Sleep Medicine for Dentists
A Practical Overview

Edited by

Gilles J. Lavigne, DMD, MSc, PhD, FRCD(C)
Professor of Oral Medicine and Canada Research Chair in Pain, Sleep and Trauma
Dean, Faculty of Dental Medicine
University of Montreal

Sleep and Biological Rhythm Center and Department of Surgery
Montreal Sacré-Coeur Hospital
Montreal, Quebec, Canada

Peter A. Cistulli, MBBS, PhD, MBA, FRACP
Professor of Respiratory Medicine
Head, Discipline of Sleep Medicine
University of Sydney

Research Leader, Woolcock Institute of Medical Research

Director, Centre for Sleep Health and Research
Royal North Shore Hospital
Sydney, New South Wales, Australia

Michael T. Smith, PhD, CBSM
Associate Professor of Psychiatry and Behavioral Sciences
Director, Behavioral Sleep Medicine Program
Johns Hopkins University School of Medicine
Baltimore, Maryland

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FOREWORD

Healthy sleep is vital for mental and physical well-being, and yet our understanding of the mechanisms that link sleep processes and brain and body function is relatively new. Until the discovery of rapid eye movement (REM) sleep in the 1950s, sleep was considered a passive state without particular import in the medical context. Today we understand that sleep is an active process that subserves many functions of the brain and body. In 1989, publication of the first book on sleep medicine (*The Principles and Practice of Sleep Medicine*, edited by Kryger et al) heralded sleep as a specialty in its own right. In a similar way, this new textbook heralds another phase in the development of clinical sleep practice for dental practitioners.

In his historical account of sleep medicine, Bill Dement points out that sleep apnea was overlooked by pulmonologists and otolaryngologists because they did not consider sleep. It was equally true that those doing research in human sleep (mostly neurologists and psychiatrists) also missed sleep apnea because they did not consider breathing. The great irony about the emergence of dental sleep medicine is that generations of dentists have looked in the mouths of countless individuals with sleep-disordered breathing without knowing of the disorder. Given that the dentist is often the first and only health care practitioner to look in the oral cavity, a good knowledge of sleep apnea should be part of the profession's knowledge base. From a broader perspective, these examples underscore the importance of a multidisciplinary approach; very few centers bring physician, surgeon, and dentist together to develop a management plan.

This book provides a compact introduction to sleep disorders. Appropriately, many chapters focus on sleep-disordered breathing because the dentist has a potentially major role in both its recognition and treatment. While continuous positive airway pressure (CPAP) remains the first-line therapy for sleep apnea, there is an important role for mandibular advancement appliances, which require adequate fitting by a well-informed dentist to be effective.

In addition, we should identify children who are at risk of developing sleep apnea. Approximately 10% of children who snore most nights are likely future apnea patients. Management plans designed to promote the growth of the upper airway and to prevent obesity provide a possibility for real prevention. This will happen only if the dental profession engages actively in the area.

The editors and contributors of this book are to be congratulated on putting together the first comprehensive text on dental sleep medicine.

Colin E Sullivan, AO, MB BS, PhD, FRACP, FTSE, FAA
Professor of Respiratory Medicine
Department of Medicine
University of Sydney
Sydney, New South Wales, Australia

FOREWORD

The science and clinical implications of sleep medicine should resonate strongly with the dental profession. Not only does the physiologic and behavioral state of our own and indeed our patients' sleep experiences involve a significant part of daily life, but dental sleep medicine is a rapidly evolving area of health care. A number of recognized sleep-related disorders have relevance to dental practice, and consequently, the availability of a book devoted to this subject has long been overdue. The book editors and authors collectively have impeccable academic credentials and clinical experience, and they have produced a lucid and apposite synthesis of the many topics that bear on sleep medicine and its particular applicability to dental practice.

The book is organized into four sections that deal first with general aspects of sleep and sleep disorders, then specifically sleep breathing disorders, sleep bruxism and other sleep-related movement disorders, and finally sleep–orofacial pain interactions. The inclusion of an exhaustive range of pertinent topics has ensured a perceptive and balanced approach to the subject. Unlike so many multi-authored texts on equally complex and fascinating health-related subjects, this one provides a mix of science, common sense, and pragmatism, particularly in the review of the management of sleep-related disorders.

We believe that this will prove to be a seminal text for the dental profession. It could very well turn out to be the catalyst required for the subject of dental sleep medicine to be included as an integral part of dental school curricula. The editors are to be commended for breaking new ground and ushering in an era of better understanding of a subject that has been relatively neglected in dental education and practice. Traditional and exclusive preoccupations with teeth, masticatory function, and related disorders—staples of dental education and texts—can now be broadened to include an awareness of our bodies' more extensive physiology and behavior.

