

Thromboembolic Disease Prophylaxis in Patients With Hip Fracture

A Multimodal Approach

Geoffrey H. Westrich, MD,* Adam J. Rana, BA,† Michael A. Terry, MD,* Nicole A. Taveras, BS,* Komal Kapoor, BA,* and David L. Helfet, MD*†

Objectives: To assess if pneumatic compression in conjunction with chemoprophylaxis is an effective way to reduce the incidence of deep vein thrombosis in orthopedic trauma patients sustaining fragility hip fractures.

Design: Two hundred patients admitted to the authors' institution between May 1998 and June 2002 for fractures of the hip were prospectively studied. All patients were treated operatively and received the VenaFlow® calf compression device on both lower extremities immediately following surgery. Chemical prophylaxis of either aspirin (n = 67) or warfarin (n = 133) was administered in addition to mechanical compression. A noninvasive serial color flow duplex scan was performed 1 to 11 days postoperatively (mean 4.5 days) to determine the presence or absence of deep vein thrombosis. All patients were followed clinically 3 months postoperatively for a clinical evaluation of symptomatic deep vein thrombosis or pulmonary embolism.

Results: Overall, the incidence of deep vein thrombosis was 3.5% (7 of 200) and included only 1 proximal thrombosis (1 out of 200, or 0.5%) and no pulmonary embolism. Five of the 7 patients positive for deep vein thrombosis were in the mechanical compression and warfarin prophylaxis group and 2 were in the aspirin arm of the study. For patients with deep vein thrombosis, the average number of risk factors was 3.71, whereas patients without clots averaged 1.75 clinical risk factors ($P \leq 0.05$). Three patients in the warfarin group developed bleeding complications (1 with a gastrointestinal bleed and 2 with minor bleeding not at the operative site). No evidence of a symptomatic deep vein thrombosis or pulmonary embolism was reported within a 3-month period following hospitalization.

Conclusions: Our findings suggest mechanical compression with the VenaFlow® calf compression device in conjunction with chemoprophylaxis is an effective means of reducing thromboembolic disease in this high-risk population.

Key Words: hip fractures, mechanical prophylaxis, chemical prophylaxis, deep venous thrombosis, pulmonary embolism

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Venous thromboembolic disease is a serious and potentially fatal complication following orthopedic surgery to the hip. Patients with fractures of the proximal femur who do not receive prophylaxis have been reported as having thromboembolic rates ranging from 46% to 83%.^{1–5} Twenty-five to 50% of these clots are proximal, and it is believed that pulmonary embolism (PE) results in 4% to 11% of cases.^{6,7} The incidence of deep vein thrombosis (DVT) in total hip arthroplasty without prophylaxis has been reported in the literature to range from 50% to 75%, with proximal thrombosis observed in 15% to 20% of patients.^{8–16} Because of these high rates of thromboembolic disease, DVT prophylaxis is recommended by most surgeons when performing surgery about the hip. Current prophylactic regimens include aspirin, warfarin, low-molecular-weight heparins, pneumatic compression, or a combination of the above.^{10–12,14,17–26}

Venous stasis has been identified as one of the major contributing factors to thromboembolic disease. A number of studies have demonstrated that mechanical compression devices designed to minimize venous stasis are effective in reducing the rate of DVT following total joint arthroplasty and orthopedic trauma to between 4%¹³ and 33%.^{27–32} Currently marketed compression devices include foot pumps, foot-calf pumps, calf pumps, and calf-thigh pumps. Some are single chamber and others provide sequential compression with a number of chambers. Although the optimal characteristics of these pumps to reduce DVT and PE are not yet known, it has been proposed that pneumatic compression devices are effective in increasing venous flow and increasing fibrinolysis.^{28,29,31–34}

No studies to date have examined the effectiveness of pneumatic compression in conjunction with chemoprophylaxis in reducing the incidence of DVT in the hip fracture population. The purpose of this prospective study was to examine the efficiency of pneumatic compression in conjunction with chemoprophylaxis in a consecutive series of patients over 60 years old who were treated operatively for a fragility hip fracture.

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From the *Hospital for Special Surgery, New York, NY; †Department of Orthopaedic Surgery, Weill Medical College of Cornell University, New York, NY; and ‡SUNY Downstate Medical School, Brooklyn, NY.

Reprints: Geoffrey H. Westrich, MD, Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021 (e-mail: westrichg@hss.edu).

