



Venothromboembolism following shoulder arthroscopy: a systematic review



Jacob J. Triplet, DO*, Hayden B. Schuette, DO, Adnan N. Cheema, MD, Erick M. Marigi, MD, Leslie C. Hassett, MLS, Jonathan D. Barlow, MS, MD, Christopher L. Camp, MD, Mark E. Morrey, MD, John W. Sperling, MD, Joaquin Sanchez-Sotelo, MD, PhD

Mayo Clinic, Rochester, MN, USA

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Background: Venous thromboembolic events (VTEs) following orthopedic surgery may lead to serious morbidity and mortality. Fortunately, VTEs following upper extremity procedures are uncommon. However, the true incidence is likely underreported. The aim of this study is to provide a systematic review, excluding large database studies, to report on the incidence of VTEs following shoulder arthroscopic procedures.

Methods: Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines, a systematic review of multiple databases was performed. A comprehensive search of several databases from inception to September 1, 2021, limited to English language and excluding animal studies, was designed and conducted. Studies were screened by 2 independent reviewers. A decision to exclude studies from large surgical or insurance claim databases was made to minimize the risk of including overlapping data points in this systematic review.

Results: Thirteen studies met inclusion and exclusion criteria and form part of this systematic review. A total of 32,407 patients were included in this study. Among these patients, the deep vein thrombosis, pulmonary embolism, and overall VTE rates were 0.15%, 0.08%, and 0.21%, respectively. Among the patients specified to have undergone arthroscopic rotator cuff repair, the rate of deep vein thrombosis, pulmonary embolism, and overall VTE was 0.71%, 0.37%, and 1.04%, respectively.

Conclusion: While symptomatic VTEs are rare following shoulder arthroscopic procedures, surgeons must be aware that they still account for a certain number of postoperative complications. Factors such as operative time, open procedures, obesity, and altitude may increase the risk of postoperative VTE although conflicting data exist. Current literature supports the idea that chemical antithrombotic prophylaxis likely provides no significant advantage over early mobilization in reducing VTEs following shoulder arthroscopy in low-risk patients.

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Venous thromboembolic events (VTEs) are feared postoperative complications following orthopedic surgery. In the United States, VTEs affect up to 1 million adults and contribute to more than 100,000 deaths annually.² The reported incidence of VTE after a major hip or knee surgery without prophylaxis ranges from 29% to 60% for deep vein thrombosis (DVT) and from 1% to 3% for fatal pulmonary embolism (PE).^{14,15} Fortunately, VTE after shoulder surgery is uncommon, with the reported incidence of symptomatic VTEs being less than 1% in most series.^{6,15–19,22,24,26–28} While the

incidence of fatal PE is truly rare,^{9,10,30} the exact incidence of VTE following shoulder arthroscopy is likely underestimated.^{9,21,31} VTEs have been cited as the most common complication following arthroscopic rotator cuff repair, accounting for approximately 37% of postoperative complications.¹¹ while PE has been mentioned as the most common reason for readmission following shoulder arthroscopy.¹² This finding is concerning, since arthroscopic rotator cuff repair remains one of the most common orthopedic procedures performed, with more than 400,000 procedures performed annually in the United States and an annual growth rate of 4%.¹¹ Currently there are no VTE prophylaxis guidelines specific to shoulder arthroscopy endorsed by either the American Academy of Orthopaedic Surgeons or the American College of Chest Physicians.¹ While several reports have been published regarding the incidence of symptomatic VTE following shoulder arthroscopy, nearly all

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*Corresponding author: Jacob J. Triplet, DO, Department of Orthopedic Surgery, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA.

E-mail address: Triplet.Jacob@mayo.edu (J.J. Triplet).

