

Jaw Exercises in the Treatment of Temporomandibular Disorders—An International Modified Delphi Study

Erik Lindfors, DDS, PhD

Department of Stomatognathic Physiology
Public Dental Health Service, Uppsala, Sweden;
Department of Dental Medicine, Karolinska Institutet and
Scandinavian Center for Orofacial Neurosciences (SCON),
Huddinge, Sweden

Taro Arima, DDS, PhD

Section of International Affairs, Faculty and Graduate School
of Dental Medicine, Hokkaido University, Sapporo, Japan

Lene Baad-Hansen, DDS, PhD, Dr Odont

Department of Dentistry and Oral Health
Aarhus University, Aarhus, Denmark;
Scandinavian Center for Orofacial Neurosciences (SCON)

Merete Bakke, DDS, PhD, Dr Odont

Department of Odontology, Faculty of Health and Medical
Sciences, University of Copenhagen
Copenhagen, Denmark

Antoon De Laat, DDS, PhD

Department of Oral Health Sciences KU Leuven and
Department of Dentistry, University Hospitals KU Leuven
Leuven, Belgium

Nikolaos Nikitas Giannakopoulos, DDS, PhD

Department of Prosthodontics, University of Würzburg
Würzburg, Germany

Alan Giaros, PhD

School of Dentistry, University of Missouri
Kansas City, Missouri, USA

Antonio Sergio Guimarães, DDS, PhD

Faculdade São Leopoldo Mandic, São Paulo, Brazil

Anders Johansson, DDS, PhD

Prosthodontics Faculty of Medicine and Dentistry
University of Bergen and Senior Consultant
National Unit for Orofacial Pain
Haukeland University Hospital, Bergen, Norway

Yrsa Le Bell, DDS, PhD

Institute of Dentistry, University of Turku, Turku, Finland

Frank Lobbezoo, DDS, PhD

Department of Oral Health Sciences
Academic Centre for Dentistry Amsterdam (ACTA)
University of Amsterdam and Vrije Universiteit Amsterdam,
Amsterdam, The Netherlands

Ambra Michelotti, BSC, DDS, Orthod

Department of Neurosciences, Reproductive Sciences and
Oral Sciences, Division of Orthodontics, University of
Naples Federico II, Naples, Italy

Frauke Müller, Dr Med Dent Habil

University Clinics of Dental Medicine
University of Geneva, Geneva, Switzerland

Richard Ohrbach, DDS, PhD

Department of Oral Diagnostic Sciences, University at
Buffalo School of Dental Medicine, Buffalo, New York, USA

Anders Wänman, DDS, PhD

Department of Odontology/Clinical Oral Physiology
Faculty of Medicine, Umeå University, Umeå, Sweden

Tomas Magnusson, LDS, PhD

Department of Natural Science and Biomedicine
School of Health and Welfare, Jönköping University
Jönköping, Sweden

Malin Ernberg, DDS, PhD

Department of Dental Medicine, Karolinska Institutet and
Scandinavian Center for Orofacial Neurosciences (SCON),
Huddinge, Sweden

Correspondence to:

Dr Erik Lindfors, Department of Stomatognathic Physiology
Public Dental Health Service, Box 1813
SE-751 48 Uppsala, Sweden, Fax: +4618-18692947
Email: erik.lindfors@ki.se

Submitted August 24, 2018;

accepted January 6, 2019

©2019 by Quintessence Publishing Co Inc.

Aims: To investigate whether an international consensus exists among TMD experts regarding indications, performance, follow-up, and effectiveness of jaw exercises. **Methods:** A questionnaire with 31 statements regarding jaw exercises was constructed. Fourteen international experts with some geographic dispersion were asked to participate in this Delphi study, and all accepted. The experts were asked to respond to the statements according to a 5-item verbal Likert scale that ranged from “strongly agree” to “strongly disagree.” The experts could also leave free-text comments, which was encouraged. After the first round, the experts received a compilation of the other experts' earlier responses. Some statements were then rephrased and divided to clarify the essence of the statement. Subsequently, the experts were then asked to answer the questionnaire (32 statements) again for the second round. Consensus was set to 80% agreement or disagreement. **Results:** There is consensus among TMD experts that jaw exercises are effective and can be recommended to patients with myalgia in the jaw muscles, restricted mouth opening capacity due to hyperactivity in the jaw closing muscles, and disc displacement without reduction. The patients should always be instructed in an individualized jaw exercise program and also receive both verbal advice and written information about the treatment modality. **Conclusion:** This Delphi study showed that there is an international consensus among TMD experts that jaw exercises are an effective treatment and can be recommended to patients with TMD pain and disturbed jaw function. *J Oral Facial Pain Headache* 2019;33:389–398. doi: 10.11607/ofph.2359

Keywords: Delphi technique, dentistry, jaw exercises, orofacial pain, physical treatment

Temporomandibular disorders (TMD) are a group of conditions affecting the masticatory muscles and temporomandibular joints (TMJs). Pain in the masticatory system is the most common symptom of TMD. Related symptoms such as headache, restricted mouth opening capacity, and pain in connection to chewing or other jaw functions are frequently reported by TMD patients.¹ These symptoms reduce the patient's quality of life. In a longitudinal epidemiologic study over 20 years, it was shown that 13% of the participants reported one or more frequent TMD symptoms.² Several conservative treatments have been proposed for the treatment of this condition.^{3–5} Therapeutic jaw exercises are often recommended in the management of TMD, as they are simple, cheap, and give treatment responsibility to the patient.

