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Prophylactic inferior vena cava filter placement prior to lumbar surgery in morbidly obese patients: Two-case study and literature review

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Abstract

Background: Preoperative "prophylactic" placement of inferior vena cava (IVC) filters in morbidly obese patients (e.g., body mass index [BMI] >40 or BMI over 35 with hypertension/diabetes) undergoing multilevel decompressive lumbar laminectomies may reduce the risk of postoperative pulmonary embolism (PE), and death.

Methods: Two patients, ages 69 and 68, with morbid obesity (BMI's of 40.4 and 37.5 both with hypertension and diabetes), received prophylactic IVC filters prior to L1–S1 laminectomies. Intraoperatively and postoperatively, both received alternating compression stocking prophylaxis, and received subcutaneous heparin 5000 U q12 h 48 h after surgery until discharge; none developed deep venous thrombosis (DVT) or PE, and both filters were uneventfully removed within 3 postoperative months.

Results: The spinal surgical literature largely supports the placement of IVC filters for major risk factors; obesity (BMI >40), a history of DVT/PE, cancer, fusions, hypercoagulation syndromes, pulmonary/circulatory disorders, preoperative/postoperative immobility, staged procedures (five spinal levels), combined anterior-posterior surgery, iliocaval manipulation, age >80, and prolonged surgery (e.g., >261 min vs. >8 h). Although the safety and efficacy of prophylactic IVC filters for spine surgery in patients with morbidly obesity are well substantiated, those for bariatric patients are less clear.

Conclusions: Prophylactic IVC filters were successfully placed/retrieved in 2 morbidly obese patients, ages 68 and 69, undergoing L1–S1 lumbar decompressions. Although the spine surgery literature documents the safety/efficacy of prophylactic IVC filters in patients with morbid obesity, the bariatric literature still has major concerns.

Key Words: Bariatric surgery, deep venous thrombosis, efficacy, inferior vena cava filter, morbidly obese patients, mortality, prophylaxis, pulmonary embolism, safety, spine surgery

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INTRODUCTION

To reduce the frequency of significant postoperative pulmonary embolism (PE), and death, the spine literature largely supports the use of prophylactic inferior vena cava (IVC) filters prior to extensive spine surgery for patients who meet high-risk criteria. These include obesity with a body mass index (BMI) >40, a history of deep venous thrombosis (DVT) or PE, cancer, hypercoagulation syndromes, >2 weeks of preoperative

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immobility, anticipated long-term postoperative immobility, fusions, staged procedures (five spinal levels), combined anterior-posterior surgery, iliocaval manipulation, and prolonged surgery among other factors [Table 1]. In this study, we prophylactically placed IVC filters prior to performing L1–S1 multilevel lumbar laminectomies (with severe ossification of the yellow ligament/stenosis) in 2 morbidly obese patients ages 68 and 69, with respective BMI's of 37.5 and 40.4. Notably both patients had hypertension and diabetes. Although the spine literature supports the prophylactic use of preoperative IVC filters for patients with morbid obesity, the bariatric literature still has major concerns regarding their safety/efficacy (e.g., increased rates of DVT, PE, perioperative morbidity, and even mortality).

CASE PRESENTATIONS

Prior to L1–S1 lumbar laminectomies without fusions, 2 morbidly obese patients, ages, 68 and 69, (BMI's of 37.5 and 40.4, both with hypertension and diabetes) underwent prophylactic IVC filter placement. Both patients were ambulated the day of surgery, and received alternating compression stocking (CS) prophylaxis intraoperatively and postoperatively/throughout the hospital course. They were also started on subcutaneous Mini Heparin 5000 U q12 h on the 2nd postoperative day (continued through discharge). Both patients had negative screening Doppler's performed on postoperative day 2 and were discharged home after 2- and 3-night hospital stays. Postoperatively, neither developed DVT or PE, and both underwent uneventful elective IVC filter removal within 3 postoperative months.

