

Pulmonary Embolism Following Laparoscopic Antireflux Surgery: A Case Report and Review of the Literature

Ninh T. Nguyen MD, James D. Luketich MD, David M. Friedman BS,
Sayeed Ikramuddin MD, Phil R. Schauer MD

ABSTRACT

Deep venous thrombosis and pulmonary embolism are concerning causes of morbidity and mortality in patients undergoing general surgical procedures. Laparoscopic surgery has gained rapid acceptance in the past several years and is now a commonly performed procedure by most general surgeons. Multiple anecdotal reports of pulmonary embolism following laparoscopic cholecystectomy have been reported, but the true incidence of deep venous thrombosis and pulmonary embolism in patients undergoing laparoscopic surgery is not known. We present a case of pulmonary embolism following laparoscopic repair of paraesophageal hernia. The literature is then reviewed regarding the incidence of pulmonary embolism following laparoscopic surgery, the mechanism of deep venous thrombosis formation, and the recommendations for deep venous thrombosis prophylaxis in patients undergoing laparoscopic procedures.

Key Words: Pulmonary embolism, Laparoscopic surgery, Deep venous thrombosis, Paraesophageal hernia.

INTRODUCTION

Approximately 260,000 cases of pulmonary embolism (PE) are clinically diagnosed each year in the United States; and, in the absence of prophylaxis, the incidence of fatal PE ranges from 0.1% - 0.8% in patients undergoing elective general surgical procedures.¹ Since the introduction of laparoscopic cholecystectomy (LC), laparoscopic surgery has become the preferred therapy for patients with gallstone disease. Significant complications following LC are uncommon compared to open cholecystectomy (OC).² Three prospective randomized trials comparing LC to OC suggest that the morbidity following LC is equal to or less than after OC.^{3,4} Deep venous thrombosis (DVT) and PE as a complication of laparoscopic surgery have been reported in multiple case reports and individual series, but incidence of DVT and PE following laparoscopic surgery is unknown.^{5,6} In this report, a case of pulmonary embolism after laparoscopic repair of a paraesophageal hernia is described, and a review of the literature is summarized with respect to the incidence of PE after laparoscopic surgery. Recommendations regarding DVT prevention after laparoscopic surgery are provided.

CASE REPORT

A 75-year-old obese male presented with a history of multiple episodes of severe postprandial coughing and epigastric pain over the previous several months. His past medical history was only significant for a history of cardiac arrhythmia. On physical examination, his abdominal exam was benign without organomegaly. As part of his workup by his internist, he underwent a computer tomography (CT) scan of his abdomen. The CT scan demonstrated an intrathoracic stomach with organoaxial volvulus without complete obstruction. Subsequently, the patient underwent a laparoscopic repair of the hiatal hernia (type III). The operation was uneventful, with an operative time of 5 hours and 14 minutes. Elastic stockings, intermittent pneumatic compression, and heparin (5,000U BID) were used as DVT prophylaxis. His immediate postoperative course was uneventful. He started ambulating on postoperative day (POD) 3 and was discharged on POD 6. The patient

Division of Gastrointestinal Surgery, University of California Davis Medical Center, 4301 X Street, Sacramento, CA 95817, USA (Dr. Nguyen).

Department of Surgery, University of Pittsburgh Medical Center, 3471 Fifth Ave., Pittsburgh, Pennsylvania 15213, USA (Drs. Luketich, Friedman, Ikramuddin, and Schauer).

Address reprint request to: Ninh T. Nguyen, MD, Department of Surgery, 4301 X Street, RM 2310, Sacramento, CA 95817.

returned to clinic on POD 15 for a follow-up visit with a complaint of shortness of breath, low grade fever and poor appetite. A chest X-ray revealed a left-sided pleural effusion. An arterial blood gas demonstrated a pO_2 of 57 on room air. A venous doppler study revealed left common femoral, superficial femoral and popliteal vein thrombosis. The patient was started on a heparin drip to maintain the activated partial thrombin time at one-and-a-half time normal. A ventilation/perfusion scan revealed almost no perfusion to the right upper lobe consistent with a high probability of PE. The patient was treated with anticoagulation, supportive care and bed rest with gradual improvement of his O_2 saturation and bilateral lower extremity edema. He was then switched to coumadin prior to discharge. At two-year follow-up, he is doing well, off all anticoagulation.