Therapeutic jaw exercises have been proposed as a treatment for the following TMD conditions: chronic arthritis of the TMJs^{6,7}; arthrogenous TMD⁸; myofascial pain/myalgia in the masticatory muscles^{9–11}; jaw hypomobility^{12–14}; radiotherapy-induced trismus¹⁵; and disc displacement with (clicking)¹⁶ and without reduction.^{17–19} However, in a recent systematic review and meta-analysis, it was concluded that the effectiveness of exercises in the management of TMD is still uncertain.²⁰

Table 1 Geographic Distribution of TMD Experts

TMD expert	Country
Antoon De Laat	Belgium
Antonio Sergio Guimarães	Brazil
Merete Bakke	Denmark
Lene Baad-Hansen	Denmark
Yrsa Le Bell	Finland
Nikolaos Nikitas Giannakopoulos	Germany
Ambra Michelotti	Italy
Taro Arima	Japan
Frank Lobbezoo	The Netherlands
Anders Johansson	Norway
Anders Wänman	Sweden
Frauke Müller	Switzerland
Alan Glaros	USA
Richard Ohrbach	USA

In the absence of high-quality evidence, the dental health professional must rely on experience in making treatment decisions. The assembled experience and consensus of colleagues are better than the experience of one individual. The most commonly used consensus methods in health care are the nominal group technique, the conference consensus technique, and the Delphi method.²¹

The Delphi method, used in this study, was named after the famous oracle in the ancient Greek city of Delphi. The oracle was thought to deliver the god Apollo's knowledge through prophecies and advice.²² Today, the Delphi method is a technique that strives to reach consensus of opinion in a group of experts through a series of questionnaires in different "rounds." In the classical Delphi method, the initial questionnaire (first round) consists of open-ended questions and collects opinions that are then analyzed with a qualitative research method. The results from the first questionnaire are then returned to the experts in a second quantitative questionnaire (second round), on which they grade a set of statements with a Likert scale. Subsequently, the experts receive controlled feedback with the results, where they can see their own answers in relation to the other experts in the panel. This process is repeated in several rounds until consensus is achieved or a decrease in the number of returned questionnaires is seen. The Delphi method has been used in many different areas, including dentistry²³ and the field of TMD.²⁴ Although the key features of the method remain intact, there are several modified Delphi techniques that have been suggested.²⁵ One strength of the Delphi method, compared to other consensus techniques, is that the experts are anonymous to one another, which removes the possible social influence on opinions in a face-to-face setting.²⁶ Other advantages over other consensus techniques are that it is

easy to get a wide geographic dispersion of the experts and that the method is relatively cheap.

The aim of this study was to investigate whether there is an international consensus among TMD specialists regarding indications, performance, follow-ups, and effectiveness of therapeutic jaw exercises.

Materials and Methods

The three main authors (E.L., T.M., M.E.), who were not a part of the expert panel, constructed a questionnaire with 31 statements regarding indications, performance, follow-up, and effectiveness of therapeutic jaw exercises in TMD patients. The statements were based on suggestions in the literature and the authors' own experiences. The questionnaire was electronic and created in the program Webropol (Webropol Sverige AB).

Fourteen international experts with some geographic dispersion were asked to participate in this Delphi study (Table 1). An expert was defined as an established academic with at least 10 years of experience with clinical treatment of TMD patients, teaching, and research, with identifiable peer-reviewed publications. The experts received carefully written information about the study before inclusion. All invited experts agreed to take part in the study.

It was decided to continue the investigation until consensus was met or stability between the different rounds was seen. Consensus was set to 80%²⁷ (11 out of 14 experts) agreement or disagreement. A secondary threshold was created according to the following: If 9 to 10 (approximately 65% to 70%) out of 14 experts agreed or disagreed with the statement, consensus had not been reached, but it was considered that a majority of experts agreed/disagreed. The experts were totally anonymous to each other.

In round 1, the link to the questionnaire was emailed to the experts, who were asked to respond to the statements according to a 5-item verbal Likert scale that ranged from "strongly agree" to "strongly disagree." The experts could also leave free-text comments to each statement, which they were encouraged to do. Some of the statements had references to specific jaw exercise programs (Figs 1 and 2). These programs were attached to the email as a pdf. If the expert did not answer, a maximum of two reminders were sent. After the first round, the expert received a compilation of the other experts' earlier responses and possible free-text comments. In this way, the expert could compare the expert panel's responses to their own opinions. Some statements for the second round were rephrased and divided after feedback to clarify the essence of the statement.

