Knowledge and beliefs regarding temporomandibular disorders among orthodontists

Felipe Porto,[a,b] Ricky Harrell,[a] Roland Fulcher,[a] and Theresa Gonzales[c]
Charleston, SC and San Antonio, TX

Introduction: This project was undertaken to accomplish 2 objectives: (1) to identify whether there is a discrepancy between orthodontists and experts in temporomandibular disorders (TMD) related to diagnosis and treatment of TMD patients, and (2) to influence the manner in which TMD curricula are taught in orthodontic residency programs, better preparing future orthodontic specialists to diagnose and treat (and refer) patients with TMD. **Methods:** A survey invitation was e-mailed to 8870 members of the American Association of Orthodontists. Items were answered on a 6-point scale (0 = I don't know; 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree). A group consensus was attributed when more than 50% of the orthodontists supported a response. Previously published responses of TMD experts were used as a reference to evaluate the orthodontists' responses. Comparisons between the responses from the 2 groups were assessed using a z-test. **Results:** Among the participants who responded to the questionnaire, 148 were residents, 1132 were private practitioners, and 61 were full-time faculty. Sixty-two percent of the participants did not think they received enough training in TMD during their orthodontic residency. Although 62% of participants indicated that they feel comfortable diagnosing TMD patients, 50.2% do not feel comfortable treating TMD patients. There was no significant difference between the 2 groups' responses under one-third of the questions. **Conclusions:** It is clear that orthodontic residencies in the U.S. need to improve methods of teaching TMD concepts. Although most orthodontists feel comfortable diagnosing TMD patients, less than half feel comfortable treating those patients, and the difference in responses with the TMD expert group was significant in 71% of the questions. (Am J Orthod Dentofacial Orthop 2019;156:475-84)

The American Academy of Orofacial Pain has defined temporomandibular disorders (TMDs) as a "collective term that embraces a number of clinical problems that involve the masticatory muscles, the TMJ [temporomandibular joint], and the associated structures."[1] As the definition states, the term TMDs does not involve a single clinical problem, but many. The etiology of these disorders has been vociferously debated since publications concerning these problems first appeared in the early 20th century.[2-8] Due to the variety of factors involved in TMD, it is not surprising to see a wide range of treatment modalities being suggested for TMD patients.[9-15] However, one determinant of treatment for TMD that is often overlooked is the practitioner's background knowledge and beliefs about these complex disorders.[16-18]

One possible reason for the large significant variation in knowledge and beliefs about TMD is that orofacial pain is often not considered a dental specialty, and therefore many dental schools in the U.S. do not have a specific orofacial pain (or TMD) discipline. Instead, any teaching about orofacial pain is usually divided up piecemeal among several disciplines such as oral surgery, prosthodontics, and orthodontics.

Furthermore, patients experiencing TMD often seek care with their general dentists, but these patients are also frequently referred to orthodontists. Even though TMDs and occlusion are taught in virtually all postgraduate orthodontic training programs in the U.S. and Canada, these residency programs might not be teaching the

[a]Department of Orthodontics, Medical University of South Carolina College of Dental Medicine, Charleston, SC.
[b]Private practice, San Antonio, TX.
[c]Department of Stomatology, Medical University of South Carolina College of Dental Medicine, Charleston, SC.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Address correspondence to: Felipe Porto, 16789 San Pedro Ave, San Antonio, TX 78232; e-mail, felipeporto77@gmail.com.
Submitted, April 2018; revised and accepted, October 2018.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2018.10.022

most current concepts in the diagnosis and management of these disorders.[19,20] Therefore, in order to improve the management of patients with TMD who often seek care among orthodontists, it is important first to understand orthodontists' knowledge and beliefs regarding TMD. Then, it is important to see how those beliefs compare to the current opinions of the TMD expert community.

Regarding the diagnosis and treatment of patients with TMD, at least 2 major time points catalyzed interest from dental professionals. First, in 1918, Prentiss[8] suggested that TMJ problems were a consequence of extractions of teeth since it would lead to the upward movement of the condyle because of the musculature, causing compression of the meniscus, which would finally result in atrophy. Second, in 1934, Costen[4] stated that TMJ problems were due to nerve impingement from overclosure of bites, lack of posterior teeth, and malocclusion. Costen further opined that dentists should routinely manage those patients.

It was not until the late 1980s that the orthodontic community paid more considerable attention to the TMD field, following a lawsuit that considered orthodontic treatment as being the proximate cause of a patient's pain.[21] Following that event, multiple research agendas were undertaken to better understand the relationship between orthodontics and TMD.[22-25] The discussion involving orthodontics and TMD usually focuses on the occlusion.[26] Among several publications that investigated the relationship between occlusion and TMD, it is possible to find extensive literature to support both options. Some studies support a direct relationship between occlusion and TMD[27-30]; whereas, many other studies defend the opposite point of view.[31-36] However, by analyzing the literature, it is defendable to state that until the end of the 20th century there were studies that supported the occlusion/TMD relationship, but in the 21st century, it has become clear that occlusion is a minor contributing factor in the etiologic complex.

Furthermore, occlusion is not the only possible etiologic factor associated with TMD. Okeson[37] identifies at least 4 other factors that can be involved in TMD, including trauma, deep pain input, parafunctional activity, and emotional stress. It is fundamental to appreciate that these factors are not the sole determinants of whether or not someone will develop TMD. Research has already identified other aspects involved in the process, such as an individual's biology, previous experiences, genetics, somatoform comorbid disorders, and psychological conditions.