DISCUSSION

DVT and PE following major surgical procedures remain significant causes of major morbidity and mortality. The incidence of DVT as demonstrated by fibrinogen scanning in surgical patients receiving no prophylaxis is 25%, and clinically significant PE occurs in 1.6% of surgical patients.⁷ The use of prophylactic regimens can significantly reduce the incidence of postoperative DVT and PE. Although laparoscopic surgery now composes a major part of general surgery, very little is known of the relative risk of developing complication of venous thrombosis after laparoscopic procedures. Furthermore, specific recommendations regarding prophylactic measures against DVT formation after laparoscopy are not widely appreciated. It is important to determine the incidence of DVT and PE following this emerging procedure. In addition, it is important to determine the risk factors in laparoscopic surgery, which can contribute to the development of DVT and the use of appropriate prophylactic measures in the prevention of this dreaded complication.

Factors predisposing patients to thromboembolism can be grouped into inherited and acquired factors. Inherited risk factors include antithrombin III deficiency, protein C deficiency, protein S deficiency, and dysfibrinogenemia. Acquired risk factors include malignancy, age over 40 years, immobilization, prior thromboembolism, stasis, obesity, pregnancy, sepsis, stroke, inflammatory bowel disease and prior major surgical procedures.⁷ Each individual surgical patient may have any number of these risk factors, which may cumulatively increase their risk.

Apart from these well recognized predisposition conditions, several factors specific to laparoscopic surgery may increase the risk of developing DVT. Others factors specific to laparoscopy may actually decrease the risk of DVT formation. Factors which increase the risk of DVT development include CO_2 pneumoperitoneum, reverse Trendelenburg position, and prolonged operative time. The pressure effects of pneumoperitoneum impair lower extremity venous return leading to venous stasis. Ido et al. demonstrated a significant decrease in femoral blood velocity and an increase in femoral vein cross-sectional area in human patients after abdominal insufflation to 10 mm gh.⁸ Millard et al. similarly showed reduction in peak systolic velocity in the femoral vein in patients undergoing pneumoperitoneum and demonstrated that these effects can be reversed with the use of intermittent sequential pneumatic compression.⁹ The frequent use of reverse Trendelenburg position during laparoscopic surgery can also enhance venous stasis. Moneta et al. demonstrated a decrease in peak velocity of femoral vein and an increase in common femoral vein diameter when proceeding from a 10-degree head-down position to a 30-degree head-up position.¹⁰ The increase in operative time associated with advanced laparoscopic procedures (ie, laparoscopic Nissen fundoplication and laparoscopic colorectal surgery) can increase the duration and, thus, effect all the above-mentioned operative factors that may promote thrombosis.

Conversely, early ambulation and the potential reduction in postoperative hypercoagulation after laparoscopic surgery may decrease the risk of DVT development. LC, for example, is associated with early ambulation, while it may take several days for patients to become fully ambulatory after an open cholecystectomy. The enhanced mobility may reduce venous stasis and decrease the risk of venous thrombosis. The hypercoagulable state normally presents after major surgery has been shown to play a major role in DVT formation. Theoretically, laparoscopic surgery may blunt the hypercoagulable response due to the reduced tissue injury and stress response associated with these procedures. Initial studies show conflicting data on whether the laparoscopic methods may to some degree attenuate the hypercoagulable response. Caprini et al. demonstrated a significant postoperative hypercoagulable state in patients undergoing LC as seen by an increase in the thromboelastography (TEG) index and a significant reduction in a PTT level in the postoperative period.¹¹ Velpen et al. demon-

strated no statistical differences in plasma concentration of interleukin-6 or various mediators of coagulation-fibrinolysis between evenly matched patients undergoing open or laparoscopic cholecystectomy.¹² Dexter et al also demonstrated similar perioperative changes in the coagulation and fibrinolytic pathway for patients undergoing laparoscopic and open cholecystectomy.¹³ Our initial results, however, provided evidence of a blunted hypercoagulable state after laparoscopic surgery.¹⁴ We measured TEG in 21 pigs selected to undergo LC (N=10) or OC (N=11). A profound hypercoagulable state was evidenced by changes in 3 of 4 TEG parameters (R, K, and MA parameters) to reflect a state of hypercoagulation compared to preoperative values following OC. Swine undergoing LC, however, developed a blunted hypercoagulable state with hypercoagulable changes in only one of the TEG parameters (MA parameter). Further investigation will be necessary to clarify the importance of laparoscopy on postoperative hypercoagulation

