# Osteopathic Cranial Manipulation and Myofascial Release of Anterior Fascia to Improve Respiratory Dynamics in Obstructive Sleep Apnea Syndrome: A Case Series

**Jonathan W. Torres, DO, MPA, FAAO, FACOFP**

CASE REPORT

From the Atlantic Health System in Morristown, NJ.

Disclosures: none reported.

Correspondence address:
Jonathan W. Torres, DO, MPA, FAAO, FACOFP
22 Prince Henry Drive
Randolph, NJ 07869
(631) 748-1870
jwtorres@gmail.com

Dr. Torres prepared this thesis as a requirement to earn fellowship in the American Academy of Osteopathy. The Committee on Fellowship in the AAO provided peer reviewing for this article, and it was edited to conform to the AAOJ's style guidelines.

## Introduction

Sleep related breathing disorders (SRBD) are a homogenous group of disorders which involve sleep disruption resulting from altered breathing dynamics. These sleep disruptions impair recovery from illness and injury, as well as maintenance of cognitive function. This paper reviews the relevant anatomy contributing to SRBD and outlines an osteopathic treatment protocol with the goals of improving both the respiratory flow dynamics and sleep impediments of the disease.

## Background

Obstructive Sleep Apnea Syndrome (OSAS) is the most severe of a group of sleep related breathing disorders (SRBD) which is defined by: apneas, the complete collapse of the airway for 10 seconds; hypopneas, 50% reduction in respiratory flow for 10 seconds, or Respiratory Effort Related Arousals (RERA), disruptions not meeting apneic or hypopneic criteria, occurring during sleep.[1]

These apneas, hypopneas and RERAs result in patient arousals, microarousals and sleep disruptions, which may occur hundreds of times in a single night. Sleep deficiencies impact neurocognitive, behavioral, metabolic, and autonomic parameters. They can also exacerbate medical conditions, such as diabetes, cardiovascular disease, cancer, and all-cause mortality.[2,3,4]

Sleep is regulated by the suprachiasmatic nuclei (SCN) within the hypothalamus. A two-process model is the dominant theory for sleep regulation, wherein sleep balance is achieved through interactions between the homeostatic process (Process S) and the circadian pacemaker (Process C). Process S is influenced by the proportion of time spent sleeping and awake and responds to sleep debt, whereas Process C refers to circadian rhythms and is influenced by light and dark periods, as well as food availability.[5]

Disrupted sleep associated with OSAS increases sleep debt (Process S), despite long periods in bed. Five stages characterize sleep: stages 1, 2, 3, 4, and Rapid Eye Movement (REM). These sleep stages cycle successively, taking 90-110 minutes total, throughout the night. Restorative sleep occurs only during the REM stage. Due to the successive nature of the sleep cycle, OSAS sufferers are often deprived of this restorative REM sleep because of frequent arousals or micro-arousals.[6]

The glymphatic system is a network of lymphatic drainage channels which travel alongside the brain vasculature. This network is most active during sleep cycles, especially REM, when the astroglial cells retract, creating perivascular tunnels through which lymphatic fluid may deliver nutrients such as "glucose, lipids, amino acids, growth factors, and neuromodulators," as well as to clear wastes.[7] Normal function of the glymphatic system facilitates normal central nervous system (CNS) function and recovery.[8,9,10]

Glymphatic function has been shown to change in response to blood pressure and respiratory rate.[11] Kiviniemi et al demonstrated cerebrospinal fluid (CSF) flow responses to cardiac activity (1 Hz), respiratory activity (0.3 Hz), and "low frequency waves (0.023-0.72 Hz = 1.38/min to 43.8/min)."[12] The low frequency wave rhythmicity may represent the short and long tide of cranial rhythmic

*(continued on page 8)*

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access

*(continued from page 7)*

impulses. Additionally, sleep was found to positively impact CSF clearance through the glymphatic system.[11] Therefore, SRBDs may negatively impact the glymphatic system, as a result of cranial strain patterns (reducing the low frequency waves) coupled with impaired sleep limiting time spent in REM sleep during which glymphatic drainage is most active.