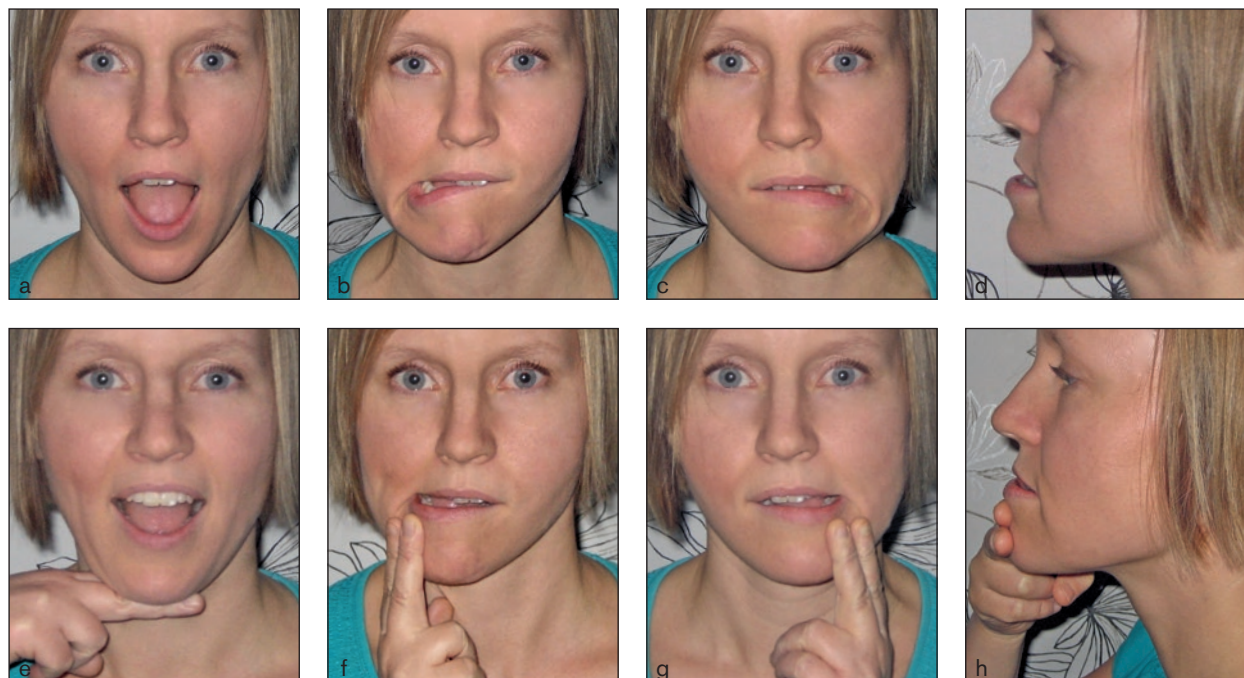


Fig 1 Exercises included in the jaw exercise program I. Free movements of the mandible: (a) Maximal jaw opening, (b, c) laterotrusion, (d) and protrusion without resistance. Movement of the mandible with a small resistance (eg, with a couple of fingers): (e) jaw opening, (f, g) laterotrusion, (h) protrusion, (i) mouth closing, and (j) stretching.



Fig 2 Directions for exercises included in the jaw exercise program II. (a) Open your mouth until you hear the clicking sound. (b, c) Protrude the mandible and simultaneously close your mouth so that the incisors come in contact. This way you prevent the condyle from sliding behind the disc. Open and then close your mouth so that the incisors come in contact. While doing this movement, no clicking sound should occur. Repeat the exercise slowly for at least 3 minutes.

The experts were then asked to answer the refined questionnaire with 32 statements (Table 2) for round 2. In the same manner as before, the experts received a compilation of the other experts' responses and possible free-text comments, and were then given the opportunity to check their answers

and correct errors/mistakes in their inputs/responses concerning the statements in the questionnaire (round 2). Two experts made minor corrections of errors/mistakes in their inputs/responses concerning specific statements in the second questionnaire (step 5, Fig 3).

Table 2 Statements Used in the Final Delphi Questionnaire**Statements**

1. I often recommend jaw exercises to my patients with temporomandibular disorders.
2. I recommend jaw exercises to patients with restricted mouth opening capacity due to hyperactivity in jaw closing muscles.
3. I recommend jaw exercises to patients with restricted mouth opening capacity due to disc displacement without reduction.
4. I recommend jaw exercises to patients with restricted mouth opening capacity due to radiation therapy.
5. I recommend jaw exercises to patients with myalgia in the jaw muscles.
6. I recommend jaw exercises to patients with catching/temporarily locking (short duration) of the jaw associated with disc displacement.
7. I recommend jaw exercises to patients with TMJ arthralgia (not arthritis).
8. I recommend jaw exercises to patients with acute painful TMJ arthritis.
9. I recommend jaw exercises to patients with chronic TMJ arthritis (due to e.g. rheumatic disease) in order to reduce the risk of restricted mouth opening.
10. The patient is always instructed and given useful verbal advice on how and when to perform the jaw exercises.
11. The patient should always be given written information on how and when to perform the jaw exercises.
12. The jaw exercise program should, if possible, be individualized according to the patient's symptoms.
13. The patient is usually given a combination of free movements, movements against a slight resistance as well as stretching (see description under Jaw Exercise Program I in enclosed PDF).
14. In patients with severe pain from the jaw system, jaw exercises will in most cases aggravate the pain. Therefore, these patients only receive relaxation exercises and careful stretching.
15. In cases of catching/temporarily locking (short duration) of the jaw due to suspected disc displacement, I recommend an exercise program where the patient is instructed to open and close the jaw in a protruded position (See Jaw Exercise Program II in enclosed PDF). The aim of this exercise is to reduce or eliminate catching/temporarily locking of the jaw.
16. Jaw exercises are usually not very successful in eliminating clicking of the jaw due to disc displacement.
17. Patients with clicking of the TMJ should not provoke these sounds when using jaw exercises, because that increases the risk of aggravating the condition of disc displacement. Thus, the patient is instructed to use only small movements that don't provoke the clicking sound.
18. Jaw exercises are well suited for a delegated way of working, where, for instance, a dental assistant or a physiotherapist may instruct the patient and also follow up the result of the training.
19. A patient who receives jaw exercises is normally followed up after 2–3 weeks concerning cooperation/adherence. Depending on condition and severity of the symptoms, recall might deviate from this "normal standard."
20. In patients with inadequate adherence, re-instruction and additional check-ups (for example by telephone) may prove valuable.
21. A patient who has received jaw exercises is normally evaluated after 6–8 weeks. Depending on condition and severity of the symptoms, follow-up evaluation might deviate from this "normal standard."
22. Jaw exercises are effective in increasing the mouth opening capacity in patients with restricted mouth opening capacity due to hyperactivity in jaw closing muscles.
23. Jaw exercises are effective in increasing the mouth opening capacity in patients with restricted mouth opening capacity due to disc displacement without reduction.
24. Jaw exercises are effective in increasing the mouth opening capacity in patients with restricted mouth opening capacity due to radiation therapy.
25. Jaw exercises are effective in reducing or eliminating myalgia in the jaw muscles.
26. Jaw exercises are effective in reducing or eliminating catching/ temporarily locking (short duration) of the jaw due to disk displacement.
27. Jaw exercises are effective in reducing or eliminating arthralgia (not arthritis) of the TMJs.
28. Jaw exercises are effective in reducing or eliminating arthritis of the TMJs.
29. Jaw exercises might aggravate the TMD pain in some cases. Still, in general jaw exercises is a treatment without any major adverse effects.
30. The treatment is often begun with counseling and jaw exercises which, if necessary, may be complemented with other treatments in a later stage.
31. Jaw exercises are often used in combination with other treatments.
32. Jaw exercises are used as a sole treatment if the patient has TMD problems that evolve during daytime.

