CASE REPORT

Pulmonary Embolism in a Baseball Pitcher Following Open Shoulder Capsular Repair

Lucas S. McDonald, MD, MPH&TM · Patrick L. Maher, MD · Victoria S. McDonald, MD · Christopher Chin, BA · Joshua S. Dines, MD

Received: 14 June 2015/Accepted: 11 September 2015/Published online: 24 November 2015
© Hospital for Special Surgery 2015

Keywords shoulder arthroscopy · shoulder arthrotomy · capsular repair · pulmonary embolism · baseball pitcher

Introduction

Pulmonary embolism (PE) following non-trauma related, non-arthroplasty shoulder surgery is uncommon. Rates of PE have been described for both arthroscopic shoulder surgery and shoulder arthroplasty but are not well reported following non-arthroplasty open shoulder surgery [4, 5, 8, 10, 14, 16]. We report the rare complication of PE after open shoulder capsular repair for stabilization in a professional baseball pitcher.

Disclaimer: The views expressed in this paper are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or United States government.

Work was performed at Hospital for Special Surgery in New York, NY.

Electronic supplementary material The online version of this article (doi:10.1007/s11420-015-9471-7) contains supplementary material, which is available to authorized users.

L. S. McDonald, MD, MPH&TM (✉) · C. Chin, BA · J. S. Dines, MD

Department of Sports Medicine and Shoulder Surgery,
Hospital for Special Surgery,
535 East 70th Street,
New York, NY 10021, USA
e-mail: lucas.s.mcdonald@gmail.com

P. L. Maher, MD
Weill Cornell Medical College,
1300 York Ave,
New York, NY 10065, USA

V. S. McDonald, MD
Department of General Surgery, Naval Medical Center San Diego,
34800 Bob Wilson Drive,
San Diego, CA 92134, USA

Case Report

Our patient was a 31-year-old, left-hand-dominant, male professional baseball pitcher. He initially presented with a 1-month history of “dead arm” symptoms described by the patient as decreased velocity and anterior shoulder pain while throwing. He had no acute injury and no history of glenohumeral dislocation or subluxation. His past medical history and known family medical history were non-contributory, and he took no medications. Physical exam was significant for the following pertinent positives: (+) apprehension test, (+) apprehension-relocation test, (+) active compression test, (+) modified O’Brien’s test, and (+) overhead valgus stress test. He had 5/5 rotator cuff strength and negative thoracic outlet impingement signs. Compared to his contralateral arm, he had 10° of increased abducted external rotation and concomitant decrease in internal rotation, an adaptive finding common in pitchers. The arm demonstrated no signs of venous thromboembolus (VTE). It was without arm swelling and had normal upper extremity radial and ulnar pulses. His magnetic resonance imaging (MRI) exam was consistent with an anterior humeral capsular tear; partial-thickness articular-sided supraspinatus tear; and no anterior, posterior, or superior labral pathology. Based on institutional preferences and the MRI quality, evaluation with magnetic resonance arthrogram was deferred. While a diagnosis of thoracic outlet syndrome was considered for this patient, physical exam findings and initial imaging studies were not consistent; therefore, further evaluation with Doppler examination was not pursued. Initial management included rest, shoulder rehabilitation for rotator cuff strengthening, periscapular muscle strengthening, and internal rotation stretching. He was unable to return to throwing at his preinjury level, and the patient was indicated for anterior capsular repair.

Under regional anesthetic with sedation, the patient underwent left shoulder diagnostic arthroscopy with rotator cuff debridement for a partial-thickness, articular-sided supraspinatus tear followed by open anterior capsular repair. Operative findings

included an intact glenoid labrum with an anterior capsular injury near the humeral insertion not amenable to an arthroscopic repair. The superior labrum was intact without evidence of a peel-back lesion, and the biceps demonstrated mild synovitis. A standard delto-pectoral approach was performed with gentle lateral retraction of the cephalic vein. The inferior aspect of the subscapularis was incised in an L-shaped fashion as described by Arciero and Mazzocca [1] and the injured capsule repaired to the humerus using suture anchors. Total operative time was 63 min, and there were no intraoperative complications. Estimated blood loss was less than 25 mL. The patient was discharged home on the day of surgery with early mobilization for deep vein thrombosis (DVT) prophylaxis without any chemoprophylaxis.

