

Occlusal Splints for Painful Craniomandibular Dysfunction



Occlusal Splints for Painful Craniomandibular Dysfunction



Hans Jürgen Schindler, Prof Dr Med Dent

Professor
Department of Prosthodontics
University of Würzburg
Würzburg, Germany

Jens Christoph Türp, DDS, Dr Med Dent, MSc, MA

Professor
Department of Oral Health and Medicine
University of Basel
Basel, Switzerland

With contributions from

Lydia Eberhard, Nikolaos Nikitas Giannakopoulos, Daniel Hellmann,
Alfons Hugger, Bernd Kordaß, Martin Lotze, and Marc Schmitter



Berlin | Chicago | Tokyo
Barcelona | London | Milan | Mexico City | Moscow | Paris | Prague | Seoul | Warsaw
Beijing | Istanbul | Sao Paulo | Zagreb



First published as Konzept Okklusionsschiene: Basistherapie bei schmerzhaften kranio-mandibulären Dysfunktionen in 2017 by Quintessenz Verlags-GmbH, Berlin, Germany.

Library of Congress Cataloging-in-Publication Data

Names: Schindler, Hans Jürgen, author. | Türp, Jens Christoph, author.
Title: Occlusal splints for painful craniomandibular dysfunction / Hans Jürgen Schindler, Jens Christoph Türp.
Other titles: Konzept Okklusionsschiene. English
Description: Batavia, IL : Quintessence Publishing Co, Inc, 2021. | Includes bibliographical references and index. | Summary: "This book offers readers with a professional interest a clear guide to help them address the issue of temporomandibular disorders in theory and practice and provide their TMD patients with the best possible treatment"-- Provided by publisher.
Identifiers: LCCN 2020008037 | ISBN 9780867157956 (hardcover)
Subjects: MESH: Craniomandibular Disorders--therapy | Occlusal Splints | Facial Pain--therapy
Classification: LCC RK523 | NLM WU 140.5 | DDC 617.6/43--dc23
LC record available at <https://lcn.loc.gov/2020008037>

A CIP record for this book is available from the British Library.
ISBN: 978086757956



©2022 Quintessence Publishing Co, Inc

Quintessence Publishing Co, Inc
411 N Raddant Road
Batavia, IL 60510
www.quintpub.com

5 4 3 2 1

All rights reserved. This book or any part thereof may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without prior written permission of the publisher.

Editor: Lori Bateman
Design: Sue Zubek
Production: Angela Kreeger and Sue Robinson

Printed in Croatia

Foreword.....	VIII
Preface.....	X
Contributors.....	XIII

Part A	
Practice of Occlusal Splint Therapy and Coordinative Training..... 1	
1	INTRODUCTION..... 3
	Jens C. Türp
	Craniomandibular Dysfunction 3
2	STRUCTURED TREATMENT APPROACH IN PRACTICE..... 11
	Hans J. Schindler
	Diagnostics..... 12
	Treatment of Painful CMD..... 23
	Typical Painful CMD Case Studies: From History Taking to Treatment..... 24
3	INTEROCCLUSAL REGISTRATION IN SPLINT THERAPY..... 45
	Daniel Hellmann, Jens C. Türp
	Method of Closing Movement onto a Frontal Plateau..... 45
4	SPLINT FABRICATION..... 53
	Daniel Hellmann
	Model Fabrication 53
	Model Mounting..... 54
	Modular Rehabilitation Splint System 54
	MRS Basic Splint (MRS 0) 55
	Modular Modification of the MRS 0 61
	Fabrication of an Efficient MRS 1 (Michigan Concept) Using CAD/CAM..... 64
5	COORDINATIVE TRAINING FOR FUNCTIONAL REHABILITATION..... 67
	Daniel Hellmann
	Pain and Motor Adaptation 67
	Pain Adaptation and Rehabilitation 68
	Rehabilitation of the Craniomandibular System..... 68
	Practice of Coordinative Training in Functional Rehabilitation..... 69
	Case Study..... 74
	Indication for Coordinative Training and Monitoring Outcome..... 79

Part B		
Aspects of Painful CMD and Splint Therapy Explored in Depth		81
6	RISKS	83
	Jens C. Türp, Hans J. Schindler, Alfons Hugger, Marc Schmitter	
	Definition of Risk	83
	Jens C. Türp	
	Definition, Calculation, and Interpretation of Odds Ratio	83
	Jens C. Türp	
	Myoarthropathies of the Masticatory System	85
	Jens C. Türp	
	Occlusion and CMD	89
	Jens C. Türp	
	TMJ Compression and Distraction	93
	Jens C. Türp, Hans J. Schindler, Alfons Hugger	
	Bruxism	95
	Marc Schmitter	
7	DIAGNOSTICS	105
	Lydia Eberhard, Nikolaos Nikitas Giannakopoulos, Hans J. Schindler	
	Staged Model of CMD Diagnostics	105
	Hans J. Schindler	
	Differential Diagnoses	106
	Hans J. Schindler	
	Criticism of Classic Taxonomies	107
	Nikolaos N. Giannakopoulos	
	Quantitative Sensory Testing and Its Practical Relevance	109
	Lydia Eberhard	
	Criticism of Samples Included in Treatment Studies	113
	Nikolaos N. Giannakopoulos	
8	TREATMENT	117
	Hans J. Schindler, Alfons Hugger	
	Effectiveness of Treatment Options for Painful CMD	118
	Possible Mechanisms of Physiotherapy in Painful CMD	121
	Treatment Results from Dental Practices	122
	Rehabilitation in Functional Therapy	123
	Alfons Hugger	

9	NEUROBIOLOGIC BACKGROUND OF OCCLUSAL SPLINT THERAPY	129
	Hans J. Schindler	
	Muscle Physiology	129
	Temporomandibular Joints	135
	Jaw Muscle Pains.....	138
	TMJ Pains.....	140
	Explanatory Models of Chronification of Pain.....	141
	Motor Adaptation to Pain.....	142
	Muscle Regeneration Potential	143
10	NEUROBIOLOGY AND BIOMECHANICS OF OCCLUSAL SPLINT THERAPY	145
	Hans J. Schindler	
	Traditional Hypotheses.....	146
	Current Hypotheses.....	147
	Pathophysiologic Effects of Postural Changes: Is Occlusal Splint Therapy a Cross-Segmental Treatment Modality?	152
11	CEREBRAL REPRESENTATION OF OCCLUSAL SPLINT THERAPY: FUNCTIONAL MRI STUDIES	157
	Martin Lotze, Bernd Kordaß, Hans J. Schindler	
	Cerebral Representation of Neuromuscular Activity.....	158
	Modification of Cerebral Activation Patterns by Occlusal Splint Therapy.....	159
	Cerebral Activation Patterns and Pain.....	160
	INDEX	163



Foreword

It is a great challenge for any teacher to write a book with the aim of presenting the theory and practice of a particular dental clinical specialty. To accomplish this task successfully requires extensive clinical experience and excellent knowledge of the scientific principles underlying the specialty. Writers engaging in such an endeavor—like the authors of this book—usually have a clear goal in mind: to improve dental health care, which means making innovations in diagnostics and treatment accessible to dental practitioners.

Achieving this goal is a particular challenge given the subject of this book. Therapy for painful craniomandibular dysfunction (CMD) is a field of dentistry that undoubtedly differs greatly from traditional subjects in dental medicine, such as periodontics, restorative dentistry, or oral surgery. In these subject areas, innovation essentially means adapting clinical procedures to new technologies, such as the use of digital resources. The objective of adaptive processes has hardly changed in the past 100 years: to enhance the mechanical perfection of treatment methods while simultaneously increasing the efficiency and safety of the working materials being used. Generations of dentists in education, research, and practice have pursued this objective—in some cases with great success. This was accompanied by a concentration on the results of mechanical working procedures. Every step toward perfection was regarded as clinical progress. Michael Heners coined the term “technomorphic model of dentistry” for this orientation of dental medicine. Based on this model, the mechanically defined actions of the clinician determine the quality of the dental therapy provided. Accordingly, better dental care can only be achieved by optimizing the dental intervention in terms of technique.

In the past 20 years, the technomorphic model has been greatly modified in all areas of dentistry because research and practice have increasingly focused on the biologic principles of dental activity. Nevertheless, many dentists continue to equate better care with better technique.

