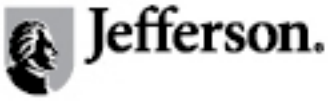

10-1-2016

Evaluation and Management of Sleep Disorders in the Hand Surgery Patient.

Michael P. Gaspar
Thomas Jefferson University, michaelpgaspar@gmail.com

Patrick M. Kane
Thomas Jefferson University, patrick.kane@jefferson.edu

Sidney M. Jacoby
Thomas Jefferson University, sidney.jacoby@jefferson.edu

Patrick S. Gaspar
Harborside Surgical Center

A. Lee Osterman
Thomas Jefferson University, a.osterman@jefferson.edu

Title:
Evaluation and Management of Sleep Disorders in the Hand Surgery Patient

Running Title:
Sleep Disorders in Hand Surgery

Authors and affiliations:

Michael P. Gaspar, MD[a]
michaelpgaspar@gmail.com

Patrick M. Kane, MD[a]
pmkkane@gmail.com

Sidney M. Jacoby, MD[a]
smjacoby@handcenters.com

Patrick S. Gaspar, MD[b]
patrickgaspar@yahoo.com

A. Lee Osterman, MD[a]
alosterman@handcenters.com

[a] The Philadelphia Hand Center, P.C.
Thomas Jefferson University
Department of Orthopedic Surgery
The Franklin Suite G114
834 Chestnut Street
Philadelphia, PA 19107, USA

[b] Harborside Surgical Center
Department of Anesthesiology
Oxon Hill, MD

Corresponding Author:
Michael P. Gaspar, MD
The Philadelphia Hand Center, P.C.
The Franklin Suite G114
834 Chestnut Street
Philadelphia, PA 19107
michaelpgaspar@gmail.com
(804) 363-9157

Key Words:
Insomnia; Sleep Disorders; Hand Surgery; Carpal tunnel syndrome; Obstructive Sleep Apnea

Abstract

Despite posing a significant public health threat, sleep disorders remain poorly understood and often mismanaged. Though seemingly unrelated, hand surgeons should be particularly mindful of sleep disorders, as numerous conditions of the upper extremity have known associations with sleep disturbances which can adversely affect patient outcomes, function and satisfaction. In addition, patients with sleep disorders are at significantly higher risk for severe, even life-threatening medical co-morbidities, further supporting the important role of hand surgeons in the recognition and management of sleep disorders that are most common in hand surgery.

Introduction

Sleep disorders are a major public health concern, affecting as many as 70 million adults in the United States alone, while accounting for billions of dollars in financial costs, disability, and even death. [1-5] Sleep disorders are also associated with a myriad of medical conditions including obesity, hypertension, diabetes heart disease, and overall higher mortality risk. [6]

Unfortunately, despite these exorbitant socioeconomic and health costs, sleep disorders are often overlooked or improperly treated. [7,8] In hand surgery, numerous conditions have known associations with sleep disorders, and sleep symptoms can directly affect patient outcomes, function and satisfaction. Thus, these disorders are important for hand surgeons to recognize and manage. The purpose of this review is to provide an overview of sleep disorders that are most common in hand surgery, with focus on the preoperative evaluation, and perioperative management of these disorders.

Sleep Disorders in Hand Surgery

This discussion will focus primarily on two classes of disorders most relevant to hand surgery: (1) d*yssomnias* which are disorders that produce excessive sleepiness or difficulty in initiating or maintaining sleep and (2) sleep disorders associated with other medical disorders. [9] A more inclusive outline of general sleep disorders is presented in Figure 1.

Intrinsic Dyssomnias

Intrinsic dyssomnias either (a) originate or develop within the body, or (b) arise from causes within the body. [9] This group includes psychological or medical disorders that *produce* a primary sleep disorder.

Obstructive Sleep Apnea

Perhaps the most widely recognized intrinsic dyssomnia in surgical patients is obstructive sleep apnea (OSA). Patients with OSA who are to undergo surgery require specialized management, as these patients are at higher risk for adverse events in the intraoperative

and postoperative periods. In the perioperative setting, the primary concern is airway management; due to OSA patients' decreased ability to protect their airway, procedures that would otherwise be performed under sedation may require monitored anesthesia care (MAC) or even general anesthesia for. [10,11] Ideally, open communication between the anesthesiologist and the hand surgeon allows these determinations to be made prior to the day of surgery, so as to minimize delays or complications.