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PATIENTS AND METHODS

Study Design

The study was designed as a prospective cohort study to determine the effectiveness of an intermittent pneumatic mechanical compression device, the VenaFlow® System (Air-cast Incorporated, Summit, NJ) in conjunction with a chemoprophylactic agent in reducing incidence of DVT in patients with hip fracture. In addition to wearing bilateral intermittent pneumatic mechanical compression devices postoperatively, patients received either aspirin or warfarin in a nonrandomized manner. All patients older than 60 years admitted to the authors' institution between May 1998 and June 2002 with fragility fractures of the hip were evaluated for possible inclusion in the study. Fractures in the intertrochanteric region, femoral neck, or subtrochanteric region were considered hip fractures for the purpose of this study.

Inclusion criteria consisted of patients older than 60 who sustained a fragility fracture to the hip and an ability and willingness to comply with the mechanical and chemical prophylaxis protocol. Patients were not included in the study if they were younger than 60, had a history of severe allergy to aspirin or warfarin, refused to use the pneumatic compression device, had multiple trauma injuries, or had a hip fracture that did not require surgical treatment. Prior to the study's initiation, approval was received from the Investigational Review Board at the authors' facility.

Background Information

Patient data were obtained for each study participant using hospital charts, office records, and preoperative and postoperative radiographs. Of the 200 patients who completed the study in compliance with the protocol, 158 were women (79%) and 42 were men (21%). The participants had a mean age of 81.3 years (range 61–99). Tables 1 to 3 provide a summary of the patient demographic data.

Study Protocol

All patients were advised as to the nature of the study, possible adverse effects of the antithrombotic medications, monitoring procedures, and alternative treatments. Written informed consent for participation was obtained prior to patient enrollment.

The patients were assessed preoperatively using their previous medical history for presence of clinical risk factors (history of thromboembolism, hypertension, cancer, coronary artery disease, high cholesterol, smoker, diabetes, chronic obstructive pulmonary disease, atrial fibrillation, congestive heart failure, asthma, hypothyroidism, varicose veins, cancer, and obesity: body mass index [BMI] > 30) that might predispose them to develop DVT (Table 3). In addition, the mechanism of injury, if available, and the preoperative prophylaxis were recorded. Intraoperatively, we evaluated the operative procedure, the type of anesthesia administered (either regional or general), and complications.

Upon admission, pneumatic compression devices (PCD) were applied bilaterally to each calf of the patient, but were removed during surgical repair of the fractured hip. Immediately following surgery, the PCDs were again applied bilaterally

TABLE 1. Demographic and Clinical Characteristics

Characteristic	No.	%
Mean age at time of injury (yrs)	81.3	
Gender		
Female	158 (5)	79
Male	42 (2)	21
Chemical prophylaxis		
Warfarin	133 (5)	66
Aspirin	67 (2)	34
Fracture type		
Femoral neck	102 (4)	51
Intertrochanteric	85 (2)	43
Subtrochanteric	13 (1)	6
Fracture side		
Right	106 (5)	53
Left	94 (2)	47
Method of injury		
Low-energy fall	194 (7)	96
No trauma (felt fracture)	5	3
Periprosthetic fracture	1	1
No. days to Doppler		
Mean	4.5	
Range	1–11	

Number in parentheses is the number of DVT-positive patients in the respective grouping.

to the patient's calves. The patients were permitted to remove the device temporarily while bathing or participating in physical therapy, after which the PCD was reapplied by hospital staff. Patients were visited by house staff, residents, and research assistants, who monitored patient compliance of the PCDs during the morning afternoon and evening. Patients who refused to use the PCD were not included in the study.

The cuffs of the VenaFlow® system filled the distal air cells first to 52 mm Hg and the proximal air cells 0.3 seconds later to 45 mm Hg. After 6 seconds, the air cells deflated. This cycle was repeated every minute. The device was applied over the duration of the patient's preoperative and postoperative stay until the time of discharge. Patients sent to a rehabilitation center were told to continue using the PCD until their final discharge home.

Chemical prophylaxis was administered to 85 (43%) of the patients preoperatively and included warfarin, aspirin, subcutaneous heparin, and low-molecular-weight heparin in addition to mechanical prophylaxis. Study patients received postoperative chemical prophylaxis consisting of either warfarin or aspirin in addition to the mechanical prophylaxis, as per the attending surgeon's preference. Chemical prophylaxis was continued for 6 weeks following surgery, independent of the type of surgery. In addition, all patients having a hemiarthroplasty procedure began weight bearing as tolerated postoperatively. For all other procedures, the patients were toe-touch weight bearing postoperatively.