The authors of this book confront these attitudes from the outset. Better basic treatment of CMD cases cannot be achieved simply by better technique but by a new way of thinking that places patients, their suffering, and what they tell their dentists center stage. Readers will only succeed in adopting a new and different way of thinking if they can free themselves from conventional, outmoded patterns of activity. This book invites them to do so. It offers those with a professional interest a clear guide to help them address the issue of CMD in theory and practice and provide their CMD patients with the best possible treatment. Great emphasis is placed on the importance of history taking. Recognizing this and drawing the necessary conclusions about diagnosis and treatment are key to the new way of thinking, which makes appropriate clinical decisions possible in CMD cases.



The book is divided into two parts. The first part presents a practical guide to the basic treatment of CMD patients, while the second builds on that basic knowledge by exploring scientific and theoretical principles in more depth. The two parts complement each other to form a “rounded” and complete picture of the present state of the art. This is why readers are strongly encouraged to study both parts. The second part examines scientific perspectives that not only reveal other courses of action but help interested practitioners to critically evaluate their own experiences.

It is possible to improve the treatment of patients with CMD. This book documents the clinical paths that will lead to a targeted and evidence-based therapeutic approach. It is up to all of us—as members of the dental profession—to seize this initiative and pursue the paths that are laid out for us.

Prof Dr Winfried Walther

Director

Dental Academy for Continuing Professional Development

Karlsruhe, Germany



Preface

The publication of this book might prompt some people to think, “Surely not another book about craniomandibular dysfunction (CMD)!” Although this might, at first sight, be a justifiable reaction, the authors are not aware of an entire book dealing with the subject of occlusal splints that has been published in the past decade.

Yet the times are constantly changing and, in the process, scientific advances are being made that inevitably lead to new discoveries. In the area of functional therapy, this is particularly true of the use of occlusal splints to treat painful CMD. There is often a considerable delay, however, before new knowledge makes its way into dental practices. Regrettably, knowledge transfer tends to take a long time (too long), and several aspects promote and negatively reinforce this situation. Three examples of these delaying factors are worth noting:

1. The preference for personal experience (that is not monitored) rather than evidence-based knowledge derived from scientific studies
2. The fact that, despite the unlimited access at least to abstracts from prominent specialty publications, too little use is made of the opportunities for expanding knowledge through open-access electronic libraries (eg, due to a lack of knowledge about how to research relevant journal articles and how these can be acquired, as well as the fact that major publications are only accessible for a fee)
3. The often poorly defined term “patient satisfaction” being used as a practice-specific measure of “success”

In this context it should be clear that patient-centered clinical decisions can no longer be based solely on the practitioner’s individual clinical experience. Experience is undoubtedly important, but it is not enough for scientifically based practice that is supported by evidence. Instead, knowledge of the current state of the art in clinical research (in the form of published study results) is essential in addition to personal experience.

The values, wishes, and concerns of the patient should be regarded as the third, equally significant pillar. Only when these three aspects are incorporated equally into individual decision making on the course of action can this be called scientifically based (commonly known as “evidence-based”) dentistry. Therefore, evidence-based dentistry automatically includes the aspect of participatory decision making. It can thus claim to be both a beneficial and a self-determined form of medicine. On the other hand, evidence-based dentistry does not mean simply following the recommendations drawn from scientific guidelines or systematic reviews; this would be “cookbook medicine,” which in many instances would not do justice to the individual case.

So much for the principle, now for the “reality.” One of the authors of this book recently gave a rather lengthy lecture on the subject of painful CMD for a continuing education program. After about an hour, one audience member raised his voice to complain angrily that what he had heard was hardly any use to his practical work (it is worth noting that he

had blissfully slept through a substantial part of the lecture). Partly this angry comment and partly the authors' decades of extensive teaching work prompted a thorough rethink and led to the following conclusions—though not necessarily a new realization:

The classic structure of knowledge transfer, especially in print media, has some serious didactic shortcomings. It is widely accepted that the diagnostic routines and treatment models developed in clinical institutions and specialist centers are barely suited to the reality of dentists' offices. Furthermore, treatment and co-therapy recommendations are frequently reduced to succinct pointers, such as "splint therapy," "home exercises," or "education," without providing any real help as to where, when, and how these recommendations should be carried out. Attentive readers will notice that the present authors are not afraid to broach the subject of (even their own) shortcomings and try hard, whenever possible, to rectify them in this book.

Knowledge and the resulting (potential) clinical benefit to dental practice obviously cannot be transmitted directly, especially since only a few dentists—even in universities, as hard as that is to believe—take advantage of access to the specialist scientific literature during the course of their clinical decision making. Furthermore, the experience and expertise of "professionals," who process the data to make it "easily digestible" even for non-scientists, are required for others to derive benefit from published research results. In the treatment of painful CMD, there is barely any equivalent to the instructions that are familiar from medicine in terms of directives, guidelines, or clinical recommendations (the compulsory nature of these standards of proper medical treatment decreasing in descending order). Another factor is that the patients included in research studies do not usually represent patients treated in dental practices, who account for around 80% of the general demand for CMD treatment. These distortions of the patient populations naturally lead to misunderstandings between clinicians based in a university setting and office-based practitioners (this aspect is dealt with in more depth in relation to "chronic CMD"). These misunderstandings stand in the way of successful treatment of patients with painful CMD, who for the most part are easily treatable. Dental routines such as minimum diagnostics, therapeutic interocclusal records, affordable fabrication of occlusal splints, physiotherapy, and behavior modification therapy tend to be described with only limited practical applicability. Furthermore, these aspects are all too often burdened with inappropriate instructions, which, in the worst case, lack any scientific foundation and, apart from that, frequently take up unnecessary amounts of time in the dental practice. A particularly serious aspect is that the term "rehabilitation" hardly ever crops up in practical day-to-day treatment. Let us not forget: pain reduction or elimination of pain is the original and primary goal of dental treatments.

Motivated by the deficiencies and shortcomings outlined here, the authors are endeavoring to correct these flaws. To accomplish this, they have chosen to adopt an approach that, contrary to the way textbooks are usually structured, puts the cart before the horse, so to speak. To be precise, the first part of the book (A) starts with a brief overview



chapter on the subject of painful CMD, then presents clinical instructions at the simplest level but based on a high level of external evidence (cooking recipes without detailed explanations). These recommendations are supported by the minimum of diagnostics and can be followed by direct, affordable laboratory fabrication of the required occlusal splint. Necessary and useful co-therapies are addressed with a brief “When?” and “Why?” “Internal proofs” refer to the expanded scientific basis of the procedure, pointing to the relevant chapters in the second part of the book (B). All the background details about the etiology, advanced diagnostic techniques, neurobiology, and pathophysiology are dealt with solely in part B.

The authors feel sure that this primarily pragmatic approach will enable readers, in a self-organizing manner, to develop their knowledge about treatment for painful CMD—from simply taking the right course of action through to developing a high level of expertise. We hope you will find this a fascinating and instructive read. We always welcome any comments or suggestions you may have.

“Bene docet, qui bene distinguit.” [He teaches well who distinguishes well.]

—Horace

The authors express special thanks to Tine Ade, Karlsruhe, Germany, for developing the illustrations in this book.

Lydia Eberhard, Dr Med Dent

Department of Prosthodontics
University of Heidelberg
Heidelberg, Germany

**Nikolaos N. Giannakopoulos, PD Dr Med Dent,
MSc**

Department of Prosthodontics
University of Würzburg
Würzburg, Germany

Daniel Hellmann, PD Dr Med Dent

Department of Prosthodontics
University of Würzburg
Würzburg, Germany

Alfons Hugger, Prof Dr Med Dent

Department of Prosthodontics
School of Dentistry
Heinrich Heine University
Düsseldorf, Germany

Bernd Kordaß, Prof Dr Med Dent

Department of Prosthodontics, Geriatric Dentistry and
Medical Materials Science
University of Greifswald
Greifswald, Germany

Martin Lotze, Prof Dr

Functional Imaging Unit
Institute of Diagnostic Radiology and Neuroradiology
University of Greifswald
Greifswald, Germany

Hans Jürgen Schindler, Prof Dr Med Dent

Department of Prosthodontics
University of Würzburg
Würzburg, Germany

Marc Schmitter, Prof Dr Med Dent

Department of Prosthodontics
University of Würzburg
Würzburg, Germany

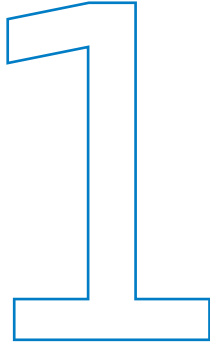
Jens Christoph Türp, DDS, Dr Med Dent, MSc, MA

Department of Oral Health and Medicine
University of Basel
Basel, Switzerland



Part A

Practice of Occlusal Splint Therapy and Coordinative Training



INTRODUCTION

Jens C. Türp

Craniomandibular Dysfunction

Terminology

Technical terms must be clarified to avoid misconceptions and misunderstandings, especially when describing the factors relating to function. In particular, a distinction must be made between “dysfunction of the masticatory system,” “craniomandibular dysfunction,” and “myoarthropathy of the masticatory system”; these terms should not be considered synonymous. In 2016, the German Society for Functional Diagnostics and Therapy published proposed definitions for these and other important terms for the first time.¹

Dysfunction of the masticatory system

Dysfunction of the masticatory system refers to a “short- or long-term disturbance of the homeostasis or economy of the masticatory system caused by any structurally or functionally substantiated deviation from normal function, such as functional deficits due to trauma, injury to the structural integrity, and functional/parafunctional stress, including deviations that justify prosthodontic, orthodontic, or surgical measures.”¹

Craniomandibular dysfunction

Craniomandibular dysfunction (CMD) is classified as “a specific functional disorder that affects the muscles of mastication, the temporomandibular joints (TMJs), and/or the occlusion.”¹ Clinically, CMD encompasses the areas of pain and/or dysfunction.