In addition to patients with a known diagnosis of OSA, surgeons are often tasked with caring for patients who lack a formal diagnosis, despite exhibiting clinical risk factors for OSA. [12] Chung et al reported an alarming 66% of patients lacking a preoperative OSA diagnosis with difficult intubations were confirmed to have OSA upon further evaluation. [13] Mutter et al found that those patients with undiagnosed OSA were at significantly higher risk of postoperative cardiac arrest than confirmed OSA patients, and that both groups faired worse than non-OSA patients. [14] These studies together point out the importance for the hand surgeon to recognize and screen for OSA, which can be done utilizing validated OSA screening methods, such as the STOP-Bang questionnaire (Table 1). Surgeons should also have a low threshold for referring patients with positive findings on OSA screening for further evaluation. [13,15] Postoperative management of OSA patients is also critical in avoiding morbidity, and OSA patients should resume continuous- or bilevel positive-airway-pressure (CPAP or BiPAP) treatment as soon as they are able. [15] Postoperative pain control regimens in OSA patients also merit special attention, which will be discussed shortly.

Extrinsic Dyssomnias

Extrinsic dyssomnias are those that originate or develop from causes outside of the body. [9] External factors are necessary to produce these disorders, and their removal is often therapeutic to the sleep disturbance. [9] In hand surgery, these most notably include both drug-induced and drug-dependant sleep disorders.

Opioid-Induced Sleep Disorders

A true understanding of the complex interplay of pain, opioid medication, and sleep disturbance remains elusive. Although evidence shows that pain and sleep exhibit a circular relationship with one another (i.e. pain causes sleep disturbance and sleep disturbance intensifies pain), [16-19] opioids used to concomitantly treat both pain and secondary sleep disorders are not always successful. [20,21]

Opioid receptors in the brain are located in the same nuclei that are active in sleep regulation and abnormal sleep architecture has been reported as a characteristic feature of opioid use, with a reduction of rapid eye movement (REM), slow wave sleep stages, and overall sleep quality. [18,20,22] Opioid use in OSA patients can be particularly troublesome, as opioids not only impair arousal, but can worsen airway obstruction, even in non-OSA patients. [21,23,24] Thus, alternative multimodal pain management approaches are recommended to minimize the need for opioids for OSA patients. These include: regional or local anesthesia when appropriate, continuous peripheral nerve blockade, and non-opioid analgesics such as acetaminophen and NSAIDS. [15,23,25-27] Recent evidence also supports use of low-dose ketamine or adjuvant clonidine injections to potentiate local or regional nerve blocks. [23,28,29] Finally, conservative measures aimed at decreasing postoperative pain and inflammation such as icing, elevation, and compression should be emphasized, especially upon discharge home.

Sedative-Dependent Sleep Disorders

The use of short-acting sedative-hypnotics, particularly non-benzodiazepine sedative hypnotics (NBSH, e.g. zolpidem), for treatment of insomnia has increased markedly in recent decades. [30] Generally intended to treat short-term insomnia, NBSH discontinuation may precipitate rebound insomnia, lasting up to weeks in extreme cases, or after taking a single dose. [31-33] Thus, the dependency potential is relatively high. [34-36] Use of zolpidem as a postoperative sleep aid or pain-adjuvant has recently been described following knee and shoulder surgery with reported success in improving sleep quality and function, while decreasing opioid requirements, pain and fatigue. [37-39] However, none of these studies reported patient outcomes beyond the acute treatment period. [37-39] Its

similar utility in hand surgery has not been reported. Perhaps surprisingly, antihistamines used as sleep aids may warrant similar caution. [41] A recent survey of patients who took the commonly-used sedative H1 antihistamine doxylamine found the majority of patients used the medication daily for at least six months, including 77% who experienced rebound insomnia when attempting to discontinue use. [41] These findings suggest that sedative hypnotics and antihistamines should be used with judiciously in hand surgery patients with sleep disorders.

Sleep Disorders Associated with Mental, Neurologic, or Other Medical Disorders

This second category includes a variety primary medical disorders that *secondarily* involve sleep disturbance or excessive sleepiness as a major clinical feature, [9] including several hand and upper extremity conditions.