Table 1: Indications for prophylactic IVC^ filter placement in spine surgery

Author year (references)	Risk factors: DVT* or PE**
Fineberg *et al.* 2013[5]	Performing a fusion Pulmonary or circulation disorders Electrolyte imbalance Anemias Teaching hospital status
Koo *et al.* 2014[10]	Preoperative walking disability Advanced age
McClendon *et al.* 2012[12]	History of DVT or PE Malignancy Hypercoagulability Prolonged immobilization Staged spinal procedures more than 5 levels Combined anterior-posterior approaches Iliocaval manipulation during exposure Anesthetic time of more than 8 h
Leon *et al.* 2005[11]	History of thromboembolism Thrombophilia Malignancy Bedridden >2 weeks prior to surgery Staged procedures or multiple levels Combined anterior/posterior approaches Significant iliocaval manipulation during exposure Single-stage anesthetic time >8 h
Schoenfeld *et al.* 2013[16] Spine	BMI*** >40 Age >80 Operative time >261 min ASA^^ classification scale of 3 or > Male sex

ASA^^: American Society of Anesthesiologists, DVT*: Deep venous thrombosis, PE**: Pulmonary embolism, IVC^: Inferior vena cava, BMI***: Body mass index

DISCUSSION

Risk factors and rates of deep venous thrombosis, pulmonary embolism, and mortality for lumbar spine surgery

Risk factors and rates of DVT, PE, and mortality were asssessed in large databases and smaller series of patients undergoing lumbar spine surgery [Tables 1 and 2].[5,16,17] Fineberg *et al.* utilized the nationwide inpatient sample (2002–2009) to assess the rates of DVT/PE and mortality for those undergoing lumbar decompressions (LD), or lumbar fusions (LF) for degenerative disease [Tables 1 and 2].[5] Out of 578,457 spine patients, DVT occurred in 0.24% of LD and 0.43% of LF cases, while PE were observed in 0.1% of LD and 0.26% of LF patients. Predictive factors for developing DVT/PE included; performance of a fusion, pulmonary/circulation disorders, electrolyte imbalance, anemias, and teaching hospital status [Table 1]. Using data from the National Surgical Quality Improvement Program (2005–2011), Schoenfeld *et al.* also correlated comorbidities/surgical parameters associated with increased risks of DVT/PE following spine surgery [Tables 1 and 2].[16] Of 27,730 patients, averaging 56.4 (±15.1) years of age, 61% underwent lumbar spine interventions; 206 (0.7%) sustained DVT, and 113 (0.4%) had PE, while there were 87 (0.3%) deaths. Factors increasing the risks of DVT and/or PE included; BMI >40, age 80 or above, operative time >261 min, American Society of Anesthesiologists classification scale of 3 or more, and male sex. Tominaga *et al.* further evaluated risk factors predisposing 80 patients undergoing spinal procedures to postoperative DVT; all patients were routinely screened with postoperative Doppler's [Table 2].[17] DVT was observed in 1 superficial femoral vein, 2 in the popliteal veins, and 18 in the soleal vein, while 1 patient had a PE. Risk factors for DVT/PE included preoperative walking disability, and to a lesser degree advanced age [Table 2]. The authors recommended gait training during the early postoperative period to prevent venous thromboembolism (VTE).

Utility of pneumatic compression stockings (CS) as prophylaxis for lumbar surgery

Table 2: Spine surgery: frequency of DVT*, PE*, and death utilizing different regimens of prophylaxis with some IVC* filters**

Author year	Number patients/surgery	DVT (%)	PE (%)	Morbidity Mortality (%)	Prophylaxis/other factors
Fineberg *et al.*[5] 2013	578,457 NIS**** (Spine)	0.24 LD**** 0.43 LF^^^^^	0.1 LD***** 0.26 LF^^^^^		Lumbar LD***** laminectomy LF^^^^^ laminectomy/fusions
Epstein[4] 2006	139	2.8 (2-6 days)	0.7 (1-hyperco-agulation syndrome-paradoxical embolism)		Compression stockings only Lumbar laminectomies Instrumented fusions (IVC*** filters only to treat DVT*/PE** postoperatively)
Koo *et al.*[10] 2014	34	20.6			Compression stockings only Both lumbar spine and knees (68 legs)
Tominaga *et al.*[17] 2015	80	25	1.25		
Cox *et al.*[2] 2014	992 941	1 2.7	0.5 0.6	0.4 EDH^ 0.6 EDH^	Compression stockings + subcutaneous heparin (5000 U t.i.d. preoperatively) No specific protocol
McClendon *et al.*[12] 2012	219	18.7	3.7	0.9 paradoxical embolism	All received IVC*** filters 62 Greenfield 157 Retrievable
Leon *et al.*[11] 2005	74	31	1.35		All received IVC*** filters 70 had 2 risk factors
Schoenfeld *et al.*[16] 2013	27,730 NSQIP^^ (Spine)	0.7	0.4	0.32 deaths	Criteria for future select patients to receive IVC*** filters BMI^^^ >40 Age >80 Surgery >261 min ASA^^^^ >3

