

Venous Thromboembolism in Lower Extremity Arthroscopy

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Abstract: Venous thromboembolism (VTE) is a relatively rare complication of arthroscopic surgery of the lower extremity, but it does have the potential to result in significant morbidity and possible mortality. VTE has been reported to occur with knee arthroscopy, and guidelines for VTE prophylaxis before and after knee arthroscopy have been proposed. There are much fewer data regarding the incidence of VTE occurring after arthroscopy of the ankle and the hip. This article reviews the literature on the incidence, treatment, and prevention of VTE in association with arthroscopy of the lower extremity. **Key Words:** Arthroscopy—Deep venous thrombosis—Lower extremity—Prophylaxis—Pulmonary embolism—Venous thromboembolism.

Arthroscopy has long been perceived as low-risk surgery relative to other areas of orthopaedics, such as total joint replacement and trauma.¹⁻³ Reported rates of venous thromboembolism (VTE) in association with lower extremity arthroscopy range from 0% to 17.9%. However, reported rates of pulmonary embolism (PE) and deep venous thrombosis (DVT) associated with total joint replacement in the absence of prophylaxis have approached 30% and 70%, respectively.² Anticoagulation prophylaxis improves the incidence to approximately 0% for PE and 1.5% for DVT, but VTE still remains a major concern for every arthroscopic surgeon.

Considerable controversy exists within the orthopaedic community regarding prophylaxis of VTE in patients undergoing total joint replacement. Multiple

studies have been performed within this population, each with its own recommendations. The Seventh American College of Chest Physicians (ACCP) Conference on Antithrombotic and Thrombolytic Therapy performed an in-depth meta-analysis of these voluminous data and published guidelines for care.⁴ However, these data nevertheless remain controversial.⁵⁻⁷ The American Academy of Orthopaedic Surgeons (AAOS) has also established its own guidelines for the prevention of VTE in total joint arthroplasty of the hip and knee.⁸ VTE in arthroscopic surgery has not garnered the same level of concern, yet it remains an important cause of morbidity and even reported cases of mortality. This article reviews the relevant literature on VTE associated with lower extremity arthroscopy.

HIP ARTHROSCOPY

In a review article regarding hip arthroscopy published 20 years ago, Hawkins⁹ warned that “systemic complications, such as pulmonary emboli, must always be considered.” In multiple series of hip arthroscopy cases published in the past 2 decades, however, PE or DVT has simply not been reported. No currently published study has specifically focused on this issue, but a review of more than 5,500 cases in the literature has revealed a 0% rate of DVT and PE (Table 1).¹⁰⁻³⁶

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TABLE 1. *Reported Incidence of Venous Thromboembolism in Hip Arthroscopy*

Author	Year	No. of Patients	DVT/PE Rate
Glick et al. ¹⁰	1987	12	0%
Small ¹¹	1988	14	0%
Funke and Munzinger ¹²	1996	19	0%
Byrd and Chern ¹³	1997	11	0%
Baber et al. ¹⁴	1999	328	0%
Griffin and Villar ¹⁵	1999	640	0%
Byrd and Jones ¹⁶	2000	38	0%
McCarthy et al. ¹⁷	2001	436	0%
Dienst et al. ¹⁸	2001	35	0%
O'Leary et al. ¹⁹	2001	86	0%
Sampson ²⁰	2001	530	0%
Byrd ²¹	2003	265	0%
Clarke et al. ²²	2003	1,054	0%
Keeney et al. ²³	2004	102	0%
McCarthy ²⁴	2004	1,475	0%
Pasa et al. ²⁵	2005	24	0%
Yamamoto et al. ²⁶	2005	10	0%
Yamamoto et al. ²⁷	2005	30	0%
Awan and Murray ²⁸	2006	22	0%
Lo et al. ²⁹	2006	73	0%
Jerosh et al. ³⁰	2006	22	0%
Mullis and Dahners ³¹	2006	36	0%
Owens and Busconi ³²	2006	11	0%
Bushnell et al. ³³	2007	156	0%
Kim et al. ³⁴	2007	43	0%
Philippon et al. ³⁵	2007	45	0%
Philippon et al. ³⁶	2007	37	0%
Total	—	5,554	0%

Abbreviations. DVT, deep venous thrombosis; PE, pulmonary embolism.