Each statement was answered by the experts on a 5-point Likert scale with the options strongly disagree, disagree, neutral, agree, and strongly agree.

Ethical Aspects

All experts were carefully informed that participation was voluntary. In a Delphi study, the experts should be anonymous to each other so that they are able to share their personal opinions unbiased by the possible social pressure of others. However, to be able to maintain a high response rate (eg, through reminders), the main researcher must know the identities of the experts, which means that there is not

true anonymity in this kind of study. Additionally, this method has been criticized because of the pressure it applies to participants, notwithstanding anonymity, to converge their opinion into consensus,²⁸ since this is an explicit objective pronounced early in the research process. After correspondence with the regional ethical review board at Uppsala University, it was concluded that this study did not need ethical vetting.

Table 3 Frequency of Answers (n) from 14 TMD Experts on Each of the 32 Statements in the Final Delphi Questionnaire

Statement no.	Answers					Majority 9–10/14	Consensus ≥ 11/14
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree		
1.	9	4	1				Yes
2.	10	2	1		1		Yes
3.	11	1	1	1			Yes
4.	6	4	4			Yes	
5.	11	2	1				Yes
6.	4	2	3	4	1		
7.	2	7	3	1	1	Yes	
8.	1	2	2	5	4	Yes	
9.	6	5	3				Yes
10.	12	2					Yes
11.	8	6					Yes
12.	12	2					Yes
13.	4	4	5		1		
14.	4	6	3		1	Yes	
15.	2	7	2	2	1	Yes	
16.	2	11	1				Yes
17.	2	7	2	2	1	Yes	
18.	4	9	1				Yes
19.	6	7		1			Yes
20.	4	8	2				Yes
21.	4	5	2	3		Yes	
22.	7	6	1				Yes
23.	8	3	2	1			Yes
24.	3	2	9				
25.	5	6	3				Yes
26.	2	4	3	4	1		
27.	3	4	6	1			
28.		1	3	8	2	Yes	
29.	3	10	1				Yes
30.	2	10	2				Yes
31.	5	9					Yes
32.	1	4	3	3	3		

Results

The results are presented in Table 3. The response rates in both rounds were 100%. After the second round, consensus was found in 18 of 32 statements (56%), and a majority of experts agreed/disagreed with the statements in another 8 of 32 cases (25%). The Delphi process was stopped after the second round because consensus was either achieved or a stability between the rounds concerning graded opinions and free-text comments was observed.

There was a consensus among the experts that jaw exercises can be recommended to patients with myalgia in the jaw muscles, chronic arthritis (to reduce the risk of hypomobility of the jaw), and restricted mouth opening capacity due to hyperactivity in the jaw closing muscles or disc displacement without reduction. A majority of experts also recommended

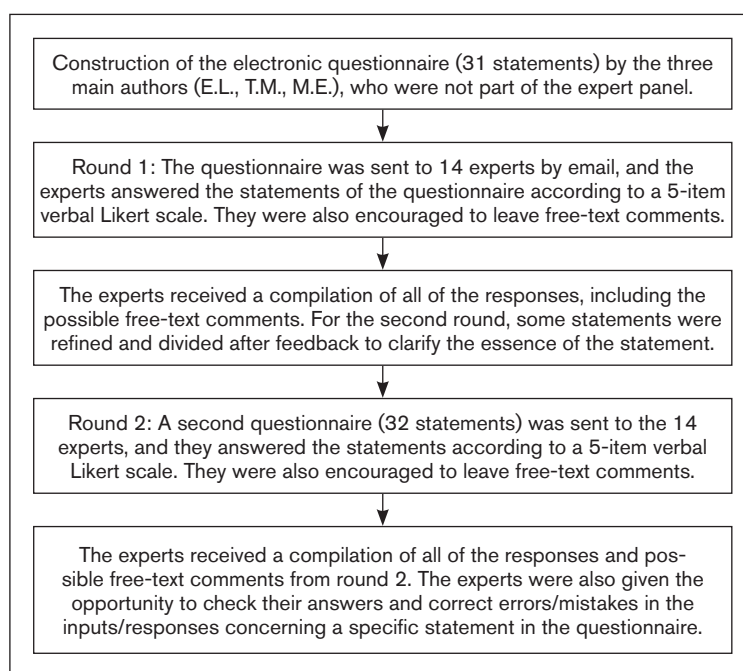


Fig 3 Flowchart describing the key features of the modified Delphi method used in this study.

jaw exercises for patients with arthralgia (not arthritis) of the TMJs and for patients with restricted mouth opening capacity due to radiation therapy. The majority did not recommend jaw exercises in patients with acute painful arthritis.

Jaw exercises were considered to be effective (consensus) in the treatment of myalgia in the jaw muscles and in increasing mouth opening capacity due to hyperactivity in jaw closing muscles or disc displacement without reduction, but the treatment was not considered to be successful in eliminating clicking of the joints due to disc displacement. There was no consensus regarding the actual way of doing the exercises, but a majority of experts recommended the exercise program proposed by Yoda et al¹⁶ in cases of catching/temporary locking (short duration) of the jaw due to disc displacement. The recommendation of short-term follow-up of jaw exercises after 2 to 3 weeks met the definition of consensus, and a majority of experts also recommended evaluation of the exercises after 6 to 8 weeks. Although jaw exercises might aggravate TMD pain in some cases, it was considered to be a treatment without any major adverse effects (consensus).