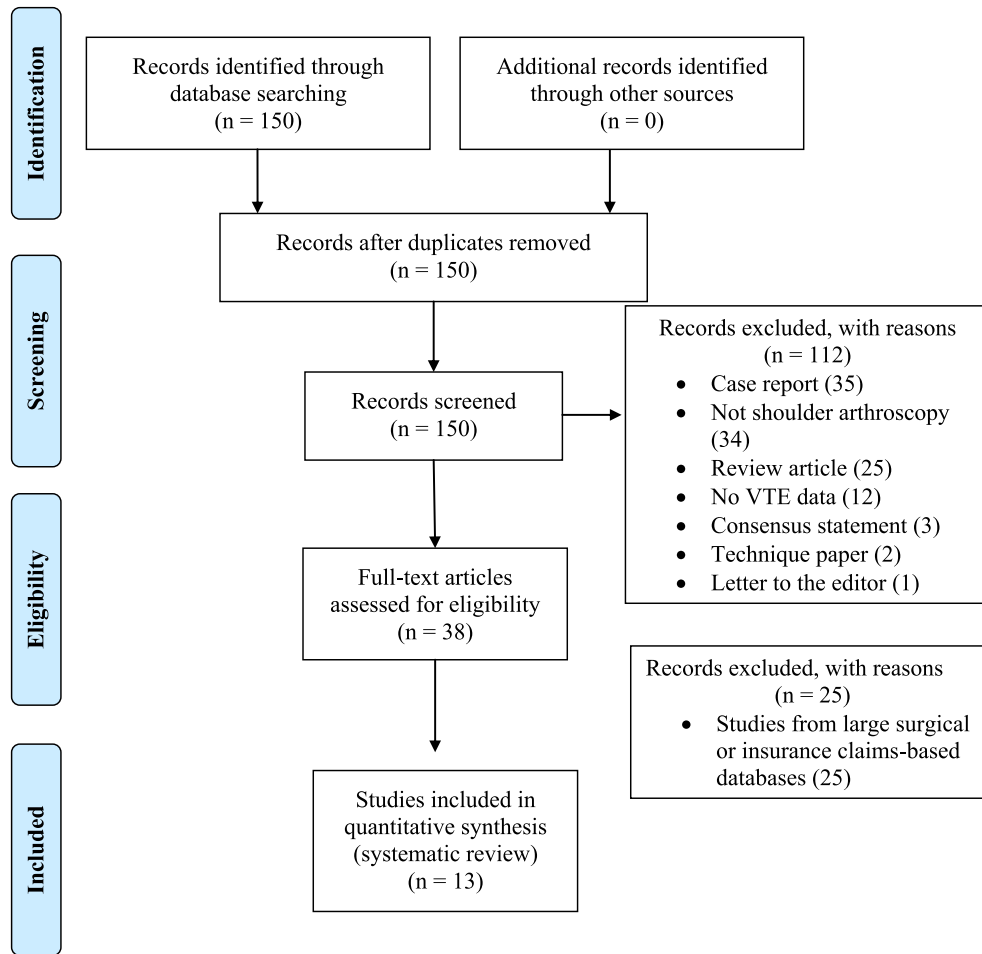


Figure 1 Search strategy. The authors' electronic search strategy is outlined using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. VTE, venous thromboembolic event.

these studies have been retrospective reviews of large commercially available databases. To our knowledge, no systematic review of the literature has been published on the incidence of VTEs following shoulder arthroscopy. The aim of this study is to provide a systematic review, excluding large database studies, to report on the incidence of VTEs following shoulder arthroscopic procedures.

Materials and methods

Search strategies and study identification

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines, a systematic review of multiple databases was performed. A comprehensive search of several databases from inception to September 1, 2021, limited to English language and excluding animal studies, was designed and conducted by an experienced biomedical librarian (L.C.H.). The databases included Ovid MEDLINE and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, Web of Science, and Scopus. Controlled vocabulary supplemented with keywords was used to search for studies describing venous thromboembolism after shoulder arthroscopy. The actual strategy listing all search terms used and how they are combined is available in [Figure 1](#).

Studies were screened by 2 independent reviewers (H.B.S and E.M.M.) by title and/or abstract to determine study eligibility based on inclusion and exclusion criteria. Full text of studies that met initial inclusion criteria based on title and/or abstract screening where then reviewed for final evaluation. Inclusion criteria included English studies, publications in peer-reviewed journals, and studies reporting the incidence of DVT, PE, and overall VTE following shoulder arthroscopy. Exclusion criteria included non-English publications, case reports, review papers, and studies from large surgical or insurance claim databases. A decision to exclude studies from large surgical or insurance claim databases was made to minimize the risk of including overlapping data points in this systematic review. [Figure 1](#) is a Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow diagram representing our search strategy.