Carpal Tunnel Syndrome

Insomnia is a nearly universal finding in patients with carpal tunnel syndrome (CTS), often serving as the primary motivating factor for seeking surgical care. [42-48] Although the mechanism linking these two conditions is unclear, McCabe and colleagues reported that patients with CTS are more likely to prefer sleeping on their side compared to control patients. [42-44] The authors acknowledge, however, that these associative findings do not necessary prove causation. In an effort to further characterize the severity of sleep disturbance in CTS patients, Patel et al prospectively studied patients with CTS and found that 78% of patients met the threshold for poor sleep quality using the Pittsburgh Sleep Quality Index (PSQI), a validated sleep-quality outcome measure. [46,49,50] The authors also noted a positive correlation between CTS-related functional impairment and severity of sleep symptoms. [46] The authors did not study the potential association of preoperative electrodiagnostic findings with sleep symptom severity, nor did they investigate the potential therapeutic effect of median nerve decompression on sleep symptoms. Both of these associations may warrant further study, as the ability to predict relief of sleep symptoms following decompressive surgery would allow clinicians to better tailor management for CTS patients whose primary complaints are sleep-related.

Rheumatoid Arthritis and Other Inflammatory Arthropathies

Sleep disturbances in patients with Rheumatoid Arthritis (RA) are multifactorial, codependent on pain, fatigue, and depression. [51-53] In a prospective analysis of RA patients seen at an outpatient clinic, Løppenthin et al reported that 61% met criteria for poor sleep using the PSQI. [52] Westhovens et al found that RA disease activity showed significantly positive correlation with worsening sleep symptoms, [53] while Fragiadaki et al reported improvement in sleep symptoms in a series of 15 RA patients treated with tocilizumab, [54] together suggesting that primary management of underlying RA activity may serve as an optimal strategy for co-managing sleep symptoms. Recent evidence has also demonstrated a significant association between psoriatic arthritis and sleep disorders, particularly OSA and insomnia. [55-58] Although etanercept was reported to improve insomnia symptoms in patients with psoriatic arthritis, treatment with adalimumab did not show a therapeutic effect on patients' OSA symptoms. [57,58] Patients with both psoriatic arthritis and OSA who are to undergo hand surgery should be managed according to the OSA principles discussed earlier.

Additional Management Considerations

Given the potential adverse effects associated with sedatives and opioid pain medication, alternative treatment modalities for concomitant sleep disturbance and acute postoperative pain warrant further discussion. Gamma-aminobutyric acid (GABA) analogues gabapentin and pregabalin may have utility for treating concomitant pain and sleep symptoms, either as primary therapeutic or adjuvant agents. [59,60] Gabapentin has previously been shown as an effective treatment for both pain and sleep disturbance in CTS patients, [61] although this finding has been both supported and refuted in more recent studies. [62,63] Pregabalin shows promise in the concomitant treatment of sleep and pain symptoms, albeit in patients with fibromyalgia, for which it is FDA-approved. [64,65] While neither medication is currently FDA-approved for neuropathic pain associated specifically with conditions of the upper extremity, further investigation to that end could be worthwhile. [59]

Another promising agent for use in hand surgery is exogenous melatonin. Although its sleep-promoting characteristics are widely-reported, melatonin possesses numerous additional benefits which suggest an ideal role as a therapeutic agent in hand surgery. [66] In vitro studies on chondrocytes demonstrate that melatonin is chondrogenic and promotes matrix synthesis, and can also serve as a rescue agent for chondrocytes that are exposed to damaging pro-inflammatory or cytotoxic factors. [67-69] In an animal model of median nerve injury, sleep deprivation made rats more vulnerable to nerve injury-induced neuropathic pain, while melatonin reversed nerve injury-induced hypersensitivity. [70] In the lone clinical study evaluating its efficacy in hand surgery, melatonin was found to improve tourniquet tolerance while decreasing opioid requirement in patients receiving regional anesthesia intravenously. [71] Given this therapeutic potential and limited adverse effect profile, use of melatonin in hand surgery certainly warrants ongoing trial and further investigation.