## Treatment Approach

Osteopathic manipulative treatment to improve pulmonary conditions emphasizes interventions intended to balance autonomic function, improve lymphatic drainage of the pulmonary tract, and restore normal functional dynamics of the ribcage and diaphragm.[13,14,15,16] The connections to be outlined in this paper include the respiratory diaphragm, the osseous and soft tissues of the mediastinum, the anterior cervical fascia, muscles of the larynx, pharynx and their connections via the median raphe's insertion on the pharyngeal tubercle of the sphenoid bone and consequently the sella turcica to the pituitary gland and hypothalamus, which houses the sleep regulatory center. These connections may provide a unifying theory relating the function of the glymphatic system with cranial strain patterns and SRBDs, prompting further investigation.

The diaphragm is the primary muscle of respiration. During contraction, it acts as a pump, creating negative intrathoracic pressure to facilitate air exchange as well as lymphatic drainage.[15,16] In fact, 35% to 60% of the thoracic duct drainage is in response to respiratory movements.[16] The respiratory diaphragm has firm attachment to ribs 7-12, the sternum, as well as L1-3 via the crus.[17] Somatic dysfunctions of these structures may limit normal respiratory function, and they can be reciprocally restricted in turn by aberrant respiratory function.

| **Table 1[26] - Muscles of the Anterior Cervical Fascia** | |
|---|---|
| ***Region: Suprahyoid*** | |
| **Muscles** | **Function** |
| Hyoglossus (vertical) | Depresses and retracts the tongue (Sp/Sw) |
| Digastric (AP) | Elevates the hyoid (Sp/Sw/Br/Ch) |
| Middle pharyngeal constrictors (posterior) | Propels food from oropharynx to esophagaus (Sw/Br) |
| Geniohyoid (longitudinal) | Dilates the upper airway, assisting respiration (Sw/Br) |
| Mylohyoid (transverse) | Elevates the hyoid and tongue (Sp/Sw/Br) |
| Stylohyoid | Initiates a swallowing action by pulling the hyoid bone in a posterior and superior direction |
| ***Region: Infrahyoid*** | |
| **Muscles** | **Function** |
| Thyrohyoid | Depresses the hyoid and elevates the larynx (Sw/Br/Sp) |
| Sternohyoid | Depresses the hyoid bone (Sp/Br) |
| Inferior pharyngeal constrictors | Pharyngeal peristalsis (Sw) [Zenker's diverticulum] |
| Cricopharyngeus | Pharyngeal peristalsis (Sw) [Zenker's diverticulum] |
| Omohyoid | Depresses the hyoid bone and larynx (Sp/Sw/Br) |
| Thyro-Arytenoideus | Shortens and relaxes the vocal folds (Sp/Br) |
| ***Region: Infrathyroid*** | |
| **Muscles** | **Function** |
| Sternothyroid | Depresses the larynx (Sp/Br) |
| Sternohyoid | Depresses the Hyoid (Sp/Br/Sw) |
| Platysma | Depresses the mandible (Ch/Sw) |
| ***Key*** | |
| Sp – Speaking | Sw – Swallowing |
| Br – Breathing | Ch – Chewing |

The diaphragm's soft tissue connections have received less attention than the osseous structures. The mediastinum firmly attaches to the diaphragm via insertion of the endothoracic fascia into the fasciae transversalis, with the pericardial fibers directly anchoring into the central tendon. The fasciae transversalis "originates in the deep and median cervical fascia (i.e., the neck, including the scalene muscles and the phrenic nerve), and extends to the occipital pharyngeal tubercle, where there is the dura mater, which is [continuous with] the reciprocal tension membranes."[18]

The anterior cervical fascia incorporate many small muscles which define the upper airway including muscles connecting the sternum, clavicle, thyroid, pharynx, and hyoid (see Table 1). Concerted contractions of these structures allow for: phonation required for speech, deglutition, and facilitation of breathing dynamics.[19]

In the presence of somatic dysfunction, limitations in motion affecting these muscles may create areas of dysfunctional stenosis, lowering the threshold for apneas and hypopneas to occur. For instance, asymmetric contraction of the thyrohyoid will result in asymmetric elevation of the larynx with depression of the hyoid, creating an airway profile with a smaller cross-sectional area potentially limiting air movement. As such, dysfunctions of these muscles may play a role in the pathophysiology of sleep disturbances described earlier.