Pain is manifest as:

- Masticatory muscle pain
- TMJ pain
- Toothache of (para)functional origin



Dysfunction can appear in the form of:

- Painful or nonpainful limitation of movement of the mandible (aspect aimed at mandibular movements)
- Hypermobility or incoordination of the mandible (aspect aimed at mandibular movements)
- Painful or nonpainful intra-articular dysfunction (aspect aimed at the TMJ)
- Premature contacts interfering with function and gliding obstacles (aspect aimed at the occlusion)

CMD is a collective term that encompasses symptoms not in need of treatment and symptoms that do need treatment. In principle, there is always a need for treatment when pain is present; in the case of dysfunction, the need for treatment is dependent on the severity of the dysfunction.

Myoarthropathy of the masticatory system

Myoarthropathy of the masticatory system (MAP), a term introduced in 1970 by Tübingen dentist Willi Schulte,² denotes a subgroup of craniomandibular dysfunction. It refers to symptoms and findings affecting the muscles of mastication, the TMJs, or associated tissue structures; it does not take into consideration the occlusion. This term equates to the term "temporomandibular disorder (TMD)." If pain is involved, these symptoms can be summarized under the heading "myoarthropathic pain."

Etiology

Numerous mechanisms have previously been held responsible for the etiology of myofascial pains of the muscles of mastication and pains in the TMJs. Nociceptive pain is currently the underlying basis of models for these musculoskeletal symptoms. This nociceptive pain can be triggered by overloading of the tissue and promoted by a number of disposing factors. Microtrauma and local ischemia³—together with their structural and functional counterparts, such as activated osteoarthritis,⁴ the myofascial trigger point,⁵ local muscle fatigue, and aching muscles⁶—essentially serve as overarching pathophysiologic explanatory models. Common to these hypotheses is the assumption that, at the end of the causal chain, afferent nerve fibers and tissue cells release protons⁷ and other endogenous algogenic substances (eg, glutamate, substance P, bradykinin, histamine, prostaglandin E, serotonin, potassium ions, adenosine triphosphate) that mediate the excitation and sensitization of nociceptors (group III and IV muscle afferents).

Modern concepts^{4,8} distinguish between the following influencing factors:

- Predisposing (eg, genetic, structural, systemic, psychologic)
- Initiating (eg, microtrauma, macrotrauma, overloading)
- Sustaining/perpetuating (eg, psychosocial)

The classification into the individual categories is not intended to be rigid. For instance, overload of the sustaining and psychosocial conditions may be the predisposing factor in one patient, whereas the opposite pattern will apply in another patient. It is important to interpret this conceptual framework correctly, in the sense that a single influencing factor is not usually capable of causing musculoskeletal pains.

Meanwhile, there is evidence that endogenous or exogenous substances, such as estrogen,⁹ nerve growth factor (NGF),¹⁰ and glutamate,¹¹ might play a key role in the etiology of painful CMD. The fact that glutamate is able to cause peripheral sensitization without discernible signs of inflammation is extremely important in this context.¹¹ These new findings have rarely been discussed in the dental literature, but they offer a plausible explanation for the observation, which has long been made and is proven through epidemiologic studies, that females, especially women of child-bearing age, more commonly suffer from myoarthropathic pain than men.^{12,13}

Epidemiology

The typical patient with painful CMD is a woman of child-bearing age with pains in the muscles of mastication. Women seek professional assistance because of their symptoms at an overwhelmingly higher rate than men. The more specialized the facility, the higher the proportion of women patients. In university pain centers, the ratio of women to men can be as high as 9:1.

Individual Need for Treatment

The question of whether an individual needs treatment automatically follows from the preceding comments. Traditionally, the range of dysfunction has been widely interpreted in dentistry. In the past, anyone who did not function like an articulator performing symmetric, noise-free movements would have run the risk of being regarded by a dental practitioner as potentially dysfunctional. Fortunately, this view has changed considerably.

CMD treatment not required

Current thinking is that certain CMD symptoms do not usually require any special (additional) diagnostic investigation and do not need treatment when people are otherwise pain-free:

- *Clicking or popping noises in the TMJs.* The most common cause of TMJ clicking or popping is an anterior position of the articular disc. Clicking or popping noises without other symptoms (pains) are also not an indication for further diagnostics or treatment in the field of orthopedics. Carrying out magnetic resonance imaging for TMJ clicking or popping can thus be viewed as an excessive use of diagnostic tools. If patients report joint pains as well as TMJ noises—if they have painful joint clicking—the pain symptoms, but not the noise, require a more thorough examination and (usually) need treatment. An exception is a very loud clicking or popping of the joints that is not tolerable for the patient and his/her social environment. In this case, the available treatment methods that are indicated need to be fully explored, bearing in mind their particular risk-benefit relationship.
- *Grating noises in the TMJs.* Grating noises in the TMJs are generally a clinical sign of contact between two bone surfaces. However, grating without other symptoms (pain) is not an indication for treatment.
- *Deviation (corrected lateral deviation) of the mandible during mouth opening.*
- *Differences in the extent of maximum laterotrusion to the left and right.* These tend to be more the rule than the exception¹⁴ and reflect the fluctuating asymmetry typical of mammals.
- *Sensitivity on palpation of jaw muscles and/or TMJs detected during a routine functional diagnostic examination.* These areas are not painful during the course of the patient's daily mandibular function.
- *Signs of osteoarthritis on radiographs (dental panoramic radiography).*

All these symptoms, which used to be classified as dysfunctions, are today viewed as a variation from normality. This means the range of normal function—or “eufunction”—has been greatly expanded. Albert Gerber (Zurich) warned as early as 1964 that “not every TMJ that causes discomfort must eo ipso be diseased” and not all discomfort must be treated.¹⁵

CMD treatment required

By contrast, further diagnostic investigation and treatment are advisable in certain clinical situations:

- *Painful symptoms in the area of the jaw muscles and/or TMJs.* Pains reported by patients must always be taken

seriously. As a general rule, pain-related information provided by patients must not be doubted in terms of its veracity. This is especially true of the maxillofacial area, since it is extremely unlikely that pains in this area will result in early retirement—unlike back pains, for example. Pains in the region of the jaw muscles or in one or both TMJs are the key symptom in more than 90% of dental patients with painful CMD—and not a reduced range of mandibular movement or TMJ noises. However, a large proportion of patients with myoarthropathic pains do not consult a clinician for treatment. Anxiety about their existing problems is an important factor in whether patients decide to have their symptoms investigated and, if necessary, get therapeutic assistance. Pains in the muscles of mastication and/or TMJs are accompanied by a distinct limitation of the range of mandibular movement in rare cases. Pain-induced repositioning of the mandible (relieving posture) can cause changes in the occlusion of the teeth (premature contacts), which patients may find very disturbing, especially in the case of acute malocclusion.

- *Reduced range of mandibular movement, which usually affects maximum mouth opening.* Limitations of movement are noticeable to some extent on laterotrusion and protrusion of the mandible but far less frequently than during mouth opening. In patients with painful CMD, there are basically two reasons for limited movement of the condyles of the mandible:

1. Mechanical obstacle in one or both TMJs caused by anterior, medial, or lateral displacement of the articular disc or by adhesions in the joint.
2. Reflex adaptation of mandibular movement (“splinting effect”) resulting from pains in the area of the jaw muscles and/or TMJs; the wider the mouth is opened, the greater the intensity of the pain. Voluntary limitations of mandibular movement in terms of a relieving posture can be interpreted as an adaptive mechanism under reflex control that aims to relieve the existing pains and protect the affected anatomical structures.