According to Rieder et al,[38] the prevalence of patients with at least a sign or symptom of TMD range from 33% to 50%. However, the number of patients with TMD who need professional treatment hovers consistently around 10%.[39] Therefore, it is essential that dentists become familiar with proper diagnosis and management of TMD patients, which admittedly has been debated.

Due to the multifactorial etiology of TMD and the controversial studies in this field, researchers and clinicians often do not agree about TMD etiology or diagnosis and treatment.[40] Despite recent advances in science related to the etiology, diagnosis, and treatment of TMD, clinicians often rely on their own beliefs when diagnosing and treating TMD patients. Typically, these beliefs are based on outdated knowledge that has not been subjected to rigorous review and does not meet evidence-based practice standards.

The first step to better educate those who diagnose and treat (or refer) TMD patients is to learn about their knowledge and beliefs in this field. Numerous studies have investigated the knowledge and beliefs regarding TMD among dentists,[16-18,41,42] and many studies have investigated the effect of orthodontic treatment on TMD.[23,24,26,43-45] Among those papers that investigated the perception of orthodontists regarding the influence of orthodontic therapy in TMD, none investigated the foundational knowledge and beliefs of orthodontists regarding the pathophysiology, chronic pain, psychophysiology, and psychiatric domains related to TMD. Therefore, this study aimed to evaluate knowledge and beliefs among orthodontists in comparison with responses from experts in TMD using the following objectives: (1) to determine possible discrepancies related to knowledge and beliefs regarding TMD between these 2 groups of specialists as pertaining to diagnosis and treatment of patients; (2) to identify which specific domain (ie, pathophysiologic, chronic pain, psychophysiological, psychiatric disorders) potentially yields the most considerable knowledge gap among the specialty cohorts evaluated; (3) to ascertain the comfort level of practicing orthodontic providers in treating TMD patients; and (4) to identify the manner in which individual orthodontists acquired their foundational and treatment knowledge of TMD.

MATERIAL AND METHODS

The University's Institutional Review Board approved this study.

The temporomandibular survey consisted of 2 sections: (1) general information, and (2) knowledge and beliefs regarding TMD. The first section contained 10 general information questions about the participants, such as where they acquired most of their TMD training and whether or not they feel comfortable diagnosing and treating TMD patients.

Knowledge and beliefs were assessed using a 38-item questionnaire used by Porto et al,[41] which was adapted from a survey used by LeResche et al.[17] The questionnaire consists of statements surveying 4 domains: pathophysiology (15 items), chronic pain (10 items), psychophysiology (9 items), and psychiatric disorders (4 items). Each item consists of a statement that prompts participants to indicate their agreement on a 6-point scale (0 = I don't know; 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree).

The survey was administered to a random sample of orthodontists in the U.S. who were members of the American Association of Orthodontists (AAO) at the time of the study. The orthodontists participated voluntarily and received no financial compensation.

A total of 8870 random orthodontists who were current members of the AAO and registered in one of the U.S. states or the District of Columbia were solicited via e-mail and requested to complete the survey online through a secure link to an online survey program (REDCap, Nashville, Tenn). The survey was sent to AAO members of all U.S. states and District of Columbia. Randomization was performed as follows: lists with all members divided per state were printed, then 1 or more pages were removed from each state's list that had more than 100 members. The members listed on the removed pages were not invited to complete the survey.

The invitation explained that the purpose of the study was to evaluate current knowledge and beliefs about the diagnosis and treatment of TMD. The invitation stressed that the completion of the survey was entirely voluntary and that responses would not be identifiable. No personal identification was requested. One reminder e-mail was sent a week after the initial solicitation to the same group of orthodontists initially included. Another reminder e-mail was sent a month after the initial solicitation if <100% participation was observed. The estimated time for the orthodontists to complete the survey was 9 minutes.

Participants who were not orthodontists or residents in orthodontics were excluded from the analysis of the second section of the survey, as well as the participants who indicated that they are AAO members outside the U.S.

The section about knowledge and beliefs regarding TMD consisted of 38 questions answered on a 6-point scale. A group consensus was attributed when more than 50% of the orthodontists supported a response. Respondent's score for each item was combined to either the "agree" (for "strongly agree" or "agree") or the "disagree" (for "strongly disagree" and "disagree") response. The TMD expert group comprised academicians who teach orofacial pain and TMD and are board certified in orofacial pain. The TMD experts' responses published in Porto et al[41] were used as a reference to evaluate the orthodontists' responses.

Table I. Demographic data indicating distribution among the orthodontists' group

Characteristic	*Numbers of participants*
First-year Ortho resident	61
Second-year Ortho resident	60
Third-year Ortho resident	27
A private practitioner in Orthodontics	1132
Full-time faculty in Orthodontics	61
Retired orthodontist	154
Resident/private practitioner/faculty outside U.S.	11
Other	33

Statistical analysis

The data obtained from the survey software (REDCap) was exported to an Excel file and then analyzed using a z-test. In order to draw comparisons with responses from the TMD experts, the percentage of agreement for each statement among the TMD expert group was compared with the percentage of agreement for each statement among the orthodontist group using a 2-proportion z-test for each statement. Even though the groups may have selected the same option as their response, if the comparison presented $P < 0.05$, the difference was considered statistically significant. Participants who were neither orthodontists nor residents in orthodontics, as well as the participants who indicated that they are members outside the U.S., were excluded from the analysis of the second section of the questionnaire (knowledge and beliefs regarding TMD).