Data analysis

When provided, the incidence of DVT, PE, and overall VTE for arthroscopic rotator cuff repair was extracted from each study. Extraction of data specific to arthroscopic shoulder surgery for instability was attempted but not performed, as only 2 studies^{23,31} with a small number of patients specifically reported these data. After data extraction, a pooled incidence for DVT, PE, and overall VTE following all arthroscopic shoulder surgeries as well as arthroscopic rotator cuff repair was reported.

Table 1
Overall venous thromboembolism results.

Study	LOE	Patients, n	DVT, n	PE, n	VTE, n
Alyea et al ¹	III	914	6	1	6
Brislin et al ³	IV	263	1	0	1
Duralde and McClelland ⁸	IV	53	0	1	1
Durant et al ⁹	IV	2003	0	5	5
Imberti et al ¹⁵	IV	982	2	1	3
Kuremsky et al ¹⁸	IV	1908	5	4	6
McIntyre et al ²⁰	IV	173	1	0	1
Pennington et al ²³	IV	28	1	0	1
Randelli et al ²⁴	III	9285	5	1	6
Schick et al ²⁸	III	15,033	15	8	23
Takahashi et al ³¹	II	175	10	1	10
Wronka et al ³²	IV	1281	3	1	4
Hoxie et al ¹³	IV	309	1	2	2
Total	-	32,407	50	29	75
Incidence	-	-	0.15%	0.08%	0.21%

LOE, level of evidence; DVT, deep vein thrombosis; PE, pulmonary embolism; VTE, venous thromboembolism.

Study methodology assessment

Study methodology was assessed by 2 using the Modified Coleman Methodology Score (MCMS).⁵ The MCMS scores study methodology on a scale of 0–100 with scores ranging from 85 to 100 are excellent, 70–84 are good, 55–69 are fair, and less than 55 are poor.

Statistical analysis

Due to the heterogeneity in data reporting among the included studies, no statistical analysis was able to be performed. Rather, this systematic review was limited to reporting overall incidence of DVT, PE, and overall VTE following all arthroscopic shoulder surgeries as well as arthroscopic rotator cuff repair.

Results

Thirteen studies^{1,3,8,9,13,15,18,20,23,24,28,31,32} met inclusion and exclusion criteria and form part of this systematic review. One study³¹ was level II evidence, 3 studies^{1,24,28} were level III evidence, and 9 studies^{3,8,9,13,15,18,20,23,32} were level IV evidence. A total of 32,407 patients were included in this study. Of these reports, a total of 2411 patients, from 7 studies,^{1,3,8,9,13,20,31} were specified as having undergone arthroscopic rotator cuff repair; 45 were specified as having undergone an arthroscopic stabilization procedure. The remaining patients were known to have undergone an arthroscopic shoulder procedure, but the specific procedure was not identified.

Among the 32,407 patients that underwent shoulder arthroscopy, the DVT, PE, and overall VTE rates were 0.15%, 0.08%, and 0.21%, respectively, (Table 1). Among the 2411 patients specified to have undergone arthroscopic rotator cuff repair, the rate of DVT, PE, and overall VTE was 0.71%, 0.37%, and 1.04%, respectively, (Table II). Table III shows the MCMS scores of the 13 included studies. Overall, 1 study²⁰ was rated as having fair methodology, while the remaining 12 studies had poor methodology. This was primarily due to most studies being retrospective in nature with follow-up less than 12 months.

Discussion

This manuscript serves as the first systematic review of the literature reporting on the incidence specific to VTEs following shoulder arthroscopy. The results of this systematic review support those findings previously reported in large database studies, being that the overall incidence of symptomatic VTEs following shoulder

arthroscopic procedures remains low, well under 1%. Moreover, it suggests that chemical antithrombotic prophylaxis is likely unnecessary following shoulder arthroscopy in most low-risk patients.