There is a generally recognized threshold beyond which it is possible to talk of limited mouth opening (= sum of vertical overbite and maximum interincisal distance). The commonly quoted value of 40 mm (or 38 mm in women) is by no means generally accepted as the threshold between “limited” and “not limited.” Essentially, a certain tolerance should be applied to any threshold because the maximum mouth opening possible with identical rotation in the condyles is dependent on the length of the mandibular body. However, dental practitioners must carry out further diagnostic measures in the following cases:

- Limitations of the range of mandibular movement reported by the patient
- Continuous reduction of maximum mouth opening lasting a period of a few days, weeks, or months
- Measured mouth opening of less than 35 mm (clinical rule of thumb)

In these cases, a careful diagnostic investigation (including imaging techniques) is needed to exclude causes other than CMD, especially tumors. A tumor should be suspected until it has been disproved with absolute certainty. It should also be borne in mind that non-neoplastic changes, such as scleroderma and undetected mandibular fractures, can cause limited mouth opening.

It is primarily the patient, not the dentist, who gauges whether diagnosis and treatment are required in a case of painful CMD—unlike with caries or periodontal diseases, for which the dental practitioner usually decides on the need for treatment. This is why screening tests, which aim to identify and treat subclinical, prepathologic dysfunctions, should be viewed as unjustified excessive diagnostics in people who are subjectively symptom-free. This does not mean to detract from the value of carrying out (simple) functional diagnostics prior to major therapeutic interventions for prosthodontics, oral surgery, or orthodontics.

During and/or after examination, the symptoms that have been observed or are troubling the patient must be explained in a one-to-one conversation, based on up-to-date, reliable information that the patient will understand. This applies as well to symptoms that do not require treatment. The patient should be told about the probable cause of the symptoms and whether or not further diagnostic tests and treatment will be required. A useful approach is to draw an analogy for the patient between muscles of mastication and back muscles, and between TMJs and the lumbar spine. In cases of normal variation, patients should also be told what diagnostic and therapeutic measures are not required (according to the most current information) but which might be proposed and carried out elsewhere. Armed with this knowledge, they will be able to argue against such proposals.

Diagnoses and Classifications

To address the lack of standardized diagnostic and classificatory criteria for differentiating myoarthropathies, internationally renowned experts presented a new system of diagnosis and classification in 1992¹⁶ that, despite some shortcomings, quickly gained a high degree of international recognition. The name of the system—Research Diagnostic Criteria for Temporomandibular Disorders, RDC/TMD for short—indicates that it was originally developed for clinical

trials for research purposes. However, it was soon applied in daily practice, often in a less strict form. RDC/TMD enables diagnostic measures and diagnoses to be standardized in a field previously characterized by inaccurate information and systems that were not comparable to each other. In 2014, the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) were published as a further refinement.¹⁷ In both systems, diagnostics and classification are spread over two areas, which are designated as Axis I and Axis II.

Axis I

Axis I covers the somatic diagnoses (Table 1-1). These are based on information provided by the patient who is consulting a dentist with symptoms affecting the masticatory system and on the results of the clinical examination. The results of a clinical examination are not sufficient to make the somatic diagnoses. What is more decisive is what the patient tells the dentist when complaining of pain, limited mouth opening, or loud noises in the TMJs. The DC/TMD, like the RDC/TMD, distinguishes between pain-related and pain-unrelated diagnoses that arise during the assessment of a patient.

However, as the category-based diagnoses have no implications for therapy, it is usually sufficient in working practice to make the following diagnostic distinctions:

- Myalgia (of the relevant muscle or muscles)
- Arthralgia (of one or both TMJs)
- (Anterior) position (displacement) of the articular disc (with or without reduction)
- Limitation of the mandibular range of movement (maximum mouth opening)

It should be stressed that a patient who, for instance, exhibits tender masseter muscles on palpation of masticatory muscles during a routine functional assessment but finds that the muscles never hurt during daily functioning would not be given a diagnosis of “myalgia of both masseters” but merely “sensitivity on palpation of both masseters.”

Axis II

Axis II comprises (mostly pain-related) psychosocial parameters, such as depression, anxiety, distress, negative stress management strategies, tendency to somatization, catastrophizing, and impairment in activities of daily living. It is currently regarded as the diagnostic standard to take into account the patient’s pain-associated psychosocial well-being. To do this, it is helpful to use validated filtered questionnaires (see chapter 2). The psychosocial findings, like the somatic diagnoses, have direct and distinctive implications for treatment.



Table 1-1 Somatic diagnoses of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), which are not compatible with each other

	RDC/TMD (1992)	DC/TMD (2014)	
Pain-related diagnoses	Myofascial pain	Myalgia	
	Myofascial pain with limited mouth opening	Local myalgia	
	Arthralgia	Myofascial pain	
	Activated TMJ osteoarthritis	Myofascial pain with referral	
		Arthralgia	
		Headache attributed to TMD	
Pain-unrelated diagnoses	Disc displacement with reduction	Disc displacement with reduction	
	Disc displacement without reduction on mouth opening, with limited mouth opening	Disc displacement with reduction and intermittent locking	
	Disc displacement without reduction, without limited mouth opening	Disc displacement without reduction, with limited mouth opening	
	TMJ osteoarthritis		Disc displacement without reduction, without limited mouth opening
			Degenerative joint disease
		Subluxation	

Diagnostics

History taking

Taking a CMD-related history forms the essential basis of the diagnostic process. It is a self-contained dental service and is regarded as more important than the subsequent clinical examination of the patient.¹⁸ History taking consists of a medical interview tailored to the particular case history of a patient. To standardize patient details, it is also advisable to use validated filtered questionnaires for assessing the psychosocial impairment of patients suffering from pain.

Immediately before first contact with the treating clinician, it is a good idea for (potential) CMD patients to complete a questionnaire about any functional impairments in their masticatory system; this also contains questions about nonpainful findings. For most patients, however, pain plays an important, if not the major, role. The official definition of pain from the International Association for the Study of Pain (IASP) is “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”¹⁹

The subsequent discussion of a patient’s pain history picks up relevant answers in the questionnaire and should cover the following areas:

- Main complaints
- Localization of the pain
- Onset of the pain
- Duration of the pain
- Frequency of the pain
- Quality of the pain
- Intensity of the pain
- Factors influencing the pain
- Accompanying symptoms
- Previous treatments
- Patient’s expectation of treatment

Patients should also be asked about psychosocial stress factors before and at the time their pain starts. An appropriate way of assessing the degree of emotional stress is to approach the matter via an “imaginary third person,” which often makes it easier for patients to cope with the



conversation taking an unexpected turn. For instance, the dentist might say: “A lot of patients who have the same kind of symptoms say that ... Is that your experience as well?”

The use of other diagnostic record forms, which patients complete in the dental practice or at home before or after their first dentist-patient contact, is suitable for diagnosing patients with persistent orofacial pain. Pains of this kind are not long-lasting acute pains, but they obey their own rules, which is why more intensive diagnostic investigation is required.

The following tools have proved valuable:

- Pain questionnaire
- Graded Chronic Pain Scale (GCPS)²⁰
- Depression anxiety stress scales (eg, the German DASS²¹)

It is particularly important to ask patients about any pains that are localized outside the facial area. Patients who consult their dentist will not normally mention pain occurring outside the jaw region unless they are asked. However, recognition of localized pain or widespread pain makes a big difference to the treatment strategy as well as the prognosis. Patients can even be given this part of the form to complete before the first consultation. To help them record any such pain, the questionnaire includes the outlines of a human figure seen from the front, back, and both sides. Patients are asked to mark all the topographic regions in which they typically experience pain. The result from a clinical point of view is that the pain drawings often provide more information than that obtained from panoramic radiographs in CMD patients. If anything, there is a risk with imaging that normal variations are erroneously interpreted as being linked to clinical signs and symptoms.

A pain history enables a working diagnosis to be made, which is confirmed in many cases during the subsequent examination, but it may also be modified to some extent.

In view of the subjective nature of pain and variables accompanying pain, which can be described by sufferers verbally and/or in writing mainly with questionnaires, some therapists occasionally assume that patients’ descriptions are “soft” data. In terms of their quality and significance, these are seen as less valuable than “hard” data obtained from clinical, imaging, and instrumental investigations. However, this view is mistaken because the opposite is often the case: Ideally, the investigations performed after the pain history has been taken merely serve to confirm or modify the diagnosis.