All patients were assessed for postoperative bleeding complications, which, if present, were recorded. The average length of stay postoperatively for this cohort of patients was

TABLE 2. Surgical Information

Surgical Characteristic	No.	%
Procedure		
Hemiarthroplasty	83 (2)	41.5
Dynamic hip screw	80 (3)	40.0
Hip pinning	16 (1)	8.0
Gamma nail	13	6.5
Intramedullary hip screw	8 (1)	4.0
Anesthesia		
Regional	133 (5)	66.5
General	67 (2)	33.5
Surgical time		
Average (mins)	93	
Range	29 to 235	
Patients requiring multiple surgery		
Two surgeries	11 (2)*	
Three surgeries	2	
Complications		
Myocardial infarction	6	
Congestive heart failure	5	
Urinary tract infection	5	
Bleed	3	
Cerebrovascular accident	2	
Stay after surgery		
Average (days)	9.6	
Range	3 to 82	

Number in parentheses is the number of DVT-positive patients in the respective grouping.

*Of the 2 DVT-positive patients, 1 had an irrigation and debridement and 1 had an inferior vena cava filter placed during the second procedure.

9.6 days. Most of patients were transferred to a rehabilitation facility where their wounds were assessed. On postoperative days 1 to 11 (mean 4.5), a noninvasive color duplex imaging examination was performed to diagnose the presence or absence of DVT. The patency of the lower external iliac, common femoral, superficial femoral, deep femoral, and popliteal veins was assessed using this technique. Duplex ultrasound imaging was done only on the operative extremity, because the incidence of DVT following hip fractures is most commonly found on the operative extremity.³⁵

Upon discharge, patients who did not develop a primary DVT were typically transferred to a rehabilitation facility. All patients were followed up with a 3-month postoperative appointment for clinical evaluation of symptomatic DVT or PE. At that time, the evaluators looked for classic symptoms of symptomatic DVT, including edema, warmth, pain, and discoloration in the involved lower extremity. The patients were also examined for symptomatic PE, including dyspnea, tachypnea, pleuritic pain, cough, and hemoptysis.

Statistical analysis involved a paired sample *t* test, and significance was set at a *P* value of 0.05.

RESULTS

Two hundred patients were included in the study. Three types of hip fractures were observed in the patient population: femoral neck fractures (102), intertrochanteric fractures (85),

and subtrochanteric fractures (13). Low-energy falls accounted for the majority of fractures (194). Additionally, 5 patients could recall no traumatic event, and 1 had a periprosthetic fracture of the femoral neck (Table 1). Intraoperatively, 133 patients received regional anesthesia and 67 received general anesthesia. Seven different surgical approaches were performed to repair the 200 fractures of the proximal femur. The cemented hemiarthroplasty and dynamic hip screw accounted for the majority of procedures (83 and 50, respectively). The average operative time was 93 minutes and ranged from 29 minutes to 235 minutes. Eleven patients required an additional surgery, 6 of which were for irrigation and debridement, 1 for inferior vena cava filter placement in a patient having a diagnosed DVT, 1 revision of a hemiarthroplasty, 1 laparoscopic cholecystectomy, 1 external fixation of the wrist, and 1 ventricular-peritoneal shunt. Two of the 11 patients required a third procedure that involved relocation of a dislocated hip (Table 2).

On postoperative days 1 to 11, a serial color flow duplex scan was performed on all 200 patients with hip fracture to determine the presence or absence of DVT. Postoperatively, 133 patients received pneumatic compression and warfarin, and 67 patients received pneumatic compression and aspirin. One patient in the aspirin group received an inferior vena cava filter following the diagnosis of a DVT. For patients receiving warfarin, therapeutic anticoagulation was reached approximately 72 hours after the initial dose. All patients received 5 mg of warfarin the night of surgery, and then dosing was adjusted to maintain an international normalized ratio (INR) of 2.0 to 2.5. This therapeutic level was monitored daily throughout the hospital stay and was monitored by the rehabilitation facility or the patient's private doctor after discharge.