George A. Zarb, BChD, DDS, MS, MS, FRCD(C)
Professor Emeritus
Department of Prosthodontics
Faculty of Dentistry
University of Toronto
Toronto, Ontario, Canada

Barry J. Sessle, MDS, PhD, DSc(hc), FRSC, FCAHS
Professor and Canada Research Chair in Craniofacial Pain and Sensorimotor Function
Faculties of Dentistry and Medicine
University of Toronto
Toronto, Ontario, Canada

PREFACE

The last 50 years have seen remarkable advances in the study of circadian biology and the neurophysiology of sleep. The genes that regulate these biologic rhythms have been isolated, and interactions between sleep and almost all other body systems (eg, respiratory, cardiovascular, endocrine, and neurologic) have become a focus for research. These scientific advances have emanated from diverse clinical disciplines, including internal medicine, pulmonology, neurology, otorhinolaryngology, pediatric medicine, psychiatry, psychology, and nursing. The range in specialties reflects the interdisciplinary nature of sleep and its disorders, and many critical contributions have also come from the field of dentistry. Currently, approximately 100 distinct clinical sleep disorders have been recognized. Certain disorders, including sleep apnea, sleep bruxism, and chronic pain, have a direct bearing on the practice of dentistry, which makes a working understanding of sleep biology (somnology) and sleep pathology (sleep medicine) a useful and necessary addition to the knowledge base of dental practitioners.

Sleep disorders decrease the quality of sleep by breaking its continuity, ie, they trigger a physiologic response that tends to push a sleeping person to a sublevel of wakefulness. Although the sleeping individual is unaware, his or her brain and autonomic nervous system are under a state of transient arousal. It is normal to observe brief arousals during sleep, but when these are too frequent or too long, they can cause mood alterations, memory problems, and performance deficits in healthy subjects after only a few days. Disordered breathing during sleep may cause serious alteration to patients' daytime vigilance, resulting in an increased risk of transport- or work-related accidents. In the long term, sleep apnea is known to be a serious and potentially modifiable factor for cardiovascular disease, including heart failure and stroke. The intrusion of snoring and tooth-grinding sounds are also a major cause of sleep disruption for the patient's bed partner and can be a source of marital conflict.

Orofacial pain may be associated with delayed sleep onset and disturbed sleep continuity; hence, it is a major cause of insomnia that may predispose patients to mood alteration and depression. Poor sleep is known to impair pain processing and can directly contribute to pain augmentation. Therefore, the prevention and management of sleep disorders should become a routine component of the treatment plan for chronic orofacial pain–related conditions.

Sleep medicine is often an overlooked part of public health. In many countries, access to sleep medicine constitutes a major public health challenge. In countries where therapy is available, treating sleep disturbances either as primary disorders or as comorbidities with other medical, psychiatric, or dental conditions is a significant opportunity to improve and prevent medical and psychiatric morbidity. It may also minimize the substantial financial burden related to the direct and indirect consequences of disturbed sleep. In Australia, for example, the overall cost of sleep disorders in 2004 was estimated to be US $7.5 billion with indirect costs of $808 million in related motor vehicle accidents.

The dentist plays an important role in sleep medicine by examining patients during their annual or biannual dental checkup for the risk of sleep-disordered breathing. Patients reporting snoring, sleepiness, and morning headaches in the presence of obesity, large tonsils, and/or dental malformation (eg, retrognathia, deep palate, large tongue) need to be guided by dentists to see their otorhinolaryngologist, respiratory-pulmonologist, or physician, as well as a sleep medicine expert. To manage the sound and tooth damage or pain generated by bruxism, oral appliances can be used, but the dentist needs to understand when such an appliance is indicated and the risks associated with its use. In cases where surgery is indicated, maxillofacial surgeons or otorhinolaryngologists collaborate closely with dentists to provide treatment.

When patients complain of morning headaches and temporomandibular disorders (TMDs), the exclusion of breathing disorders is a critical decision that is usually made in collaboration with the sleep medicine specialist, pulmonologist, neurologist, psychiatrist, and internal medicine physician. Dentists should refer patients who experience sleep bruxism in combination with a TMD for polysomnographic evaluation when they also complain of significant insomnia or poor sleep, even if they do not meet the traditional risk factors for sleep apnea. An increasing body of data suggests that both sleep bruxism and TMDs, which often occur in females of normal weight, are associated with increased risk for sleep disorder breathing.

Dentists caring for patients with chronic orofacial pain conditions (such as TMDs) also need to understand basic sleep hygiene principles and to know when to refer patients with chronic or intractable insomnia for behavioral sleep medicine evaluation. Behavioral treatments for chronic insomnia are considered first-line interventions over pharmacologic treatment options. A subset of chronic orofacial pain patients presents with a complex psychologic overlay that contributes to their ongoing pain and disability, a combination that can be managed by sleep psychologists working in conjunction with the interdisciplinary team.

The key aim of *Sleep Medicine for Dentists* is to provide a rapid source of practical information to students, practicing dentists, and scientists. Section I introduces dental sleep medicine, while sections II to IV provide an overview of how to understand, recognize, and manage sleep disorders such as sleep apnea, sleep bruxism, and orofacial pain, which often interfere with or intrude into sleep and are critically important to the practice of dentistry.

Dental sleep medicine is a rapidly evolving field of preventive medicine. However, there remains a shortage of well-trained dental sleep medicine specialists. Those learning more about this field will discover an exciting interdisciplinary arena that is rife with opportunities to develop new dental interventions to treat complex clinical situations and improve the health and well-being of the estimated 20% of the population suffering from sleep disorders.