We present in this report a case of pulmonary embolism following laparoscopic repair of 67 paraesophageal hernias at our institution. The risk factors for venous thrombosis in this patient included age over 40 years, obesity, pneumoperitoneum, reverse Trendelenburg position, and lengthy operative time. DVT prophylaxis in this patient included the use of elastic compression stockings, intermittent pneumatic compression boots intraoperatively and postoperatively, and low-dose sub-

Table 1.
DVT/Pulmonary Embolism following Laparoscopic Cholecystectomy, Single Institution.

Author	Year	Number of Patients	Number of PE/DVT (%)
Bailey et al.	1991	375	1 DVT (0.27%)
Soper et al.	1992	600	1 DVT (0.17%)
Stoker et al.	1992	252	0 DVT (0.00%)
Fabre et al.	1992	262	1 PE (0.38%)
Williams et al.	1994	600	1 PE (0.17%) 1 DVT (0.17%)
Mayol et al.	1994	200	2 PE (1.00%)
Bonatsos et al.	1995	1788	1 PE (0.06%)
Buanes et al.	1996	250	1 PE (0.40%)
Total		4,327	6 PE (0.139%)

cutaneous heparin. Despite these measures, he developed DVT and subsequently pulmonary embolism on POD 15. This thromboembolic complication after an advanced laparoscopic procedure raises the issue regarding the risk of DVT/PE formation after laparoscopy.

Multiple reports of DVT and PE have been described in the literature following laparoscopic cholecystectomy,

Table 2.
DVT/Pulmonary Embolism following Laparoscopic Cholecystectomy, Multiple Institutions.

Author	Study	Year	Number	Number of of Patients DVT/PE (%)
Nenner et al.	New York State	1992	304	1 PE (0.329%)
Orlando et al.	Connecticut	1993	4640	1 PE (0.022%)
Deziel et al.	National (USA)	1993	77604	3 PE (0.004%)
Croce et al.	National (Italy)	1994	6865	1 PE (0.015%)
Schlumpf et al	National (Swiss)	1994	3722	1 PE (0.027%)
Vincent-Hamelin et al.	National (Spain)	1994	2342	1 PE (0.043%)
Wherry et al.	Dept of Defense	1996	9130	8 PE (0.089%)
Collet et al.	National (France)	1997	4624	2 PE (0.043%)
Shea et al.	Pennsylvania	1998	2031	2 PE (0.098%)
Total			111,262	20 PE (0.018%)

Table 3.

DVT/Pulmonary Embolism following Laparoscopic Nissen Fundoplication and Laparoscopic Paraesophageal Hernia Repair (PEH).

Author	Year	Number of Patients	Number of DVT/PE (%)
Pitcher et al.	1994-Nissen	70	1 DVT (1.43%)
Jamieson et al.	1994-Nissen	155	4 PE (2.58%)
Collard et al.	1994-Nissen	39	1 PE (2.56%)
Zaninotto et al.	1995-Nissen	41	0 PE (0.00%)
Watson et al.	1995-Nissen	230	4 PE (1.74%)
Gotley et al.	1996-Nissen	200	1 PE (0.50%)
Sataloff et al.	1997-Nissen	20	2 PE (10.00%)
Hungtington	1997-PEH	58	1 PE (1.72%)
Perdikis et al.	1997-PEH	65	1 PE (1.54%)
Willekes et al.	1997-PEH	30	1 PE (3.33%)
Total		908	16 PE (1.76%)

Table 4.

DVT/Pulmonary Embolism following Laparoscopic Colorectal Surgery.

