



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



# Venous thromboembolism after arthroscopic rotator cuff repair in a patient with a negative presurgical SARS-CoV-2 test who developed symptomatic COVID-19 three days after surgery

Aakash Chauhan, MD, MBA<sup>a,\*</sup>, Diego Villacis, MD<sup>a</sup>, Ryan Boente, MD<sup>b</sup>, Anthony A. Romeo, MD<sup>a</sup>

<sup>a</sup>Dupage Medical Group Musculoskeletal Institute, Naperville, IL, USA

<sup>b</sup>Division of Pulmonary, Critical Care, Sleep, and Occupational Medicine, Indiana University School of Medicine, Indianapolis, IN, USA

The rate of venous thromboembolism (VTE) after elective shoulder arthroscopy cases is rare, and there also has not been substantial evidence to support the use of routine postoperative anticoagulation.<sup>1,6,8,9</sup> However, with the recent pandemic of the SARS-CoV-2 virus that causes COVID-19 infections, there has been significant concern over the high rate of VTE observed in infected patients.<sup>3,5,7</sup> The virus seems to stimulate a strong microvascular endothelial cell response that leads to thrombosis and clot formation.<sup>7</sup> As we have resumed normal elective surgeries, we have nationally implemented routine preprocedural SARS-CoV-2 screening in patients. However, as our testing has improved, it is still far from perfect. Anecdotally in our practice, we have had numerous asymptomatic patients who test positive for the virus in their routine preprocedure screening that are either latent infections or false positives. However, the real concern occurs when patients who test negative, have surgery, but are actually infected and become symptomatic soon thereafter.

In this case report, we discuss the rare occurrence of a postoperative upper extremity deep venous thrombosis (DVT) and pulmonary embolus (PE) that formed acutely after an elective, outpatient arthroscopic rotator cuff repair

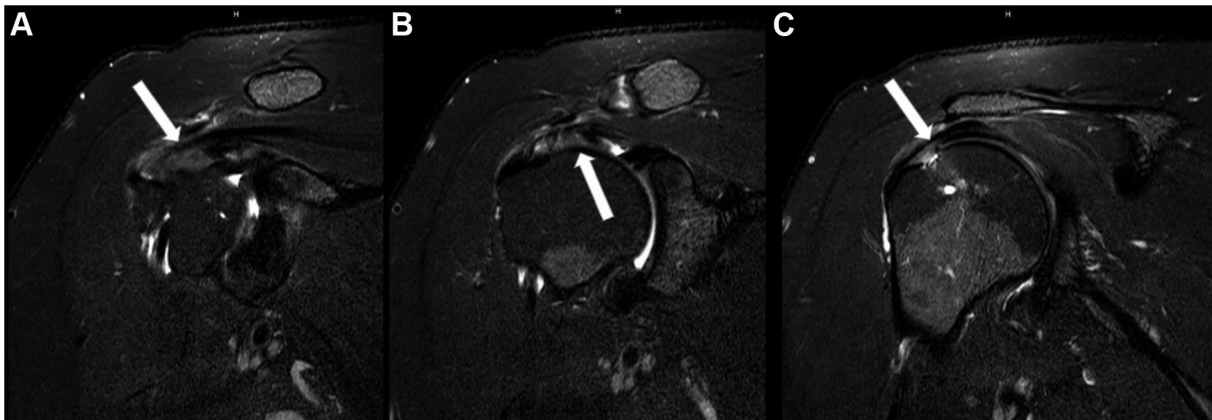
in an otherwise healthy, young patient. The patient tested negative for the SARS-CoV-2 virus on her preoperative screening, indicating no active COVID-19 infection. However, the patient became symptomatic 3 days after surgery and was found to have a positive exposure the day before surgery, which led to her infection. We believe the risk factors of surgery combined with her unknown COVID-19 infection created a significant prothrombotic state that led her to have this rare VTE event.