TABLE 3. Clinical Risk Factors Negative Versus Positive Doppler

Risk Factor (Total No. Patients)	Negative (193)	Positive (7)
Age	81.5	75.1
Gender (M:F)	40:153	2:5
Hypertension	101	5
Cancer	49	4
Coronary artery disease	28	2
High cholesterol	28	3
Cerebral vascular accident	22	2
Smoker	20	2
Diabetes	19	1
Chronic obstructive pulmonary disease	17	2
Atrial fibrillation	15	0
Congestive heart failure	15	2
Ex-smoker	11	1
Asthma	9	1
Hypothyroid	8	0
Previous history of DVT/PE	4	1
Varicose veins obesity	2	0
Obese	1	0
Average no. risk factors/person	1.75	3.71

All patients in the aspirin group received 325 mg of enteric coated aspirin 2 times a day postoperatively until discharge. Patients' postoperative stay ranged from 3 to 82 days, with an average length of stay of 9.6 days (9.6 ± 8.75).

All patients were followed up with a 3-month postoperative appointment for a clinical evaluation of symptomatic DVT or PE. No evidence of a symptomatic DVT or PE was reported at this 3-month period.

Risk Factors

Clinical risk factors (Table 3) were analyzed with respect to postoperative thromboembolism. No individual clinical risk factor was significantly correlated with thromboembolism; however, the average number of risk factors per patient proved to be significant. For patients with DVT, the average number of risk factors was 3.71, whereas patients without clots averaged 1.75 clinical risk factors ($P \leq 0.05$). There was no significant difference in the mean age or gender of the patients who had thrombosis compared to those who did not have a DVT. In addition, the occurrence of DVT did not correlate significantly with a history of cancer, smoking, or thromboembolic disease (Table 3).

Prevalence of Deep Venous Thrombosis

Serial color flow duplex scans of the operative leg were performed on all patients. Venous anatomy was imaged, and the patency of the lower external iliac, common femoral, superficial femoral, deep femoral, and popliteal veins was assessed using this technique. Deep vein thrombosis was diagnosed in 7 patients (3.5%) overall. Five of these patients came from the group of 133 patients who received concomitant warfarin. The other 2 patients diagnosed with DVT came from the group of 67 receiving aspirin in addition to mechanical compression ($P = 0.74$). There was 1 incident of proximal thrombosis from a patient in the warfarin group, and there were no incidents of PE. All 5 DVT-positive patients receiving warfarin were maintained at therapeutic INRs between 2.0 and 2.5 postoperatively. This therapeutic level was monitored throughout their hospital stay and was consistent with the INR of patients without DVTs. The 2 DVT-positive patients receiving aspirin had received 325 mg of enteric coated aspirin 2 times a day postoperatively prior to their duplex ultrasound.

Complications

One postoperative gastrointestinal bleed was reported in an in-hospital patient taking warfarin. The warfarin was discontinued, the bleeding was controlled, and the warfarin was reintroduced, and we maintained an INR of between 1.5 and 2.0. The patient responded well to medical management and was discharged without further complications. Two additional patients in the mechanical compression and warfarin group developed minor bleeding complications, but neither of these were at the operative site. Six patients suffered a myocardial infarction postoperatively, 5 patients developed congestive heart failure, and an additional 5 patients developed a urinary tract infection. The present study did not investigate the possible occurrence of secondary asymptomatic DVTs or PEs evaluated during the patients' 2- to 3-month general

postoperative follow-up. However, no symptomatic DVTs or PEs were observed during this period.

DISCUSSION

Although venous thromboembolic disease is the most common fatal complication of orthopedic surgery, very few studies have examined the efficacy of dual prophylactic modalities in patients with hip fracture. Prophylactic regimens include the use of pharmacological agents, such as aspirin,^{8,19,22,33,36-41} low-molecular-weight heparin,^{42,43} and warfarin,^{6,8,19,27,32,43-45,45a} and mechanical methods such as pneumatic compression.^{6,11,26-28,33,37,38,40,44,45a,46-66} Low-dose warfarin has been used for prophylaxis against thromboembolic disease, but it is associated with bleeding complications, routine phlebotomy, notable cost, and inconvenience after discharge.^{6,8,19,27,38,43-45,67}

Historically, studies have reported the incidence of DVT in patients with hip fracture and total hip arthroplasty patients to be between 28% to 73% with aspirin, 21% to 69% with warfarin, and 7% to 45% with low-molecular-weight heparins.^{1,5,7,19,20,27,29,31,33,68-73,73a} Although these studies report the effectiveness of chemoprophylaxis, little work has been done exploring chemoprophylaxis in conjunction with mechanical prophylaxis in reducing thromboembolism rates. Our results investigating the prevention of primary DVT demonstrated a rate of 3.5%, which is considerably lower than previously reported DVT rates using various prophylactic regimens.^{74,75} Thus, the present results demonstrate efficacy in the combined use of mechanical and chemical prophylaxis for the prevention of primary DVT.