CONTRIBUTORS

Ghizlane Aarab, DDS
Assistant Professor Oral Kinesiology
Academic Centre for Dentistry Amsterdam
University of Amsterdam
Amsterdam, The Netherlands

Florin Amzica, PhD
Professor of Stomatology
Faculty of Dental Medicine
University of Montreal
Montreal, Quebec, Canada

Taro Arima, DDS, PhD
Assistant Professor of Oral Rehabilitation
Graduate School of Dental Medicine
University of Hokkaido
Sapporo, Japan

Lene Baad-Hansen, DDS, PhD
Associate Professor of Clinical and Oral Physiology
School of Dentistry
Faculty of Health Sciences
Aarhus University
Aarhus, Denmark

Pierre J. Blanchet, MD, FRCP(C), PhD
Associate Professor of Stomatology
Faculty of Dental Medicine
University of Montreal

Neurologist
University of Montreal Hospital Centre
Montreal, Quebec, Canada

Peter R. Buchanan, MD, FRACP
Senior Clinical Research Fellow
Woolcock Institute of Medical Research
University of Sydney

Senior Staff Specialist of Respiratory Medicine
Liverpool Hospital
Sydney, New South Wales, Australia

Luis F. Buenaver, PhD, CBSM
Assistant Professor of Psychiatry and Behavioral Sciences
Johns Hopkins University School of Medicine
Baltimore, Maryland

Brian E. Cairns, RPh, ACPR, PhD
Associate Professor and Canada Research Chair in Neuropharmacology
Faculty of Pharmaceutical Sciences
University of British Columbia
Vancouver, British Columbia, Canada

Claudia M. Campbell, PhD
Postdoctoral Fellow, Department of Psychiatry and Behavioral Sciences
Johns Hopkins University School of Medicine
Baltimore, Maryland

Maria Clotilde Carra, DMD
Research Fellow, Faculty of Dental Medicine
University of Montreal

Sleep and Biological Rhythm Centre
Montreal Sacré-Coeur Hospital
Montreal, Quebec, Canada

Andrew S. L. Chan, MBBS, FRACP
Clinical and Research Fellow, Centre for Sleep Health and Research
Department of Respiratory Medicine
Royal North Shore Hospital

Woolcock Institute of Medical Research
University of Sydney
Sydney, New South Wales, Australia

Lam L. Cheng, MDSc, MOrthRCSEd, MRACDS(Ortho)
Lecturer, Discipline of Orthodontics
Faculty of Dentistry
University of Sydney
Sydney Dental Hospital
Sydney, New South Wales, Australia

Peter A. Cistulli, MBBS, PhD, MBA, FRACP
Professor of Respiratory Medicine
Head, Discipline of Sleep Medicine
University of Sydney

Research Leader, Woolcock Institute of Medical Research

Director, Centre for Sleep Health and Research
Royal North Shore Hospital
Sydney, New South Wales, Australia

François-Louis Comyn, DDS, MS
Resident of Orthodontics
School of Dental Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

M. Ali Darendeliler, PhD, BDS, CertifOrth, DipOrth, PrivDoc
Professor of Orthodontics
Faculty of Dentistry
University of Sydney
Sydney, New South Wales, Australia

Robert R. Edwards, PhD
Assistant Professor of Anesthesiology, Perioperative and Pain Medicine
Brigham & Women's Hospital
Boston, Massachusetts

Adjunction Assistant Professor of Psychiatry and Behavioral Sciences
Johns Hopkins University School of Medicine
Baltimore, Maryland

Parisa Gazerani, PharmD, PhD
Postdoctoral Fellow, Faculty of Pharmaceutical Sciences
University of British Columbia
Vancouver, British Columbia, Canada

Edward G. Grace, DDS, MA, FACD
Associate Professor of Neural and Pain Sciences
University of Maryland Dental School
Baltimore, Maryland

Ronald R. Grunstein, MD, PhD, FRACP
Professor and Head, Sleep and Circadian Group
Woolcock Institute of Medical Research
University of Sydney

Department of Respiratory and Sleep Medicine
Royal Prince Alfred Hospital
Sydney, New South Wales, Australia

Christian Guilleminault, MD, BioID
Professor, Sleep Medicine Program
Department of Psychiatry and Behavioral Sciences
Stanford University School of Medicine
Stanford, California

Monika Haack, PhD
Instructor of Neurology
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Raphael C. Heinzer, MD, MPH
Associate Physician, Pulmonary Department
Center for Investigation and Research in Sleep
University of Lausanne
Lausanne, Switzerland

Nelly Huynh, PhD
Postdoctoral Fellow, Sleep Medicine Program
Department of Psychiatry and Behavioral Sciences
Stanford University School of Medicine
Stanford, California

Takafumi Kato, DDS, PhD
Associate Professor, Institute for Oral Science
Matsumoto Dental University

Chief, Dental Sleep Medicine Clinic
Matsumoto Dental University Hospital
Shiojiri, Japan

Kiyoshi Koyano, DDS, PhD
Professor and Chair of Oral Rehabilitation
Faculty of Dental Science
Kyushu University
Fukuoka, Japan

Gilles J. Lavigne, DMD, MSc, PhD, FRCD(C)
Professor of Oral Medicine and Canada Research Chair in Pain, Sleep and Trauma
Dean, Faculty of Dental Medicine
University of Montreal

Sleep and Biological Rhythm Center and Department of Surgery
Montreal Sacré-Coeur Hospital
Montreal, Quebec, Canada