## Case report

A 42-year-old right hand–dominant woman, with no significant medical history, suffered a left shoulder injury after a fall 8 months prior to presentation. She failed conservative treatment with physical therapy, and magnetic resonance imaging was obtained by her primary care physician. She was then sent to orthopedic surgery for evaluation and treatment. Her left shoulder examination demonstrated 90° of painful standing forward flexion, passive forward flexion to 150°, active external rotation of 80°, and active internal rotation to L1. She had 3/5 supraspinatus strength, but the remainder of the rotator cuff tendons had 5/5 strength. She had significant pain of the proximal biceps tendon and positive Jobe, O'Brien's, and impingement testing. Radiographs of the left shoulder showed no acute or chronic

\*Reprint requests: Aakash Chauhan, MD, MBA, 100 Spalding Dr., Suite 300, Naperville, IL 60540, USA.

E-mail address: [achauhan1000@gmail.com](mailto:achauhan1000@gmail.com) (A. Chauhan).

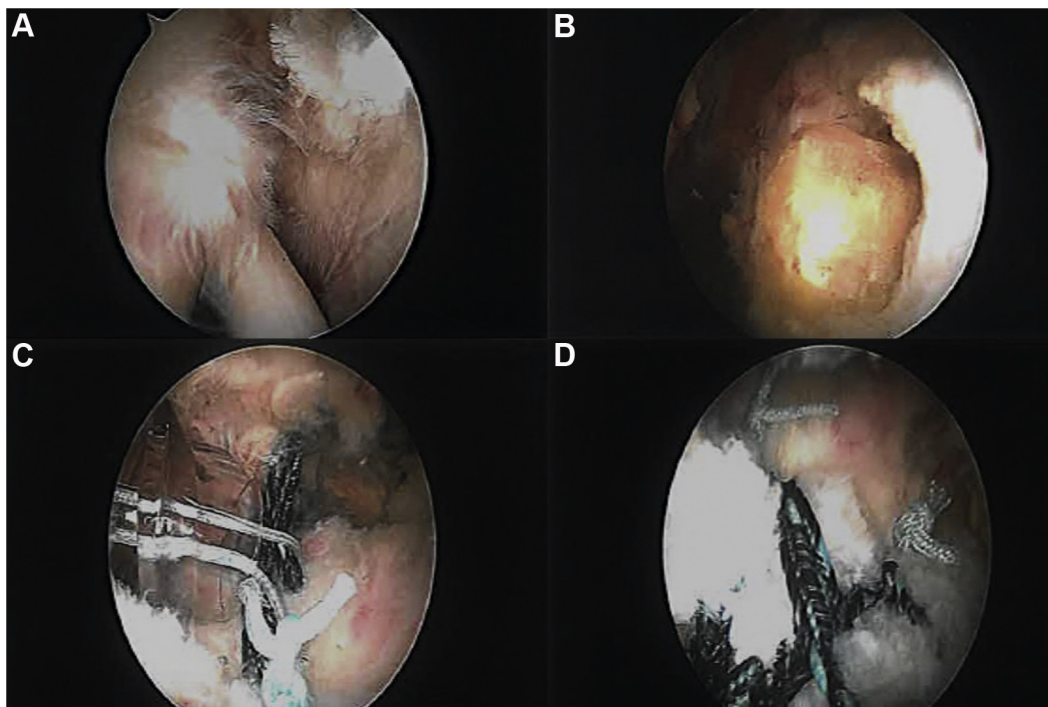


**Figure 1** Preoperative magnetic resonance imaging of left shoulder. Coronal T2-weighted fat-saturated images from anterior to posterior (A, B, C) show a high-grade articular-sided supraspinatus tendon tear with retraction of the torn fibers (*white arrow*).

