Management of COVID-induced Acute Respiratory Failure Requiring Intubation with Osteopathic Manipulative Medicine

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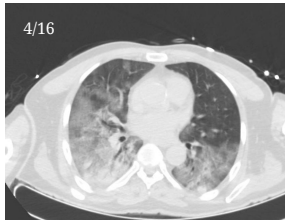
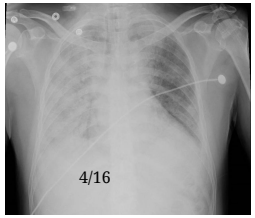
Introduction

New York City saw the first severe COVID-19 outbreak in the United States, with a crude mortality rate of 9.2% overall and 32.1% among hospitalized patients between February and June 2020(1). At that time, few reliable treatments for management of severely ill COVID-19 afflicted patients were known. Residents specializing in Osteopathic Neuromusculoskeletal Medicine (ONMM) at St Barnabas Hospital in the Bronx worked on the frontlines and cared for a number of patients admitted with COVID-19 related pneumonia and Acute Respiratory Failure (ARF) requiring intubation.

Date	Method	Liters (L)
04/14	NRB	15L
04/15	NRB	15L
04/16	INTUBATION	
04/29	EXTUBATION	
04/30	NC	4L
05/01	NC	4L
05/04	NRB	15L
05/05	NC	6L
05/06	NC	5L
05/07	NC	5L
05/11	NC	4L
05/12	NC	4L
05/13	NC	4L
05/14	NC	3L
05/15	NC	3L





Case

Initial Consult 04/14: 67 year old male with medical history of hypertension and diabetes mellitus was admitted on 04/13/2020 with respiratory failure. Placed on non-rebreather mask (NRB) 15L O2 sat 91%; prior on room air at 61% with symptoms of +cough, productive sputum, chest pain.

Physical exam: notable for NRB at 15L, breathing comfortably with supplemental O2*, peripheral pulses palpable, soft, non-tender abdomen, no noted rashes on skin.
Imaging: Pertinent for Chest Xray demonstrating bilateral ground-glass opacities and left-sided consolidation; CT with ground glass, crazy paving patterns, vascular dilatation and consolidation. (as above)
Pertinent Labs: D-Dimer: 04/13 (4.36) → 04/16 (>35.2)

Brief Hospital Course:
The ONMM department was consulted on hospital day 2, and he received osteopathic manipulative treatment (OMT) on 04/14 and 04/15. Patient was intubated on 04/16 with acute respiratory failure and transferred to the ICU. Course was complicated by bilateral pulmonary embolism and left common femoral deep vein thrombosis, sacral decubitus ulcer & right foot dry gangrene
Oxygen Requirements: depicted in chart to the left while patient off of ventilation

Medications Received: IV steroids, ceftriaxone, azithro, hydroxychloroquine, tocilizumab

*heart and lung sounds were not performed due to lack of resources to sterilize supplies between patients

Osteopathic Structural Exams

04/14: OSE Initial: SBS compression, extended; R lower ribs inhaled, severe mediastinal fascial strain, prevertebral fascial strain, T4 FRSr, flattened L1-2, sacral base posterior, left innominate posterior, bilateral hip compression, left clavicle inhaled, right lower ribs inhaled, right>left hemidiaphragm inhaled

04/17: Significant OSE post-intubation findings: SBS compression, flexed; severe prevertebral fascial strain, T1-2 FRSr; R lower ribs exhaled, decreased rib compliance

Treatment: provided from initial consult 5 days/week; utilizing modalities as follows:
- Balanced Ligamentous Tension
- Myofascial Release
- Articulatory
- Osteopathy in the Cranial Field

Results

Patient was extubated 04/29

04/30: Significant OSE post-extubation: right condyle anterior, moderate SBS compression, extended; moderate mediastinal fascial strain, moderate prevertebral fascial strain, right ribs exhaled, left upper ribs exhaled, decreased rib compliance

Patient was treated **NINE** times between intubation and extubation, and continued treatment with ONMM residents 5 days/week. Discharged 05/15 to rehab.

Discussion

Of the **Five Osteopathic Models** several were integral to the osteopathic approach to this patient with COVID-associated pneumonia and respiratory failure

RESPIRATORY-CIRCULATORY
Severe manifestations of SARS-CoV-2 requiring intubation frequently present with a picture of acute respiratory failure (ARF) and Acute Respiratory Distress Syndrome (ARDS), which prompted early intubation at the start of the pandemic (2). Experienced clinicians approached patients with concern for cytokine storm, the highly reactive immune response that can lead to ARDS, and this has been a prominent feature of severe COVID disease under investigation. Initial medical management often utilized IL-6 inhibitors due to evidence of elevations in IL-6 in severe disease (3). Higher acuity cases demonstrated evidence of systemic inflammation with fluid accumulation in lungs, generalized edema, erythema in distal extremities and vascular damage to small vessels, with worse outcomes in patients with pre-existing inflammatory conditions including diabetes mellitus (4,5,6). In normal function the lymphatic drainage plays a significant role in removing the proteins that leak into the interstitium causing distal edema and inflammation and help maintain osmotic balance of the tissues (7).

Treatments to affect the lymph movement were heavily utilized in this patient and others with ARF and COVID. Osteopathic lymphatic pump techniques can enhance release of leukocytes and inflammatory mediators into lymphatic circulation but can also improve fluid return and lymphatic duct function which can assist the body in decreasing it's inflammatory load (7, 8, 9). In a study from Castillo et al, results indicated that thoracic duct lymph had a suppressive effect on macrophage inflammatory mediators equally in the pre, during, and post treatment groups. During lymphatic pump, there was a 10-fold increase in thoracic duct flow rate (mL/min) and protein flux (pg/min) however no significant difference in protein concentration (9). A study from Schander in 2011 demonstrated mobilization of inflammatory mediators following lymphatic pump technique application.