Clinical examination

Elements of the clinical examination include the following:

- Measurement of the range of mandibular movement (condylar movement with simultaneous assessment of the presence of joint noises; maximum mouth opening; maximum laterotrusion and protrusion of the mandible). It is advisable to use a ruler marked in millimeters to numerically record the range of mandibular movement; the ruler must start immediately at one end with the 0-mm mark.
- Palpation of the palpable muscles of mastication (temporalis, masseter) and the TMJs. Use of a pressure algometer enables clinicians to standardize this examination.
- Occlusal examination. This particularly involves checking for the presence of occlusal contacts in maximum intercuspatation and any changes to the dental hard tissues that have occurred (areas of attrition and abfraction) as evidence of teeth grinding or jaw thrusting.

The findings of the clinical examination are documented on a standardized record form.

Imaging

In principle, a dental panoramic radiograph, also known as an orthopantomogram (OPG or OPT), should be taken during the diagnosis of patients with symptoms of painful CMD. In view of the concerns patients frequently express over radiographic procedures, it is worth mentioning the favorable risk-benefit ratio given the relatively low radiation exposure of panoramic radiographs. The main purpose of a panoramic radiograph lies in differential diagnosis. Furthermore, it reveals gross morphologic changes in the TMJs, although these changes often have no pathologic significance. The radiographic findings generally play much less of a role than the results of the clinical examination when making the diagnosis and deciding whether CMD patients require treatment.

The use of advanced imaging—primarily cone beam computed tomography (CBCT) and magnetic resonance imaging (MRI)—following pain-focused history taking, clinical examination, and the availability of a recent panoramic radiograph—is reserved for cases in which the anticipated findings of further imaging techniques are likely to have a clear relevance in terms of clarifying the diagnosis and the resulting treatment or prognosis. Such relevance exists if the individual’s signs and symptoms or the examination findings cause the clinician to consider in differential diagnostic terms (for the purpose of exclusion or differentiation) diagnoses that may have specific and, in some cases, irreversible therapeutic consequences. Relevance can also apply if the signs and symptoms or the examination findings cannot be satisfactorily influenced despite the initiation of conservative, reversible

therapeutic measures. By contrast, clear relevance does not exist if the findings from the advanced imaging would have no implications for the diagnosis being made and the treatment being adopted but are only being gathered together with other data in the sense of “bulk screening.”

Treatment

A number of treatment methods are available for patients with the different facets of painful CMD. However, the level of evidence is not high for all of these methods. In this age of evidence-based medicine, unchecked personal experience and advice from recognized authorities that is given without proof is no longer sufficient for patient-centered decision making. Instead, evidence of the benefit of prospective intervention(s) is required. The evidence largely comes from results and findings gained from clinical trials and published in specialist journals.

Modern treatment of painful CMD is characterized by an interdisciplinary and multimodal approach, which is always guided by the severity of the symptoms in the individual patient. For instance, a clear distinction must be made between acute, acute persistent, and chronic pains. Painful CMD is a regional variant of musculo-skeletal discomfort that can be found in other parts of the body. Contemporary diagnostics and treatment of painful CMD are therefore based on proven medical concepts.

Treatment recommendations from well-known professional associations suggest that reversible therapies are preferable to invasive interventions.²²⁻²⁵ The risk-benefit ratio of the available treatment methods must always be considered.

Oral splints are the most commonly used method for CMD treatment in dentistry. Their pain-reducing effect is proven, irrespective of the design and material used.²⁶ The Michigan splint is regarded internationally as the gold standard because of its favorable risk-benefit ratio²⁷; it is also the most widely used type of splint worldwide.²⁸

Furthermore, there is a high level of external evidence for physiotherapy self-treatment²⁹ and drug therapy (eg, nonsteroidal anti-inflammatory drugs taken for a few days for TMJ pains; a few months' administration of low-dose tricyclic antidepressants for persistent pains).^{30,31} In addition, physical therapy and professional physiotherapy,³² muscle-relaxing techniques (including biofeedback and behavioral therapy),^{33,34} and acupuncture^{35,36} are recommended, even though the degree of efficacy of these methods has been only partly qualified in recent studies.^{37,38} The

listed treatment methods should not be selected based on an either/or decision but should be used in a multimodal way depending on the particular case, especially in complex cases.³⁹


Dentists who wish to care for the whole range of patients with painful CMD would be wise to build up a network of colleagues from other professional spheres so that they can act skillfully and quickly when necessary. This includes:

- *Physiotherapy.* It is important to ensure that the physiotherapist is very knowledgeable about treatment of the facial region.
- *Pain psychotherapy.* Look online for certified therapists in your local area who offer specialized pain psychotherapy.

Moreover, making contact with the patient's family doctor before treatment is strongly recommended, especially in cases that have become chronic. Other disciplines, such as orthopedics; rheumatology; pain medicine; neurology; or ear, nose, and throat (ENT) medicine, should also be involved in the treatment when necessary.

References

1. Hugger A, Lange M, Schindler HJ, Türp JC. Begriffsbestimmungen. Funktionsstörung, dysfunktion, kraniomandibuläre dysfunktion (CMD), myoarthropathie des kausystems (MAP). Dtsch Zahnärztl Z 2016;71:165.
2. Schulte W. The functional treatment of the myoarthropathies of the masticatory apparatus: A diagnostic and physio-therapeutic program [in German]. Dtsch Zahnärztl Z 1970;25:422-449.
3. Sessle BJ. The neural basis of temporomandibular joint and masticatory muscle pain. J Orofac Pain 1999;13:238-245.
4. Palla S. Myoarthropathien des kausystems. In: Palla S (ed). Myoarthropathien des Kausystems und Orofaziale Schmerzen. Zürich: Department of Prosthodontics and Total Prosthetics, Center for Oral and Maxillofacial Surgery, University of Zurich, 1998:3-16.
5. Simons DG. Clinical and etiological update of myofascial pain from trigger points. J Musculoskelet Pain 1996;4:93-121.
6. Fridén J, Seger J, Sjöström M, Ekblom B. Adaptive response in human skeletal muscle subjected to prolonged eccentric training. Int J Sports Med 1983;4:177-183.
7. Hoheisel U, Reinohl J, Unger T, Mense S. Acidic pH and capsaicin activate mechanosensitive group IV muscle receptors in the rat. Pain 2004;110:149-157.
8. De Boever JA, Carlsson GE. Etiology and differential diagnosis. In: Zarb GA, Carlsson GE, Sessle BE, Mohl ND (eds). Temporomandibular Joint and Masticatory Muscle Disorders, ed 2. Copenhagen: Mosby, 1994:171-187.
9. LeResche L, Saunders K, Von Korff MR, Barlow W, Dworkin SF. Use of exogenous hormones and risk of temporomandibular disorder pain. Pain 1997;69:153-160.
10. Stohler CS. Masticatory myalgias. Emphasis on the nerve growth factor-estrogen link. Pain Forum 1997;6:176-180.