Richard W.W. Lee, MBBS, FRACP
Clinical and Research Fellow, Centre for Sleep Health and Research
Department of Respiratory Medicine
Royal North Shore Hospital

Woolcock Institute of Medical Research
University of Sydney
Sydney, New South Wales, Australia

Frank Lobbezoo, DDS, PhD
Professor of Oral Kinesiology
Academic Centre for Dentistry Amsterdam
University of Amsterdam
Amsterdam, The Netherlands

Guido Macaluso, MD, DDS, MDS
Professor of Dentistry
Faculty of Medicine
University of Parma
Parma, Italy

Marie Marklund, PhD, DDS
Associate Professor of Orthodontics
Department of Odontology
Faculty of Medicine
Umeå University
Umeå, Sweden

Charles M. Morin, PhD
Professor of Psychology and Canada Research Chair in Sleep Disorders
School of Psychology
Laval University

Director, Sleep Research Center
Robert-Giffard Research Center
Quebec City, Quebec, Canada

Janet M. Mullington, PhD
Associate Professor of Neurology
Harvard Medical School

Director, Human Sleep and Chronobiology Research Unit
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Craig L. Phillips, PhD
Scientist, Department of Respiratory and Sleep Medicine
Royal North Shore Hospital

Research Fellow, Woolcock Institute of Medical Research
University of Sydney
Sydney, New South Wales, Australia

Paola Pirelli, DDS
Assistant Professor of Orthodontics
Department of Odontostomatological Sciences
Faculty of Medicine
University of Rome "Tor Vergata"
Rome, Italy

Richard J. Schwab, MD
Professor of Sleep Medicine
Pulmonary, Allergy and Critical Care Division
Center for Sleep and Respiratory Neurobiology
University of Pennsylvania Medical Center
Philadelphia, Pennsylvania

Jennifer Scott-Sutherland, PhD
Research Fellow, Department of Anesthesiology, Perioperative and Pain Medicine
Children's Hospital Boston
Boston, Massachusetts

Navil Sethna, MB, ChB, FAAP
Associate Professor of Anaesthesia
Harvard Medical School

Associate Director, Pain Treatment Service
Children's Hospital Boston
Boston, Massachusetts

Michael T. Smith, PhD, CBSM
Associate Professor of Psychiatry and Behavioral Sciences
Director, Behavioral Sleep Medicine Program
Johns Hopkins University School of Medicine
Baltimore, Maryland

Peter Svensson, DDS, PhD, DrOdont
Professor and Chairman of Clinical Oral Physiology
University of Aarhus

Department of Oral and Maxillofacial Surgery
Aarhus University Hospital
Aarhus, Denmark

Nicole K.Y. Tang, DPhil
Research Fellow, Department of Psychology
Institute of Psychiatry
King's College London
London, England

Yoshihiro Tsukiyama, DDS, PhD
Associate Professor of Oral Rehabilitation
Faculty of Dental Science
Kyushu University
Fukuoka, Japan

Henri Tuomilehto, MD, PhD
Postdoctoral Fellow, Sleep and Biological Rhythm Center
Faculty of Dental Medicine
University of Montreal

Department of Surgery
Montreal Sacré-Coeur Hospital
Montreal, Quebec, Canada

Jacques van der Zaag, DDS
Assistant Professor of Oral Kinesiology
Academic Centre for Dentistry Amsterdam
University of Amsterdam
Amsterdam, The Netherlands

Ephraim Winocur, DMD
Coordinator, Clinic for Orofacial Pain and TMD
Department of Oral Rehabilitation
The Maurice and Gabriela Goldschleger School of Dental Medicine
Tel Aviv University
Tel Aviv, Israel

Keith Wong, MBBS, PhD
Sleep Physician, Department of Respiratory and Sleep Medicine
Royal Prince Alfred Hospital

Research Fellow, Woolcock Institute of Medical Research
University of Sydney
Sydney, New South Wales, Australia

CHAPTER 9

AN OVERVIEW OF OBSTRUCTIVE SLEEP APNEA TREATMENT

Peter R. Buchanan, MD, FRACP
Ronald R. Grunstein, MD, PhD, FRACP

Continuous positive airway pressure (CPAP) therapy is the treatment option of first choice for most patients with symptomatic and significant obstructive sleep apnea (OSA) (Fig 9-1). There is a strong evidence base to support prescription of CPAP for symptomatic (eg, sleepy) patients with moderate and severe OSA, and such treatment usually has positive neurobehavioral and cardiovascular outcomes if patients can use CPAP effectively and consistently. However, it is less clear how to manage patients with all disease severities who are relatively asymptomatic or sleepy patients who are not compliant with CPAP therapy. For these patients, a range of other options may be considered, including lifestyle modification, sleep positional modification, oral appliances, and upper airway surgery. At this time, there is no reliably effective pharmacologic therapy for OSA.