On postoperative day 8, the patient noted pleuritic chest pain with minimal shortness of breath. He attributed this to a viral illness and did not seek medical attention. Three days later, he developed hemoptysis, prompting him to seek medical attention. A left upper extremity ultrasound revealed an acute occlusive thrombus in the left cephalic vein. A chest computed tomography (CT) pulmonary angiogram identified an acute PE in the medial and posterior basal right lower lobes (Fig. 1). Therapeutically dosed heparin anticoagulation was initiated as an inpatient and transitioned to warfarin for outpatient therapy.

Thrombophilia workup was performed after completion of anticoagulation. This revealed a normal coagulation panel. His only abnormality on genetic testing was a heterozygous C677T mutation in the methylenetetrahydrofolate reductase (MTHFR) gene. Further investigation into family history revealed that his mother had previously been diagnosed with the hypercoagulable state of factor V Leiden, though the patient was unaware of this at the time of his presurgical screening and genetic testing revealed that he did not inherit this trait.

The patient is currently asymptomatic from his PE and completing a throwing program without difficulty.

Discussion

We are reporting a case of PE following a combination arthroscopic and open shoulder surgery for capsular repair in a

Fig. 1. Chest CT identifying pulmonary embolus in the right medial and posterior basal lower lobes. The *arrow* highlights the filling defect in the vasculature.

healthy professional athlete with no prior personal history of VTE. To our knowledge, no such case has been previously reported. Dattani et al. reviewed the published literature on VTE rates following shoulder surgery. For arthroscopic shoulder surgeries, they reported a VTE rate of 0.038 % for more than 90,000 arthroscopic cases, 0.45 % in more than 37,000 arthroplasty cases, and 0.82 % for nearly 10,000 cases of operatively treated proximal humerus fractures [4].

Risk factors for VTE following orthopedic surgery include history of a prior VTE, obesity, delays in ambulation following surgery, and female gender [15]. Several risk factors for VTE after shoulder surgery have been identified. Notably, diabetes mellitus, rheumatoid arthritis, ischemic heart disease, and increased age have been reported as major risk factors [4]. Patient positioning during surgery has also been suggested as a possible risk factor. For arthroscopic shoulder surgeries, Dattani's review found that of 18 published cases which reported the patient position, 14 cases were in the lateral decubitus position and 4 in the beach chair position [4]. Our patient did not have any of the medical risk factors, and the surgery was performed in the beach chair position. Due to the wide institutional and surgeon preferences for patient position and a lack of solid evidence as to a causal factor, we cannot draw firm conclusions as to whether patient positioning affects VTE rate.

While the reported rate of DVT following shoulder surgery is low, Takahashi et al. suggested that the rate of asymptomatic DVT following shoulder arthroscopy may be higher than previously described. They performed a prospective cohort study on patients undergoing arthroscopic shoulder surgery evaluating the presence of asymptomatic DVT following elective shoulder arthroscopy. They performed four-extremity screening ultrasounds on 175 patients reporting an overall DVT rate of 5.7 %, with most occurring 1–2 days after surgery. Interestingly, only one DVT was identified in the upper extremity [14].

While much literature exists on DVT following shoulder arthroscopy and open shoulder surgery, the literature on PE following these same surgeries is sparse. In their review, Dattani et al. reported a rate of PE following shoulder arthroscopy of only 0.017 %, while rates of PE following shoulder arthroplasty and trauma surgery were more than ten times higher [4]. They identified 54 cases of PE following shoulder arthroplasty, with an overall reported rate of 0.15 %, and 26 cases following surgical treatment for proximal humerus fractures, with an overall rate of 0.26 % [4].

Hoxie et al. completed a retrospective review of all patients at the Mayo clinic undergoing arthroscopic rotator cuff repair over a 4-year period, reporting PE rate of 0.64 % [10]. Similarly, in a recent single-surgeon retrospective review by Durant et al., the authors reported a PE incidence of 0.25 % following any arthroscopic shoulder surgery and a rate of 0.89 % [5]. A case report of PE following arthroscopic rotator cuff repair by Yamamoto et al. involved a lengthy surgical time of more than 3 h [16]. More recently, Goldhaber and Lee reported on a spontaneous PE without identifying a causal DVT following a 90-min arthroscopic shoulder surgery in the lateral position [8]. At 63 min, our operative time was less than both of these previously reported cases.