Discussion

The main findings of this study were that there is consensus among TMD experts that: (1) jaw exercises can be recommended to patients with myalgia in the jaw muscles, chronic arthritis (in order to reduce the risk of hypomobility of the jaw), and restricted mouth opening capacity due to hyperactivity in the jaw closing muscles or disc displacement without reduction; (2) the patients should always be instructed in an individualized jaw exercise program and receive both verbal advice and written information about the treatment modality; (3) the jaw exercises are normally followed up after 2 to 3 weeks concerning cooperation/adherence; (4) jaw exercises are effective in the treatment of myalgia in the jaw muscles and in increasing mouth opening capacity due to hyperactivity in jaw closing muscles or disc displacement without reduction; and (5) even though jaw exercises might aggravate TMD pain in some cases, they are considered to be a treatment without any major adverse effects. These results, based on the knowledge and clinical experience of a group of 14 TMD experts, are important as guidelines for the general practitioner in the absence of solid evidence for the effectiveness of exercises in the management of TMD.²⁰

In medicine and dentistry, there are divergent attitudes toward opinions that are based on clinical experience. In the hierarchy of evidence presented by Rinchuse et al,²⁹ consensus opinion of experts was

considered to be number 10 on an 11-point scale, and only anecdotal reports and testimonies were considered to be of less research quality. On the other hand, clinical experience is considered to be very important when research findings are applied to individual patients³⁰ and also in areas such as treatment with jaw exercises, where there is insufficient research-based evidence.²⁰

In the present study, the experts came to consensus that jaw exercises can be recommended and are effective in patients with myalgia of the jaw muscles. Magnusson and Syrén⁹ concluded in a randomized controlled study that therapeutic jaw exercises are a cost-effective TMD treatment in patients with myalgia in the jaw muscles, with an effect comparable to treatment with a stabilization appliance. Michelotti et al¹⁰ have also shown that the combination of education and a home physical therapy regimen is slightly more effective than education alone for the treatment of myofascial pain of the jaw muscles. The sample sizes in these studies were small, and it is therefore difficult to draw general conclusions from an evidence-based point of view. The studies of Tegelberg and Kopp^{6,7} lend support to the achieved consensus that jaw exercises can also be recommended to patients with chronic arthritis (eg, due to rheumatic disease) in order to reduce the risk of hypomobility of the jaw. In cases of acute painful arthritis, the first choice of treatment is pharmacologic management,³¹ and a majority of the experts concluded that jaw exercises are not to be recommended in these patients.

Studies have shown that jaw exercises can be effective in patients with restricted mouth opening capacity due to disc displacement without reduction^{17,19,32} or hyperactivity in jaw closing muscles.³³ Other studies have not been able to demonstrate that jaw exercises produce a significant increase in mouth opening capacity compared to controls in these patient groups.^{34,35} Still, despite these contradictory results, the expert panel came to a consensus that jaw exercises are effective and can be recommended in patients with restricted mouth opening capacity due to these two conditions. A majority of experts also recommended jaw exercises for patients with restricted mouth opening capacity due to radiation therapy, but there was no consensus on the effectiveness of jaw exercises for this condition. In a study on head and neck cancer patients who received radiotherapy, Loorents et al³⁶ showed that there was no significant difference in the effect on mouth opening capacity between jaw training with TheraBite and a control group. In contrast, Pauli et al³⁷ showed that jaw exercises with emphasis on stretching with TheraBite or the Jaw Trainer (Engström device) had a significant positive effect on mouth opening capacity in patients with head and neck cancer after treatment

with radiotherapy compared to matched controls. In a systematic review, Kamstra et al³⁸ concluded that a large variation of stretching techniques and performances of jaw exercises have been presented in studies on trismus in head and neck cancer patients. No stretching/exercise technique was more effective than any other, and a majority of studies reported an increase in mouth opening capacity after treatment.

Clicking of the TMJs due to disc displacement is a common condition³⁹ that seldom progresses into more serious conditions such as locking of the TMJs.⁴⁰ Some studies have shown that jaw exercises can reduce the frequency of clicking of the TMJs to a great extent,^{16,41} while another study showed only a minor effect on the clicking sounds.⁴² There was a consensus in the expert panel that jaw exercises are usually not very successful in eliminating clicking of the joints due to disc displacement. Even though the clicking sound is not harmful, it might give the patient discomfort. It has been shown that some patients are afraid that TMD pain is a symptom of a more serious disease,⁴³ and it can be speculated that a TMJ symptom such as clicking can provoke similar fears. Initial reassuring information about the cause of the clicking sound and its benign character is therefore important.

A majority of experts recommended the exercise program proposed by Yoda et al¹⁶ (Fig 2) for cases of catching/temporary locking (short duration) of the jaw due to disc displacement. The aim of this exercise is to reduce or eliminate the catching/temporary locking of the jaw, and not primarily to reduce/eliminate clicking. In such cases, it is very important to give the patient thorough information about this topic to avoid unrealistic expectations. A majority of experts also recommend that the patients should not provoke clicking of the jaw when using jaw exercises because that may increase the risk of aggravating the condition of disc displacement. Having said that, it is of course important not to give the patient fear of jaw movement. Visscher et al⁴⁴ have shown that functional TMD problems (ie, TMJ sounds) are strongly associated with fear of movement. It is therefore of the utmost importance that the patient realizes that they should not avoid the clicking TMJ sounds during normal function and that such normal provocation is not harmful.