In a study similar to ours, Dorfman et al performed serial compression sonography to determine the location and timing of DVT in patients with hip fracture.⁷⁶ All patients in the study received warfarin, sequential compression boots, or gradient elastic stockings postoperatively. Eighteen (19%) out of 96 patients evaluated developed a venous thrombosis. In addition, 14 (78%) of these 18 patients had a clot proximal to the knee, and 9 (64%) of these 14 patients had the clot identified in their first perioperative evaluation. Their findings demonstrated early development of DVT after surgery. These primary DVTs, detected after the first perioperative evaluation, occurred at a rate of 64%, thus demonstrating a need for patient prophylaxis immediately following surgery. Mechanical methods of prophylaxis, applied postoperatively, achieve this objective, whereas chemoprophylaxis, such as warfarin, often takes a number of days to reach maximum efficacy.

Many studies have evaluated combination therapy in patients for DVT and PE prevention but have not focused on the hip fracture population. One such study conducted by Borow and Goldson evaluated different modalities of DVT prophylaxis versus no treatment in 562 patients over the age of 40 years undergoing various types of surgery for greater than 1 hour.²⁷ The study found a 35.6% incidence of DVT in the control population compared with a reduced rate of thrombosis in patients when treated with subcutaneous heparin, aspirin, low-molecular-weight dextran, compression stockings, or sequential compression devices. They also evaluated a similar group of 272 patients who received combined mechanical

prophylaxis and chemoprophylaxis using aspirin, heparin, dextran, and Coumadin. They found a dramatically reduced rate of DVT of 1.5% (4 out of 272) with the addition of mechanical compression. Fishmann et al evaluated patients who underwent open reduction and internal fixation of pelvic and acetabular fractures.⁶⁸ All patients were treated with mechanical prophylaxis in conjunction with 3 weeks of Coumadin postoperatively. The study found 11 DVTs in 197 patients preoperatively (6%) and 6 postoperatively (3%) in addition to 2 cases of PE (1%). Although the patients in these 2 studies cannot be directly compared to our study patients because of the different types of injuries and surgery, the results do support the efficacy of combination therapy. Additional studies using chemoprophylactic regimens to treat DVT in the hip fracture population have been conducted by Gerhart et al, Hamilton et al, and Galasko et al.^{1,69,77} Gerhart et al evaluated a low-molecular-weight heparinoid followed by warfarin and warfarin alone in treatment of 263 patients with hip fracture.⁶⁹ The study found a DVT rate of 7% in the patients taking low-molecular-weight heparinoid-warfarin and a rate of 21% in the warfarin-alone group. Hamilton et al evaluated patients with fractures about the hip treated with oral anticoagulants postoperatively versus controls and found that 19% of the treatment group developed a DVT postoperatively compared to 48% of the nontreatment group.⁷⁷ These data are from patients that were ambulatory preoperatively and had surgery that was not delayed more than 48 hours. Galasko et al's study evaluated elderly female patients with hip fractures.¹ Patients were randomized into a 5000 U subcutaneous heparin group or a control group. The heparin group received subcutaneous heparin from admission until ambulation or discharged. The results showed that 16% of the treatment group developed a DVT versus 46% of the control group.

In addition to the VenaFlow® device, other mechanical compression devices include foot pumps, sequential compression devices that extend to the thigh, and compression stockings. Fisher et al conducted a prospective, randomized clinical trial using pneumatic sequential compression devices (SCDs) on 304 patients with hip and pelvic fractures.⁷⁸ Sequential compression devices are believed to decrease the incidence of DVT by 2 mechanisms. One mechanism is the increase of plasma fibrinolytic activity by stimulating the blood vessel walls to release plasminogen activator. The second mechanism is by mechanically decreasing the transit time of venous blood, thereby preventing stasis and the accumulation of coagulant materials. In addition to their proven efficacy, these devices of prophylaxis are also safe and inexpensive. In cases where a patient may be at increased risk of bleeding, PCDs are not contraindicated, whereas the potential hemorrhagic complications associated with the newer forms of pharmacological prophylaxis, such as low-molecular-weight heparin, would preclude their use. In the patients with hip fracture, the control group had a thromboembolic event incidence of 12%, whereas the group being treated with the pneumatic sequential leg compression device had a thromboembolic event incidence of only 4% ($P = 0.03$).⁷⁸ Mechanical compression devices have been compared to each other in numerous studies with conflicting results. Spain et al found no difference in the DVT rate between groups treated with foot pumps and sequential com-

pression devices in 184 multiple-trauma patients considered high risk for thromboembolism.⁷³ Elliott et al compared calf thigh compression devices with plantar devices in 124 patients with no lower extremity trauma.⁷⁹ Deep vein thrombosis was reported in 6.5% of the patients with a calf-thigh sequential PCD and 21% of the patients with a plantar venous intermittent PCD.