There are no clear guidelines concerning the use of VTE prophylaxis for patients undergoing elective shoulder

surgery. The UK National Institute for Health and Care Excellence (NICE) guidelines recommend against the routine use of VTE prophylaxis in patients undergoing upper limb surgery, unless that patient is determined to be at a higher risk for VTE [9]. The guidelines recommend that for patients at increased risk, mechanical prophylaxis should be initiated at the time of admission, and pharmacological VTE prophylaxis should be started 6–12 h after surgery [9]. Jameson et al. retrospectively reviewed a UK national database, demonstrating no difference in the rate of VTE following the introduction of the NICE criteria [11]. The American College of Chest Physicians does not make any specific recommendations regarding VTE prophylaxis in upper extremity surgery [6]. Our institutional clinical practice guidelines call for VTE prophylaxis with enteric-coated aspirin following shoulder arthroplasty; however, no local or national standards have been set for prophylaxis following non-arthroplasty open shoulder surgeries. Based on NICE and American College of Chest Physicians guidelines, this patient did not require either mechanical or chemical prophylaxis as he was a low-risk patient undergoing upper extremity surgery.

A further consideration in this case is the high rate of vascular events in throwing athletes, specifically baseball players. Adaptive shoulder laxity in pitchers alters humeral head mechanics and can cause vascular compression. Two studies by Bast and colleagues demonstrated changes in axillary artery blood flow with decreased wrist/brachial indices more pronounced in pitchers with shoulder laxity [2, 3]. Similarly, primary upper extremity VTE is associated with thoracic outlet syndrome and Paget-Schroetter syndrome [7]. Thoracic outlet syndrome describes compression of the brachial plexus or blood vessels at the base of the neck and axilla. Venous manifestations result from compression between the clavicle and the first rib and are an established cause of primary upper extremity VTE [12]. Paget-Schroetter syndrome, or effort thrombosis, is a specific manifestation of thoracic outlet syndrome, occurring in young individuals and is related to strenuous sporting activities causing microtrauma of vessels activating the coagulation cascade [7]. The possibility of chronic alteration in blood flow mechanics is a consideration in our patient as to the causal factor for developing an upper extremity DVT and subsequent PE. While these conditions were part of the differential diagnosis preoperatively, his clinical symptoms and imaging were consistent with a capsular tear, rather than a vascular manifestation, and no vascular studies were indicated.

While no risk factors for VTE were identified preoperatively, the patient later learned that his mother carried the factor V Leiden disorder, predisposing her to VTE. While laboratory testing did not reveal this autosomal dominant condition in our patient, this family history would have prompted further preoperative laboratory examination and possible genetic testing before elective surgery. This may have revealed his C677T mutation in the MTHFR gene. This translocation is implicated in the development of homocysteinemia and may be correlated with development of VTE. A meta-analysis by Ray et al. reviewed 31 studies

of homozygous C677T MTHFR genotypes and pooled the data demonstrating that the prevalence of VTE was only slightly higher among cases than controls [13]. This, however, is not strong enough evidence to recommend routine evaluation for C677T MTHFR polymorphism during thrombophilia assessment. Heterozygous cases, as in our patient, are even less likely to be associated with a clotting disorder. Other causes of VTE including antiphospholipid antibodies, PT mutation, PAI-1, protein S, and protein C were negative in our patient. While the specific cause of his VTE remains unknown, had the family history of a hypercoagulable state been available preoperatively, greater consideration would have been given to intraoperative mechanical and postoperative chemical VTE prophylaxis.

This is the first reported case of pulmonary embolus following a combination arthroscopic and open shoulder surgery for capsular repair. While rates of pulmonary embolus remain low following both arthroscopic and open shoulder surgery, surgeons should elicit hypercoagulable states in all patients preoperatively and maintain vigilance for diagnosis postoperatively. In throwing athletes, considerations for preoperative screening ultrasounds can be considered, though no firm recommendations can be made based on this case report. Specific guidelines for VTE prophylaxis following non-arthroplasty open shoulder procedures should be clarified.

Disclosures

Conflict of Interest: Lucas S. McDonald, MD, MPH&TM, Patrick L. Maher, MD, Victoria S. McDonald, MD, and Christopher Chin, BA, have declared that they have no conflict of interest. Joshua S. Dines, MD, reports personal consulting fees from Arthrex, and family member receives royalties from Biomet, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