Current Limitations and Future Directions

Due to the complex interplay of sleep with pain, psychiatric disorders, social factors, and other associated conditions, the evaluation of sleep disorders in the hand surgery patient is rarely straightforward. In a recent study by Peters and colleagues, the authors attempted to determine a relationship between sleep disturbance and upper-extremity disability, and found that psychological factors such as ineffective coping strategies were more likely to predict arm disability than sleep symptoms. [72] The authors discussed the possibility that sleep disturbance was also the product of these psychological factors, suggesting a bidirectional relationship. Their study exemplifies the challenging nature inherent to determining underlying pathology and causal relationships regarding sleep disturbances. This is echoed by Shulman et al, who found that sleep disturbance following distal radius fracture at long-term follow-up was more dependent on mental health than on functional status. [73]

A second limitation of the current evidence regarding sleep disorders in hand surgery is with respect to the heterogeneity of the patient populations studied; a shortcoming fully

acknowledged by Peters and colleagues. [72] In their study fractures, soft-tissue injuries, and degenerative conditions were all treated as equivalent upper extremity disabilities. Furthermore, CTS and cubital tunnel syndrome were lumped together although there is no current literature that describes sleep disorders in patients with cubital tunnel syndrome. Similarly, in their study of melatonin's utility in improving tourniquet tolerance and decreasing opioid requirements, Mowafi and Ismail did not stratify or match patients based on condition or procedure. [71] Future studies using larger, more homogenous patient cohorts, would be critical to fully understanding the relationships between sleep disorders and hand pathologies, and developing precise and effective regimens to treat coexisting sleep and hand disease.

References

1. Hillman DR, Murphy AS, Pezzullo L. The economic cost of sleep disorders. *Sleep*. 2006 Mar;29(3):299-305.

2. Daley M, Morin CM, LeBlanc M, Grégoire JP, Savard J, Baillargeon L. Insomnia and its relationship to health-care utilization, work absenteeism, productivity and accidents. *Sleep Med*. 2009 Apr;10(4):427-38.

3. Daley M, Morin CM, LeBlanc M, Grégoire JP, Savard J. The economic burden of insomnia: direct and indirect costs for individuals with insomnia syndrome, insomnia symptoms, and good sleepers. *Sleep*. 2009 Jan;32(1):55-64.

4. Hossain JL, Shapiro CM. The prevalence, cost implications, and management of sleep disorders: an overview. *Sleep Breath*. 2002 Jun;6(2):85-102.

5. Léger D, Bayon V. Societal costs of insomnia. *Sleep Med Rev*. 2010 Dec;14(6):379-89.

6. Taylor DJ, Mallory LJ, Lichstein KL, Duurence HH, Riedel BW, Bush AJ. Comorbidity of chronic insomnia with medical problems. *Sleep*. 2007;30(2):213-218.

7. Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med Rev.* 2002;6:97–111.

8. Wittchen HU, Krause P, Hofler M, Pittrow D, Winter S, Spiegel B, et al. NISAS-2000: the ‘‘nationwide insomnia screening and awareness study’’. Prevalence and interventions in primary care. *Fortschr Med Orig*. 2001;119:9–19.

9. American Academy of Sleep Medicine (AASM). The International Classification of Sleep Disorders: 2nd Edition. Westchester, IL: American Academy of Sleep Medicine; 2005.

10. LaPorte D, Vallera C. Sedation for Hand Surgery in Adults. *J Hand Surg Am*. 2011;36(7):1231-1233.

11. Vallera C, LaPorte D. Monitored Anesthesia Care for Hand Surgery in Adults. *J Hand Surg Am*. 2011;36(7):1235-1236.

12. Kaw R, Michota F, Jaffer A, Ghamande S, Auckley D, Golish J. Unrecognized Sleep Apnea in the Surgical Patient. *Chest*. 2006;129(1):198-205.

13. Chung F, Yegneswaran B, Herrera F, Shenderey A, Shapiro C. Patients with Difficult Intubation May Need Referral to Sleep Clinics. *Anesth Analg*. 2008;107(3):915-920.

14. Mutter TC, Chateau D, Moffatt M, Ramsey C, Roos LL, Kryger M. A matched cohort study of postoperative outcomes in obstructive sleep apnea: could preoperative diagnosis and treatment prevent complications? *Anesthesiology*. 2014 Oct;121(4):707-18.

15. Joshi GP, Ankichetty SP, Gan TJ, Chung F. Society for Ambulatory Anesthesia consensus statement on preoperative selection of adult patients with obstructive sleep apnea scheduled for ambulatory surgery. *Anesth Analg*. 2012 Nov;115(5):1060-8.