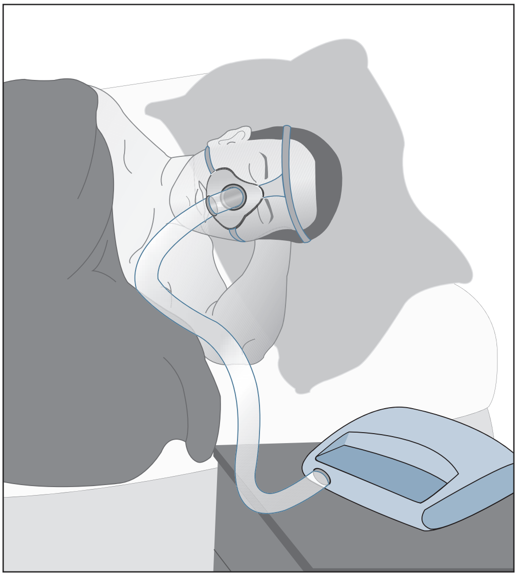

Fig 9-1 Typical CPAP machine.

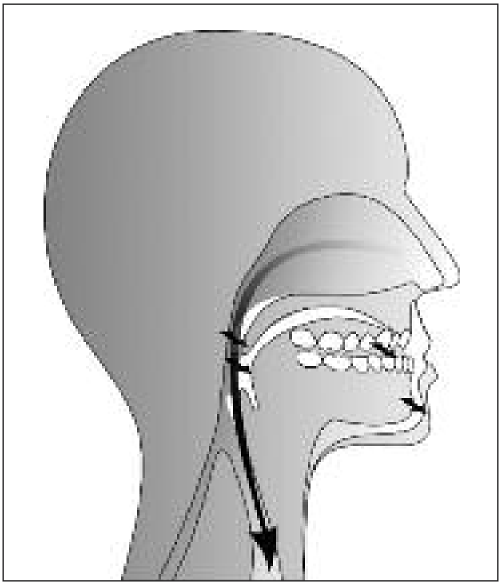

Fig 10-1 Upper airway with *(arrows)* and without the MRA. (Illustration courtesy of Drs Marie Marklund and Michael Munkholm.)

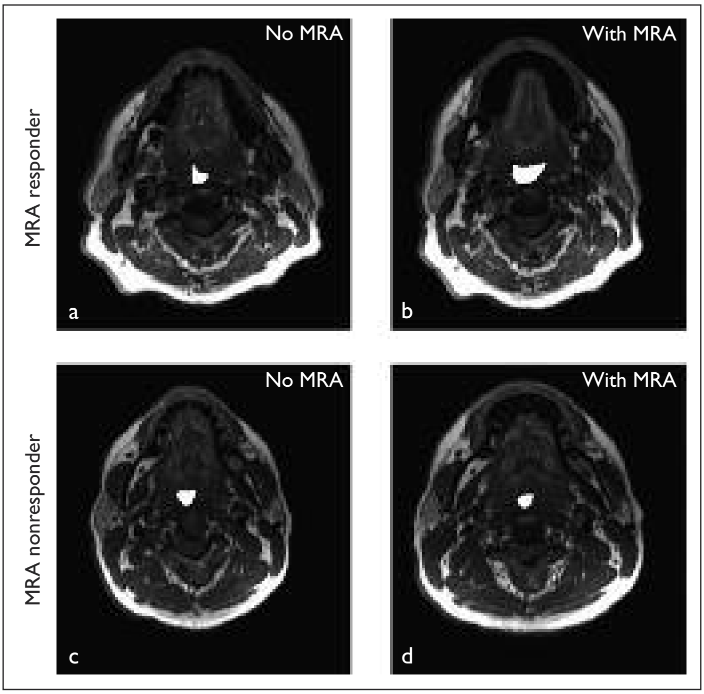

Fig 10-2 Axial magnetic resonance imaging sections at the retroglossal level in two patients with OSA, taken with and without an MRA. The MRA responder *(a and b)* shows an increase in lateral airway dimensions with the MRA, whereas the nonresponder *(c and d)* does not (airways are highlighted).

Table 10-1 Effects of MRAs as reported in randomized controlled studies

		AHI or RDI*			AHI < 10		AHI < 5	
Study	N	MRA	CPAP	Control	MRA	CPAP	MRA	CPAP
Ferguson et al[10]	20	25 [15] 14 [15] †	24 [17] 4.0 [2.2]†§		55%	70%		
Engleman et al[9]	48	31 [26] 15 [16]	31 [26] 8.0 [6.0]§		47%	66%	19%	34%
Gotsopoulos et al[6]	73	27 (2) 12 (2) †‡		27 (2) 25 (2)			36%	
Barnes et al[5]	80	21 (1.3) 14 (1.1) †‡	21 (1.3) 4.8 (0.5)†§	21 (1.3) 20 (1.1)	49%			
Lam et al[11]	101	21 (1.7) 11 (1.7) †‡	24 (1.9) 2.8 (1.1)†§	19 (1.9) 21 (2.5)				

(RDI) respiratory disturbance index.
*Results are presented as mean and (standard error of mean) or [standard deviation] before intervention *(upper row)* and after intervention *(lower row)*.
†Lower AHI or RDI with treatment than without treatment.
‡Lower AHI or RDI with MRA than with control.
§Lower value AHI or RDI with CPAP than with MRA.

Clinical Outcomes

The majority of patients treated with MRAs report reduced daytime sleepiness, and snoring and sleep apnea measurements confirm fewer apneic and hypopneic events. Complete treatment success, defined as an apnea-hypopnea index (AHI) of fewer than 5 events per hour and resolution of symptoms, has been reported to occur in 19% to 75% of patients with mild-to-moderate OSA; the use of a more liberal definition of success, namely an AHI of fewer than 10 events per hour, has demonstrated higher success rates[5–8] (Table 10-1). Persistent snoring and daytime sleepiness during MRA treatment indicate a subtherapeutic effect.