Author	Year	Number of Patients	Number of DVT/PE (%)
Guillou et al.	1993	59	2 PE (3.39%)
Rhodes et al.	1996	84	2 PE (2.38%)
Kwok et al.	1996	83	1 PE (1.20%)
Lumley et al.	1996	240	1 PE (0.42%)
Gellman et al.	1996	102	1 PE (0.98%)
Begos et al.	1996	50	0 PE (0.00%)
Milsom et al.	1998	55	1 PE (1.82%)
Köckerling et al.	1998	500	0 PE (0.00%)
Total		1,173	8 PE (0.68%)

laparoscopic Nissen fundoplication and laparoscopic colorectal surgery. **Table 1** lists all reported series in a single institution with DVT or PE described as a complication of LC. The mean incidence of PE among these single institutional series that report PE as a complication is 0.139%. This value is only an estimate, and caution is necessary in interpreting these data since there is tremendous variability in describing the types and range of complications among different studies. Some studies provide an exhaustive list of complications, while others only provide a limited list. In addition, it is difficult to know if DVT and PE occurred in a series that did not report these complications in their report. We only considered studies that specifically stated DVT or PE as a complication of the procedures—thus excluding studies in which no DVT or PE was reported. The incidence of PE following laparoscopic cholecystectomy is comparable to other reported incidences of open cholecystectomy. Berci et al. reported a 0.167% incidence of PE following 1,200 open cholecystectomies, and Shea et al. reported an incidence of 0.31% following 1,611 open cholecystectomies.^{15,16} **Table 2** lists the incidence of PE/DVT as reported in a multiple institution series of laparoscopic cholecystectomy. This incidence of PE ranged between 0.004% - 0.329%, with a mean incidence of 0.018%. **Table 3** lists all studies with DVT or PE reported as a complication following laparoscopic Nissen fundoplication and laparoscopic paraesophageal hernia repair (PEH). The incidence of PE is estimated to be 1.76%. This number is

significantly higher than the described incidence for patients undergoing LC. This may be due, in part, to the prolonged operative time associated with this advanced laparoscopic procedures. **Table 4** lists studies that report DVT and PE as a complication following laparoscopic colorectal surgery. The number of reported laparoscopic colorectal procedures is small compared to LC and laparoscopic antireflux surgery. The incidence of PE in this group ranged from 0.00% - 3.39%, with a mean incidence of 0.68%. Additional risk factors for development of DVT in this group of patients are the presence of malignancy, advanced age and prolonged operative time.

Data from randomized control trials have shown that prophylaxis in general surgical patients reduces the incidence of DVT at least by half compared to control patients. Randomized trials of low-dose heparin showed a 68% reduction in DVT and a 49% reduction in PE.¹ There was also a reduction in the mortality associated with PE.

Currently, the recommended modality of DVT and PE prevention in patients undergoing general surgery and laparoscopic surgery are categorized according to the risk classification.¹⁷ Caprini et al. developed a Risk Assessment System to determine criteria for instituting prophylaxis and the appropriate regimen for a given patient.¹⁸ This system is based on a scoring system containing 20 clinical risk factors. For low risk general surgery patients (0-1 factor), early ambulation and elastic

stocking are recommended. For moderate risk patients (2-4 factors), either low-dose heparin or a combination of elastic stocking and intermittent pneumatic compression is advocated. For the high risk group (>4 factors), a combination of heparin, elastic stocking and pneumatic compression is recommended. According to the Caprini DVT Risk Assessment System, most patients undergoing laparoscopic surgery will fall into the category of moderate or high risk and, therefore, will require DVT prophylaxis in the form of low-dose heparin or pneumatic stockings. Although these guidelines for DVT prophylaxis are not validated by prospective studies, they constitute a rational approach that is currently applicable until further investigation yields alternative recommendations.

Conditions specific to laparoscopic surgery may profoundly impact normal physiologic mechanisms of coagulation and thrombosis. Based on the current literature, it is unclear whether laparoscopic surgery results in an increase or decrease in the rate of DVT formation. Retrospective studies show similar incidences of DVT/PE in both open and laparoscopic cholecystectomy but slightly higher incidences following more advanced laparoscopic procedures, like laparoscopic Nissen fundoplication and paraesophageal hernia repair. Well-controlled prospective studies are lacking. Until reliable data regarding DVT incidence after laparoscopy are available, it is prudent to assume that laparoscopy carries an added risk. Liberal application of DVT prophylaxis for laparoscopic procedures thus seems warranted. The prevention and management of thromboembolic complications in this rapidly expanding era of modern laparoscopic surgery constitutes an important issue that requires more attention and investigation.