*DVT: Deep venous thrombosis, **PE: Pulmonary embolism, ***IVC: Inferior vena cava, EDH^: Epidural hematoma, BMI^^^: Body mass index, ASA^^^^: American Society of Anesthesiologists, NIS****: National in-patient sample, NSQIP^^: National Surgical Quality Improvement Program, LF^^^^^: Lumbar fusions, LD*****: Lumbar decompressions

Pneumatic CS alone reduce the incidence of DVT/PE in patients undergoing spinal surgery.[4,10] To reduce the risk of DVT/PE in lumbar surgery, Epstein promoted CS prophylaxis alone in 139 patients undergoing multilevel lumbar laminectomies (average 3.8 levels) and instrumented fusions (average 1.4 levels) [Table 2].[4] Low dose heparin (LDH) prophylaxis was not used to avoid the risk of postoperative hematoma/seroma and/or wound breakdown/dehiscence. Prophylactic lower extremity Doppler's were performed on the 2nd postoperative day, and thereafter when clinically indicated. CS prophylaxis resulted in a 2.8% incidence of DVT within 2–6 postoperative days; all 4 received IVC filters, and 1 patient developed a PE (0.7%) when he embolized around the filter 3 weeks later (positive for Factor V Leiden mutation) [Table 2]. There were no mortalities. In a randomized prospective study, Koo *et al.* compared the relative efficacy of two types of sequential compression devices (SCD's) to avoid DVT in 34 patients (68 limbs) undergoing knee and spine operations [Tables 1 and 2].[10] Patients recieved either ASCD vs. SCCD (variants of compression stockings). All were followed with routine lower extremity Doppler's performed on the 4th and 7th postoperative days. DVT was documented in the calf in 7 asymptomatic patients (20.6%); 2 with ASCD (11.8%) and 5 with SSCD (29.4%) (not statistically different). Risk factors for developing DVT included preoperative walking disability and advanced age [Table 1].

Sequential compression devices and chemoprophylaxis reduce deep venous thrombosis/pulmonary embolism without risking spinal epidural hematomas

Two authors determined the safety/efficacy of SCD and chemoprophylaxis in complex spine surgery.[2,7] From 2008–2010, Cox *et al.* evaluated whether the anticipated 2–4% risk of DVT/PE following spine surgery could be reduced by implementing early multimodality prophylaxis including SCD and subcutaneous LDH (low dose heparin) [Table 2].[2] The LDH regimen was 5000 U subcutaneously t.i.d. (except for patients age >75 years or weight <50 kg. whose dose was reduced to 5000 U b.i.d.). Chemoprophylaxis was started either preoperatively or the day of surgery, and was maintained throughout hospitalization. For this new protocol, the incidence of DVT/PE, and epidural hematomas (EDHs) requiring evacuation were retrospectively compared to those obtained for 2 prior years from patients treated without a uniform regimen (old protocol). Comparison of the old versus new treatment groups (941 vs. 992 patients

respectively) showed significant reductions in the rates of DVT (2.7% [old] vs. 1% [new]), but smaller reductions in PE (0.6% vs. 0.5%), and nearly comparable frequencies of postoperative EDH (0.6% vs. 0.4%) [Table 2]. Glotzbecker *et al*. further evaluated the varied methods and timing of DVT/PE prophylaxis for high-risk spinal surgery.[7] They queried 94 orthopedic and neurosurgical spine surgeons who answered 10 questions focused on the risk of; DVT, PE, and postoperative EDH. The surgeons' preferred method of chemoprophylaxis was low molecular weight heparin (LMWH: 58%). They determined whether and when surgeons thought chemoprophylaxis could be safely used; before surgery (no percentage), 12% <24 h, 15% at 24 h, 22% at 48 h, 13% at 72 h, 10% at 96 h, and some said they would never start it. Interestingly, 77% would strongly consider prophylactic IVC filter placement. Many (47%) considered the risk of clinically significant postoperative EDH to be 1–5%; 29% felt the risk was <1%, while 17% determined it was as high as 5–10%.