There was no consensus regarding the actual way of performing the exercises (specific programs were attached to the web questionnaire, Figs 1 and 2). It has been shown that exercise intervention for spinal pain based on patient-specific tailored interventions, compared to standardized protocols, has the potential to improve treatment outcomes.⁴⁵ In exercise treatment for patients with fibromyalgia and related syndromes, it is stressed that the patient population

is heterogenous and therefore the prescription of exercise must be individualized.⁴⁶ In TMD patients the individualized prescription of jaw exercises for each patient and their condition and severity of symptoms is probably as important as in other pain conditions. Therefore, it might be difficult to reach consensus concerning a standardized treatment protocol.

There was consensus among the experts concerning a short-term follow-up of jaw exercises after 2 to 3 weeks, and a majority of experts recommended evaluation of the exercises after 6 to 8 weeks. Follow-ups and evaluations must also always be individualized depending on the patient's adherence, on the specific condition, and on the severity of the symptoms.

There was also consensus that jaw exercises are well suited for delegated work. Chronic pain management is often team based.⁴⁷ Because of a scarcity of TMD experts, teamwork in the management of TMD is a necessity. A dental assistant or a physiotherapist may instruct the patient in jaw exercises and also follow up on the results.²⁴

Even though there is an uncertainty about the effectiveness of exercises in the management of TMD,²⁰ a national survey in the United Kingdom among consultants in oral and maxillofacial surgery showed that 72% considered physiotherapy to be effective in the management of TMD, and among these respondents, 79% considered jaw exercises to be an effective treatment option.⁴⁸ In the light of the results from the present study, there is obviously substantial clinical experience and knowledge that points to the conclusion that jaw exercises are effective and highly indicated in a number of different TMD conditions.

Methodologic Concerns

The term "expert" and the claim that a selected group represents a valid "expert opinion" have been criticized.²⁵ In the present study, the experts were chosen based on strict criteria of clinical experience of TMD treatment (≥ 10 years as TMD specialist), academic research experience, and geographic dispersion. Naturally, this selection process is exposed to bias. Still, it is important to remember that these experts are chosen for a specific purpose: to share their knowledge on a specific problem. The experts in the present study have produced a significant number of articles in peer-reviewed journals, with a median of 105 published articles (range 29 to 372 articles). The geographic dispersion shows a significant cluster of European experts, and this must be taken into consideration when interpreting the results. The number of participants in the expert panel has also been a subject for discussion over the years, and panels with less than 10 participants are rarely conducted.⁴⁹ A very large sample size might create

more representative information but will also generate a larger amount of data, which in turn can lead to analysis difficulties. In this study, it was decided to invite 14 TMD experts, and all experts agreed to participate.

One of the key features and strengths of a Delphi study is the anonymity among the experts on the panel list. The classical study of Asch⁵⁰ showed how easily people change their judgment in order to fit a group majority. The anonymity between experts reduces this normative social influence, and more true opinions are considered to be produced.⁵¹ However, due to the outspoken goal of consensus and the feedback with averages in opinions, even a Delphi method can put pressure on the participants to converge their opinions into a group consensus.^{25,26} In the information that followed the present questionnaire, it was clearly stated that the expert should deliver their own opinion on the different statements. True anonymity cannot be attained with the Delphi method due to the necessity that the researcher knows the experts' identities to be able to manage reminders, compile the results, and give feedback to the experts according to the described method above. In the present study, only the main author (E.L.) could couple the experts and the graded opinions together.

In the classical Delphi method, the first step is a questionnaire with only open-ended questions. These opinions are then analyzed with a qualitative research method in order to produce a quantitative questionnaire for the following rounds.²⁸ In some modified forms of the Delphi method, this approach has been changed so that the experts in the first round receive a "pre-existing" questionnaire with information for ranking or response.⁵² This approach can limit the possible options and also introduce bias in the responses.²⁵ In the present study, the first round was started with a pre-existing quantitative questionnaire based on the existing literature and the experience of the main authors (E.L., T.M., M.E.). Due to published studies concerning indications and treatment effects of jaw exercises,⁶⁻¹⁹ it was decided that it was not necessary to start with a hypothesis-generating qualitative part with only open-ended questions. Still, the experts were encouraged to leave free-text comments to each statement. The feedback from the experts after round 1 resulted in minor refinements of the questionnaire to clarify the essence of some statements.

The most common way of defining consensus in a Delphi study is percentage agreement.⁵³ Different researchers have proposed different percentage agreements as thresholds for consensus: Loughlin and Moore⁵⁴ proposed 51%, Sumsion⁵⁵ recommended 70%, and Green et al²⁷ suggested 80% agreement. An alternative indicator of consensus used in

some cases is stability of responses between a series of rounds.⁵³ In the present study, it was decided that 80% had to agree or disagree for consensus to be achieved, and if 65% to 70% agreed or disagreed, the second threshold majority was met. It is important to realize that even though consensus was met in a number of statements and a majority of experts agreed on different topics, this does not mean that the "truth" or correct belief has been found.

The classical Delphi method consists of four rounds, but some studies show that two or three are preferred.^{25,28} Too few rounds will not generate meaningful data, and too many will risk sample fatigue with a drop-out response rate.^{28,56} The present study was stopped after two rounds because either consensus was reached or a stability concerning responses between the two rounds was seen. It can of course be questioned if stability can be reached after only two rounds, but it was judged in the present study that the graded opinions and free-text comments showed a stability between the two rounds, and therefore the study was ended, even though all statements did not result in consensus. The present study presents a response rate of 100%, which is optimal.

The Delphi method has been criticized for lack of reliability and validity,^{25,28} but there are studies that have suggested that the method has good reliability⁵² and content validity.⁵¹ Due to the strict definition of an expert, the expert panel's size, and geographic dispersion, it can be concluded that the expert panel in the present study is representative of an international group of TMD experts, and therefore content validity in the results can be expected.