Specific recommendations for prophylaxis of VTE in hip arthroscopy have not been reported. Numerous authors have discussed VTE prophylaxis in other surgical procedures of the hip, but applying these data to hip arthroscopy is inappropriate because of fundamental differences in the type of surgical procedures and in the patient populations. Rather than emphasizing the arthroscopic procedure itself as a risk factor, the surgeon should instead focus on factors related to the patient's medical history and current medical condition. Most of these risk factors have been well described throughout the medical and surgical literature (Table 2). Decisions regarding anticoagulation prophylaxis for hip arthroscopy should be made on an individualized patient basis and documented in the medical record.

ANKLE ARTHROSCOPY

As in hip arthroscopy, ankle arthroscopy has a low rate of VTE. While not specific for ankle ar-

throscopy, a 0.2% to 4% incidence of VTE has been reported in association with all types of foot and ankle surgery.³⁷⁻³⁹ A review of recent literature specific for ankle arthroscopy confirms that this very low incidence rate can indeed be extrapolated to arthroscopic ankle surgery. In 15 studies involving more than 1,300 patients total, no DVT or PE was reported (Table 3).⁴⁰⁻⁵⁴

Three particular studies of VTE in ankle surgery in general merit discussion in light of their relevance to arthroscopic ankle surgery. Mizel et al.³⁷ performed a prospective, multicenter analysis of the rate of VTE in 2,373 patients undergoing various procedures of the foot and ankle. They reported a 0.22% incidence of VTE, including a 0.15% rate of non-fatal pulmonary embolus. Patients were diagnosed by clinical examination alone. The authors found that postoperative immobilization and non-weight-bearing status statistically correlated with an increased risk of VTE. They also performed a cost-benefit analysis of screening tests and prophylaxis for VTE, and they concluded that neither is justified in routine clinical care.

Solis and Saxby³⁸ published a prospective study in which 201 consecutive patients undergoing general foot and ankle surgery received duplex ultrasound testing. No prophylaxis for VTE was used in any of

TABLE 2. *General Risk Factors for Venous Thromboembolism*

Advanced age
Personal or family history of previous deep venous thrombosis or pulmonary embolism
Major systemic trauma
Lower extremity trauma
Prolonged immobilization
Full or partial paralysis of lower extremities
Central venous catheterization
Obesity
Tobacco use
Cancer
Pregnancy or postpartum status
Hormonal contraceptive use
Hormone replacement therapy
Treatment with selective estrogen receptor modulators
Known thrombophilic condition
Varicose veins
Acute medical illness
Heart failure
Respiratory failure
Inflammatory bowel disease
Myeloproliferative disorders
Nephrotic syndrome
Paroxysmal nocturnal hemoglobinuria

TABLE 3. *Reported Incidence of Venous Thromboembolism in Ankle Arthroscopy*

Author	Year	No. of Patients	DVT/PE Rate
Van Dijk et al. ⁴⁰	1996	30	0%
Harrington et al. ⁴¹	1996	24	0%
Acevedo et al. ⁴²	2000	29	0%
Rasmussen et al. ⁴³	2002	105	0%
Ono et al. ⁴⁴	2004	105	0%
Hintermann et al. ⁴⁵	2004	51	0%
Thomas et al. ⁴⁶	2005	50	0%
Nihal et al. ⁴⁷	2005	11	0%
Maiotti et al. ⁴⁸	2005	22	0%
Ferkel et al. ⁴⁹	2005	35	0%
Okuda et al. ⁵⁰	2005	30	0%
Lui et al. ⁵¹	2006	5	0%
Savva et al. ⁵²	2007	808	0%
Collman et al. ⁵³	2007	39	0%
Hassan ⁵⁴	2007	23	0%
Total	—	1,367	0%

Abbreviations. DVT, deep venous thrombosis; PE, pulmonary embolism.

these patients. Deep calf vein thrombi were diagnosed in 7 patients, representing a 3.5% incidence rate. The authors concluded that postoperative immobilization, surgery of the hindfoot, increased tourniquet time, and advanced age all were risk factors for VTE.