Prophylactic inferior vena cava filters in spine surgery

Several authors effectively used prophylactic IVC filters to avoid PE/death in complex spine surgery.[11,12] Due to the anticipated 13% morbidity/mortality attributed to PE in patients undergoing complex spine surgery, McClendon *et al*. recommended the prophylactic placement of IVC filters in his series of 219 patients undergoing spine procedures [Tables 1 and 2].[12] Indications for prophylactic IVC filter placement included; a history of DVT/PE, malignancy, hypercoagulability, prolonged immobilization, staged spinal procedures (>five spinal segments), combined anterior-posterior approaches, iliocaval manipulation, and anesthetic time of >8 h [Table 1]. All 150 women and 69 men, averaging 58.8 years of age, received IVC filters (62 Greenfield filters; 157 retrievable filters). The frequency of DVT was 18.7%, PE 3.7% (8/219 patients), and paradoxical embolus 0.5% (1 patient); only 2 direct filter-related complications were encountered. There were 14 deaths over the 8-year period, but none were related to PE, paradoxical embolism, or the IVC filter. The authors concluded prophylactic IVC filters significantly lowered the rate of postoperative PE. When Leon *et al*. prophylactically placed IVC filters in 74 patients (average age 56.2) prior to high-risk spine surgery, they had to meet at least one of the following criteria; history of DVT/PE, thrombophilia, malignancy, being bedridden >2 weeks prior to surgery, staged procedures or anticipated mulitlevel surgery, combined anterior/posterior approaches, the expected need for significant iliocaval manipulation during exposure, and single-stage anesthetic time >8 h. [Tables 1 and 2]; 70 patients exhibited least two risk factors.[11] Postoperatively, patients had weekly screening duplex ultrasound performed of the lower extremities (e.g., average 2.6 studies/68 patients). Additionally, one-third underwent computed tomography angiograms. An average of 11 months postoperatively, 27 limbs in 23 patients developed DVT (5 calf, 22 proximal), and 1 patient had a PE. Six deaths were unrelated to the IVC filters.

Orthopedic surgery (joints/fractures/spine) use inferior vena cava filters with/without prophylaxis

Bass *et al*. evaluated how IVC filters were utilized in orthopedic surgery at one institution.[1] They were applied in 90 (0.96%) of 9348 in-patient orthopedic procedures; 61% were placed prophylactically (despite the fact that only 42% had contraindications to anticoagulation). Prophylactic-to-treatment ratios for filter placement varied with different procedures; 3.25 for fracture surgeries, 2.1 for arthroplasties, and 0.89 for spine surgeries. DVT developed in 5% of those receiving prophylactic filters. Although 52% of filters were retrievable, only 40% were removed within an average of 5.1 postplacement months; 11% experienced filter-related complications, and an additional 10% could not be removed.

Inferior vena cava filters used in mixed populations at tertiary care centers

At a large Level I trauma center, Rottenstreich *et al*. observed that 405 retrievable filters were inserted from 2009 to 2013; 52 patients (12.8%) developed a minimum of one filter-related complication, the most common being DVT (6.9%).[14] Notably, the 42% of patients receiving prophylactic filters experienced one-third of all filter-related complications. The authors concluded more IVC filters were being placed without sufficient indications, and that only 13.6% in this series were retrieved, leading to increased long-term morbidity.[14]

Inferior vena cava filters in bariatric patients

In bariatric surgery, the safety and efficacy of prophylactic IVC filters remains controversial.[6,9,15] Kaw *et al*. in his meta-analysis, observed that PE was responsible for 40% of deaths following bariatric surgery; therefore, many studies began placing prophylactic IVC filters.[9] To look at studies involving adults undergoing bariatric surgery with and without IVC filters, they engaged three investigators to systematically evaluate the PubMed, EMBASE, and Web of Science and Scopus databases (ending February 28, 2013). Their analyses of outcomes included assessment of the incidence of DVT, PE, and death. From 3 weeks to 3 months postoperatively utilizing IVC filters, seven observational studies showed the incidence of DVT to be 0.9%, PE 1.6%, and mortality 1.0% [Table 3]. They concluded; placing IVC filters in bariatric surgery patients led to "an approximately 3-fold higher risk of DVT and death," but "there was no difference in the risk of PE." In another bariatric series, Rowland *et al*. reviewed the preferred reporting items for systematic reviews and meta-analyses guidelines and MEDLINE databases; two

Table 3: Bariatric surgery: frequency of DVT*, PE*, and death utilizing different regimens of prophylaxis all with IVC* filters**