1. Arciero RA, Mazzocca AD. Mini-open repair technique of HAGL (humeral avulsion of the glenohumeral ligament) lesion. *Arthrosc: J Arthrosc Relat Surg: Off Publ Arthrosc Assoc N Am Int Arthrosc Assoc.* 2005; 21(9): 1152. doi:10.1016/j.arthro.2005.06.009.
2. Bast SC, Perry JR, Poppiti R, Vangness CT, Weaver FA. Upper extremity blood flow in collegiate and high school baseball pitchers: a preliminary report. *Am J Sports Med.* 1996; 24(6): 847–51.
3. Bast SC, Weaver FA, Perese S, Jobe FW, Weaver DC, Vangness CT Jr. The effects of shoulder laxity on upper extremity blood flow in professional baseball pitchers. *J Shoulder Elbow Surg / Am*

- Shoulder Elbow Surg.* 2011; 20(3): 461-6. doi:[10.1016/j.jse.2010.09.007](https://doi.org/10.1016/j.jse.2010.09.007).
4. Dattani R, Smith CD, Patel VR. The venous thromboembolic complications of shoulder and elbow surgery: a systematic review. *Bone Joint J.* 2013; 95-B(1): 70-4. doi:[10.1302/0301-620X.95B1.29854](https://doi.org/10.1302/0301-620X.95B1.29854).
 5. Durant TJ, Cote MP, Arciero RA, Mazzocca AD. Fatal pulmonary embolism after arthroscopic rotator cuff repair: a case series. *Muscles, Ligaments Tendons J.* 2014; 4(2): 232-7.
 6. Falck-Ytter Y, Francis CW, Johanson NA, et al. Prevention of VTE in orthopedic surgery patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012; 141(2 Suppl): e278S-325S. doi:[10.1378/chest.11-2404](https://doi.org/10.1378/chest.11-2404).
 7. Flinterman LE, Van Der Meer FJ, Rosendaal FR, Doggen CJ. Current perspective of venous thrombosis in the upper extremity. *J Thrombosis Haemostasis: JTH.* 2008; 6(8): 1262-6. doi:[10.1111/j.1538-7836.2008.03017.x](https://doi.org/10.1111/j.1538-7836.2008.03017.x).
 8. Goldhaber NH, Lee CS. Isolated pulmonary embolism following shoulder arthroscopy. *Case Rep Orthop.* 2014; 2014: 279082. doi:[10.1155/2014/279082](https://doi.org/10.1155/2014/279082).
 9. Hill J, Treasure T. National clinical guideline centre for a chronic C. Reducing the risk of venous thromboembolism in patients admitted to hospital: summary of NICE guidance. *BMJ.* 2010; 340: c95. doi:[10.1136/bmj.c95](https://doi.org/10.1136/bmj.c95).
 10. Hoxie SC, Sperling JW, Cofield RH. Pulmonary embolism following rotator cuff repair. *Int J Shoulder Surg.* 2008; 2(3): 49-51. doi:[10.4103/0973-6042.42576](https://doi.org/10.4103/0973-6042.42576).
 11. Jameson SS, James P, Howcroft DW, et al. Venous thromboembolic events are rare after shoulder surgery: analysis of a national database. *J Shoulder Elbow Surg / Am Shoulder Elbow Surg.* 2011; 20(5): 764-70. doi:[10.1016/j.jse.2010.11.034](https://doi.org/10.1016/j.jse.2010.11.034).
 12. Jamieson CW. Venous complications of the thoracic outlet syndrome. *Eur J Vascular Surg.* 1987; 1(1): 1-3.
 13. Ray JG, Shmorgun D, Chan WS. Common C677T polymorphism of the methylenetetrahydrofolate reductase gene and the risk of venous thromboembolism: meta-analysis of 31 studies. *Pathophysiol Haemost Thromb.* 2002; 32(2): 51-8.
 14. Takahashi H, Yamamoto N, Nagamoto H, Sano H, Tanaka M, Itoi E. Venous thromboembolism after elective shoulder surgery: a prospective cohort study of 175 patients. *J Shoulder Elbow Surg / Am Shoulder Elbow Surg.* 2014; 23(5): 605-12. doi:[10.1016/j.jse.2014.01.054](https://doi.org/10.1016/j.jse.2014.01.054).
 15. White RH, Henderson MC. Risk factors for venous thromboembolism after total hip and knee replacement surgery. *Curr Opin Pulm Med.* 2002; 8(5): 365-71.
 16. Yamamoto T, Tamai K, Akutsu M, Tomizawa K, Sukegawa T, Nohara Y. Pulmonary embolism after arthroscopic rotator cuff repair: a case report. *Case Rep Orthop.* 2013; 2013: 801752. doi:[10.1155/2013/801752](https://doi.org/10.1155/2013/801752).