Hanslow et al.³⁹ reported on a retrospective review of 602 patients undergoing general foot and ankle surgery utilizing VTE prophylaxis which varied depending on the treating surgeon. The diagnosis of VTE was made by clinical exam, and a 4% incidence of VTE was reported. A significantly increased risk was present in cases involving postoperative immobilization, previous DVT, rheumatoid arthritis, and recent air travel.

As in hip arthroscopy, screening patients for VTE risk in ankle arthroscopy involves the evaluation of general medical risk factors (Table 2). No specific studies of VTE in isolated arthroscopic ankle cases have been reported, but unique risk factors can be extrapolated from a small number of studies focusing on ankle surgery in general (Table 4). Orthopaedic surgeons should consider some sort of VTE prophylaxis when these risk factors are present, but no guidelines or studies have been reported regarding the choice of prophylaxis.

KNEE ARTHROSCOPY

The majority of the literature regarding VTE of lower extremity arthroscopy involves the knee. The

TABLE 4. *Risk Factors for Venous Thromboembolism Associated Specifically with Foot and Ankle Surgery*

Postoperative immobilization
Nonweightbearing status
Hindfoot surgery
Increasing tourniquet time
Advancing age
Previous thromboembolic event
Rheumatoid arthritis
Recent air travel

two major groups of studies that exist are those determining the incidence of VTE without prophylaxis and those evaluating the prophylactic benefit of low-molecular weight heparin (LMWH). The remaining literature involves case reports and small series illustrating important considerations in medical management. Upon a thorough review of the literature, the incidence of VTE associated with knee arthroscopy ranges from 0% to 17.9% (Table 5).⁵⁵⁻⁷⁵

Incidence

Articles associating VTE and knee arthroscopy include those that have reported both the incidence of DVT and/or PE. Some of these studies published the incidence of thromboembolic events as their

TABLE 5. *Reported Incidence of Venous Thromboembolism in Knee Arthroscopy*

Author	Year	DVT	PE
Jackson and Abe ⁵⁵	1972	1.4%	0.5%
McGinty et al. ⁵⁶	1977	7.3%	0%
Carson ⁵⁷	1979	4.9%	1.6%
Guhl ⁵⁸	1979	1.0%	0%
Lysholm et al. ⁵⁹	1981	1.0%	0%
Dandy and O'Carroll ⁶⁰	1982	0.3%	0%
Mulhollan ⁶¹	1982	0.3%	0.02%
DeLee ⁶²	1985	0.1%	0.03%
Rand ⁶³	1985	3.4%	0%
Coudane et al. ⁶⁴	1986	0.75%	0.25%
Collins ⁶⁵	1989	0.3%	0.06%
Stringer et al. ⁶⁶	1989	4.2%	0%
Williams et al. ⁶⁷	1995	3.5%	0%
Cullison et al. ⁶⁸	1996	1.5%	0%
Durica et al. ⁶⁹	1997	3.2%	0%
Demers et al. ⁷⁰	1998	17.9%	0%
Delis et al. ⁷¹	2001	7.8%	0%
Berqvist and Lowe ⁷²	2002	4.2%	0%
Ng et al. ⁷³	2005	1.2%	0%
Hoppener et al. ⁷⁴	2006	5.7%	0.003%
Reigstad and Grimsgaard ⁷⁵	2006	0%	0.17%

Abbreviations. DVT, deep venous thrombosis; PE, pulmonary embolism.

primary focus, while others reported it secondarily as part of a study with a different goal. The incidence of VTE, DVT, and PE differs significantly among various studies based upon multiple factors, including patient age, medical history, and type of surgical procedure performed. The literature and its reports of incidence reflect the changes in VTE management over the last 3 decades. In the 1980s and 1990s, published studies regarding the incidence of VTE and knee arthroscopy reported the diagnosis based upon clinical signs and symptoms—a method which suffers from low sensitivities and specificities. Recent articles have reported that 40% to 50% of cases of DVT diagnosed by ultrasound or venogram were clinically asymptomatic, implying that the earlier studies may have missed several cases of VTE.⁷¹ In more recently published articles, however, the diagnosis has been based upon the objective results of venography and/or ultrasound.