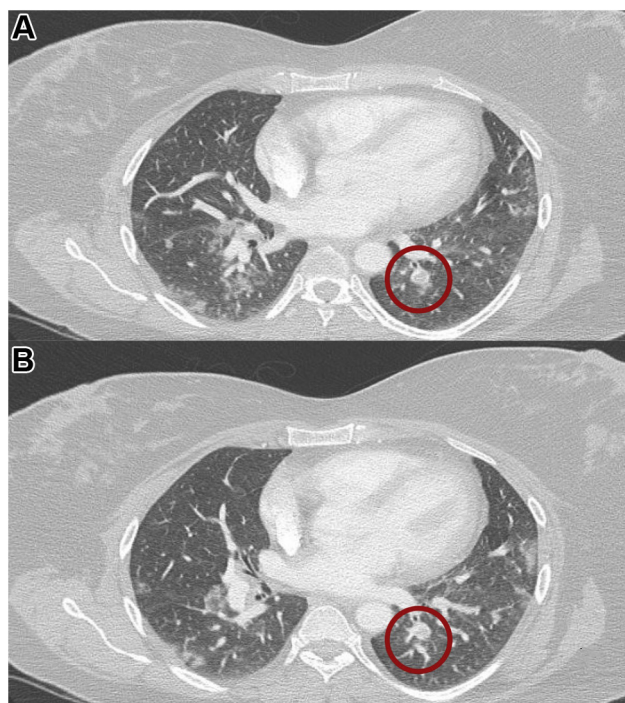
abnormalities. The left shoulder magnetic resonance imaging showed a high-grade (~80%), articular-sided partial-thickness supraspinatus tear with retraction of the torn fibers ([Fig. 1](#)) and proximal biceps tendon inflammation with an associated superior labrum anterior to posterior (SLAP) tear. She was indicated for surgery given her failed conservative treatment, age, activity level, diminished shoulder function, and severity of the rotator cuff tear on magnetic resonance imaging. The patients' preoperative reported outcomes were a visual analog scale score of 5, American Shoulder and Elbow Surgeons Standardized

Shoulder Assessment Form score of 6 of 30, shoulder score index of 35 of 100, and simple shoulder test of 2 of 12.

The patient underwent routine arthroscopic management of her shoulder under an interscalene regional block. Given the high grade of the articular side of the tear, the bursal side of the tendon was taken down to complete the tear to perform a full repair. A transosseous-equivalent, double-row repair with a medial-row double pulley was performed as previously described ([Fig. 2](#)).<sup>2</sup> Based on her preoperative clinical and imaging findings, a subacromial decompression and an arthroscopic suprapectoral biceps tenodesis was also



**Figure 2** Arthroscopy images. (A) A high-grade articular-sided supraspinatus tear is seen from the posterior glenohumeral joint viewing portal. (B) A posterior subacromial viewing portal shows the supraspinatus tendon after the tear was completed and (C) posterior and (D) lateral subacromial viewing portal views showing a double-row transosseous-equivalent supraspinatus tendon repair augmented with a medial-row double pulley.



**Figure 3** (A and B) Computed tomography of the chest with intravenous contrast shows a pulmonary embolus in the left lower lobe (○) with accompanying interstitial changes of the lungs associated with COVID-19 pneumonia.

performed as described.<sup>4</sup> The operative time was recorded as 65 minutes for this case.

At our institution, a preprocedure SARS-CoV-2 viral polymerase chain reaction test is administered 48-72 hours before all elective surgeries. The patient's test was negative 3 days before surgery. However, unknown to the patient, she had a positive exposure with an infected individual the day before her scheduled surgery. She became symptomatic 3 days after surgery with a confirmed positive SARS-CoV-2 test. She was initially treated with home isolation and routine management of her symptoms. After her positive diagnosis, she was instructed by her primary care physician to take Aspirin 325 mg daily for prophylaxis against any potential coagulopathy. On postoperative day 10, the patient called stating she had new and increased pain and swelling of the operative upper arm and forearm. She was immediately sent for an ultrasonographic examination that showed an extensive DVT involving the subclavian, axillary, brachial, midbasilic, and midcephalic veins. Additionally, there was superficial thrombus within the left proximal basilic vein to the cephalic vein. She was sent to the emergency department, where computed tomography of the chest with intravenous contrast was obtained that showed a left lower lobe PE in the setting of bilateral lower lobe pneumonia that is also commonly seen in COVID-19 patients (Fig. 3). She was admitted to the intensive care unit (ICU) for respiratory monitoring and started on a heparin drip to treat her coagulopathy. During her admission,

vascular surgery was consulted and recommended a venogram with possible thrombectomy. At the time of the procedure, she was found to have some residual clot in the brachial veins, but overall the course from the subclavian vein distal was widely patent, indicating success with anticoagulation. There was also no evidence for any superimposed thoracic outlet syndrome that could have contributed to her clot formation in the left arm. The patient remained stable and was discharged postadmission day 4 on apixaban as outpatient treatment for her coagulopathy.