16. Brennan MJ, Lieberman JA 3rd. Sleep disturbances in patients with chronic pain: effectively managing opioid analgesia to improve outcomes. *Curr Med Res Opin.* 2009; 25: 1045-55.

17. Kundermann B, Krieg JC, Schreiber W, Lautenbacher S. The effect of sleep deprivation on pain. *Pain Res Manag* 2004;9:25-32.

18. Onen SH, Onen F, Courpron P, Dubray C. How pain and analgesics disturb sleep. *Clin J Pain*. 2005;21:422-31.

19. Finan P, Goodin B, Smith M. The Association of Sleep and Pain: An Update and a Path

Forward. *J Pain*. 2013;14(12):1539-1552.

20. Wang D, Teichtahl H. Opioids, sleep architecture and sleep disordered breathing. *Sleep Med Rev.* 2007; 11: 35-46.

21. Yue HJ, Guilleminault G. Opioid medication and sleep-disordered breathing. *Med Clin North Am*. 2010; 94: 435-46.

22. Dinsdale J, Norman D, DeJardin D, et al. The effect of opioids on sleep architecture. *J Clin Sleep Med*. 2007; 3: 33-6.

23. Mulier JP. Perioperative opioids aggravate obstructive breathing in sleep apnea syndrome: mechanisms and alternative anesthesia strategies. *Curr Opin Anaesthesiol*. 2016 Feb;29(1):129-33.

24. Arora N, Cao M, Javaheri S. Opioids, Sedatives, and Sleep Hypoventilation. *Sleep Med Clin*. 2014;9(3):391-398.

25. Lalonde D. Minimally invasive anesthesia in wide awake hand surgery. *Hand Clin*. 2014 Feb;30(1):1-6.

26. Fingerman M. Regional Anesthesia for Outpatient Hand Surgery: Ultrasound-Guided Peripheral Nerve Block. *J Hand Surg Am*. 2011;36(3):532-534.

27. Richman J, Liu S, Courpas G et al. Does Continuous Peripheral Nerve Block Provide Superior Pain Control to Opioids? A Meta-Analysis. *Anesthesia & Analgesia*. 2006;102(1):248-257.

28. Macintyre, PE, Loadsman JA, Scott DA. Opioids, ventilation and acute pain management. *Anesth Int Care*. 2011;39:545–58

29. Kaur S, Saroa R, Aggarwal S. Effect of intraoperative infusion of low-dose ketamine on management of postoperative analgesia. *J Nat Sci Biol Med*. 2015; 6:378–382.

30. Moloney M, Konrad T, Zimmer C. The Medicalization of Sleeplessness: A Public Health Concern. *Am J Public Health*. 2011;101(8):1429-1433.

31. Mendelson WB, Jain B. An assessment of short-acting hypnotics. *Drug Saf*. 1995 Oct;13(4):257-70.

32. Kales A, Manfredi RL, Vgontzas AN, Bixler EO, Vela-Bueno A, Fee EC. Rebound insomnia after only brief and intermittent use of rapidly eliminated benzodiazepines. *Clin Pharmacol Ther*. 1991 Apr;49(4):468-76.

33. Monti JM, Attali P, Monti D, Zipfel A, de la Giclais B, Morselli PL. Zolpidem and rebound insomnia--a double-blind, controlled polysomnographic study in chronic insomniac patients. *Pharmacopsychiatry*. 1994 Jul;27(4):166-75.

34. Victorri-Vigneau C, Gérardin M, Rousselet M, Guerlais M, Grall-Bronnec M, Jolliet P. An update on zolpidem abuse and dependence. *J Addict Dis*. 2014;33(1):15-23.

35. Victorri-Vigneau C, Dailly E, Veyrac G, Jolliet P. Evidence of zolpidem abuse and dependence: results of the French Centre for Evaluation and Information on Pharmacodependence (CEIP) network survey. *Br J Clin Pharmacol*. 2007 Aug;64(2):198-209.

36. Manthey L, Lohbeck M, Giltay EJ, van Veena T, Zitman FG, Penninx BW. Correlates of benzodiazepine dependence in the Netherlands Study of Depression and Anxiety. *Addiction*. 2012 Dec;107(12):2173-82.

37. Tompkins M, Plante M, Monchik K, Fleming B, Fadale P. The use of a non-benzodiazepine hypnotic sleep-aid (Zolpidem) in patients undergoing ACL

reconstruction: a randomized controlled clinical trial. *Knee Surg Sports Traumatol Arthrosc*. 2011 May;19(5):787-91.