There is as yet little good evidence of any beneficial clinical effects from TRDs, and they tend to be more cumbersome than MRAs.

Continuous positive airway pressure (CPAP) more effectively reduces sleep-related breathing disturbances than do oral appliances, particularly in patients with more severe disease.[5,7,9–11] Nevertheless, patients usually prefer MRAs over CPAP when both treatments are effective.[10] A comparison of MRA and CPAP is presented in Table 10-2.

The modification of the health risks associated with OSA is a key goal of treatment (see chapter 6). Recent studies demonstrate MRAs to have a blood pressure–lowering effect of a similar magnitude to that achieved with CPAP.[12] Similarly, some

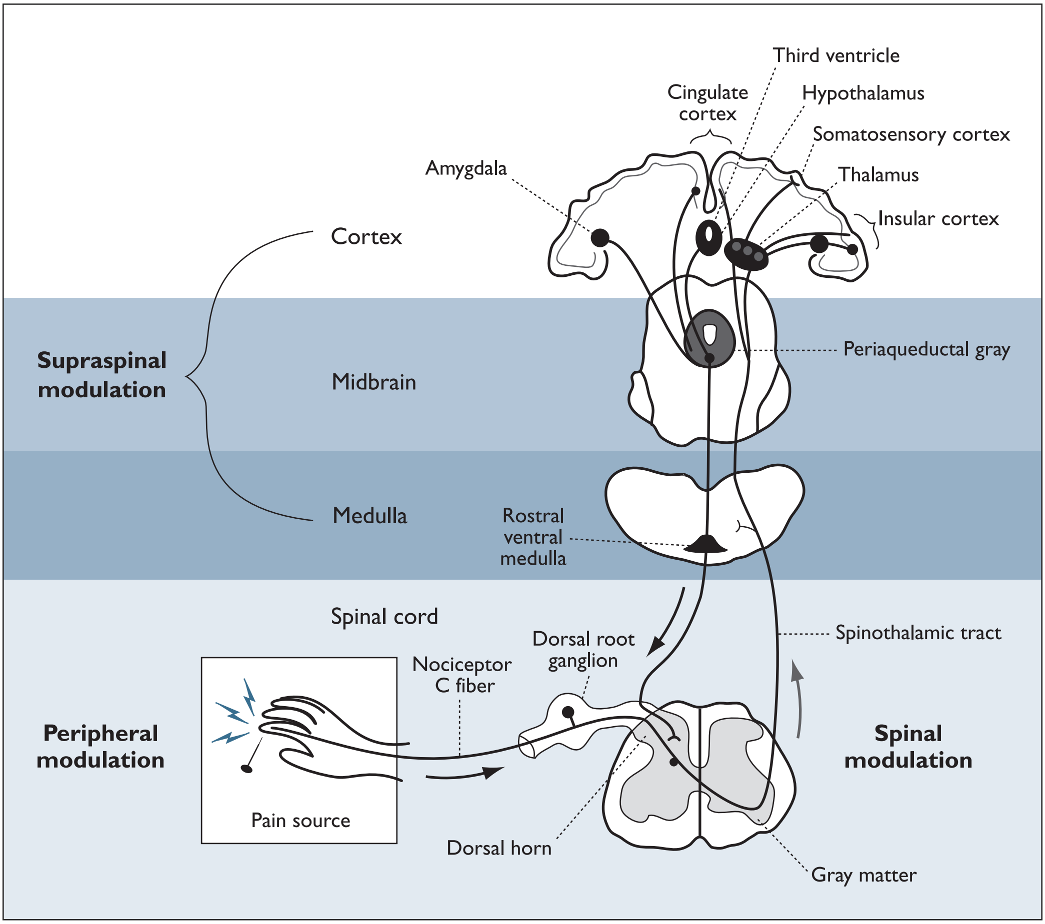

Fig 18-1 Areas of pain processing. (Adapted from DeLeo[11] with permission.)

the rostral ventral medulla are heavily involved. Serotonergic and opioidergic neurotransmission are the mainstays of these descending systems (see Fig 18-1), although numerous neurotransmitters and neuromodulators are also implicated.

In addition to the processes of sensitization, chronic pain is also characterized by reductions in the effectiveness of pain-inhibitory circuitry in the brain and spinal cord. Indeed, many chronic pain syndromes are characterized by both above-average sensitivity to pain and below-average endogenous pain-inhibitory capacity.[14] Collectively, chronic pain conditions have been associated with alterations in central processing of noxious stimuli, and chronic pain is now classified as a CNS disease (eg, nerve signals transmitted from injured tissue lead to pathologic long-term changes in the CNS).[14] The substantial comorbidity among many idiopathic pain-related conditions, such as TMDs, fibromyalgia and musculoskeletal chronic widespread pain, and irritable bowel syndrome, and their overlapping symptoms, including affective distress, cognitive deficits, and fatigue, suggest a common set of potentially CNS-related mechanisms.