Perhaps the best overall analysis of VTE incidence after knee arthroscopy in patients without prophylaxis is a meta-analysis by Ilahi et al.⁷⁶ which included a review of six studies and a total of 684 patients.⁷⁷ This meta-analysis suggested an overall DVT rate of 9.9% and a proximal DVT rate of 2.1%. Criteria for inclusion in the meta-analysis were screening for DVT with ultrasound or venography and the exclusion of concomitant ligament repair or open knee surgical procedures.

Obviously, the general medical risk factors for VTE incidence also apply to knee arthroscopy (Table 2). A direct assessment of some of these factors has been performed in some studies specific to knee arthroscopy. Demers et al.⁷⁰ performed an analysis which included age, sex, family history of VTE, previous personal history of VTE, home medications, anesthesia, duration of surgery, duration of immobilization, and tourniquet time. Despite a review of all of these risk factors, only a tourniquet time of greater than 60 minutes was found to be a statistically significant factor associated with the development of VTE. Delis et al.⁷¹ studied the following criteria: age greater than 65 years, body mass index over 30, smoking, hormone replacement or contraceptive use, history of chronic venous insufficiency, and history of previous VTE. In this series, the only statistically significant single risk factor was a history of previous VTE. The authors also concluded that two or more general risk factors for hypercoagulability increased the risk of VTE after knee arthroscopy.⁷¹

Prophylaxis

The second major group of articles regarding VTE in knee arthroscopy involves a series of studies regarding prophylactic options. There are three published randomized, controlled trials and three cohort studies that have assessed prophylaxis with LMWH after knee arthroscopy. While results have varied slightly between these studies, the overall consensus seems to be that LMWH is effective at reducing VTE risk.

Wirth et al.⁷⁸ followed 239 total patients and randomized them into matched groups: 117 receiving rivaroxaban for 7 to 10 days after surgery and 122 receiving no treatment. DVT was diagnosed by color-coded sonography. There was a VTE incidence of 0.85% in the rivaroxaban group and 4.1% in the control group, correlating with a relative risk reduction of 80%. The single patient with a DVT in the rivaroxaban group was found to have low levels of protein C and protein S, indicating a possible coagulopathy. There were no patients with major bleeding episodes in the rivaroxaban group.⁷⁸

Michot et al.⁷⁹ published a similar study involving 130 patients randomized into two groups: 66 treated with dalteparin and 64 without prophylaxis. The first dose of LMWH was given just before surgery and continued daily for 4 weeks. DVT was diagnosed by compression ultrasonography. There was a VTE incidence of 15.6% without prophylaxis and 1.5% with prophylaxis. This represented a statistically significant risk reduction for VTE ($P = .004$). The authors reported that 80% of all DVTs were diagnosed within the first 2 weeks after surgery.⁷⁹

Marlovits et al.⁸⁰ reported on 175 patients undergoing arthroscopic anterior cruciate ligament repair. All patients received enoxaparin preoperatively and during their 3- to 8-day postoperative hospitalization. Patients were then randomized into two groups: 87 patients receiving enoxaparin and 88 receiving placebo for 3 weeks after discharge. This study employed magnetic resonance venography to evaluate for DVT and lung scans to evaluate for PE. There was a 2.8% incidence of DVT in patients treated with enoxaparin, compared to a 41.2% incidence of DVT of those receiving placebo. This represented a statistically significant reduction in risk of DVT with enoxaparin ($P < .001$). There was no statistically significant difference in bleeding events between the two groups, and there were no cases of PE. After an analysis of risk factors, this study concluded that age greater than 30

years and immobilization before surgery were statistically significant for increased risk of VTE.

Three other studies focusing on VTE prophylaxis did not involve a randomized, controlled design but still merit discussion here. Schippinger et al.⁸¹ and Obernosterer et al.⁸² followed a cohort of 101 patients who received dalteparin after knee arthroscopy. Ultrasound, phlebography, and lung scans were used to screen for DVT and PE. This study reported a 12% rate of VTE. Three patients had DVT, 4 patients developed PE, and 5 patients had both DVT and PE. This study reported an increased rate of VTE in spite of LMWH prophylaxis, which is especially concerning in that 4 of the 8 DVTs and 8 of the 9 PEs were clinically silent. There was no correlation with tourniquet time, anesthetic type, or duration of surgery with the incidence of DVT.