- 
11. Lam DK, Sessle BJ, Cairns BE, Hu JW. Neural mechanisms of temporomandibular joint and masticatory muscle pain: A possible role for peripheral glutamate receptor mechanisms. *Pain Res Manag* 2005;10:145-152.
 12. Howard JA. Temporomandibular joint disorders, facial pain, and dental problems in performing artists. In: Sataloff RT, Brandfonbrener AG, Lederman RJ (eds). *Textbook of Performing Arts Medicine*. New York: Raven, 1991:111-169.
 13. Türp JC. Temporomandibular Pain. Clinical Presentation and Impact. Berlin: Quintessenz, 2000.
 14. Türp JC, Alpaslan C, Gerds T. Is there a greater mandibular movement capacity towards the left? Verification of an observation from 1921. *J Oral Rehabil* 2005;32:242-247.
 15. Gerber A. Logik und mystik der kiefergelenksbeschwerden. *Schweiz Monatsschr Zahnmed* 1964;74:687-697.
 16. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: Review, criteria, examinations and specifications, critique. *J Craniomandib Disord Facial Oral Pain* 1992;6:301-355.
 17. Schiffman E, Ohrbach R, Truelove E, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *J Oral Facial Pain Headache* 2014;28:6-27.
 18. Okeson JP. *Bell's Oral and Facial Pains*, ed 7. Chicago: Quintessence, 2014.
 19. Merskey H, Bogduk N (eds). *Classification of Chronic Pain*, ed 2. Seattle: IASP, 1994.
 20. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain* 1992;50:133-149.
 21. Nilges P, Essau C. Depression, anxiety and stress scales: DASS—A screening procedure not only for pain patients [in German]. *Schmerz* 2015;29:649-657.
 22. de Leeuw R, Klasser GD. *Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management*, ed 5. Chicago: Quintessence, 2013.
 23. Greene CS. Managing the care of patients with temporomandibular disorders: A new guideline for care. *J Am Dent Assoc* 2010;141:1086-1088.
 24. Hugger A, Schindler HJ, Böhner W, et al. Therapy of temporomandibular joint pain: Recommendations for clinical management [in German]. *Schmerz* 2007;21:116-130.
 25. Schindler HJ, Türp JC, Sommer C, Kares H, Nilges P, Hugger A. Therapy of masticatory muscle pain: Recommendations for clinical management [in German]. *Schmerz* 2007;21:102-115.
 26. Ebrahim S, Montoya L, Busse JW, Carrasco-Labra A, Guyatt GH. The effectiveness of splint therapy in patients with temporomandibular disorders: A systematic review and meta-analysis. *J Am Dent Assoc* 2012;143:847-857.
 27. Friction J, Look JO, Wright E, et al. Systematic review and meta-analysis of randomized controlled trials evaluating intraoral orthopedic appliances for temporomandibular disorders. *J Orofac Pain* 2010;24:237-254.
 28. Klasser GD, Greene CS. Oral appliances in the management of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;107:212-223.
 29. 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.
 30. Hugger A, Schindler HJ, Türp JC, Hugger S. Pharmacological therapy of temporomandibular joint pain [in German]. *Z Evid Fortbild Qual Gesundheitswes* 2013;107:302-308.
 31. Sommer C. Pharmacology of orofacial pain [in German]. *Schmerz* 2002;16:381-388.
 32. Kraaijenga S, van der Molen L, van Tinteren H, Hilgers F, Smeele L. Treatment of myogenic temporomandibular disorder: A prospective randomized clinical trial, comparing a mechanical stretching device (TheraBite®) with standard physical therapy exercise. *Cranio* 2014;32:208-216.
 33. Hellmann D, Schindler HJ. Koordinatives training zur funktionellen rehabilitation des kraniomandibulären systems. *Quintessenz* 2015;66:1499-1507.
 34. Kaiser U, Nilges P. Behavioral concepts in the treatment of orofacial pain [in German]. *Schmerz* 2015;29:179-185.
 35. Cho SH, Whang WW. Acupuncture for temporomandibular disorders: A systematic review. *J Orofac Pain* 2010;24:152-162.
 36. La Touche R, Goddard G, De-la-Hoz JL, et al. Acupuncture in the treatment of pain in temporomandibular disorders: A systematic review and meta-analysis of randomized controlled trials. *Clin J Pain* 2010;26:541-550.
 37. 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.
 38. Zhang Y, Montoya L, Ebrahim S, et al. Hypnosis/relaxation therapy for temporomandibular disorders: A systematic review and meta-analysis of randomized controlled trials. *J Oral Facial Pain Headache* 2015;29:115-125.
 39. Türp JC, Jokstad A, Motschall E, Schindler HJ, Windecker-Gétaz I, Ettlín DA. Is there a superiority of multimodal as opposed to simple therapy in patients with temporomandibular disorders? A qualitative systematic review of the literature. *Clin Oral Implants Res* 2007;18(suppl 3):s138-s150.

Page references followed by “f” denote figures;
“t” denote tables.

A

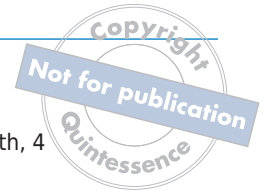
Actin, 130
Action potential, 130
Activated osteoarthritis
 case study of, 38–40, 38f–40f
 diagnostic criteria for, 22
 illustration of, 20f
 pathogenic model of, 141f
 treatment-refractory, 40, 40f
Acupuncture, 120
Acute pain, 107–108
Acute-persistent pain, 107–108, 141
ADD. See Anterior disc displacement.
Advanced diagnostics, 105f, 106
Algometer, 17, 18f, 109f
Allodynia, 142
Anesthesia
 auriculotemporal nerve, 37f
 of lateral pterygoid muscle, 36, 37f
Anterior disc displacement
 diagnostic criteria for, 22
 myofascial pain and, 31–33, 31f–33f
Anterior insula, 160, 160f
Aqualizer, 75, 76f
Arthralgia, 22
Arthrocentesis, 40, 120
Arthroscopy, 120
Articular disocclusion potential, 94, 135
Ash, Major M., 89
ATPase, 132
Auriculotemporal nerve anesthesia, 37f
Axis I
 description of, 6
 somatic findings, 17
Axis II, 6

B

Balance training, 75, 75f
Balkwill, Francis H., 89
Baseplate, 46, 46f
Bauer, A., 90
Behavioral therapy, 120
Bennett, Norman G., 89
Bennett movement, 89
Biofeedback, 120
Biomedical interventions, 42
Biopsychosocial function, 124
biteFork, 75, 77f
BiteStrip, 96, 96f
Bock, Oskar, 89
Brace, C. Loring, 90
Bradford Hill criteria, 90t, 91–92
Brady, W.J., 90
Bruxism, sleep
 definition of, 95
 description of, 29, 35, 39
 diagnosis of, 95f, 95–96
 Michigan splint for, 97
 nocturnal, 95
 NTI-tss device for, 98
 occlusion and, 91
 painful craniomandibular dysfunction and, 97
 prevalence of, 95
 protrusive splints for, 97–98
 scalloped impressions associated with, 95, 95f
 stippling associated with, 95, 95f
 treatment of, 97–98
Bruxoff, 96, 96f

C

Calcium, 130, 131f
Case-control studies, 84
CBCT. See Cone beam computed tomography.



CBT. See Cognitive behavioral therapy.
 CDT. See Cold detection threshold.
 Central sensitization, 142, 152, 153f
 Centric guide, 31f
 Cerebellum, 158
 Cerebral activation patterns, 151, 157-161, 159f-160f
 Chewing, 157
 Christensen, Carl, 89
 Christensen's phenomenon, 89
 Chronic pain, 107-108
 Cinderella hypothesis, 139-140
 Clinical examination, 8
 Closing movement
 illustration of, 46f
 onto wax record, 50, 50f-51f
 physiology of, 45
 registration using
 aids for, 46f-47f, 46-48
 interocclusal, 48, 49f
 performing of, 46f
 wax impressions, 49f
 reproducibility of, 48
 CMD. See Craniomandibular dysfunction.
 Cognitive behavioral therapy, 42
 Cold detection threshold, 109f, 110t
 Cold pain threshold, 109f, 110t
 Compression, of temporomandibular joint, 93
 Condylar position, 93-94
 Condyle repositioning, 146
 Cone beam computed tomography, 8
 Confidence interval, 85
 Coordination disorders, 72f
 Coordinative training
 balance training, 75, 75f
 case study of, 74-78, 74f-78f
 description of, 67
 EMG feedback training, 75-76, 76f
 feedback training, 73-74
 indication for, 79
 kinematic feedback, 74
 myofunctional exercises. See Myofunctional exercises.
 RehaBite. See RehaBite.
 self-massage, 69, 69f
 Cortical plasticity, 134
 CPT. See Cold pain threshold.
 Craniomandibular dysfunction, painful
 Axis I, 6, 17
 Axis II, 6
 bruxism as risk factor for, 35, 39, 97
 case studies of, 24-43
 characteristics of, 43
 clinical examination for, 8
 clinical findings, 15f
 definition of, 3
 diagnoses, 6, 11
 diagnostics for. See Diagnostics.