No identifiers were requested from the participants. No internet protocol address was recorded. The answers were hosted on a secure database at the Medical University of South Carolina.

RESULTS

Of the 8870 e-mails sent, 727 e-mails were returned as an undeliverable address. Forty-six orthodontists, who responded to the solicitation e-mail, explained that they are retired and did not feel comfortable participating. A total of 1545 (19%) participants answered the questionnaire.

Table I shows the demographic distribution of the 1545 participants included in the analysis. Six participants did not fill out this question, 5 participants were neither orthodontists nor residents in orthodontics,

Table II. Preferred treatment modality to treat the most common TMD problems

Treatment modality	*Percentage of participants*
Splint therapy	51.3
Do not treat TMD	28.6
Ortho-occlusal treatment	12.9
Pharmacological	1.2
Biofeedback	0.9
None of the options	5.2

and 11 were AAO members outside the U.S. Among the participants who answered this question, 9.7% were residents in an orthodontic program. The majority of the participants were private practitioners.

Among those who answered "other," 1 participant did not indicate status, 2 indicated they were staff members, 2 indicated they were fellows, and the remaining participants were either part-time faculty members or orthodontists in the military service.

Fifteen percent of the participants graduated from an orthodontic program <5 years ago, 9.2% between 5 to 10 years ago, 17.6% between 10 to 20 years ago, and 48.3% over 20 years ago.

Among the participants, almost 35% indicated that they acquired most of their knowledge in TMD from an orthodontic residency. Continuing education course was the most selected option (37%). Dental school was selected by 20% of the participants, and <10% selected either orofacial pain residency, another residency, or not applicable.

When the participants were asked what was the preferred treatment modality to treat the most common TMD problems, 64.2% selected modalities related to occlusion (Table II).

The majority of the participants reported that they do not think they received enough training in TMD during their orthodontic residency. Even though almost 62% of the participants feel comfortable diagnosing TMD patients, more than half do not feel comfortable treating TMD patients, and only 4.7% feel comfortable performing diagnostic injections to confirm their working diagnosis (Table III).

In the second section of the survey, the participants' knowledge and beliefs regarding TMD were evaluated based on 4 different domains: pathophysiology (Table IV), chronic pain (Table V), psychophysiology (Table VI), and psychiatric disorders (Table VII). Among the 38 statements in this section of the survey, 19 statements received >15% "neutral" responses, and 14 statements received >15% "I don't know" responses. The pathophysiology domain had the highest number of statements (86.7%) with >15% "neutral" or "I don't know" responses. The pathophysiology domain also had the highest percentage of statements without consensus (40%). The domain with the lowest incidence of "neutral" or "I don't know" responses that were >15% was the psychophysiology domain (22.2%). The statement with the highest agreement among the orthodontists was "all individuals with clicking TMJs require treatment," which was suggested to be incorrect by 96% of the orthodontists.

Table III. Other questions presented in the general information section of the survey

Question	*Yes*	*No*	*N/A*
Do you think you received enough training in TMD during the orthodontic residency?	35.7	61.6	2.7
Do you feel comfortable diagnosing TMD patients?	61.9	36.6	1.5
Do you feel comfortable performing diagnostic injections to confirm your working diagnosis?	4.7	90.5	4.7
Do you record pain levels using ordinal pain scales (1-10) for your TMD patients?	37.3	57.9	4.8
Do you feel comfortable treating patients with TMD?	46.6	50.2	3.2

Note. Values are %.

Of the total statements in the second section, 10 statements did not reach a consensus level among the orthodontist group. Comparison between the 2 groups (orthodontist group and TMD expert group) indicated only 10 statements in which the difference between the 2 groups' responses was not statistically significant.

DISCUSSION

The purpose of this study was to identify whether or not there was a discrepancy between orthodontists and experts in TMD related to diagnosis and treatment of TMD patients. In the long term, the authors expect to influence the way TMD is taught in orthodontic residency programs in order to better prepare future orthodontic specialists to diagnose and treat (or refer) patients with TMD who often seek care among orthodontists.

A secondary aim of this study was to evaluate knowledge and beliefs regarding TMD among orthodontists in comparison with responses from experts in TMD. More specifically, the objectives were as follows: (1) to determine possible discrepancies related to knowledge and beliefs regarding TMD between these 2 groups of specialists as pertaining to diagnosis and treatment of TMD patients; (2) to identify which specific domain (ie, pathophysiologic, chronic pain, psychophysiological, psychiatric disorders) potentially yields the most considerable knowledge gap among the specialty cohorts evaluated; (3) to