The patient was seen during follow-up in clinic shortly after testing negative for active infection and started formal physical therapy with gentle passive range of motion 3 weeks after surgery because of the delay in care from her illness. A wide range of coagulopathy labs were ordered and have been found to be negative. Her mother did have a history of DVT. However, the patient has never had previous VTE events, even after prior orthopedic surgeries on her hip and knee. The patient continues to have some symptomatic sequelae from COVID-19 but is expected to have a full recovery.

## Discussion

The emergence of the novel coronavirus, SARS-CoV-2, that causes COVID-19, has placed an unprecedented amount of stress and burden on our health care system. Early in 2020, rapid cancellation of inpatient and outpatient elective orthopedic surgery was implemented to preserve resources for hospitals. As we have slowly emerged and tried to return to a new normalcy in day-to-day orthopedic care, the long-lasting effects of the pandemic will continue to be felt.

Our case report highlights concerns we have so that we can raise awareness surrounding potential complications related to COVID-19 and elective orthopedic surgeries. Our patient was appropriately screened 3 days prior to her surgery with a negative SARS-CoV-2 polymerase chain reaction test. The sensitivity and specificity of SARS-CoV-2 polymerase chain reaction testing has been reported over the last year to be 71%-98% and 95%, respectively.<sup>11,12</sup> Unfortunately for our patient, she had a known positive exposure at work that led to a positive and symptomatic infection 3 days after surgery. Routine incubation time for symptoms to emerge for COVID-19 has ranged from 2-14 days.<sup>3</sup> We recommend self-isolation prior to surgery for all patients, but in reality, this can be difficult to effectively implement. It is unrealistic to expect that all patients will comply with strict preoperative isolation protocols or be able to mitigate the risk of exposure from other sources, which are simply out of their control.

To add more complexity to this case, an otherwise healthy, young patient developed a significant postoperative coagulopathy in the form of a DVT in her operative shoulder and a subsequent pulmonary embolus. This was diagnosed 10 days after surgery but was likely developing



from the onset of her illness. The rate of DVT and PE in routine elective arthroscopic shoulder surgery is reported to be between 0.1% and 0.3%<sup>6,8,9</sup> Routine postoperative anticoagulation has not been recommended after shoulder arthroscopy.<sup>1</sup> However, this highlights the other significant concern about this case, which is the rapid development of a DVT with an associated PE that could have been life-threatening to this patient.

As our health care system has learned more about the complications that arise from COVID-19 infections, coagulopathy is being recognized as a common finding in these patients. Large systematic reviews have analyzed the rate of VTE in COVID-19 patients, with reported rates ranging from 12%-17% for DVT and 8%-14% for PE.<sup>3,5,10</sup> Surprisingly, a large majority of PEs were not associated with a DVT, and it is thought the rate of undiagnosed clots is even higher than reported. Also, as expected, the rates of DVT and PE are higher in critically ill or ICU patients.<sup>5</sup> Although surgery is always considered a risk factor for DVT or PE, especially in lower extremity procedures, the rates of DVT or PE after arthroscopic shoulder surgery is exceedingly rare. We believe that in this circumstance, the patient experienced the perfect storm of risk factors to lead to this complication. Her undiagnosed COVID-19 infection with recent surgery placed her at increased risk to develop a DVT and subsequent PE. Our concern is that this situation may become more common even in light of negative preoperative testing. The patient was appropriately started on anticoagulation after her diagnosis, but whether it was too late at that point is yet to be determined. COVID-19 has been proposed to stimulate a significant inflammatory response along the endothelial lining of venous and arterial blood vessels that starts almost immediately after infection.<sup>7</sup> This unusual, but robust, response has been found to result in high VTE rates in severely ill patients.<sup>3,5</sup> We still have yet to understand the effect on baseline risk for developing a DVT or PE in less severe infections. Certainly, other factors such as immobilization and deconditioning from the illness can additionally predispose patients to venous stasis and subsequent thrombosis as well. However, particular to this case, we believe that the patient's underlying COVID-19 infection helped to rapidly stimulate an otherwise rare complication in a routine, elective, outpatient surgery in an otherwise healthy, young patient.

## Conclusion

This case report serves to make orthopedic surgeons aware of the possible risk factors for venous thromboembolic events associated with routine, elective arthroscopic surgeries in the setting of the COVID-19 pandemic. Even with negative preoperative testing, patients still may be infected and become symptomatic postoperatively. Orthopedists should be vigilant in their

awareness of potential thromboembolic complications that may arise as a result of infection even in less serious cases of COVID-19 infections. Although we cannot recommend the widespread use of anticoagulation after elective shoulder arthroscopy based on this single case report, strong consideration should be given to starting anticoagulation in postoperative patients who develop COVID-19 acutely after their surgery.