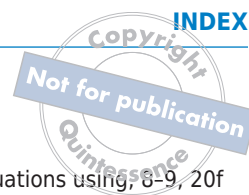
 endogenous substances associated with, 4
 epidemiology of, 4
 etiology of, 4, 12
 gender predilection of, 4
 history taking for. See History taking.
 imaging of, 8-9, 20f
 manifestations of, 4
 occlusion and, 89-92
 oral splints for, 9
 pain associated with. See Pain.
 pain psychotherapy for, 9
 physiotherapy for, 9
 quantitative sensory testing in, 112-113
 terminology associated with, 3-4
 treatment of. See Treatment.
 Craniomandibular system rehabilitation, 68-69
 Curative medicine, 123
 Curve of Spee, 89
 Cytokines, 121

D

DASS. See Depression anxiety stress scales.
 DC/TMD. See Diagnostic Criteria for Temporomandibular Disorders.
 Depression anxiety stress scales, 8
 Diagnostic Criteria for Temporomandibular Disorders, 6, 7t
 Diagnostics
 advanced, 105f, 106
 description of, 7-9
 history taking. See History taking.
 imaging. See Imaging.
 minimum, 12f, 12-23, 105f, 106
 staged model of, 105f, 105-106
 standard, 105f, 106
 time required for, 21f
 Differential diagnoses, 106
 Distraction, of temporomandibular joint, 93
 Distraction splints, 147
 DMA. See Dynamic mechanical allodynia.
 Dynamic mechanical allodynia, 110t, 113

E

Education, as treatment, 23, 118
 Electromyography
 bruxism diagnosis using, 96, 96f
 feedback training using, 75-76, 76f
 EMG. See Electromyography.
 Emotional stress, 7
 Endomysium, 129
 Epimysium, 129
 Estrogen, 4
 Extrinsic feedback, 73

**F**

Facebow, 54, 54f
 Feedback training, 73–74
 Feedforward loops, 158
 Fibromyalgia, 106
 Flupirtine, 30
 fMRI. *See* Functional magnetic resonance imaging.
 Follow-up sessions, 41
 Freesmeyer, Wolfgang, 89
 Frontal plateau
 closing movement onto. *See* Closing movement.
 fabrication of, 46, 47f–48f
 illustration of, 46f
 MRS 2 splint with, 61, 62f
 occlusal splint with, 41
 Frontal tracing stylus record, 47f
 Functional magnetic resonance imaging, 157
 Functional rehabilitation, 124

G

GCPS. *See* Graded Chronic Pain Scale.
 Gerber, Albert, 93
 Glutamate, 4, 139
 Graded Chronic Pain Scale, 8, 21f
 GrindCare, 96, 96f
 Gutowski, A., 90
 Gysi, Alfred, 89

H

H reflex, 154
 Heat pain threshold, 109f, 110t
 History taking
 definition of, 7
 description of, 7–8
 pain-related invasive measures, 108
 semi-structured questionnaire, 12–17, 14f–15f
 Home exercises
 physiotherapy, 126
 rehabilitation, 68–69, 124
 HPT. *See* Heat pain threshold.
 Hydrostatic principle, 75, 76f
 Hypnosis, 120

I

IASP. *See* International Association for the Study of Pain.
 ICF. *See* International Classification of Functioning, Disability, and Health.
 ICSD. *See* International Classification of Sleep Disorders.

Imaging

 craniomandibular dysfunction evaluations using, 8–9, 20f
 panoramic radiographs, 8, 20f
 Insula, anterior, 160, 160f
 International Association for the Study of Pain, 7
 International Classification of Functioning, Disability, and Health, 123
 International Classification of Sleep Disorders, 95
 Interocclusal record, 45
 Intrinsic feedback, 73
 Isometric exercises, 70f–71f, 71
 Isotonic exercises, 71, 71f

J

Jarabak, J.R., 89
 Jaw clenching, 154
 Jaw muscles/musculature
 pain in, 138–140
 physiologic resting activity of, 138
 structural heterogeneity of, 132
 Jaw thrusting, 29, 41
 JMA measuring device, 74, 74f

K

Kinematic feedback, 74

L

Laboratory-fabricated registration aids, 46, 46f–47f
 Langer, Karl, 89
 Langer diagram, 89
 Lateral pterygoid muscle anesthesia, 36, 37f
 Laterotrusion restrictions, 72f
 Long-term synaptic plasticity, 134
 Loos, R., 90
 L-systems, 131f

M

Magnetic resonance imaging, 8
 Mandibular movement
 limitations in, 5–6
 measurement of, 8
 reflex adaptation of, 5
 Mandibular splint, 63, 63f
 Masseter muscle
 motor units in, 131f
 palpation of, 18f
 Masticatory muscles
 anatomy of, 129f



- fibers of, 129, 130f, 132–133
 - functional pattern reorganization of, 147, 148f
 - learning capacity of, 134
 - motor adaptations of, 134
 - neuromuscular training effects on, 151, 151f
 - occlusal splint effects on activity of, 146–147
 - palpation of, 8, 16f, 17, 18f–19f
 - regeneration potential of, 143
 - structural heterogeneity of, 132–133
 - Masticatory system
 - dysfunction of, 3
 - finite element model of, 150f
 - muscle cells of, 129, 129f
 - myoarthropathy of, 4
 - neck muscles and, 154
 - Maximum intercuspation, 93
 - Maximum laterotrusion, 5
 - McCollum, Beverly B., 89
 - MDT. *See* Mechanical detection threshold.
 - Mechanical detection threshold, 110t
 - Mechanical pain sensitivity, 109f, 110t, 113
 - Mechanical pain threshold, 109f, 110t, 113
 - Methocarbamol, 30, 119
 - Michigan splint
 - bruxism treated with, 97
 - description of, 9, 61, 62f
 - fabrication of, 61, 62f, 64, 64f–66f
 - Microdistraction, of temporomandibular joint, 150
 - Microdistraction splint, 24, 40, 40f
 - Micro-edema, 139
 - Microtrauma, 140
 - Minimum diagnostics, 12f, 12–23, 105f, 106
 - Model, for occlusal splint fabrication
 - fabrication of, 53, 54f
 - mounting of, 54, 54f–55f
 - Modular rehabilitation splints
 - case studies of, 26, 29, 35, 39
 - description of, 23–24, 54
 - MRS 0
 - fabrication of, 55–60, 56f–60f
 - features of, 55
 - finishing of, 59, 59f–61f
 - modular modification of, 61, 62f–63f
 - spray-on fabrication technique for, 55, 56f
 - thermoforming sheet for, 57, 57f–58f
 - MRS 1, 61, 62f, 64, 64f–66f
 - MRS 2, 61, 62f
 - MRS 3, 63, 63f
 - MRS 4, 63, 63f
 - Monson, George S., 89
 - Motor adaptations, 134, 142–143, 147
 - Motor control, 68f, 133
 - Motor units, 130, 130f–131f, 148f
 - Mouth opening
 - maximum pain-free, 17f
 - passive stretching for, 73, 73f
 - reduced, stretching exercises for, 73, 73f
 - MPS. *See* Mechanical pain sensitivity.
 - MPT. *See* Mechanical pain threshold.
 - MRI. *See* Magnetic resonance imaging.
 - MRS. *See* Modular rehabilitation splints.
 - Muscle relaxants
 - methocarbamol, 119
 - severe myofascial pain treated with, 30
 - Muscular imbalance
 - EMG feedback training for, 75–76, 76f
 - RehaBite for, 77
 - Myoarthropathic pains
 - prevalence of, 138
 - risk factors for, 85–89, 86t–88t
 - Myofascial pain. *See also* Pain.
 - algorithm for, 42f
 - anterior disc displacement and, 31–33, 31f–33f
 - arthrogenic, 34–35
 - case studies of, 25f–37f, 25–37
 - chronic, 32–33
 - diagnostic criteria for, 22
 - differential diagnosis of, 106
 - moderate, 25f, 25–27
 - severe, 28–30
 - temporomandibular joint clicking with, 34f
 - Myofunctional exercises
 - for coordination disorders, 72f
 - elements of, 69
 - isometric exercises, 70f–71f, 71
 - isotonic exercises, 71, 71f
 - for laterotrusion restrictions, 72f
 - mechanisms of, 121
 - for straight jaw movement, 72, 72f
 - Myosin, 130
 - Myosin heavy chains, 132
- ## N
- Nerve growth factor, 4
 - Neuromuscular activity, cerebral representation of, 158, 158f
 - Neuronal plasticity, 151
 - Neuropathic pain, 13, 106, 111
 - Neuropeptides, 142
 - Neuroplasticity, 134, 143
 - Nociception, 149
 - Nociceptive pain, 4, 140
 - Nociceptive trigeminal inhibition tension suppression system.
 - See* NTI-tss device.
 - Nociceptors, 138f, 141, 152f
 - Nocturnal bruxism, 95
 - Nonsteroidal anti-inflammatory drugs, 119
 - NSAIDs. *See* Nonsteroidal anti-inflammatory drugs.
 - NTI-tss device, 98