38. Gong L, Wang Z, Fan D. Sleep Quality Effects Recovery After Total Knee Arthroplasty (TKA)--A Randomized, Double-Blind, Controlled Study. *J Arthroplasty*. 2015 Nov;30(11):1897-901.

39. Cho CH, Lee SW, Lee YK, Shin HK, Hwang I. Effect of a sleep aid in analgesia after arthroscopic rotator cuff repair. *Yonsei Med J*. 2015 May;56(3):772-7.

40. Chung SD, Lin CC, Wang LH, Lin HC, Kang JH. Zolpidem Use and the Risk of Injury: A Population-Based Follow-Up Study. *PLoS One*. 2013 Jun 27;8(6):e67459.

41. Roussin A, Bouyssi A, Pouché L, Pourcel L, Lapeyre-Mestre M. Misuse and dependence on non-prescription codeine analgesics or sedative H1 antihistamines by adults: a cross- sectional investigation in France. *PLoS One*. 2013 Oct 3;8(10):e76499.

42. McCabe S, Uebele A, Pihur V, Rosales R, Atroshi I. Epidemiologic Associations of Carpal Tunnel Syndrome and Sleep Position: Is There a Case for Causation?. *HAND*. 2007;2(3):127-134.

43. McCabe S, Xue Y. Evaluation of sleep position as a potential cause of carpal tunnel syndrome: preferred sleep position on the side is associated with age and gender. *HAND*. 2010;5(4):361-363.

44. McCabe S, Gupta A, Tate D, Myers J. Preferred sleep position on the side is associated with carpal tunnel syndrome. *HAND*. 2010;6(2):132-137.

45. Patel J, McCabe S, Myers J. Characteristics of sleep disturbance in patients with carpal tunnel syndrome. *HAND*. 2011;7(1):55-58.

46. Patel A, Culbertson M, Patel A et al. The Negative Effect of Carpal Tunnel Syndrome on Sleep Quality. *Sleep Disorders*. 2014;2014:1-7.

47. Becker S, Makanji H, Ring D. Expected and Actual Improvement of Symptoms With Carpal Tunnel Release. *J Hand Surg Am*. 2012;37(7):1324-1329.e5.

48. Kadzielski J, Malhotra L, Zurakowski D, Lee S, Jupiter J, Ring D. Evaluation of Preoperative Expectations and Patient Satisfaction After Carpal Tunnel Release. *J Hand Surg Am*. 2008;33(10):1783-1788.

49. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193-213.

50. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Med Rev*. 2016 Feb;25:52-73.

51. Luyster FS, Chasens ER, Wasko MC, Dunbar-Jacob J. Sleep quality and functional disability in patients with rheumatoid arthritis. *J Clin Sleep Med*. 2011 Feb 15;7(1):49-55

52. Løppenthin K, Esbensen BA, Jennum P, Østergaard M, Tolver A, Thomsen T, Midtgaard J. Sleep quality and correlates of poor sleep in patients with rheumatoid arthritis. *Clin Rheumatol*. 2015 Dec;34(12):2029-39.

53. Westhovens R, Van der Elst K, Matthys A, Tran M, Gilloteau I. Sleep problems in patients with rheumatoid arthritis. *J Rheumatol*. 2014 Jan;41(1):31-40.

54. Fragiadaki K, Tektonidou MG, Konsta M, Chrousos GP, Sfikakis PP. Sleep disturbances and interleukin 6 receptor inhibition in rheumatoid arthritis. *J Rheumatol.* 2012;39:60-2.

55. Gupta MA, Simpson FC, Gupta AK. Psoriasis and sleep disorders: A systematic review. *Sleep Med Rev*. 2015 Sep 21;29:63-75.

56. Egeberg A, Khalid U, Gislason GH, Mallbris L, Skov L, Hansen PR. Psoriasis and Sleep Apnea: A Danish Nationwide Cohort Study. *J Clin Sleep Med*. 2015 Dec 22.

57. Tyring S, Gottlieb A, Papp K, Gordon K, Leonardi C, Wang A, et al. Etanercept and clinical outcomes, fatigue, and depression in psoriasis: double-blind placebo-controlled randomised phase III trial. *Lancet* 2006;367:29e35.