Author year Surgery	Number of patients	Rate of DVT (%)	Rate of PE (%)	Morbidity (%)	Prophylaxis/other factors
Kaw *et al.* 2014[9]	7 studies	0.9	1.6	1.0 Death	Prophylactic IVC*** filters 3X > risk of DVT and death with IVC*** filter SCC^ No difference with IVC*** filter for risk of PE
Rowland *et al.* 2015[15]	497 patients (12 case series)	0-20.8	0-6.4		SCC^^ LMWH prophylactic IVC*** filters
Gargiulo *et al.* 2010[6]	58 IVC*** filters	1 (1.7) hyper-coagulation syndrome: coumadin		1 (1.7) Phlegmasia cerulea dolens: loss legs Death	58 Prophylactic IVC*** filters All BMI^^^ over 55

*DVT: Deep venous thrombosis, **PE: Pulmonary emboism, ***IVC: Inferior vena cava, ^SCC: Sequential compression stockings, ^^LMWH: Low molecular weight heparin, ^^^BMI: Body mass index

investigators independently screened studies and found 18 controlled cohort studies but no randomized controlled trials [Table 3].[15] Although these studies indicated that patients who undergo IVC filter insertion preoperatively might have a higher incidence of DVT/PE, the risk of PE-related mortality was reduced in only a small number of patients. They identified 12 case series involving 497 patients undergoing prophylactic IVC filter placement; here DVT rates ranged from 0% to 20.8%, and PE rates varied from 0% to 6.4% [Table 3]. Gargiulo *et al.* further noted the utility of prophylactic IVC filter placement for open gastric bypass (OGB) surgery to prevent DVT/PE and death for patients with BMI's over 55 (kg/m^2) [Table 3].[6] This study evaluated 58 (10%) of 571 morbidly obese patients having OGB who underwent prophylactic IVC filter placement; filters included the TrapEase (n = 35), Simon-Nitinol (n = 9), Greenfield (n = 2), and bard recovery (n = 12) devices [Table 3]. Although 56 patients had no complications over 8 postoperative years, one developed DVT (prothrombin 20,210 gene mutation) that resolved with 6 months on Coumadin, while another patient with multiple surgical complications (who could not be managed with intravenous heparin) developed complete IVC thrombosis, phlegmasia cerulea dolens, required bilateral above-the-knee amputations, and died 3 months later.

Mixed population receiving inferior vena cava filters including bariatric patients

Patel *et al.* evaluated 180 medical records (International Classification of Diseases, Ninth Revision-9) for patients receiving IVC filters over a 5 year period utilizing different guidelines from the American College of Chest Physicians and the Society of Interventional Radiologists.[13] Patients averaged 62.4 years of age and included 96 men and 84 women. Notably, 140 had a history of DVT, PE or both. Filters placed included; 107 permanent, 34 retrievable, and 39 with unknown types. The authors found that 20–40% of those receiving IVC filters did not meet insertion criteria. They also noted that the literature regarding the safety and efficacy of IVC filters particularly in bariatric surgical patients was "highly heterogeneous." Furthermore, there was no evidence to suggest "that the potential benefits of IVC filters outweighed the significant risks of therapy."

Complications of inferior vena cava filters

Various complications of IVC filters have been reported.[3,8,11] For 1 patient in Leon *et al.* spine series, the IVC filter deployed in the iliac vein.[11] In Dazley *et al.* study, in which prophylactic IVC filters were placed for patients with two or more risk factors for VTE undergoing complex spine surgery, although none exhibited postoperative symptomatic PE, cavograms at the time of attempted filter retrieval revealed; 17% had entrapped thrombi, and 17% had changed position/could not be removed.[3] Haga *et al.* also noted that IVC filters may not only perforate the IVC, but that they can also penetrate other adjacent major vessels or organs.[8] They specifically reported an 83-year-old male whose filter perforated the abdominal aorta; he was successfully followed over 1-year without surgery. Once the author had a patient with DVT, where a radiologist deployed a new retrievable filter into the pulmonary artery; as this could not be endovascular retrieved, it was surgically removed.

CONCLUSION

To reduce the risk of fatal PE, various regimens of DVT/PE prophylaxis have been offered for morbidly obese patients undergoing complex spinal surgery; CS, CS with LDH/LMWH, and the latter with prophylactic IVC filters. The 2 morbidly patients in this series were successfully treated with CS/LDH and prophylactic IVC filter placement; neither DVT or PE occurred, and filters were uneventfully removed. Although the literature substantiates the safety/efficacy of prophylactic IVC filter placement in morbidly obese patients undergoing spine surgery, the data for bariatric procedures remains uncertain.

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Conflicts of interest
There are no conflicts of interest.

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