These components of the larynx transition to the pharynx where they anchor into the hyoid, mandible, and muscles

*(continued on page 9)*



Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access

*(continued from page 8)*

making up the floor of the tongue as well as continuing upwards to attach to the pharyngeal tubercle on the underside of the sphenoid. While the sphenoid is hollow, containing the sphenoid sinus, the periosteum is continuous around its entirety, including through the sphenobasilar junction (SBJ) and sutures. Here it invests into the sella turcica with connections to the anterior pituitary and periosteal continuity to the tentorium cerebelli at the clinoid processes and the falx cerebri anteriorly across the ethmoidal plate.

Embryologically, the anterior pituitary derives from the stomodeum between the diencephalon and the pericardium, and merges with the posterior pituitary in week 4 of development.[20] While cranial and spinal nerves merge with the foramina they traverse, the anterior pituitary is loosely attached in the sella turcica, where "the meninges blend with the pituitary capsule and are not separate layers."[21] The pituitary, in turn, is attached to the hypothalamus, and ultimately the thalamus.

Dr. Sutherland taught that "the mobility of the pituitary body within the sella turcica was essential to its function."[22] While not widely accepted, in *Contributions of Thought*, he posits that

> The cerebrospinal fluid receives products from the pituitary body. However, motion of the pituitary is more important than the function of its secretion. Without the motion that occurs as the sphenoid moves upward and downward during respiratory periods, there would be no resultant secretion by the pituitary.[23]

The pituitary, the master gland, with its secretion of cortisol stimulating hormone (CSH) and other vital hormones, may play a role in propagating chronic stress.[24]

This CNS attachment is more relevant, as the sleep center resides within the suprachiasmatic nucleus (SCN) of the hypothalamus. Viewed together, we can see a direct connection between cranial rhythmic motion (primary respiration) and pulmonary breathing dynamics (secondary respiration).

Building upon these relationships, a manipulative approach to address sleep disordered breathing begins to congeal. The "bowstring" concept drawn from *Ligamentous Articular Strain* defined many of the respiratory structures above discussed. It focuses upon the anterior connections which complement the posterior spinal column within a tensegrity model. This anatomical investigation ceased at the pharyngeal tubercle of the sphenoid where force was transmitted via the SBS to the occiput and then to the spine.[25] The cranio visceral link (CVL) extends the bowstring concept to unite the pulmonary structures to the cranial concept, unifying primary and secondary respirations.

## Cases

AG is a seven-year-old female fraternal twin with a history of OSAS, motor tics, plagiocephaly and torticollis. She was planning for tonsillectomy and adenoidectomy for her OSAS. Her structural exam revealed cranial flexion dysfunction with a central dural pull, R pterygoid hypertonicity, intermaxillary restriction, C3-4 neutral, sidebent left, rotated left, thoracic inlet restriction on the right, rib 3-4 restriction on the right, L2-4 neutral, sidebent left, rotated right, sacrum cranial flexion dysfunction, left anterior innominate, right trapezius hypertonicity, right piriformis hypertonicity. Examination of her Cranio Visceral Link (CVL) dysfunctions are listed below in Table 2. Following OMT to correct the CVL, she had improvement in her breathing, and a subsequent sleep endoscopy demonstrated improved airway dynamics. As a result, her tonsillectomy and adenoidectomy were cancelled.