58. Maari C, Bolduc C, Nigen S, Marchessault P, Bissonnette R. Effect of adalimumab on sleep parameters in patients with psoriasis and obstructive sleep apnea: a randomized controlled trial. *J Dermatol Treat*. 2014;25:57e60.

59. Brunton L, Laporte D. Use of Gabapentin and Pregabalin for Hand Surgery Patients. *J Hand Surg Am*. 2012;37(7):1486-1488.

60. de la Calle JL, De Andres J, Pérez M, López V. Add-on treatment with pregabalin for patients with uncontrolled neuropathic pain who have been referred to pain clinics. *Clin Drug Investig*. 2014 Dec;34(12):833-44.

61. Duman I, Aydemir K, Ozgul A, Kalyon TA. Assessment of the efficacy of gabapentin in carpal tunnel syndrome. *J Clin Rheumatol*. 2008 Jun;14(3):175-7.

62. Eftekharsadat B, Babaei-Ghazani A, Habibzadeh A. The Efficacy of 100 and 300 mg Gabapentin in the Treatment of Carpal Tunnel Syndrome. *Iran J Pharm Res*. 2015 Fall;14(4):1275-80.

63. Hui AC, Wong SM, Leung HW, Man BL, Yu E, Wong LK. Gabapentin for the treatment of carpal tunnel syndrome: a randomized controlled trial. *Eur J Neurol*. 2011 May;18(5):726-30.

64. Roth T, Lankford DA, Bhadra P, Whalen E, Resnick EM. Effect of pregabalin on sleep in patients with fibromyalgia and sleep maintenance disturbance: a randomized, placebo-controlled, 2-way crossover polysomnography study. *Arthritis Care Res (Hoboken).* 2012 Apr;64(4):597-606.

65. Roth T, Bhadra-Brown P, Pitman VW, Resnick EM. Pregabalin Improves Fibromyalgia-Related Sleep Disturbance. *Clin J Pain*. 2015 May 28.

66. Landis CA. Is Melatonin the Next " New " Therapy to Improve Sleep and Reduce Pain ? *Sleep*. 2014;37(9):1405-1406.

67. Lim H-D, Kim Y-S, Ko S-H, et al. Cytoprotective and anti-inflammatory effects of melatonin in hydrogen peroxide-stimulated CHON-001 human chondrocyte cell line and rabbit model of osteoarthritis via the SIRT1 pathway. *J Pineal Res*. 2012;53(3):225-237.

68. Liu X, Xu Y, Chen S, et al. Rescue of proinflammatory cytokine-inhibited chondrogenesis by the antiarthritic effect of melatonin in synovium mesenchymal stem cells via suppression of reactive oxygen species and matrix metalloproteinases. *Free Radic Biol Med*. 2014;68:234-246.

69. Pei M, He F, Wei L, Rawson A. Melatonin enhances cartilage matrix synthesis by porcine articular chondrocytes. *J Pineal Res*. 2009;46(2):181-187.

70. Huang C-T, Chiang RP-Y, Chen C-L, Tsai Y-J. Sleep deprivation aggravates median nerve injury-induced neuropathic pain and enhances microglial activation by suppressing melatonin secretion. *Sleep*. 2014;37(9):1513-1523.

71. Mowafi HA, Ismail SA. Melatonin improves tourniquet tolerance and enhances postoperative analgesia in patients receiving intravenous regional anesthesia. *Anesth Analg*. 2008;107(4):1422-1426.

72. Peters RM, Menendez ME, Mellema JJ, Ring D, Vranceanu AM. Sleep Disturbance and Upper-Extremity Disability. *Arch Bone Jt Surg*. 2016 Jan;4(1):35-40.

73. Shulman BS, Liporace FA, Davidovitch RI, Karia R, Egol KA. Sleep disturbance after fracture is related to emotional well-being rather than functional result. *J Orthop Trauma*. 2015 Mar;29(3):e146-50.

Figure 1. Flow chart outlining the key types of sleep disorders relative to hand surgery in the context of a broader overview of all sleep disorder categories. The first level represents the three main categories of sleep disorders. Note that boxes in grey are not relevant to this discussion, those in red highlight the key types of sleep disorders known to be related to hand surgery patients, and those in purple represent conditions that are likely to be associated with sleep disorders based on current evidence.

