



## Is Venous Foot Pump Effective In Prevention of Thromboembolic Disease After Joint Arthroplasty: A Meta-Analysis

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### ARTICLE INFO

#### Article history:

Received 23 April 2012  
Accepted 1 August 2012

#### Keywords:

total hip arthroplasty  
total knee arthroplasty  
thromboembolism  
pulmonary emboli  
venous foot pump

### ABSTRACT

The goal of this meta-analysis was to evaluate the efficacy of venous foot pumps in prevention of venous thromboembolism following joint arthroplasty. Using different databases, we found 13 prospective clinical trials published meeting our inclusion criteria. In total, 1514 patients were included in the final analysis. Venous foot pump devices are effective in prevention of venous thromboembolic disease after total hip and knee arthroplasty compared to chemoprophylaxis. This was especially significant in prevention of major deep vein thrombosis and pulmonary emboli rate. The use of mechanical devices like venous calf or foot pump, either alone or in combination with less potent chemical prophylaxis, on the other hand can reduce the rate of venous thromboembolism and complications of potent chemoprophylaxis like wound hematoma.

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The rate of deep vein thrombosis after major orthopaedic surgery is estimated to be around 40%–60% [1]. Fatal pulmonary embolism, though rare, occurs in 0%–0.4% of patients after total joint arthroplasty [2,3]. Because of the real, though rare, possibility of fatal embolism a form of thromboprophylaxis is recommended following total joint arthroplasty [1,4–6]. Despite extensive research, the best strategy in general, and the exact modality in particular, to prevent venous thromboembolic disease following joint arthroplasty is not known [4,5,7,8].

There are two main categories of prophylaxis, chemical and mechanical. The mechanical devices are used to decrease the venous stasis and increase the blood flow in the lower extremities. The physiologic venous foot pump was described in 1983 [9]. The deep plantar veins have an intramuscular course which will create a pumping mechanism with weight bearing. The venous foot pump devices are designed to activate this system without weight bearing in the postoperative period. The chemoprophylaxis consists of drugs that target platelet function and/or the coagulation cascade.

It is believed that all patients undergoing joint arthroplasty should be treated with a form of venous thromboembolism prophylaxis [5]. The use of potent chemoprophylactic agents has been shown to result in increased postoperative surgical complications such as bleeding, hematoma formation, wound drainage, reoperation, and peripros-

thetic infection [4,5,8,10–12]. The use of mechanical devices like venous calf or foot pump, either alone or in combination with less potent chemical prophylaxis, like aspirin, low dose warfarin or low dose subcutaneous heparin on the other hand can reduce the rate of these complications. However, some believe that mechanical prophylaxis may not be as effective as chemical prophylaxis in prevention of thromboembolic disease. In addition, it is not known if all mechanical devices behave in the same fashion and if, for example, there is a difference between calf and foot pumps. The goal of this meta-analysis was to evaluate the efficacy of venous foot pumps in prevention of venous thromboembolism following joint arthroplasty.

### Methods and Materials

We carried out a literature search using Pubmed, Cochrane, EMBASE and CINAHL databases to identify all articles published between January 1966 and February 2011. No restrictions were placed on the origin or language of the publications. Reports relating to both primary and revision arthroplasties and bilateral cases were included, and the results were analyzed separately if the sample size was large enough. Key words used were venous foot pump, total hip arthroplasty/replacement, total knee arthroplasty/replacement, deep vein thrombosis, thromboembolic disease and pulmonary emboli. We performed a literature search for each author of the studies and bibliographies of all the retrieved articles were also searched for reports that evaluated outcome following venous foot pump use in total joint replacement. Studies that combined the outcome of venous foot pump devices with the outcome of sequential calf compression

The Conflict of Interest statement associated with this article can be found at <http://dx.doi.org/10.1016/j.arth.2012.08.003>.

We did not receive any outside funding in support of this study.

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**Table 1**  
The Studies Used in Meta-Analysis.