KG was AG's fraternal twin sister, was also seen at age seven. She has a history of juvenile rheumatoid arthritis, sleep disordered breathing which did not meet OSAS criteria, and with chronic snoring. Osteopathic structural exam revealed: condylar compression bilaterally, OA compression left, fourth ventricle restricted, C2 flexed, rotated right, sidebent right, T2 flexed, rotated right, sidebent right, rib 12 exhalation dysfunction bilaterally, L5 flexed, rotated left, sidebent left, generalized restriction of the sacroiliac joint bilaterally, pubes compression bilaterally, and respiratory diaphragm restrictions worse on the right. CVL findings noted in table 2. Following OMT to address the CVL, she experienced marked reductions in snoring, as well as much more frequent closed mouth posture during the day.

JG-1 is a nine-year-old boy with OSA s/p tonsillectomy and adenoidectomy with a history of motor and verbal tics since age 5, as well as pes planus. He has ongoing disrupted sleep, although tics don't occur while sleeping. Osteopathic structural exam revealed: OA flexed, rotated right, sidebent left, C2 flexed, rotated right, sidebent right, T2 flexed, rotated left, sidebent left, rib 12 exhalation right, L5 flexed, rotated right, sidebent right, L3 flexed,

*(continued on page 10)*

**Table. 2 Cranio Visceral Link (CVL) Findings**

| *Patient* | *AG* | *KG* | *JG* | *AW* | *JG-2* |
|---|---|---|---|---|---|
| Sella Turcica | Left | Left | Left | Right | Right |
| Suprahyoid | Right | Right | Right | Left | Left |
| InfraHyoid | Left | Left | Left | Right | Right |
| InfraThyroid | Right | Right | Right | Left | Left |
| Mediastinum | Left | Left | Left | Right | Right |
| Pericardium | Right | Right | Right | Left | Left |
| Respiratory diaphragm | Right > left | Right > left | Right > left | Left > right | Left > right |

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access

*(continued from page 9)*

rotated left, sidebent left, generalized restriction of the sacroiliac joint bilaterally, worse on the right, pubes compression, right superior innominate shear, respiratory diaphragm restriction, and internally rotated tibias bilaterally. CVL exam findings are noted in Table 2. Following OMT to address the CVL, sleep quality improved with reductions in snoring, sleep disruptions and daytime somnolence.

AW is a nine-year-old female with Down Syndrome, OSA, recurrent otitis media with permanent hearing loss, and a history of congenital heart defect reconstructive surgery presented for evaluation of her airway and recurrent otitis media. Osteopathic structural exam showed: OA extended sidebent left, rotated right, ethmoid/maxilla restriction bilaterally, decreased Cranial Rhythmic Impulse (CRI) amplitude, restriction at the falx cerebelli, increased dural pull at C3 bilaterally with C3 flexed, sidebent right, rotated right, pronounced sternal and mediastinal restrictions (defined in Table 2), L2-4 neutral, sidebent left, rotated right, generalized restriction of the sacroiliac joint on the right, right sacrum cranial extension, right anterior innominate, left hemidiaphragm restriction, and left tibia internal rotation. Additional CVL findings are also detailed in Table 2. Following treatment of the CVL, she experienced less snoring, more closed mouth posture, and less daytime fatigue.

JG-2 is an eight-year-old male with a history of OSAS status post adenoidectomy with continued snoring and mouth breathing, asthma, recurrent otitis media with tympanostomy tubes placed, as well as speech delays. He was experiencing dyspnea with exertion and had a negative cardiology workup recently. Osteopathic structural exam revealed: OA generally compressed on the left, C2 flexed, rotated right, sidebent right, C3 flexed, rotated left, sidebent left, T2 flexed, rotated right, sidebent right, rib 12 restricted bilaterally, L5 flexed, rotated right, sidebent right, generalized restriction of the sacroiliac joint bilaterally, pubes compression, left posterior innominate, respiratory diaphragm restricted left, externally rotated hips bilaterally. CVL findings described in Table 2.

## Discussion

This structural relationship between the CNS and the respiratory system has not yet, to my knowledge, been described. Utilizing this anatomical relationship, a method for utilizing OMT to bring about improved dynamics of primary and secondary respiration takes shape. Ligamentous articular strain is a convenient modality to address these anterior fascial relationships, which often manifests as an alternating sidebending strain pattern as a result of asymmetric muscular function of the longitudinally related muscles described above, and is effectively treated by emphasizing translation or sidebending indirectly.[20] The fascial structures of the mediastinum and pericardium tend to alternate in the directionality of their strain, while the anterior cervical fascia commonly manifest as three distinct zones, each of which also alternates strain direction (please see Figure 1 for further detail).

