection with periodontal pathogens. Graves et al. found a widespread presence of IL-1 and TNF in the connective tissue and loss of alveolar bone along with periodontal inflammation [20]. High levels of IL-1 and TNF-α are a response to the inflammatory process and they might penetrate into the TMJ synovial fluid and cause bone tissue resorption; therefore, the degree of endogenous cytokine control is important for bone tissue destruction in the TMJ structure [21].

Table 4. Comparisons of parafunctional behaviours between the TMD and non-TMD elderly.

Parafunctional habit	TMD (n = 146)		Non-TMD (n = 112)		p-value[a]
	n	%	n	%	
Sleep activities					
Clench or grind teeth when asleep	16	11.0	9	8.0	0.431
Sleep in a position that puts pressure on the jaw	57	39.0	44	39.3	0.968
Waking activities					
Grind teeth together during waking hours	9	6.2	7	6.3	0.977
Clench teeth together during waking hours	12	8.2	10	8.9	0.840
Press, touch, or hold teeth together other than while eating	28	19.2	24	21.4	0.655
Hold, tighten, or tense muscles without clenching	11	7.5	2	1.8	**0.036***
Hold or put jaw forward or to the side	17	11.6	11	9.8	0.641
Press tongue forcibly against teeth	31	21.2	14	12.5	0.067
Place tongue between teeth	32	21.9	15	13.4	0.079
Bite, chew, or play with your tongue, cheeks or lips	27	18.5	19	17.0	0.750
Hold jaw in rigid or tense position	17	11.6	10	8.9	0.480
Hold between the teeth or bite objects	8	5.5	8	7.1	0.583
Use chewing gum	20	13.7	19	17.0	0.468
Play musical instrument that involves use of mouth or jaw	4	2.7	1	0.9	0.392
Lean with your hand on the jaw	50	34.2	36	32.1	0.722
Chew food on one side only	82	56.2	63	56.3	0.989
Eating between meals that food requires chewing	63	43.2	64	57.1	**0.026***
Sustained talking	67	45.9	49	43.8	0.732
Singing	33	22.6	34	30.4	0.159
Yawning	48	32.9	43	38.4	0.353
Hold telephone between your head and shoulders	10	6.8	6	5.4	0.622
Number of parafunctional habits					
0	15	10.3	12	10.7	0.921
1 – 4	72	49.3	54	48.2	
5 – 8	36	24.7	31	27.7	
≥ 9	23	15.8	15	13.4	
Mean number of parafunctional habits ± SD[b]	4.40 ± 3.71		4.36 ± 3.23		0.928

[a] Chi-square test, [b] Student's t-test, * statistically significant.
TMD: Temporomandibular disorders, SD: standard deviation.

Regarding peripheral sensitization, nociceptive afferents in the periodontal ligament could be activated when periodontal tissues under pressure become painful due to bacterial infections. Afferent nerve fibres carry the impulse to the trigeminal spinal tract nucleus and stimulate interneurons. The efferent fibres of the inhibitory interneurons synapse, which lead to the elevator muscle reaction, bring the teeth away from the noxious stimulus [22,23]. These repetitions might cause masticatory muscle dysfunction. The

findings of Jeon et al. [19] suggested a positive correlation between chronic periodontitis and TMD-related muscle pain, while Fabri et al. [24] found that there were clinical comorbidities between periodontal disease and craniofacial pains. All these studies support our findings indicating that periodontitis accumulated over time might be a risk factor for TMD.

TMD are a group of disorders that disrupt function or cause parafunction of the masticatory system. Surprisingly, the number of oral parafunctional activities was equal across two groups; participants in both groups had a range of 4–5 parafunctional behaviours. Our study is in accordance with Leketas et al.'s study [25] indicating that the behaviours of "Lean with your hand on the jaw", "Chew food on one side only", and "Sleep in a position that puts pressure on the jaw" were the most common in the TMD group. Meulen et al. [26] showed that these parafunctional behaviours often had higher scores than other parafunctional items when evaluating the validity items of OBC-21 in the Dutch population. This could suggest that the frequency of parafunctional behaviours affected TMD.