Table IV. Pathophysiology domain

Item	Orthodontists				TMD experts	Comparison between groups	
	Agree and strongly agree	Disagree and strongly disagree	I don't know	Neutral		z-value	P value
Occlusal equilibration is a useful early treatment for TMD.	22.8	50.4	6.32	20.5	90.9*	−4.47	<0.001
Orthodontic treatment can prevent the onset of TMD.	16.6	59.8	2.89	20.7	93.9*	−3.85	0.0001
Arthroscopic surgery is almost completely effective in repositioning the disk in patients with internal derangements.	5.2	58.1	22.8	13.9	93.9*	−4.00	<0.001
Orthodontic therapy is the best treatment to resolve TMD in a patient with a skeletal malocclusion.	9.8	67.5	4.9	17.7	90.9*	−2.76	0.0058
TMD caused by trauma is much more difficult to treat and has a far worse prognosis than other types of TMD. (NC among orthodontists)	33.1	31.5	20.6	14.8	75.7*	–	–
Panoramic film is a reasonable method to evaluate the bony structures of the TMJ	16.1	66.7	1	16.2	NC	–	–
When bony changes are seen on a panoramic film, a tomogram is mandatory in order to define the treatment plan. (NC among orthodontists)	45.7	26.1	9.8	18.4	79.7*	–	–
The presence of arthritic changes on tomograms, along with crepitus in the joint indicates the need for treatment. (NC among orthodontists)	19.6	48.5	12.2	19.7	81.8*	–	–
The position of the condyle in the fossa as seen on tomogram is a very accurate indicator of internal derangement	11.3	53.8	18.7	16.1	84.8*	−3.43	0.0006
Mandibular repositioning splints are more effective than maxillary repositioning splints. (NC among orthodontists)	10.1	47.5	23.6	18.8	87.8*	–	–
Splint therapy is only effective when the splint is used more than 16 h/d. (NC among orthodontists)	27.3	40.8	17.3	14.5	90.9*	–	–
Nocturnal bruxism is caused by occlusal interference	8.3	71.2	3.9	16.6	87.8*	−2.02	0.0434
Ice packs and/or heat packs and passive muscle stretching are good early treatments for TMD	74.7	5.6	5.7	13.9	78.7†	−0.5	0.6171
All individuals with clicking TMJs require treatment	1.8	96.2	0.5	1.5	90.9*	1.52	0.1285
Balancing interference are commonly related to TMD. (NC among orthodontists)	34.5	31.1	11.7	22.7	81.8*	–	–

Note. Values are %. If consensus not achieved, z and *P* values were not calculated.
NC, no consensus.
*Disagree; †Agree.

ascertain the comfort level of practicing orthodontic providers in treating TMD patients; and (4) to identify the manner in which individual orthodontists acquired their foundational and treatment knowledge of TMD.

Since the survey indicated that the comparison would be drawn between orthodontists and TMD experts, one may argue that residents should be excluded from the analysis. However, the statements without consensus were the same when excluding residents from the analysis. Removing the residents' responses also did not change the statements with statistically significant differences between the 2 groups.

Table V. Chronic pain domain

Item	Orthodontists				TMD experts	Comparison between groups	
	Agree and strongly agree	Disagree and strongly disagree	I don't know	Neutral		z-value	P value
PRN narcotics ("as needed" for pain) are a treatment of choice when TMD pain is severe.	17	55.3	10.9	16.7	90.3*	−4.09	<0.001
Antidepressants are never indicated in the management of TMD.	6.4	60.1	18.2	15.2	93.5*	−3.77	0.0002
An extensive history of previous treatment failures in a TMD patient is usually an indication for surgery.	13.9	55.7	12.3	18.1	96.7*	−4.55	<0.001
Chronic pain is a behavioral, as well as a physical problem.	63.4	9.2	10.6	16.7	93.5†	−3.46	0.0005
Although some TMD patients have psychological problems, these problems are usually unrelated to their pain.	4.9	70.8	10.1	14.3	83.8*	−1.58	0.1141
Poor quality of sleep is a major factor in the development of TMD. (NC among orthodontists)	32.1	18.3	21.4	28.1	NC	–	–
Difficulty with sleep is a common finding in chronic pain.	72.2	2.4	13.7	11.7	96.7†	−3.03	0.0024
Some patients use pain as an excuse to avoid unpleasant chores. (NC among orthodontists)	41	9.7	21.4	27.9	83.8†	–	–
Behavior modification treatments are appropriate for patients with chronic TMD pain.	69.4	2.6	11.5	16.4	87.1*	−2.11	0.0349
Chronic TMD patients should be advised to rest and limit their work and social activities when they are experiencing pain. (NC among orthodontists)	24.4	34.1	15.2	26.2	51.6*	–	–

Note. Values are %. If consensus not achieved, z and *P* values were not calculated.
NC, no consensus.
*Disagree; †Agree.

On 27 out of the 38 statements in the second section, the majority of both groups selected the same options as their responses. However, the difference between the numbers of participants selecting the same response was not statistically significant in 10 questions.

In the second section of the survey, the consensus among the orthodontists was not reached on 10 of the 38 statements. Interestingly, the specified domain with the highest lack of consensus among the orthodontists was the pathophysiology domain. This domain covered diagnosis and some of the most common treatment modalities for TMD. The first statement that did not reach consensus was "TMD caused by trauma is much more difficult to treat and has a far worse prognosis than other types of TMD." Approximately 33.1% agreed with that statement, 31.5% disagreed, 20.6% did not know, and 14.8% were neutral. The literature, however, does not fully support that statement. Although trauma is one of the factors that can lead to TMD,[37] there is not enough scientific evidence to support the assertion that patients with trauma are more challenging to treat.

The second statement without consensus was "when bony changes are seen on a panoramic film, a tomogram is mandatory in order to define the treatment plan." Most of the orthodontists (45.7%) agreed. However, a tomogram is not always necessary when evaluating patients with TMJ bony changes observed on a panoramic film. Even though a tomogram reveals more detail of the hard tissue than the panoramic image, there was no statistically significant difference between panoramic imaging and tomograms in diagnosing flattening of the condyle.[46] When bony changes are observed on a panoramic image, before the clinician requests a more detailed image, they should consider whether or not a new image would likely change the diagnosis or treatment plan. Stockstill et al[19] also mentioned that the use of cone beam computed tomography was being advocated in orthodontic residencies when patients presented with asymptomatic TMJ sounds. It seems, therefore, that the use of cone beam computed tomography is a common practice among orthodontists even when the clinical situation does not warrant this investigation.