We chose to use the VenaFlow® device because of its excellent augmentation of peak venous blood flow. Whitelaw et al evaluated the increase in peak venous flow from various devices used in mechanical prophylaxis.²⁵ The study results demonstrated the VenaFlow® device to increase peak venous flow by over 200% of baseline venous blood flow velocity, a greater increase than any of the other devices evaluated. In addition, the study found active or passive dorsiflexion of the ankles to increase peak venous velocity by over 200%. These findings highlight the VenaFlow® device's ability to decrease venous stasis in the lower extremity in the postoperative nonambulating hip fracture patient.

A previous hemodynamics study, comparing the effect of several pneumatic compression devices and active dorsoplantar flexion in patients who underwent total hip arthroplasty, showed all of the pneumatic compression devices augmented venous velocity and venous volume.³⁴ Moreover, pulsatile calf compression produced the greatest increase in peak venous velocity, whereas sequential compression of the calf and thigh showed the greatest increase in venous volume. The newer pulsatile devices such as the PlexiPulse foot-calf device and the Venaflow device appear to augment peak venous velocity significantly compared to the Jobst Athrombic Pump, Flowtron DVT, and SDC system.³⁴ On the basis of 2 in vivo flow studies, it appears that a calf compression device (with or without sequential foot compression) with an asymmetric multichamber system that applies at least 50 mm Hg of sequential external pressure at a frequency of at least once per minute with an inflation time of less than 1 second is the ideal device for prophylaxis against DVT in patients undergoing elective orthopedic surgery.^{34,80}

The choice of the most effective mechanical compression device becomes more clouded when issues of compliance, application, and patient comfort are addressed. Comerota et al studied external PCD application in patients in the intensive care unit and on the regular nursing floor.⁴⁶ The study results demonstrated a significant improvement in device application in the intensive care unit versus the nursing floor with a 78% application rate compared with a 48% rate, respectively. Despite these issues, our study found patient compliance and application using the VenaFlow® device to be consistent during our daily rounds with the patients.

The authors recognize limitations of this study in that we did not randomize patients into 2 chemical prophylaxis groups to compare their efficacy. We did not randomize for 2 reasons. First, many physicians were involved with this study and each had differing preferences regarding chemical prophylaxis. Second, many of our patients were treated preoperatively with chemical prophylaxis in varying doses that would make postoperative therapy decisions less feasible for randomization (eg, a patient with atrial fibrillation receiving preoperative coumadin is an excellent candidate for postoperative

coumadin therapy). Our patients were assigned to their postoperative regimen based on their treating physician's preference. Because randomization into various drug regimens did not take place, it is our opinion that the question of which medication is best cannot be answered with this study. If a randomized prospective trial were to be completed, it could help to answer the question of which drug is most effective when combined with mechanical compression for DVT prophylaxis. In addition to the aforementioned limitation, the authors recognize the decision not to include a control group was a limitation. Our belief was that a control group that did not receive pharmaceutical or mechanical prophylaxis would be an unethical and unsafe practice.

In conclusion, these findings demonstrate that combination prophylaxis for patients with hip fractures using VenaFlow® mechanical prophylaxis and some form of chemoprophylaxis, either aspirin or warfarin, is a safe and efficacious means of preventing DVT and PE in this patient population. By using this protocol we were able to attain one of the lowest rates of thromboembolic disease following hip fracture in the existing literature. We believe that the immediate postoperative use of mechanical prophylaxis is useful in "bridging the gap" where warfarin therapy has not reached therapeutic levels, because warfarin prophylaxis takes 3 to 5 days to achieve the appropriate INR. The authors advocate a primary prophylaxis of mechanical compression devices combined with chemoprophylaxis while the patient is in the hospital and a secondary chemoprophylaxis regimen of either aspirin or warfarin after discharge to reduce the risk of developing secondary DVT.

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