## Disclaimer

Diego Villacis serves as a paid consultant for Wright Medical Technology, Inc. Anthony Romeo receives royalties from Arthrex, Inc., serves as a consultant to Arthrex, Inc. and Paragen Technologies, serves on the editorial board of *Orthopedics Today* (Chief Medical Editor), *Techniques in Shoulder and Elbow*, *Techniques in Sports Medicine*, *Sports Health*, and *Orthopedics*, and holds stock in DuPage Medical Group, Healthpoint Capital, and Paragen Technologies. The other authors, their immediate family, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

## References

1. Alyea E, Gaston T, Austin LS, Wowkanech C, Cypel B, Pontes M, Williams G. The effectiveness of aspirin for venous thromboembolism prophylaxis for patients undergoing arthroscopic rotator cuff repair. *Orthopedics* 2019;42:e187-92. <https://doi.org/10.3928/01477447-20181227-05>
2. Chauhan A, Regal S, Frank DA. Hybrid repair of large crescent rotator cuff tears using a modified SpeedBridge and double-pulley technique. *Arthrosc Tech* 2014;3:e409-12. <https://doi.org/10.1016/j.eats.2014.04.001>
3. Goswami J, MacArthur TA, Sridharan M, Pruthi RK, McBane RD, Witzig TE, Park MS. A review of pathophysiology, clinical features, and management options of COVID-19 associated coagulopathy [Epub ahead of print]. *Shock* 2020. <https://doi.org/10.1097/SHK.0000000000001680>
4. Hammarstedt JE, Rinaldi J, Guth J, Akhavan S. The loop 'n' tack biceps tenodesis: an all-arthroscopic, intra-articular technique. *Arthrosc Tech* 2020;9:e1899-902. <https://doi.org/10.1016/j.eats.2020.08.017>
5. Jimenez D, Garcia-Sanchez A, Rali P, Muriel A, Bikkdeli B, Ruiz-Artacho P, et al. Incidence of VTE and bleeding among hospitalized patients with coronavirus disease 2019: a systematic review and meta-analysis. *Chest* 2020;159:1182-96. <https://doi.org/10.1016/j.chest.2020.11.005>
6. Kuremsky MA, Cain L Jr, Fleischli E. Thromboembolic phenomena after arthroscopic shoulder surgery. *Arthroscopy* 2011;27:1614-9. <https://doi.org/10.1016/j.arthro.2011.06.026>
7. Lowenstein CJ, Solomon SD. Severe COVID-19 is a microvascular disease. *Circulation* 2020;142:1609-11. <https://doi.org/10.1161/CIRCULATIONAHA.120.050354>
8. Sager B, Ahn J, Tran J, Khazzam M. Timing and risk factors for venous thromboembolism after rotator cuff repair in the 30-day

- perioperative period. *Arthroscopy* 2019;35:3011-8. <https://doi.org/10.1016/j.arthro.2019.05.045>
9. Shick CW, Westermann RW, Gao Y, ACCESS GroupWolf BR. Thromboembolism following shoulder arthroscopy: a retrospective review. *Orthop J Sports Med* 2014;2:2325967114559506. <https://doi.org/10.1177/2325967114559506>
  10. Suh YJ, Hong H, Ohana M, Bompard F, Revel MP, Valle C, et al. Pulmonary embolism and deep vein thrombosis in COVID-19: a systematic review and meta-analysis. *Radiology* 2021;298:E70-80. <https://doi.org/10.1148/radiol.20202035>
  11. Surkova E, Nikolayevskyy V, Drobniowski F. False-positive COVID-19 results: hidden problems and costs. *Lancet Respir Med* 2020;8:1167-8. [https://doi.org/10.1016/S2213-2600\(20\)30453-7](https://doi.org/10.1016/S2213-2600(20)30453-7)
  12. Watson J, Whiting PF, Brush JE. Interpreting a COVID-19 test result. *BMJ* 2020;369:m1808. <https://doi.org/10.1136/bmj.m1808>