Conclusions

This Delphi study showed that an international panel of TMD specialists/experts met consensus that jaw exercises are effective in the treatment of myalgia in the jaw muscles and in increasing mouth opening capacity due to hyperactivity in jaw closing muscles and disc displacement without reduction. Jaw exercises are also recommended in cases of chronic TMJ arthritis in order to reduce the risk of restricted mouth opening capacity. Even though jaw exercises might aggravate TMD pain in some cases, it is considered to be a treatment without any major adverse effects.

Acknowledgments

The authors thank the Public Dental Health Service, Uppsala, Sweden, for financial support (grant number 79900). The authors report no conflicts of interest.

References

- Okeson JP, American Academy of Orofacial Pain (eds). *Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management*, ed 3. Chicago: Quintessence, 1996.
- Magnusson T, Egermark I, Carlsson GE. A longitudinal epidemiologic study of signs and symptoms of temporomandibular disorders from 15 to 35 years of age. *J Orofac Pain* 2000; 14:310–319.
- Anastassaki A, Magnusson T. Patients referred to a specialist clinic because of suspected temporomandibular disorders: A survey of 3194 patients in respect of diagnoses, treatments, and treatment outcome. *Acta Odontol Scand* 2004; 62:183–192.
- Carlsson GE, Magnusson T. *Management of temporomandibular disorders in the general dental practice*. Chicago: Quintessence, 1999.
- De Laat A, Stappaerts K, Papy S. Counseling and physical therapy as treatment for myofascial pain of the masticatory system. *J Orofac Pain* 2003;17:42–49.
- Tegelberg A, Kopp S. A 3-year follow-up of temporomandibular disorders in rheumatoid arthritis and ankylosing spondylitis. *Acta Odontol Scand* 1996;54:14–18.
- Tegelberg A, Kopp S. Short-term effect of physical training on temporomandibular joint disorder in individuals with rheumatoid arthritis and ankylosing spondylitis. *Acta Odontol Scand* 1988;46:49–56.
- Ismail F, Demling A, Hessling K, Fink M, Stiesch-Scholz M. Short-term efficacy of physical therapy compared to splint therapy in treatment of arthrogenous TMD. *J Oral Rehabil* 2007;34:807–813.
- Magnusson T, Syrén M. Therapeutic jaw exercises and interocclusal appliance therapy. A comparison between two common treatments of temporomandibular disorders. *Swed Dent J* 1999;23:27–37.
- Michelotti A, Steenks MH, Farella M, Parisini F, Cimino R, Martina R. The additional value of a home physical therapy regimen versus patient education only for the treatment of myofascial pain of the jaw muscles: Short-term results of a randomized clinical trial. *J Orofac Pain* 2004;18:114–125.
- Michelotti A, de Wijer A, Steenks M, Farella M. Home-exercise regimes for the management of non-specific temporomandibular disorders. *J Oral Rehabil* 2005;32:779–785.
- Buchbinder D, Currivan RB, Kaplan AJ, Urken ML. Mobilization regimens for the prevention of jaw hypomobility in the radiated patient: A comparison of three techniques. *J Oral Maxillofac Surg* 1993;51:863–867.
- Austin BD, Shupe SM. The role of physical therapy in recovery after temporomandibular joint surgery. *J Oral Maxillofac Surg* 1993;51:495–498.
- McCarty WL Jr, Darnell MW. Rehabilitation of the temporomandibular joint through the application of motion. *Cranio* 1993;11:298–307.
- Scherpenhuizen A, van Waes AM, Janssen LM, Van Cann EM, Stegeman I. The effect of exercise therapy in head and neck cancer patients in the treatment of radiotherapy-induced trismus: A systematic review. *Oral Oncol* 2015;51:745–750.
- Yoda T, Sakamoto I, Imai H, et al. A randomized controlled trial of therapeutic exercise for clicking due to disk anterior displacement with reduction in the temporomandibular joint. *Cranio* 2003;21:10–16.
- Yuasa H, Kurita K. Treatment Group on Temporomandibular Disorders. Randomized clinical trial of primary treatment for temporomandibular joint disk displacement without reduction and without osseous changes: A combination of NSAIDs and mouth-opening exercise versus no treatment. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001;91:671–675.
- Minakuchi H, Kuboki T, Maekawa K, Matsuka Y, Yatani H. Self-reported remission, difficulty, and satisfaction with nonsurgical therapy used to treat anterior disc displacement without reduction. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98:435–440.
- Minakuchi H, Kuboki T, Matsuka Y, Maekawa K, Yatani H, Yamashita A. Randomized controlled evaluation of non-surgical treatments for temporomandibular joint anterior disk displacement without reduction. *J Dent Res* 2001;80:924–928.
- Armijo-Olivo S, Pitance L, Singh V, Neto F, Thie N, Michelotti A. Effectiveness of manual therapy and therapeutic exercise for temporomandibular disorder: Systematic review and meta-analysis. *Phys Ther* 2016;96:9–25.
- Murphy MK, Black NA, Lamping DL, et al. Consensus development methods, and their use in clinical guideline development. *Health Technol Assess* 1998;2:1–88.
- Marchais-Roubelat A, Roubelat F. The Delphi method as a ritual: Inquiring the Delphic Oracle. *Technol Forecast Soc Change* 2011;78:1491–1499.
- Cramer CK, Klasser GD, Epstein JB, Sheps SB. The Delphi process in dental research. *J Evid Based Dent Pract* 2008;8: 211–220.
- Durham J, Al-Baghdadi M, Baad-Hansen L, et al. Self management programmes in temporomandibular disorders: Results from an international Delphi process. *J Oral Rehabil* 2016; 43:929–936.
- Hasson F, Keeney S, McKenna H. Research guidelines for the Delphi survey technique. *J Adv Nurs* 2000;32:1008–1015.
- Bolger F, Wright G. Improving the Delphi process: Lessons from social psychological research. *Technol Forecast Soc Change* 2011;78:1500–1513.
- Green B, Jones M, Hughes D, Williams A. Applying the Delphi technique in a study of GPs' information requirements. *Health Soc Care Community* 1999;7:198–205.
- Keeney S, Hasson F, McKenna HP. A critical review of the Delphi technique as a research methodology for nursing. *Int J Nurs Stud* 2001;38:195–200.
- Rinchuse DJ, Rinchuse DJ, Kandasamy S, Ackerman MB. Deconstructing evidence in orthodontics: Making sense of systematic reviews, randomized clinical trials, and meta-analyses. *World J Orthod* 2008;9:167–176.
- Haynes RB, Devereaux PJ, Guyatt GH. Clinical expertise in the era of evidence-based medicine and patient choice. *ACP J Club* 2002;136:A11–A14.
- Häggman-Henrikson B, Alstergren P, Davidson T, et al. Pharmacological treatment of oro-facial pain—Health technology assessment including a systematic review with network meta-analysis. *J Oral Rehabil* 2017;44:800–826.
- Haketa T, Kino K, Sugisaki M, Takaoka M, Ohta T. Randomized clinical trial of treatment for TMJ disc displacement. *J Dent Res* 2010;89:1259–1263.
- Maloney GE, Mehta N, Forgione AG, Zawawi KH, Al-Badawi EA, Driscoll SE. Effect of a passive jaw motion device on pain and range of motion in TMD patients not responding to flat plane intraoral appliances. *Cranio* 2002;20:55–66.
- Craane B, Dijkstra PU, Stappaerts K, De Laat A. Randomized controlled trial on physical therapy for TMJ closed lock. *J Dent Res* 2012;91:364–369.