*Figure 1*

Once the anterior cervical fascia has been addressed, the relationship between the pituitary, sella turcica and pharyngeal structures can be addressed. By obtaining contact with the anterior cervical fascia just below the hyoid with one hand, and an anterior frontal hold with the other, one may balance the sella turcica and sphenoid (pituitary) into the cervical fascia. The palpation through the parenchyma of the brain to the level of the hypothalamus and pituitary can be achieved through the parenchyma directly, or via the falx cerebri attachment at the crista galli and then moving posteriorly to the diaphragma sella. Once this connection has been achieved and brought to a point of balance, there is a substantial shift in the primary respiratory motion (PRM), and palpable releases throughout the anterior cervical fasciae. Afterwards correction of residual cranial dysfunction to complete treatment is also facilitated.

*(continued on page 11)*



Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access

*(continued from page 10)*

Several muscles in the anterior cervical fascia have a significant effect on the shape of the airway and can alter airflow dynamics with respiration. The alternating pattern of strains in the anterior cervical musculature can result in a wringing or narrowing of the airway, exacerbating SRBD phenomena. These muscles may also play a role in altering support for tongue movements and vocal cord function vital for latching, deglutition, and most of all speech production.[20] The application of focused manipulation to the anterior fasciae, coupled with treatment of cranial connections, may improve the airway dynamics, while also addressing the relationship between primary and secondary respiration, thereby reducing sleep disordered breathing episodes, improving sleep quality, and reducing the severity of sleep related conditions.

Further research is needed to more fully explore the impact that such a manipulative approach to sleep disorders may play. Limitations to such research include costs associated with sleep studies, as well as identifying a population willing to undertake an extensive study involving a second night of polysomnography. I am exploring options to undertake such research but have been encouraged by the case studies herein discussed.

## Acknowledgements

Millicent King Channell, DO, MA, FAAO,
Professor of OMM and Family Medicine,
Assistant Dean for Curriculum,
Rowan University School of Osteopathic Medicine.