Assessment of Pain

In patients, direct assessment of activity in spinal cord or brain neurons is only possible by cell recording in patients undergoing elective surgery. Brain imaging offers an indirect method to assess brain cellular and metabolic activities in relation to pain perception. The integrity of nociceptive pathways and the pain-processing mechanism can be estimated with peripheral pain–related stimulations (eg, mechanical, thermal, or chemical) and *(1)* cortical recording of evoked potentials or brain imaging (millisecond to second processing); *(2)* sensory motor behavioral responses (eg, withdrawal reflexes in the second range); or *(3)* pain reports from patients (eg, numerical or visual analog scale and verbal state descriptors in the second to minute range).

Quantitative sensory testing

QST, in which standardized noxious stimuli (eg, thermal: cold or heat; mechanical: pressure or vibration; chemical: infusion of noxious substances) are administered under highly controlled conditions, can reveal the presence of hypersensitivity to pain as well as dysfunction in descending pain-inhibitory systems. A complex method has been developed to assess the functional integrity of endogenous modulation of pain through CNS sensitization; this technique is termed the *temporal summation of pain*, or *windup*. Such tests are accomplished by administering repeated noxious stimuli in a short time period and measuring the resulting increase in pain response. Dramatically increased ratings with repetitive stimulation are thought to reflect CNS hyperexcitability.[14]

Diffuse noxious inhibitory controls

Another assessment of endogenous pain-inhibitory systems is possible through the use of the paradigm of diffuse noxious inhibitory controls (DNIC).[14] In brief, DNIC refers to the phenomenon in which one pain inhibits the perception of a second pain applied to a distant body site. It can be captured by assessing responses to a phasic (ie, repetitive) noxious stimulus before and then during heterotopic (elsewhere on body; arm versus leg) application of a tonic (sustained) noxious stimulus. Generally, responses to the phasic noxious stimulus are reduced during concurrent administration of the tonic stimulus. Such experimental methods are used to evaluate normal pain-inhibitory functioning as a proxy for how clinical pain and nociception are processed and modulated. The magnitude of the reduction serves as a measure of the efficacy of central endogenous analgesic systems.

Although such experimental pain studies are utilized to model clinical pain processing, they do not necessarily capture the complexity of clinical pain pathophysiology. Abundant research, however, has suggested the relevance of experimental pain induction procedures in predicting clinical pain outcomes.[15] For example, imaging studies suggest that acute, standardized, noxious stimuli produced in the laboratory parallel the magnitude of CNS activity in brain regions associated with pain processing.[16,17] Thus, QST techniques, such as temporal summation and DNIC, provide a window to better understand how the human nervous system processes pain-related information.

Evidence for central hypersensitivity in chronic pain patients

There is consistent and abundant evidence that many chronic pain syndromes, including somatic, visceral, neuropathic, and inflammatory chronic pain (see chapter 21), are characterized by generalized hyperalgesia (eg, an increased reactivity to pain) and diminished effectiveness of descending pain inhibition, which may result in hyperalgesia.[18] It is not at all surprising that pain conditions such as fibromyalgia, headache, TMDs, rheumatoid arthritis, complex regional pain syndrome, irritable bowel syndrome, and many others enhance pain sensitivity at the sites of

CONCLUSION

SCIENTIFIC AND CLINICAL FRONTIERS

As the general public better recognizes the interactions among sleep-disordered breathing (SDB), sleep bruxism (SB), sleep and orofacial pain, craniofacial form, and overall health, dentists are expected to become proficient in a broader range of health issues. In direct collaboration with physicians, dentists often identify patients who are likely to have a sleep disorder. Based on their experience with the fabrication and use of oral appliances and their skills in evaluation of jaw position, oral mucosa, craniofacial morphology, tooth movement, and jaw muscle pain, dentists are ideally suited to provide several forms of therapy in this field.

Sleep-Disordered Breathing

Correct diagnosis of the different types of sleep-related breathing disorders is essential to identifying the best therapeutic option. Assessment for any type of sleep disorder (see chapter 3) requires a thorough clinical evaluation of the patient to determine the likelihood of the condition as well as overnight testing to demonstrate the presence of SDB before treatment is initiated. Obstructive sleep apnea (OSA) has been associated with serious long-term adverse health consequences such as hypertension, metabolic dysfunction, cardiovascular disease, neurocognitive deficits, and motor vehicle accidents (see chapter 6). Polysomnography remains the most common test for a definitive diagnosis (see chapter 7).

Portable sleep studies may be useful for confirming disease in patients with evidence of OSA, but their limitations are well documented. The value of portable monitoring as a titration aid and to assess treatment responses deserves further verification. Both static and dynamic imaging techniques have been used to examine the structure and function of the upper airway during wakefulness and sleep. The lateral pharyngeal walls, in addition to the tongue and soft palate, affect upper airway size. Although the cause-and-effect relationship between craniofacial morphology and OSA remains to be proven, growth factors and anomalies in oropharyngeal development that predispose to upper airway obstruction may contribute to the disorder. Advanced imaging modalities such as computed tomography and magnetic resonance imaging can assist in the assessment of such patients, but the actual site of airway obstruction during sleep is extremely difficult to capture (see chapter 8). However, none of these tools has been proven to completely replace the information provided by polygraphic recordings during sleep.