References:

1. Colditz GA, Tuden RL, Oster G. Rates of venous thrombosis after general surgery: combined results of randomized clinical trials. *Lancet*. 1986;1:143-146.
2. Shea JA, Healey MJ, Berlin JA, et al. Mortality and complications associated with laparoscopic cholecystectomy. *Ann Surg*. 1996;224:609-620.
3. Bailey RW, Zucker KA, Flowers JL, Scovill WA, Graham SM, Imbembo AL. Laparoscopic cholecystectomy: experience with 375 consecutive patients. *Ann Surg*. 1991;214:531-541.
4. Buanes T, Mjaland O. Complications in laparoscopic and open cholecystectomy: a prospective comparative trial. *Surg Laparosc Endosc*. 1996;6:266-272.
5. Mayol J, Vincent-Hamelin E, Sarmiento JM, Oshiro EO, Diaz-Gonzales J, Tamayo FJ. Pulmonary embolism following laparoscopic cholecystectomy: report of two cases and review of the literature. *Surg Endosc*. 1994;8:214-217.
6. Bonatsos G, Leandros E, Dourakis N, Birbas C, Delibaltadakis G, Golematis B. Laparoscopic cholecystectomy: intraoperative findings and postoperative complications. *Surg Endosc*. 1995;9:889-893.
7. Clagett GP. Prevention of postoperative venous thromboembolism: an update. *Am J Surg*. 1994;168:515-522.
8. Ido K, Suzuki T, Kimura K, et al. Lower-extremity venous stasis during laparoscopic cholecystectomy as assessed using color doppler ultrasound. *Surg Endosc*. 1995;9:310-313.
9. Millard JA, Hill BB, Cook PS, Fenoglio ME, Stahlgren LH. Intermittent sequential pneumatic compression in prevention of venous stasis associated with pneumoperitoneum during laparoscopic cholecystectomy. *Arch Surg*. 1993;128:914-919.
10. Moneta GL, Bedford G, Beach K, Strandness DE. Duplex ultrasound assessment of venous diameters, peak velocities, and flow patterns. *J Vasc Surg*. 1988;8:286-291.
11. Caprini JA, Arcelus JI, Laubach M, et al. Postoperative hypercoagulability and deep-vein thrombosis after laparoscopic cholecystectomy. *Surg Endosc*. 1995;9:304-309.
12. Velpen G, Penninckx F, Kerremans R, Van Damme J, Arnout J. Interleukin-6 and coagulation-fibrinolysis fluctuations after laparoscopic and conventional cholecystectomy. *Surg Endosc*. 1994;8:1216-1220.
13. Dexter SP, Griffith JP, Grant PJ, McMahon MJ. Activation of coagulation and fibrinolysis in open and laparoscopic cholecystectomy. *Surg Endosc*. 1996;10:1069-1074.
14. Nguyen NT, Luketich JD, Shurin MR, et al. Coagulation modifications after laparoscopic and open cholecystectomy in a swine model. *Surg Endosc*. 1998;12:973-978.
15. Morgenstem L, Wong L, Berci G. Twelve hundred open cholecystectomies before the laparoscopic era: a standard for comparison. *Arch Surg*. 1992;127:400-403.
16. Shea JA, Berlin JA, Bachwich DR, et al. Indications for and outcomes of cholecystectomy: a comparison of the pre and postlaparoscopic eras. *Ann Surg*. 1998;3:343-350.
17. National Institutes of Health: Consensus conference on prevention of venous thrombosis and pulmonary embolism. *JAMA*. 1986;256:744-748.
18. Caprini JA, Arcelus JI, Hasty JH, Tamhane AC, Fabrega F. Clinical assessment of venous thromboembolic risks in surgical patients. *Sem Thromb Hemost*. 1991;17:304-312.