## References

1. Judd BG, Sateia MJ. Classification of Sleep Disorders. Updated May 30, 2017. Accessed December 15, 2018. https://www.uptodate.com/contents/classification-of-sleep-disorders?search=classification%20of%20sleep%20disorders&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1
2. Finan PH, Goodin BR, Smith MT. The association of sleep and pain: an update and a path forward. *J Pain*. 2013;14(12):1539-1552. doi:10.1016/j.jpain.2013.08.007
3. Van Dongen HP, Maislin G, Mullington JM, Dinges DF. The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep*. 2003;26(2):117-126. doi:10.1093/sleep/26.2.117
4. Orzeł-Gryglewska J. Consequences of sleep deprivation. *Int J Occup Med Environ Health*. 2010;23(1):95-114. doi:10.2478/v10001-010-0004-9
5. Borbély AA, Daan S, Wirz-Justice A, Deboer T. The two-process model of sleep regulation: a reappraisal. *J Sleep Res*. 2016;25(2):131-143. doi:10.1111/jsr.12371.
6. Ramar K, Olson EJ. Management of common sleep disorders. *Am Fam Physician*. 2013;88(4):231-238.
7. Jessen NA, Munk AS, Lundgaard I, Nedergaard M. The Glymphatic System: A Beginner's Guide. *Neurochem Res*. 2015;40(12):2583-2599. doi:10.1007/s11064-015-1581-6
8. Iliff JJ, Lee H, Yu M, et al. Brain-wide pathway for waste clearance captured by contrast-enhanced MRI. *J Clin Invest*. 2013;123(3):1299-1309. doi:10.1172/JCI67677
9. Iliff JJ. One more reason to get a good night's sleep. TEDMed 2014. Accessed December 15, 2018. https://www.tedmed.com/talks/show?id=293015
10. Xie L, Kang H, Xu Q, et al. Sleep drives metabolite clearance from the adult brain. *Science*. 2013;342(6156):373-377. doi:10.1126/science.1241224
11. Plog BA, Nedergaard M. The Glymphatic System in Central Nervous System Health and Disease: Past, Present, and Future. *Annu Rev Pathol*. 2018;13:379-394. doi:10.1146/annurev-pathol-051217-111018
12. Kiviniemi V, Wang X, Korhonen V, et al. Ultra-fast magnetic resonance encephalography of physiological brain activity - Glymphatic pulsation mechanisms? *J Cereb Blood Flow Metab*. 2016;36(6):1033-1045. doi:10.1177/0271678X15622047
13. Kuchera ML, Kuchera WA. Lower respiratory disorders. In: Kuchera ML, Kuchera WA eds. *Osteopathic Considerations in Systemic Dysfunction*. 2nd rev ed. Greyden Press. 1994:23-51.
14. DiGiovanna EL, Rivera-Martinez S. Pulmonary applications. In: DiGiovanna EL, Schititz S, Dowling DJ eds. *An Osteopathic Approach to Diagnosis and Treatment*. 3rd ed. Lippincott Williams & Wilkins. 2005:618-623.
15. Foley W, Ettlinger H, D'Alonzo G, Carreiro J. Difficulty breathing. In: Chila A, eds. *Foundations for Osteopathic Medicine.* 3rd ed. Lippincott Williams and Wilkins. 2011:931-938.
16. Morelli-Haskell MA, Sanchez J. Uncontrolled asthma. In: Chila A, eds. *Foundations for Osteopathic Medicine.* 3rd ed. Lippincott Williams and Wilkins. 2011:883-888.
17. Moore KL, Dalley, AF. Abdomen. In: Moore KL, Dalley, AF eds. *Clinically Oriented Anatomy.* 5th ed. Lippincott Williams and Wilkins. 1999:325-328.
18. Bordoni B, Zanier E. Anatomic connections of the diaphragm: influence of respiration on the body system. *J Multidiscip Healthc.* 2013;6:281-291. Published 2013 Jul 25. doi:10.2147/JMDH.S45443.
19. Moore KL, Dalley, AF. Neck. In: Moore KL, Dalley, AF eds. *Clinically Oriented Anatomy*. 5th ed. Lippincott Williams and Wilkins. 1999:1069.
20. Moore KL, Dalley, AF. Neck. In: Moore KL, Dalley, AF eds. *Clinically Oriented Anatomy*. 5th ed. Lippincott Williams and Wilkins. 1999:1051,1066-67,1069.
21. Schoenwolf G, Bleyl S, Brauer P, Fracis-West P. Development of the central nervous system. In: Schoenwolf G, Bleyl S, Brauer P, Fracis-West P, eds. *Larsen's Human Embryology*. 5th ed. Churchill Livingstone; 2015:225-228.
22. Strauss I, Lipsman N, Lozano AM. Diencephalon. In: Standring S, eds. *Gray's Anatomy*. 41st ed. Elsevier; 2016:359-361.
23. Sutherland WG. The motility of the neural tube. *Teachings in the Science of Osteopathy*. SCTF Press; 1990:61.
24. Sutherland AS, Wales A. *Contributions of Thought: The collected writings of William Garner Sutherland, D.O.* 2nd edition. Sutherland Cranial Teaching Foundation; 1998:138.

*(continued on page 12)*

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access

*(continued from page 11)*

25. Kudielka BM, Wüst S. Human models in acute and chronic stress: assessing determinants of individual hypothalamus-pituitary-adrenal axis activity and reactivity. *Stress*. 2010;13(1):1-14. doi:10.3109/10253890902874913
26. Speece CA, Crow WT, Simmons SL. The bowstring. In: Speece CA, Crow WT, Simmons SL, eds. *Ligamentous Articular Strain: Osteopathic Manipulative Techniques for the Body*. Eastland Press; 2009:139-158 ■

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-10 via free access