Therapeutic options and treatment outcomes in the field of SDB continue to improve with time (see chapters 9 and 10). Randomized controlled clinical trials have indicated that oral appliances may be used as first-line therapy for the treatment of mild to moderate OSA. Patients who cannot tolerate nasal continuous positive airway pressure (CPAP) or who prefer oral appliance therapy may use an oral appliance, provided that a sleep study has confirmed an adequate therapeutic response to the treatment. Side effects are usually mild and transient but may influence the length of acclimatization required to complete the treatment. Occlusal changes are common, especially over the long term, and warrant careful monitoring.

Future studies are needed to compare the effectiveness of different types of oral appliances and different design and advancement features. The precise indications, complication rates, and reasons for treatment failure must be identified for each oral appliance. Only when the actual mechanisms of action are fully understood can more effective appliances be developed. Prospective validation studies are required to evaluate predictors of treatment outcome, and more research is needed to determine optimal titration protocols to increase the effectiveness of oral appliances and to decrease titration times. A compliance monitor that will allow an objective determination of the efficacy and safety of oral appliances is required.

CPAP remains the mainstay for effective treatment of significant OSA, but further research is required to define effective solutions to improve compliance. In specific patients, oral appliances may not be as effective as CPAP. In particular, oral appliances are less effective in patients with significant hypoxemia or morbid obesity. They are most effective in younger, thinner patients with mild-to-moderate OSA. However, oral appliances are not the preferred initial treatment for patients with severe or highly symptomatic OSA, in part because of the time it may take to titrate the appliance.

There is growing evidence of the beneficial role of alternative therapies (eg, positional training using sensors, t-shirts with balls or tubes, or specific pillow types), and further research is required to define the subsets of patients for whom each of these therapies is most effective. In addition, combination (CPAP and oral appliance) and adjunctive therapies have not yet been adequately tested.

Sleep Bruxism

The etiology of SB is not well understood but is believed to include both behavioral and physiologic factors (see chapters 12 and 15). Evidence-based studies are necessary to determine whether currently identified risk factors prevent or mitigate SB. To date, there are no rapid and reliable clinical diagnostic tests that combine diagnostic validity and cost effectiveness (see chapter 14). The exact pathophysiology of SB is not known, but current evidence suggests that jaw movement and tooth grinding appear secondary to repetitive brief arousals during sleep. There may also be a genetic component to SB, as there is to SDB.

Clinicians must be aware that a proportion of SDB patients may actually exhibit worsening symptoms when a traditional occlusal splint is used (see chapter 17). Before deciding the most appropriate management strategy for SB in adults, the clinician should carefully consider the actual or expected damage caused by SB, the anticipated side effects of therapy, and contraindications. Pediatric SB is poorly managed currently because of the lack of knowledge and evidence about its risk factors, pathophysiology, and consequences (see chapters 16 and 17).

Sleep-Pain Interactions

Patients with orofacial pain often complain of insufficient sleep duration and frequent awakenings. Conversely, SDB may be present in a substantial number of patients with temporomandibular disorders. Temporomandibular disorders are commonly found in patients with other idiopathic pain disorders, particularly fibromyalgia and headache disorders. The complex factors that lead to the development of chronic pain are multiple and poorly understood (see chapters 18 to 21). The opioid, monoaminergic, immune, and melatonin systems are all affected by a loss of sleep. A better understanding of the triad of sleep disturbance, pain, and analgesia remains a challenge for the management of patients suffering from acute and chronic pain, sleep disorders, or both.

The management of orofacial pain and sleep disturbances is complex and requires careful evaluation, appropriate diagnosis, and knowledge of pharmacologic and nonpharmacologic interventions, including behavioral and physical therapies (see chapters 22 to 24). The development of pharmacologic agents designed to relieve pain without side effects unfavorable to sleep is particularly needed (eg, opioid use may be harmful in some OSA patients). Sleep management therapies, including information and counseling as well as pharmacologic options, should be offered to patients with orofacial pain. Conversely, outcome measures of orofacial pain should also include measures of sleep quality.

Cognitive-behavioral therapy is a viable treatment alternative as a first-line intervention for primary insomnia. Dentists, as frontline professionals dealing with a large number of patients suffering from both pain and sleep disturbances, are encouraged to promote sleep hygiene education, refer patients to behavioral sleep medicine specialists, and consider taking on further behavioral sleep medicine training (see chapter 24).

Summary

The field of dental sleep medicine is relatively new and has made major research and clinical advances in the past decade. However, much of the currently available evidence comes from observational cohort or experimental (mechanistic) studies, which have many deficiencies, including small sample size, selection bias, and a lack of control subjects. These issues can and will be better addressed in the future by longitudinal and randomized controlled trials of adequate sample size that are controlled for the influence of known risk factors.

As a larger number of dentists are adequately trained in the field of dental sleep medicine and as the general public and the medical profession demand more from dentistry, professional services for patients with sleep disorders will continue to expand and improve. Dentists who become involved in sleep medicine are often surprised at how grateful SDB patients are after only a few nights' uninterrupted sleep and the subsequent restoration of adequate sleep. The ability to substantially improve the quality of a patient's life can be a very rewarding experience for health care providers working in this interdisciplinary field.

Alan A. Lowe, DMD, PhD, FRCD(C), FACD
Professor and Chair
Division of Orthodontics
Department of Oral Health Sciences
Faculty of Dentistry
University of British Columbia
Vancouver, British Columbia, Canada