The third statement that did not reach a consensus among the orthodontists was "the presence of arthritic changes on tomograms, along with crepitus in the joint, indicates the need for treatment." Even though a

Table VI. Psychophysiology domain

Item	Orthodontists				TMD experts	Comparison between groups	
	Agree and strongly agree	Disagree and strongly disagree	I don't know	Neutral		z-value	P value
The mechanisms of acute and chronic pain are the same.	2.5	82.6	10.2	4.7	96.7*	−2.07	0.0385
Biofeedback can be useful for treating TMD.	64.9	1.2	21.1	12.8	87.0†	−2.56	0.0105
Oral parafunction habits are often significant in the development of TMD.	71	7.5	7.2	14.3	74.2†	−0.39	0.6965
Patients with TMD who clench/brux do so either during the day or at night, but not both.	2.8	78.6	12.2	6.4	90.3*	−1.58	0.1141
Stress management is indicated for many TMD patients.	89.8	1.3	2.1	6.8	90.3†	−0.08	0.9362
Stress is a major factor in the development of TMD.	78.3	4.2	3.9	13.6	74.1†	0.56	0.5755
Tension and stress increase jaw muscle EMG levels in susceptible patients.	79.6	0.5	14.3	5.6	61.2†	2.49	0.0128
Progressive muscle relaxation is not an effective treatment for TMD.	4.2	61	20.3	14.5	80.6*	−2.22	0.0264
Information on the daily pattern of the TMD symptoms can be helpful for identifying contributing factors.	91.7	0.9	3.7	3.7	90.3†	0.28	0.7795

Note. Values are %.
EMG, electromyography.
*Disagree; †Agree.

Table VII. Psychiatric disorders domain

Item	Orthodontists				TMD experts	Comparison between groups	
	Agree and strongly agree	Disagree and strongly disagree	I don't know	Neutral		z-value	P value
Clinical depression is rare in chronic TMD patients.	2.1	65.2	22.7	10	80.6*	-1.78	0.0751
Depressed mood is fairly common in chronic TMD patients.	70.1	2.3	15.8	11.8	93.5†	−2.82	0.0047
Anxiety disorders are more common in TMD patients than in the population at large. (NC among orthodontists)	49.7	4.1	30.1	16	74.2†	–	–
Depression can be an important etiologic factor in chronic pain.	73.5	2.4	14.4	9.7	74.1†	−0.08	0.9362

Note. Values are %. If consensus not achieved, z and *P* values were not calculated.
NC, no consensus.
*Disagree; †Agree.

consensus was not achieved, the majority of the respondents disagreed (48.5%), which is in line with the response from TMD expert group. A treatment directed to the TMJ structure for a patient with those characteristics would be necessary only if the patient had significantly impaired function and symptomatology.

The next 2 statements that gave the orthodontists pause were related to splint therapy. The studies about splint therapy for TMD are equivocal,[47-50] but comparisons between several types of splints showed no difference among them,[47] and there is no data to support the belief that splints must be used at least 16 hours/day to be effective.

The statement "balancing interferences are commonly related to TMD" also did not obtain a consensus among the orthodontists. As mentioned previously, the relationship between occlusion and TMD has been extensively investigated, yet the literature has not been conclusive. There are studies to support both sides of this debate,[31,51-54] and therefore not reaching a consensus in this particular question reflects the lack of agreement in the literature.

Almost 65% of the participants indicated that they would treat TMD patients focusing on the occlusion (51.3% selected splint therapy, and 12.9% selected orthodontic and occlusal therapy). Once again, this data

indicated that the relationship between occlusion and TMD is still triggering controversial opinions, even though the most current literature demonstrates a minimal relationship between the occlusion and TMD.[55] Okeson[56] summarized, "Recent data does not support that static relationship of teeth is strongly associated with TMD. Yet to believe that the occlusal condition could not influence masticatory system function and dysfunction seems rather naïve." Reid and Greene[57] also suggested that dentists should abandon older mechanistic models which may include irreversible bite-changing and jaw-repositioning interventions to treat TMD, instead of more conservative treatment modalities should be considered.

The statement, "poor quality of sleep is a major factor in the development of TMD" also obtained no consensus, not only among the orthodontists but also among the TMD experts. The relationship between pain and sleep quality in TMD patients is well-documented,[58-60] but whether TMD is a cause or a result of sleep disorders may have given some respondents pause.

Another statement that did not obtain consensus stated, "anxiety disorders are more common in TMD patients than in the population at large." The orthodontists almost reached a consensus on this question, since 49.7% agreed with the statement, but a similar number of orthodontists responded either "neutral" or "I don't know." In support of these findings, Reissmann[61] reported that the incidence of anxiety among TMD patients was higher than among the general population.

The lack of agreement on some statements may be associated with the time when the respondents obtained their knowledge of TMD since the reality of some topics in this field has changed over the years. However, this does not excuse any orthodontist from being updated on this area of dentistry.