The current study found that 2 out of 21 items of OBC were significantly associated with TMD among the elderly. The TMD group had higher frequency of "Hold, tighten, or tense muscles without clenching", but a lower frequency of "Eating between meals (i.e., food that requires chewing)" than the non-TMD group. These findings could be explained by muscular activity. The increase in the frequency of tensing muscles heightened the risk of TMD between 2.9 – 10.8 times [25]. Based on an electromyography study, Ohrbach et al. found [27] a high score of masseter muscular activity in subjects with tense muscles. A high activity of masseter muscle in combination with the neuromuscular change in older age would cause muscular disorders, a subgroup of TMD. This also explained why the TMD elderly group had a lower frequency of eating between meals in our study because of muscular impairment.

The current study reported difficulty chewing tough and hard food in most participants, but none indicating that TMD was related to functional limitations of mastication; such findings contrast with findings of Brandini et al. [28]. In older adults, the rate of loss was often higher in the posterior than the anterior teeth; therefore, the impaired masticatory performance was prevalent in both groups in our study. There were no differences between the two groups concerning other functional limitations related to mandibular mobility and verbal/emotional expression. However, limited mouth opening could occur with increasing age. Ikebe et al. found that 7.9% of elderly Japanese exhibited this limitation [29]. Similarly, our study demonstrated that approximately 23% of examinees self-reported a reduced mouth opening capacity to perform daily activities. The age-related degeneration of the temporomandibular joints and muscle weakness could contribute to such limitation in older people.

Although the prevalence of functional limitations was high in the TMD group, there were no correlations between the functional limitations of masticatory system and TMD when compared to the non-TMD group. This suggests that multiple factors could affect the function of the masticatory system in the elderly, including chronic orofacial pain, psychological disorders, and age-related reduction of the motor function of masticatory muscles [29–31]. The important finding of the current study was that determining the JFLS-20 score of older adults might enable us to predict TMD, as the prevalence of TMD is correlated with an increasing JFLS-20 score in the general population [13]. The limitation of the study was that we only studied the oral function and parafunctional behaviours based on self-rated questionnaires. There is a need for more clinical research on this aspect.

5. Conclusion

Temporomandibular disorders were associated with missing teeth and periodontal diseases. There was no association between TMD and mandibular functional limitations among the elderly. The elderly suffering from TMD tended to have increased frequency of holding, tightening, or tensing muscles.

Conflicts of interest

The authors declare that they have no conflict of interest.

Author contributions

MSN searched literature, performed clinical studies, data acquisition and statistical analysis, and wrote draft of manuscript. ÜVO, TJ, and MS designed protocol, interpreted data, and edited the manuscript. All authors read and approved the final manuscript.

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Minh Son NGUYEN

DDS, PhD
Department of Prosthodontics, Faculty of Stomatology
Danang University of Medical Technology and Pharmacy
99 Hung Vuong, Danang, Vietnam

CV

Dr. Minh Son Nguyen completed dental curriculum at the Hue University of Medicine and Pharmacy, Vietnam (2001–2007). He has been the lecturer of the Danang University of Medical Technology and Pharmacy Vietnam since 2008 and appointed as the Head of the Department of Prosthodontics in 2014. More than ten articles were published in international peer-reviewed journals, four manuscripts have been submitted for publication, and fourteen abstracts were presented at international conferences, all of which are his scientific achievements during the period of the Doctoral curriculum at the University of Tartu, Estonia (2014–2018). His research interest is related to prosthodontics, community dental health, geriatric dentistry, occlusion, orofacial pain, and temporomandibular disorders.

Questions

1. What is true for temporomandibular disorders (TMD)?

❑a. TMD mainly cause parafunctional behaviors;
❑b. The most prevalent orofacial pain is from TMD;
❑c. It only affects temporomandibular joint;
❑d. TMD signs tend to increase with aging.

2. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) axis II is used to evaluate:

❑a. Clinical signs of temporomandibular disorders;
❑b. Quality of life related to temporomandibular disorders;
❑c. Psychological domains and oral function;
❑d. The balance of occlusion.

3. Which is not considered as oral parafunction:

❑a. Limited mouth opening;
❑b. Bruxism;
❑c. Clenching;
❑d. Unilateral chewing habit.

4. Prevalence of edentulousness among TMD population is:

❑a. 0–5%;
❑b. 11–35%;
❑c. 51–70%;
❑d. Over 80%.