This patient had pre-existing diabetes mellitus with vascular complications and contended with initial poor oxygenation (61% on room air at admission), pulmonary emboli, DVT and gangrene following COVID infection. Undeniably, the respiratory failure and inflammation caused by COVID pneumonia contributes significantly to past and present virulence of COVID.

BIOMECHANICAL
In addition to the inflammatory response affecting respiratory function, physical changes affecting musculoskeletal function also contribute to respiratory distress and worsen in the setting of intubation (10). In any ventilated patient, reduced spine and rib compliance will increase "work of breathing" by increasing load to muscles of respiration. The diaphragm and other muscles of respiration are not recruited by the artificial mechanical process of ventilators and do not follow physiologic mechanics. This leads to weakening and atrophy of these muscles and causes a challenge for patients when attempting to extubate (10, 11).

Our patient in this case was found to have R sided lower rib dysfunction initially that went on to include the left upper ribs as his symptoms progressed. Notably, rib compliance was a repeated issue in his OSEs. He also was noted to have severe prevertebral fascial strain and chest wall strain.

PSYCHOSOCIAL
Although a smaller role in this discussion, patients on COVID units experience significant isolation, and often the OMM team played a significant role in giving patients access to human interaction and assistance in contacting family members. In many hospitals IV pumps were kept outside of patient rooms to reduce frequency of staff exposure and conserve PPE (12). ONMM residents spent on average twenty minutes doing hands-on treatments for each patient under their care, and often took on tasks to connect patients with family and other parts of their medical team, especially in a setting where hospital visitors were not permitted.

Conclusions

Patients suffering from COVID-19, once intubated, the death rate exceeds 80%. This case illustrates an intubated COVID patient treated with OMT who was extubated and ultimately discharged, suggesting the safety of OMT as a management method in such patients. As new research expands our understanding of COVID's pathophysiology, we may also be able to understand how OMT can provide additional therapeutic benefit.

Acknowledgements

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References

1. Thompson CN, Baumgartner J, Pichardo C, et al. COVID-19 Outbreak — New York City, February 29–June 1, 2020. MMWR Morb Mortal Wkly Rep 2020;69:1725–1729. DOI: http://dx.doi.org/10.15585/mmwr.mm6946a2
2. Rola P, Farkas J, Spiegel R, et al. Rethinking the early intubation paradigm of COVID-19: time to change gears?. Clin Exp Emerg Med. 2020;7(2):78-80. doi:10.15441/ceem.20.043
3. Leisman DE, Ronner L, Pinotti R, Taylor MD, Sinha P, Calfee CS, Hirayama AV, Mastroiani F, Turtle CJ, Harhay MO, Legrand M, Deutschman CS. Cytokine elevation in severe and critical COVID-19: a rapid systematic review, meta-analysis, and comparison with other inflammatory syndromes. Lancet Respir Med. 2020 Dec;8(12):1233-1244. doi: 10.1016/S2213-2600(20)30404-5. Epub 2020 Oct 16. PMID: 33075298; PMCID: PMC7567529.
4. Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020 Apr 7;323(13):1239-1242. doi: 10.1001/jama.2020.2648. PMID: 32091533.
5. Li X, Xu S, Yu M, Wang K, Tao Y, Zhou Y, Shi J, Zhou M, Wu B, Yang Z, Zhang C, Yue J, Zhang Z, Renz H, Liu X, Xie J, Xie M, Zhao J. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. J Allergy Clin Immunol. 2020 Jul;146(1):110-118. doi: 10.1016/j.jaci.2020.04.006. Epub 2020 Apr 12. PMID: 32294485; PMCID: PMC7152876.
6. Merrill, J.T., Erkan, D., Winakur, J. et al. Emerging evidence of a COVID-19 thrombotic syndrome has treatment implications. Nat Rev Rheumatol 16, 581–589 (2020). https://doi.org/10.1038/s41584-020-0474-5
7. Ettlinger H, Willard FH. Anatomy and physiology of the lymphatic system. In: Seffinger MA , 4th ed. Foundations of Osteopathic Medicine: Philosophy, Science, Clinical Applications and Research. Wolters Kluwer 2018: 175-195.
8. Schander A, Downey HF, Hodge LM. Lymphatic pump manipulation mobilizes inflammatory mediators into lymphatic circulation. Exp Biol Med (Maywood). 2012 Jan;237(1):58-63. doi: 10.1258/ebm.2011.011220. Epub 2011 Dec 14.
9. Castillo R, Schander A, Hodge LM. Lymphatic Pump Treatment Mobilizes Bioactive Lymph That Suppresses Macrophage Activity In Vitro. J Am Osteopath Assoc. 2018;118(7):455-461. doi:10.7556/jaoa.2018.099
10. Tobin, Martin J. "Narrative Review: Ventilator-Induced Respiratory Muscle Weakness." Annals of Internal Medicine 153.4 (2010): 240-45. Web.
11. Levine, Sanford. "Rapid Disuse Atrophy of Diaphragm Fibers in Mechanically Ventilated Humans." The New England Journal of Medicine 358.13 (2008): 1327-335. Web.
12. Shah et al; Relocating IV Pumps for Critically Ill Isolated Coronavirus Disease 2019 Patients From Bedside to Outside the Patient Room, Critical Care Explorations: August 2020 - Volume 2 - Issue 8 - p e0168 doi: 10.1097/CCE.0000000000000168