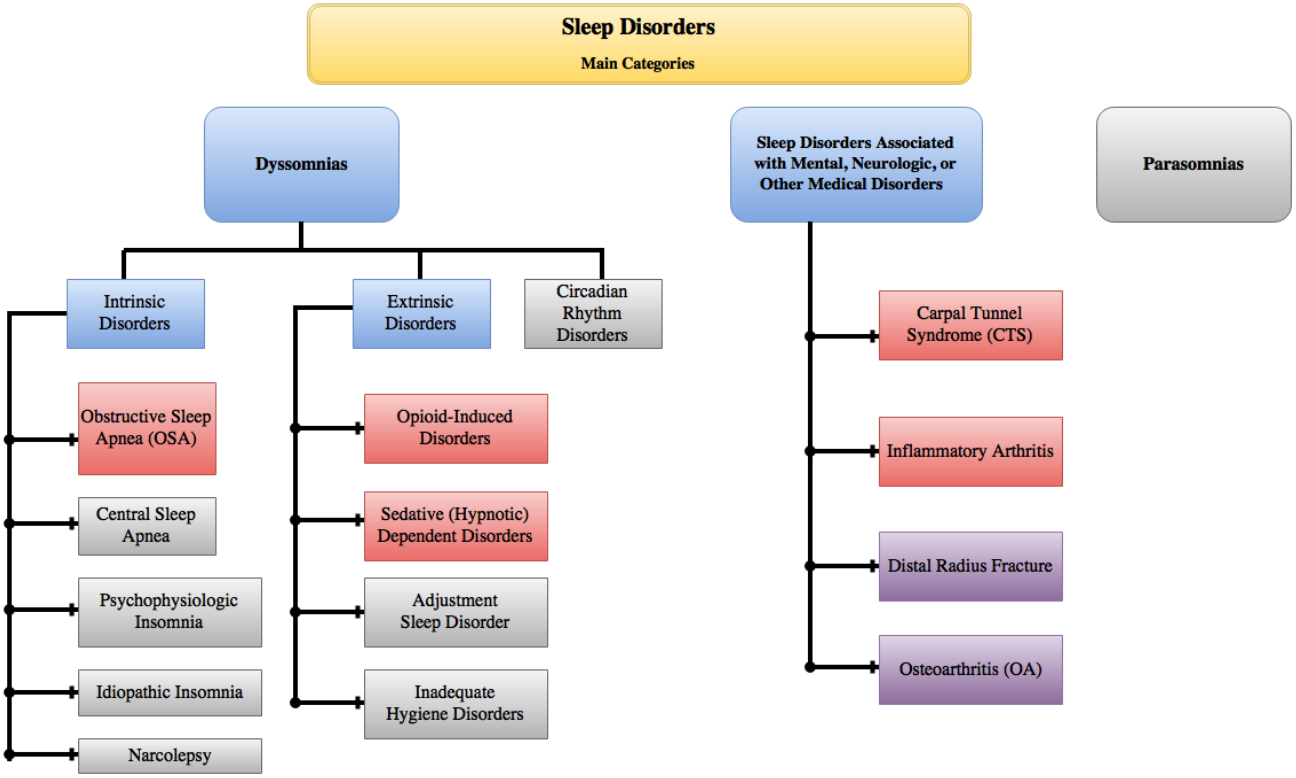

Table 1. STOP-BANG Questionnaire to assess for risk of Obstructive Sleep Apnea (OSA). The first section (STOP) consists of four history or symptom-related questions for the patient to answer, while the second section (BANG) consists of four items that may be objectively measured by the clinician. Answers of "Yes" to any question or measure results in a point, while "No" does not result in a point. Patients with total scores of 0-2, 3-4 and 5-8 points are considered low, intermediate, and high risk of having OSA, respectively.

Question or Variable	YES	NO
STOP		
Do you **SNORE** loudly (louder than talking or loud enough to be heard through closed doors)?	1	0
Do you often feel **TIRED**, fatigued, or sleepy during daytime?	1	0
Has anyone **OBSERVED** you stop breathing during your sleep?	1	0
Do you have or are you being treated for high blood **PRESSURE**?	1	0
BANG		
BMI more than 35kg/m2?	1	0
AGE over 50 years old?	1	0
NECK circumference > 16 inches (40cm)?	1	0
GENDER: Male?	1	0