Risk factors

When considering VTEs following any orthopedic procedure, the surgeon must consider any known patient risk factors that would increase the postoperative likelihood of its occurrence. Unfortunately, risk factors for VTEs following shoulder arthroscopy have not been well defined in the literature, and several reports contradict one another. Using the National Surgical Quality Improvement Program (NSQIP) database, Heyer et al¹¹ evaluated the risk factors for 30-day complications following arthroscopic rotator cuff repair. In this review of 21,143 patients, the authors reported that <1% of patients had a complication within 30 days, the most common of which was a VTE, accounting for 37% of all complications. The authors concluded that male sex, American Society of Anesthesiology class >2, and history of chronic obstructive pulmonary disease and dyspnea were independent risk factors for 30-day complications following arthroscopic rotator cuff repair.¹¹ Additionally, in a review of a prospective multicenter registry of patients undergoing shoulder surgery, the vast majority of which were arthroscopic shoulder procedures, Imberti et al¹⁶ identified a duration of surgery greater than 60 minutes as an independent risk factor for symptomatic VTE. Interestingly, cancer, medical disease, venous insufficiency, and previous VTE were not found to be independent risk factors. The authors had since refined their initial report to focus specifically on patients undergoing shoulder arthroscopy.¹⁵ In their more recent report, which included 20% of patients being prescribed thromboprophylactic treatment, a cumulative incidence rate of 0.31% was reported. Other reports have found that being overweight or a diabetic with class 1 obesity are risk factors for VTE following orthopedic arthroscopic procedures.²¹ Conversely, some studies have failed to demonstrate statistically significant correlations between VTE and obesity despite a higher occurrence of VTE in those with a BMI greater than 40²⁵; others have failed to identify any significant risk factors for VTE following shoulder arthroscopy.²⁸

Interestingly, geographical location may play an important role in postoperative VTE occurrence following arthroscopic shoulder surgery. Cacienne et al⁴ reviewed the Medicare database for all patients that underwent arthroscopic rotator cuff repair over an 8-year period and compared patients who lived at a high altitude (>4000 feet) with those at a lower altitude (<100 feet). The rate of combined VTE, DVT, and PE was significantly higher in patients who

Table II
Rotator cuff repair venous thromboembolism results.

Study	LOE	Patients, n	DVT, n	PE, n	VTE, n
Alyea et al ¹	III	914	6	1	6
Brislin et al ³	IV	263	1	0	1
Duralde and McClelland ⁸	IV	53	0	1	1
Durant et al ⁹	IV	2003	0	5	5
McIntyre et al ²⁰	IV	173	1	0	1
Takahashi et al ³¹	II	175	10	1	10
Hoxie et al ¹³	IV	309	1	2	2
Total	-	2411	17	9	25
Incidence	-	-	0.71%	0.37%	1.04%

LOE, level of evidence; DVT, deep vein thrombosis; PE, pulmonary embolism; VTE, venous thromboembolism.

Table III
Modified Coleman Methodology Scores (MCMS).

Study	MCMS
Alyea et al ¹	44
Brislin et al ³	54
Duralde and McClelland ⁸	51
Durant et al ⁹	39
Imberti et al ¹⁵	46
Kuremsky et al ¹⁸	24
McIntyre et al ²⁰	58
Pennington et al ²³	48
Randelli et al ²⁴	22
Schick et al ²⁸	24
Takahashi et al ³¹	51
Wronka et al ³²	31
Hoxie et al ¹³	44
Total, mean ± SD	41.2 ± 12.2

SD, standard deviation.

had arthroscopic shoulder surgery performed at a high altitude. The authors concluded that surgeries performed above 4000 feet may be associated with the significantly increased rate of a postoperative VTE compared with surgery performed at an attitude less than 100 feet. The role of chemoprophylaxis for patients at a high altitude remains unknown.

Open vs. arthroscopic shoulder surgery

Some authors have stated that the risk of VTE is greater following open shoulder procedures than that after arthroscopic surgery.^{10,29} Previous studies have reported on the postoperative VTE rates of patients who underwent open vs. arthroscopic shoulder procedures.^{7,10,27} Goodloe et al¹⁰ compared VTE occurrence in patients undergoing arthroscopic Bankart repair, open Bankart repair, or Latarjet-Bristow procedures. They noted that patients undergoing Latarjet-Bristow had a nearly 10-fold increase in the risk of surgical complications compared with those undergoing an arthroscopic or open Bankart repair, which included deep surgical site infections, return to operating room within 30 days, and symptomatic VTE. Their reported DVT rate for arthroscopic Bankart repair and Latarjet-Bristow was 0.1% and 0.8%, respectively, with no differences in the odds of developing a surgical complication or VTE between patients undergoing arthroscopic and those undergoing open Bankart repair. The authors concluded that patients undergoing a Latarjet-Bristow procedure are at significantly higher risk for short-term postoperative complications, including symptomatic VTE, than those undergoing Bankart repair. Conversely, Day et al⁷ retrospectively reviewed postoperative complications following arthroscopic and open rotator cuff repair surgery. While reporting an overall higher complication following open rotator cuff repair, the authors failed to show any clinically