It is important to appreciate that 61.6% of the participants feel that they did not receive enough TMD training during their orthodontic residencies. This finding is surprising, as Stockstill et al[19] reported that 87% of the 46 programs that responded to their survey have formal curriculum covering TMD and orofacial pain didactic and clinical topics. All these programs reported teaching their residents in the area of TMD and orofacial pain as an integral part of the orthodontic curriculum. Our data indicate that orthodontic residency programs must consider revisiting their curricula regarding TMD.

The Accreditation Standards for Advanced Specialty Education Programs in Orthodontics and Dentofacial Orthopedics created by the Commission on Dental Accreditation states that "a graduate of an advanced specialty education program in orthodontics must be competent to ... manage patients with functional occlusal and temporomandibular disorders." Even though both residents and faculty agree that some disciplines teach TMD and Orofacial Pain during postgraduate training, the results of those surveys indicated that there are no standard TMD and Orofacial Pain curricula on postgraduate orthodontic training.[19,62] Another paper from Greene et al[20] suggested a well-structured curriculum which would potentially improve the understanding on those topics during orthodontic training.

Coincidently, 61.9% of the participants indicated they do not feel comfortable diagnosing TMD patients, and less than half (46.6%) feel comfortable treating patients with TMD. However, this statement could be interpreted in different ways. For instance, it could be interpreted as if the statement were asking if participants would feel comfortable treating an orthodontic patient who happens to have TMD (not necessarily to treat the patient's TMD). It also could be interpreted as if it were asking if participants would feel comfortable treating the patient's TMD. Therefore, the numbers collected from this question should be interpreted with some necessary caution.

Although more than half of the participants do not feel comfortable treating TMD patients, only 28.6% reported that they do not treat TMD patients. This finding can be analyzed in at least 2 different ways: (1) there are orthodontists who treat TMD patients without knowing how to diagnose them or (2) the ones who treat the TMD patients rely on another dentist to diagnose the patient, while they perform the orthodontic treatment.

Finally, despite an increase of research and publications about TMD, knowledge and beliefs regarding this topic among orthodontists is still equivocal on most of the items investigated. It would seem prudent to incorporate contemporary TMD diagnostic and evidence-based treatment algorithms into the curricular structure of the orthodontic residency programs. Even though we did not have access to the questionnaire used in previous studies,[19,62] it is possible that there are several similarities on the questions used. However, instead of interpreting this current survey as redundant, we believe the papers complement each other. Although the articles by Guess et al[62] and Stockstill et al[19] surveyed residents and orthodontic residency programs, this study investigated orthodontists in general and therefore, by interpreting the results from all these studies, it is possible to conclude that the TMD curriculum used in orthodontic residencies is minimally effective. Greene et al[20] is an excellent reference which could be used by the postgraduate orthodontic programs willing to improve their TMD and Orofacial Pain curriculum.

The return rate for this survey was 19%, which is not considered high. However, the number of respondents

(N = 1545) is high for a survey study. Some of the possible reasons that led participants to not answer to the survey include the number of questions and statements, as well as the time necessary to answer them.

This study has limitations associated with survey-based studies, which include opinions instead of evidence-based responses. However, surveys are essential to indicate the perception, beliefs, and knowledge of the participants, which may lead to significant changes around the topic being investigated.

CONCLUSIONS

Although several articles involving the diagnosis and treatment of TMD have been published, no recent study has investigated if the findings from these articles were translated into clinical practice and orthodontic training. This study intended to investigate the knowledge and beliefs of orthodontists regarding TMD by drawing a comparison to the group of TMD experts.

This study indicated that most of the orthodontists believe not enough training regarding TMD is offered during orthodontic residency programs. Furthermore, most of them do not feel comfortable in diagnosing or treating TMD patients. One-third indicated they do not treat TMD patients, which is disconcerting since this data may suggest that some patients are being treated by professionals who do not feel comfortable doing so.

When comparisons were made between the 2 groups about their responses related to knowledge and beliefs regarding TMD, the responses, though considered to be a consensus, showed a statistically significant difference on 28 of the 38 questions.

In conclusion, it is evident that orthodontic residencies need to improve the quality and impact of TMD training in their curriculum. Although most orthodontists feel comfortable diagnosing TMD patients, less than half feel comfortable treating those patients, and the difference in responses with the TMD expert group was significant in 71% of the questions.