Holland and Schain⁸³ reviewed 102 patients who underwent postoperative prophylactic treatment with nadroparin for 5 to 6 days after knee arthroscopy. There was a 4.9% rate of symptomatic DVT in spite of prophylaxis with LMWH. Eighty percent of the DVTs occurred after prophylactic treatment was terminated.

Montebugnoli et al.⁸⁴ reported no proximal DVT or other thromboembolic events in a study of 509 patients receiving parnaparin after minor arthroscopic knee surgery. The authors recommended treatment with the LMWH for 10 days after surgery. There were 8 adverse events related to the parnaparin, however, raising some concern about the risk–benefit ratio of treatment.⁸⁴

Future research is required to determine if the benefits of prophylaxis for VTE after knee arthroscopy outweigh the risks and costs. However, the randomized, controlled trials of LMWH prophylaxis seem to support its use in decreasing the risk of VTE after knee arthroscopy. Yet the cohort studies illustrate that multiple issues must be resolved before definitive prophylactic treatment recommendations can be made. A recent Cochrane Database review⁷ highlighted the inability of the current literature to definitively support thromboprophylaxis of any type, and recommended that future studies perform more organized stratification of patients by risk factor and type of procedure. The type of LMWH, duration of therapy, timing of therapy (preoperative and postoperative), method of DVT/PE diagnosis, and screening for other risk factors may all play a role in the analysis of LMWH efficacy and also must be considered. Although future studies will be required to determine the appropriate methodology of using LMWH, this treatment currently represents the best literature-supported

option for prophylaxis.^{4,78-81,83} Specific indications for LMWH use thus remain to be more clearly defined. In addition, while the use of other methods such as aspirin, warfarin, heparin, and multimodal prophylaxis have all been well described in relation to total joint arthroplasty, no studies have focused on their use specifically for arthroscopy.

Fatal Pulmonary Embolism

As evidenced by the literature discussed earlier, PE appears to be a very rare occurrence in association with knee arthroscopy, and most cases of PE are clinically silent or respond to treatment.⁸⁵⁻⁸⁸ Several case reports of fatal PE exist in which one or more risk factors were present for VTE.⁸⁹⁻⁹² In some cases, however, the only risk factor may have been the arthroscopy itself (i.e., lower extremity surgery as a risk factor). For example, a fatal PE was reported by Navarro-Sanz and Fernandez-Ortega⁹¹ in a 46-year-old man who had no known risk factors other than his orthopaedic procedure, which involved a tourniquet time of only 35 minutes. This case serves as a reminder of the importance of always considering the potential risk of VTE in every surgical case, appropriately discussing the possibility of this complication with the patient preoperatively, and documenting that discussion in the medical record.

Another recent case report by Janssen and Sala⁹² involved a 17-year-old female soccer player who suffered a fatal PE after an anterior cruciate ligament reconstruction. This patient had identifiable risk factors of oral contraceptive use and family history of coagulopathy. This case raises the question of whether or not to discontinue oral contraceptives before and after knee arthroscopy. Berg and Montanarella⁹³ recommended that oral contraceptive pills be continued with the addition of chemoprophylaxis in patients undergoing knee arthroscopy—arguing that the risk of pregnancy-related death as a consequence of unprotected sex is higher than the risk of death as a complication of oral contraceptive use.

CONCLUSIONS

VTE remains one of the most feared potential complications of arthroscopy of the lower extremity. There have been no reports of cases of DVT or PE associated with hip or ankle arthroscopy to date, and thus the surgeon should base prophylaxis decisions before these procedures on the existing medical factors associated with each individual patient. The vast

majority of existing data about VTE prophylaxis in lower extremity arthroscopy pertains to the knee, including specific guidelines and recommendations. The incidence of VTE associated with knee arthroscopy appears to be approximately 10% and can be reduced with the use of prophylactic LMWH. Presently, however, the guidelines of the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy remain the only current official recommendations that are specific to knee arthroscopy. The guidelines recommend prophylaxis with LMWH only when patients have pre-existing risk factors for hypercoagulability or after a complicated/prolonged procedure.⁴ Further research is required to evaluate thromboembolic disease in lower extremity arthroscopy, with attention to specifics such as indications, risks, benefits, dosages, intervals, costs, and other features of various prophylactic options.

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