significant difference in either PE or DVT incidence between procedures; findings which have been supported.²⁷ This reported PE and DVT incidences were 0.19% vs. 0.24% for open and 0.11% vs. 0.14% for arthroscopic procedures, respectively.

Chemoprophylaxis

While the use of chemical antithrombotic prophylaxis remains controversial, the incidence of VTE in those treated without prophylaxis remains very low, under 1%.^{1,15,24} Previous studies have evaluated the effectiveness of anticoagulation for the prevention of VTE following shoulder arthroscopic procedures. Randelli et al²⁴ showed that the risk of DVTs was not decreased with heparin prophylaxis following arthroscopic shoulder surgery. Additionally, Alyea et al¹ reported on 914 patients that underwent arthroscopic rotator cuff repair in which postoperative aspirin or mechanical prophylaxis with early ambulation was used for VTE prophylaxis. They noted that the percentages for all patients with combined VTE, DVT, and PE were 0.66%, 0.66%, and 0.11%, respectively, with no significant difference in DVT or PE prevalence between the groups. Moreover, the mechanical prophylaxis group had an incidence of 0.62% and 0.00% for DVT and PE, respectively; the aspirin group had an incidence of 0.70% and 0.23% for DVT and PE, respectively. The authors concluded the aspirin did not lead to a clinically significant reduction in either DVT or PE in patients that underwent arthroscopic rotator cuff repair and noted that mechanical prophylaxis with early mobilization is likely a sufficient method of VTE prophylaxis in low-risk patients. Additionally, Jameson et al¹⁷ found that the incidences of DVT, PE, and mortality rate were 0.01%, 0.01%, and 0.03%, respectively, following shoulder arthroscopic procedures. They too concluded that VTE is not a significant problem following shoulder surgery, and chemical antithrombotic prophylaxis may not be required even in high-risk individuals. For this reason, several surgeons advocate that no chemical antithrombotic prophylaxis is indicated following shoulder arthroscopic procedures.

Limitations

There are several limitations to this study. First, this is a systematic review of the literature and is subject to the errors possibly contained within each manuscript. Additionally, while trying to mitigate the redundancy of reported VTEs represented in large database studies, this systematic review focused on published reports specifically following shoulder arthroscopy. As such, this review is limited to such reports that have been published. Moreover, as these reports have focused mostly on symptomatic VTEs following shoulder arthroscopy, the true incidence of postoperative VTEs may be underrepresented, as asymptomatic VTE is most certainly underreported. For these reasons, a larger prospective,

multicenter study is needed to monitor and adequately record the true incidence of VTE following shoulder arthroscopic procedures; however, this may be difficult, as a very large patient population is likely required to provide an adequate power analysis. Lastly, a majority of the patients included in this systematic review did not have their arthroscopic procedure specified. While it appears that there is a higher likelihood of symptomatic VTEs following rotator cuff surgery, there are not enough data to adequately support this finding. It is likely, however, that this is the case, given the older age and frequent medical comorbidities, of those patients undergoing rotator cuff repair compared with those undergoing surgical stabilization procedures. Lastly, while the overall reported incidence of VTEs is low, there were not enough data within the manuscripts included to compare the efficacy of those treated with or without chemical antithrombotic prophylaxis to draw any definitive conclusions.

Conclusion

While symptomatic VTEs are rare following shoulder arthroscopic procedures, surgeons must be aware that they still account for a certain number of postoperative complications. Factors such as operative time, open procedures, obesity, and altitude may increase the risk of postoperative VTE although conflicting data exist. Current literature supports the idea that chemical antithrombotic prophylaxis likely provides no significant advantage over early mobilization in reducing VTEs following shoulder arthroscopy in low-risk patients.

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