35. Craane B, Dijkstra PU, Stappaerts K, De Laat A. One-year evaluation of the effect of physical therapy for masticatory muscle pain: A randomized controlled trial. *Eur J Pain* 2012;16:737–747.
36. Loorents V, Rosell J, Karlsson C, Lidbäck M, Hultman K, Börjeson S. Prophylactic training for the prevention of radiotherapy-induced trismus—A randomised study. *Acta Oncol* 2014;53:530–538.
37. Pauli N, Svensson U, Karlsson T, Finizia C. Exercise intervention for the treatment of trismus in head and neck cancer—A prospective two-year follow-up study. *Acta Oncol* 2016;55:686–692.
38. Kamstra JI, van Leeuwen M, Roodenburg JL, Dijkstra PU. Exercise therapy for trismus secondary to head and neck cancer: A systematic review. *Head Neck* 2017;39:160–169.
39. Elfving L, Helkimo M, Magnusson T. Prevalence of different temporomandibular joint sounds, with emphasis on disc-displacement, in patients with temporomandibular disorders and controls. *Swed Dent J* 2002;26:9–19.
40. Magnusson T, Carlsson GE, Egermark I. Changes in clinical signs of craniomandibular disorders from the age of 15 to 25 years. *J Orofac Pain* 1994;8:207–215.
41. Au AR, Klineberg IJ. Isokinetic exercise management of temporomandibular joint clicking in young adults. *J Prosthet Dent* 1993;70:33–39.
42. Nicolakis P, Erdogmus B, Kopf A, Djaber-Ansari A, Piehslinger E, Fialka-Moser V. Exercise therapy for craniomandibular disorders. *Arch Phys Med Rehabil* 2000;81:1137–1142.
43. Lindfors E, Hedman E, Magnusson T, Ernberg M, Gabre P. Patient experiences of therapeutic jaw exercises in the treatment of masticatory myofascial pain: A qualitative study. *J Oral Facial Pain Headache* 2017;31:46–54.
44. Visscher CM, Ohrbach R, van Wijk AJ, Wilkosz M, Naeije M. The Tampa Scale for Kinesiophobia for Temporomandibular Disorders (TSK-TMD). *Pain* 2010;150:492–500.
45. Falla D, Hodges PW. Individualized exercise interventions for spinal pain. *Exerc Sport Sci Rev* 2017;45:105–115.
46. Mannerkorpi K, Iversen MD. Physical exercise in fibromyalgia and related syndromes. *Best Pract Res Clin Rheumatol* 2003;17:629–647.
47. Driscoll MA, Kerns RD. Integrated, team-based chronic pain management: Bridges from theory and research to high quality patient care. *Adv Exp Med Biol* 2016;904:131–147.
48. Rashid A, Matthews NS, Cowgill H. Physiotherapy in the management of disorders of the temporomandibular joint—Perceived effectiveness and access to services: A national United Kingdom survey. *Br J Oral Maxillofac Surg* 2013; 51:52–57.
49. Akins RB, Tolson H, Cole BR. Stability of response characteristics of a Delphi panel: Application of bootstrap data expansion. *BMC Med Res Methodol* 2005;5:37.
50. Asch SE. Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied* 1956;70:1–70.
51. Goodman CM. The Delphi technique: A critique. *J Adv Nurs* 1987;12:729–734.
52. Duffield C. The Delphi technique: A comparison of results obtained using two expert panels. *Int J Nurs Stud* 1993;30:227–237.
53. Diamond IR, Grant RC, Feldman BM, et al. Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol* 2014; 67:401–409.
54. Loughlin KG, Moore LF. Using Delphi to achieve congruent objectives and activities in a pediatrics department. *J Med Educ* 1979;54:101–106.
55. Sumsion T. The Delphi technique: An adaptive research tool. *British Journal of Occupational Therapy* 1998;61:153–156.
56. Schmidt RC. Managing Delphi surveys using nonparametric statistical techniques. *Decision Sciences* 1997;28:763–774.