REFERENCES

1. Leeuw RD. Orofacial pain: Guidelines for assessment, diagnosis, and management. Chicago, IL: Quintessence Publishing books; 2008. p. 316.
2. Sicher H. Some aspects of the anatomy and pathology of the temporomandibular articulation. NY State Dent J 1948;14: 451-69.
3. Sicher H. Temporomandibular articulation in mandibular overclosure. J Am Dent Assoc 1948;36:131-9.
4. Costen JB. A syndrome of ear and sinus symptoms dependent upon disturbed function of the temporomandibular joint. Ann Otol Rhinol Laryngol 1934;43:1-15.
5. Hall RE. Movements of the mandible and approximate mechanical imitation of these movements for the arrangement and grinding of artificial teeth for the efficient restoration of lost masticatory function in edentulous cases. The J Natl Dent Assoc 1920;7:677-86.
6. Wright WH. Deafness as influenced by malposition of the jaws. The J Natl Dent Assoc 1920;7:979-92.
7. Monson GS. Occlusion as applied to crown and bridge-work. The J Natl Dent Assoc 1920;7:399-413.
8. Prentiss HJ. A preliminary report upon the temporo-mandibular articulation in the human type. The Dent COSMOS 1918;60: 505-12.
9. Yatani H, Minakuchi H, Matsuka Y, Fujisawa T, Yamashita A. The long-term effect of occlusal therapy on self-administered treatment outcomes of TMD. J Orofac Pain 1998;12:75-88.
10. Polso HL, Näpänkangas R, Raustia AM. Treatment outcome in patients with TMD—A survey of 123 patients referred to specialist care. Cranio 2010;28:156-65.
11. Litt MD, Shafer DM, Kreutzer DL. Brief cognitive-behavioral treatment for TMD pain: Long-term outcomes and moderators of treatment. Pain 2010;151:110-6.
12. Littner D, Perlman-Emodi A, Vinocuor E. Efficacy of treatment with hard and soft occlusal appliance in TMD. Refuat Hapeh Vehashinayim (1993) 2004;21:52-8: 94.
13. Miller DB. Invisalign in TMD treatment. Int J Orthod Milwaukee 2009;20:15-9.
14. Tecco S, Teté S, Crincoli V, Festa MA, Festa F. Fixed orthodontic therapy in temporomandibular disorder (TMD) treatment: An alternative to intraoral splint. Cranio 2010;28:30-42.
15. Stack BC. Intraoral orthotics for treatment of TMD. Funct Orthod 2004;21:16-22.
16. Glaros AG, Glass EG, McLaughlin L. Knowledge and beliefs of dentists regarding temporomandibular disorders and chronic pain. J Orofac Pain 1994;8:216-22.
17. Le Resche L, Truelove EL, Dworkin SF. Temporomandibular disorders: A survey of dentists' knowledge and beliefs. J Am Dent Assoc 1993;124:90-4: 97-106.
18. Lee WY, Choi JW, Lee JW. A study of dentists' knowledge and beliefs regarding temporomandibular disorders in Korea. Cranio 2000;18:142-6.
19. Stockstill J, Greene CS, Kandasamy S, Campbell D, Rinchuse D. Survey of orthodontic residency programs: Teaching about occlusion, temporomandibular joints, and temporomandibular disorders in postgraduate curricula. Am J Orthod Dentofacial Orthop 2011;139:17-23.
20. Greene CS, Stockstill J, Rinchuse D, Kandasamy S. Orthodontics and temporomandibular disorders: A curriculum proposal for postgraduate programs. Am J Orthod Dentofacial Orthop 2012; 142:18-24.
21. Pollack B. Case of Note. Michigan Jury Awards $850,000 in Ortho case: A tempest in teapot. Am J Dentofacial Orthop 1998;94: 358-9.
22. McNamara JA Jr, Seligman DA, Okeson JP. Occlusion, Orthodontic treatment, and temporomandibular disorders: A review. J Orofac Pain 1995;9:73-90.
23. Fernández-González FJ, Cañigral A, López-Caballo JL, Brizuela A, Moreno-Hay I, Del Río-Highsmith J, et al. Influence of orthodontic treatment on temporomandibular disorders. A systematic review. J Clin Exp Dent 2015;7:e320-7.
24. Leite RA, Rodrigues JF, Sakima MT, Sakima T. Relationship between temporomandibular disorders and orthodontic treatment: A literature review. Dent Press J Orthod 2013;18:150-7.
25. Dibbets JM, van der Weele LT. Long-term effects of orthodontic treatment, including extraction, on signs and symptoms attributed to CMD. Eur J Orthod 1992;14:16-20.