O

- Occlusal dysesthesia, 43
- Occlusal examination, 8
- Occlusal splints
- bruxism diagnosis using, 95
 - CAD/CAM-fabricated, 66f
 - cerebral activation patterns, 151, 157-161, 159f-160f
 - condyle repositioning by, 146
 - description of, 22
 - effectiveness of, 113-114, 119
 - fabrication of
 - impression taking for, 53
 - model used in, 53-54, 54f-55f
 - follow-up sessions for, 41
 - functional magnetic resonance imaging studies of, 157-161
 - joint-loading pattern reorganization by, 147, 148f
 - literature review regarding, 113-114
 - mechanism of action, 119
 - muscular functional pattern reorganization by, 147, 148f
 - neurobiology of, 129-155
 - nonspecific behavioral therapeutic effects of, 147
 - pain perception affected by, 160
 - rehabilitative uses of, 124-126
 - temporomandibular joint benefits of, 145
 - tensile forces from torque, 149f
 - therapeutic effects of, hypotheses regarding, 146-152
- Occlusal vertical dimension, 146-147, 150f
- Occlusion
- Bradford Hill criteria for assessing, 90t, 91-92
 - craniomandibular dysfunction and, 89-92
 - definition of, 124
 - historical descriptions of, 89-90
- Odds ratio
- calculation of, 84
 - definition of, 83-84
 - interpretation of, 85
- OR. *See* Odds ratio.
- Oral splints, for craniomandibular dysfunction, 9
- Orthopantomogram, 8
- Osteoarthritis, activated
- case study of, 38-40, 38f-40f
 - diagnostic criteria for, 22
 - illustration of, 20f
 - pathogenic model of, 141f
 - treatment-refractory, 40, 40f
- OVD. *See* Occlusal vertical dimension.
- P**
- Pain. *See also* Myofascial pain.
- acute, 107-108
 - acute-persistent, 107-108, 141
 - affective-emotional component of, 151
 - biomechanical chain reactions of, 153f, 153-154
 - cerebral activation patterns and, 160
 - chronic, 107-108, 152
 - chronification of, 141-142
 - in craniomandibular dysfunction, 3
 - definition of, 7
 - diagnoses related to, 7t
 - duration of, 13
 - frequency of, 13
 - jaw muscle, 138-140
 - motor adaptation to, 142-143, 147
 - motor control affected by, 68f
 - myoarthropathic, 85-89, 86t-88t
 - neuropathic, 13, 106, 111
 - nociceptive, 4, 140
 - psychotherapy for, 9
 - quality of, 13
 - referred, 142
 - sensory-discriminatory component of, 151
 - temporomandibular joint, 5, 36, 140-141
 - in temporomandibular joint, 5
 - whole-body drawings of, 20f
- Pain adaptation
- description of, 67-68
 - model of, 68, 142f, 142-143
- Pain history, 7-8, 13
- Pain perception, 160
- Pain threshold, 153f
- Painful craniomandibular dysfunction. *See* Craniomandibular dysfunction, painful.
- Palmitoylethanolamide, 119
- Palpation
- of masticatory muscles, 8, 16f, 17, 18f-19f
 - of temporomandibular joint, 19f
- Panoramic radiographs, 8, 20f
- Paradoxical heat sensations, 110t
- Parafunctional habits and activities, 17, 147, 154f. *See also* Bruxism.
- Passive stretching, 73, 73f, 121
- PEA. *See* Palmitoylethanolamide.
- Perimysium, 129
- Peripheral sensitization, 141
- Phantom bite syndrome, 43
- Pharmacotherapy, 119
- PHS. *See* Paradoxical heat sensations.
- Physical therapy, 119-121
- Physiotherapy
- for craniomandibular dysfunction, 9
 - effectiveness of, 119-120
 - home exercises, 126
 - mechanisms of, 121
 - self-treatment, 120
 - severe myofascial pain treated with, 30
- Placebo effect, 147
- PPT. *See* Pressure pain threshold.
- Pressure pain threshold, 109f, 110t, 113
- Progressive muscle relaxation, 120



Protrusive splints, for bruxism, 97–98
 Psychosocial stress, 7
 Psychotherapy, pain, 9

Q

QST. See Quantitative sensory testing.
 Qualitative somatosensory testing, 111
 QualST. See Qualitative somatosensory testing.
 Quantitative sensory testing
 in craniomandibular dysfunction, 112–113
 definition of, 109
 in orofacial region, 111–113
 parameters of, 110t
 principles of, 109
 somatosensory profiles, 111, 111f
 test methods for, 109, 110t

R

RDC/TMD. See Research Diagnostic Criteria for Temporomandibular Disorders.
 Reconstruction, 123
 Referred pain, 142
 Regional sensitization, 152f
 Registration aids
 chairside fabrication of, 46–48, 47f
 laboratory-fabricated, 46, 46f–47f
 Rehabilitation
 curative medicine versus, 123
 definition of, 123
 in dentistry, 124
 functional, 124
 in functional therapy, 123–126
 historical changes in, 123f
 home exercises for, 68–69, 124
 occlusal splints and, 124–126
 overview of, 68–69
 RehaBite
 description of, 40
 function of, 77, 77f
 illustration of, 27f, 77f
 training intensity with, 78, 78f
 Research Diagnostic Criteria for Temporomandibular Disorders, 6, 7t, 22
 Restoration, 123
 Risk, 83

S

Sarcoplasmic reticulum, 131f
 SB-RDC. See Sleep Bruxism Research Diagnostic Criteria.

Scalloped impressions, 95f
 Schlund, D., 90
 Schweitzer, J.M., 90
 Secondary hyperalgesia, 142
 Segmental comorbidities, 13
 Self-massage, 69, 69f
 Semi-structured questionnaire, 12–17, 14f–15f
 Short-term synaptic plasticity, 134
 Siebert, Götz, 89
 Sleep bruxism. See Bruxism, sleep.
 Sleep Bruxism Research Diagnostic Criteria, 96
 Spee, Ferdinand Graf von, 89
 Splints. See Modular rehabilitation splints; Occlusal splints.
 Spray-on technique, for MRS 0 fabrication, 55, 56f
 Standard diagnostics, 105f, 106
 Stippling, 95, 95f
 Straight jaw movement, 72, 72f
 Stress, 7
 Stuart, Charles E., 89
 Swallowing, 159
 Synaptic plasticity, 134
 Synovial fluid, 93

T

Taxonomies, 107f, 107–108
 Temporalis muscle, 133f
 Temporomandibular joint
 anatomy of, 135f
 biomechanical stresses on, 147
 biomechanics of, 135–136
 clicking of, 5, 13, 34f
 compression of, 93
 degrees of freedom, 135–136
 disc-condyle complex in, 135f
 distraction of, 93
 grating noises in, 5
 kinematics of, 136
 microdistraction of, 150
 muscular function pattern reorganization in, 147, 148f
 neurobiologic function of, 135–136
 occlusal splint benefits for, 145, 147
 pain in, 5, 36, 140–141
 palpation of, 19f
 popping of, 5
 self-massage of, 69, 69f
 symmetry of, 137–138
 TENS. See Transcutaneous electrical nerve stimulation.
 Thermal sensory limen, 109f, 110t
 Thermoforming, 57, 57f–58f
 Thomas, Peter K., 89
 TMJ. See Temporomandibular joint.
 Transcutaneous electrical nerve stimulation, 119–120
 Transverse tubules, 130, 131f

**Treatment**

- acupuncture, 120
 - algorithm for, 42f
 - arthrocentesis, 40, 120
 - arthroscopy, 120
 - aspects of, 23
 - behavioral therapy, 120
 - biofeedback, 120
 - coordinative training. *See* Coordinative training.
 - description of, 4-6, 9
 - education as, 23, 118
 - effectiveness of, 118t, 118-120
 - hypnosis, 120
 - medication, 23
 - modular rehabilitation splints. *See* Modular rehabilitation splints.
 - nonsteroidal anti-inflammatory drugs, 119
 - occlusal splints. *See* Occlusal splints.
 - options for, 117t
 - pharmacotherapy, 119
 - physical therapy, 119-121
 - physiotherapy. *See* Physiotherapy.
 - progressive muscle relaxation, 120
 - results of, 122, 122f
- Treatment-refractory activated osteoarthritis, 40, 40f
- Triad, 131f
- Tricyclic antidepressants, 119
- TSL. *See* Thermal sensory limen.
- T-tubules. *See* Transverse tubules.

V

- VDT. *See* Vibration detection/disappearance threshold.
- Vibration detection/disappearance threshold, 109f, 110t

W

- Warm detection threshold, 109f, 110t
- Washburn, H.B., 90
- Wax record
 - closing movement onto, 50, 50f-51f
 - instruments for, 50f
- WDT. *See* Warm detection threshold.
- Wheeler, H.L., 90
- WHO. *See* World Health Organization.
- Whole-body pain drawings, 20f
- Wind-up ratio, 110t, 113
- World Health Organization, 123
- WUR. *See* Wind-up ratio.