26. Luther F, Layton S, McDonald F. Orthodontics for treating temporomandibular joint (TMJ) disorders. Cochrane Database Syst Rev 2010;CD006541.
27. Olsson M, Lindqvist B. Mandibular function before and after orthodontic treatment. Eur J Orthod 1995;17:205-14.
28. Tsolka P, Walter JD, Wilson RF, Preiskel HW. Occlusal variables, bruxism and temporomandibular disorders: A clinical and kinesiographic assessment. J Oral Rehabil 1995;22:849-56.
29. Raustia AM, Pirttiniemi PM, Pyhtinen J. Correlation of occlusal factors and condyle position asymmetry with signs and symptoms of temporomandibular disorders in young adults. Cranio 1995;13:152-6.
30. Seligman DA, Pullinger AG. Analysis of occlusal variables, dental attrition, and age for distinguishing healthy controls from female patients with intracapsular temporomandibular disorders. J Prosthet Dent 2000;83:76-82.
31. Manfredini D, Perinetti G, Guarda-Nardini L. Dental malocclusion is not related to temporomandibular joint clicking: A logistic regression analysis in a patient population. Angle Orthod 2014;84:310-5.
32. Baldini A, Nota A, Cozza P. The association between Occlusion Time and temporomandibular Disorders. J Electromyogr Kinesiol 2015;25:151-4.
33. Macfarlane TV, Gray RJM, Kincey J, Worthington HV. Factors associated with the temporomandibular disorder, pain dysfunction syndrome (PDS): Manchester case-control study. Oral Dis 2001;7:321-30.
34. Hirsch C, John MT, Drangsholt MT, Mancl LA. Relationship between overbite/overjet and clicking or crepitus of the temporomandibular joint. J Orofac Pain 2005;19:218-25.
35. de Sousa ST, de Mello VV, Magalhães BG, de Assis Morais MP, Vasconcelos MM, de França Caldas Junior A, et al. The role of occlusal factors on the occurrence of temporomandibular disorders. Cranio 2015;33:211-6.
36. Manfredini D, Lombardo L, Siciliani G. Dental Angle class asymmetry and temporomandibular disorders. J Orofac Orthop 2017;78:253-8.
37. Okeson JP. Management of temporomandibular disorders and occlusion. MO: Elsevier Mosby; 2013.
38. Rieder CE, Martinoff JT, Wilcox SA. The prevalence of mandibular dysfunction. part I: Sex and age distribution of related signs and symptoms. J Prosthet Dent 1983;50:81-8.
39. Solberg WK, Woo MW, Houston JB. Prevalence of mandibular dysfunction in young adults. J Am Dent Assoc 1979;98:25-34.
40. Okeson JP. A response to the AADR's "Managing the care of patients with temporomandibular disorders: a new guideline for care". Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:134-5.
41. Porto FB, Litt M, Jennings ME, Rifaey H, Reisine S. Knowledge and beliefs Regarding TMD: Has anything changed after 20 years? Health Scope 2016;5:e31328.
42. Just JK, Perry HT, Greene CS. Treating T M disorders: A survey on diagnosis, etiology and management. JADA 1991;122:55-60.
43. Ortega ACBA, Pozza DH, Rodrigues LLFR, Guimarães AS. Relationship Between orthodontics and temporomandibular disorders: A prospective study. J Oral Facial Pain Headache 2016;30:134-8.
44. Yang EY, Kiyak HA. Orthodontic treatment timing: A survey of orthodontists. Am J Orthod Dentofacial Orthop 1998;113:96-103.
45. Coêlho TG, Caracas HC. Perception of the relationship between TMD and orthodontic treatment among orthodontists. Dent Press J Orthod 2015;20:45-51.
46. Shetty US, Burde KN, Naikmasur VG, Sattur AP. Assessment of condylar changes in patients with temporomandibular joint pain using digital volumetric tomography. Radiol Res Pract 2014;2014:106059.
47. Macedo CR, Silva AB, Machado MA, Saconato H, Prado GF. Occlusal splints for treating sleep bruxism (tooth grinding). Cochrane Database Syst Rev 2007;CD005514.
48. Al-Ani Z, Gray RJ, Davies SJ, Sloan P, Glenny AM. Stabilization splint therapy for the treatment of temporomandibular myofascial pain: A systematic review. J Dent Educ 2005;69:1242-50.
49. Michelotti A, Iodice G, Vollaro S, Steenks MH, Farella M. Evaluation of the short-term effectiveness of education versus an occlusal splint for the treatment of myofascial pain of the jaw muscles. J Am Dent Assoc 2012;143:47-53.
50. Kuzmanovic Pficer J, Dodic S, Lazic V, Trajkovic G, Milic N, Milicic B. Occlusal stabilization splint for patients with temporomandibular disorders: Meta-analysis of short and long term effects. PLOS ONE 2017;12:e0171296.
51. Haralur SB, Addas MK, Othman HI, Shah FK, El-Malki AI, Al-Qahtani MA. Prevalence of malocclusion, its association with occlusal interferences and temporomandibular disorders among the Saudi sub-population. Oral Health Dent Manag 2014;13:164-9.
52. Manfredini D, Perinetti G, Stellini E, Di Leonardo B, Guarda-Nardini L. Prevalence of static and dynamic dental malocclusion features in subgroups of temporomandibular disorder patients: Implications for the epidemiology of the TMD-occlusion association. Quintessence Int 2015;46:341-9.
53. Landi N, Manfredini D, Tognini F, Romagnoli M, Bosco M. Quantification of the relative risk of multiple occlusal variables for muscle disorders of the stomatognathic system. J Prosthet Dent 2004;92:190-5.
54. Chiappe G, Fantoni F, Landi N, Biondi K, Bosco M. Clinical value of 12 occlusal features for the prediction of disc displacement with reduction (RDC/TMD Axis I group IIa). J Oral Rehabil 2009;36:322-9.
55. Manfredini D, Lombardo L, Siciliani G. Temporomandibular disorders and dental occlusion. A systematic review of association studies: End of an era? J Oral Rehabil 2017;44:908-23.
56. Okeson JP. Temporomandibular disorders: Etiology and classification. In: Kandasamy S, Greene CS, Rinchuse DJ, Stockstill JW, editors. TMD and orthodontics. Berlin: Springer; 2015. p. 19-36.
57. Reid KI, Greene CS. Diagnosis and treatment of temporomandibular disorders: An ethical analysis of current practices. J Oral Rehabil 2013;40:546-61.
58. Roehrs T, Hyde M, Blaisdell B, Greenwald M, Roth T. Sleep loss and REM sleep loss are hyperalgesic. Sleep 2006;29:145-51.
59. Okifuji A, Hare BD. Do sleep disorders contribute to pain sensitivity? Curr Rheumatol Rep 2011;13:528-34.
60. Lentz MJ, Landis CA, Rothermel J, Shaver JL. Effects of selective slow wave sleep disruption on musculoskeletal pain and fatigue in middle aged women. J Rheumatol 1999;26:1586-92.
61. Reissmann DR, John MT, Seedorf H, Doering S, Schierz O. Temporomandibular disorder pain is related to the general disposition to be anxious. J Oral Facial Pain Headache 2014;28:322-30.
62. Guess A, Causey M, Stockstill J, Rinchuse D, DeLeon E. TMD/Orofacial pain survey of orthodontic residents in the U.S. and Canada. Orthod Pract US 2013;4:42-5.