Authors	Number of Cases	Number of Controls	Venous Foot Pump Device	Chemoprophylaxis	Diagnostic Test for Thrombosis	Detsky Score
<i>Total Hip arthroplasty</i>						
Santori et al.	67	65	A-V system	Heparin	Venography-Doppler	14
Pitto et al.	100	100	A-V system	Lovenox	Doppler	18
Fordyce et al.	39	40	A-V system	Heparin	Venography	12
Warwick et al.	147	143	A-V system	Lovenox	Doppler	19
Stannard et al.	25	25	A-V system	Heaprin-ASA	Venography-Doppler	12
Pietsch et al.	50	50	A-V system	Lovenox	Doppler	14
<i>Total Knee arthroplasty</i>						
Hass et al.	36	36	Kendall	ASA	Venography	11
Tamir et al.	24	24	Walkcare	Lovenox	Venography	10
Windisch et al.	40	40	A-V system	Lovenox	Doppler	13
Blanchard et al.	63	67	AVIS system	Lovenox	Venography-Doppler	16
Warwick et al.	117	112	A-V system	Lovenox	Venography	19
Westrich et al.	41	39	Plexipulse	ASA	Venography	11
Norgren et al.	21	19	Actone	Lovenox	Venography	15

device together or studies on any hip or knee surgery for trauma were excluded. We then reviewed all articles identified in this manner to determine if they met strict eligibility criteria, as determined by the investigators, for inclusion in the meta-analysis (described below).

Outcome data required for inclusion were the incidence of deep vein thrombosis and pulmonary emboli after surgery. The quality of the selected studies was independently assessed with use of a quality-assessment tool derived from the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group [13]. This assessment was made by 2 of the authors who were blinded to the source institution, journal, and the authors for each included publication. We used the quality measure scale published by Detsky et al. [14] for thorough assessment of the studies. This scale consists of 5 categories and has been shown to have high interobserver reliability. Each study will get between 0 and 21 points based on the quality. The Detsky score for papers used in this meta-analysis is presented in the Table 1. We also used the PRISMA guidelines [15]. It is an evidence-based minimum set of items needed for high quality reporting of systematic reviews and meta-analyses. The PRISMA Statement consists of a 27-item checklist categorized under 7 main categories and a four-phase flow diagram. It is an update and expansion of the QUOROM Statement. The assessors reviewed the instructions on both Oxman and Guyatt and PRISMA Statement. Any discrepancy was discussed with senior authors and resolved by consensus.

For all continuous outcomes, means and standard deviations were extracted for analysis. If means and confidence intervals were reported instead, standard deviations were calculated from these values.

There were 2 specific questions: 1. Does the use of venous foot pump devices reduce the risk of deep vein thrombosis in total hip and knee replacement compared to potent chemoprophylactic agents? 2. Does the use of venous foot pump devices reduce the rate of pulmonary emboli following total hip and knee replacement compared to potent chemoprophylactic medications?

#### Data Analysis

As the studies related to different populations in different countries, limited data on comparability of surgical technique, different venous foot pump devices and use of different chemoprophylactic medications; a random effects model was used for statistical analysis of the data. All statistical analysis was performed using the Comprehensive Meta-analysis software package (Biostat Inc., Englewood, New Jersey). We used relative risk to express the effectiveness of venous foot pump devices in preventing deep venous thrombosis and pulmonary emboli. The results of our analyses were expressed as Forrest plots, which showed weighted, mean reduction or increase in

the relative risks of thromboembolic events postoperatively with 95% confidence intervals for each study, and a cumulative weighted mean effect for all the studies in the analyses.

#### Results

We found 42 papers published on the venous foot pump devices. Twenty-six out of 42 papers were published in the total hip and knee arthroplasty field and 13 of them were prospective clinical trials meeting our inclusion criteria. Due to small size of the bilateral arthroplasty cases, we only included unilateral hip and knee arthroplasties in the final analysis. In all of these studies, all patients underwent one of the two diagnostic tests for DVT (ultrasonography or venography). If patients had symptoms of pulmonary emboli, they underwent one of the 2 diagnostic tests for pulmonary emboli (CT angiography versus nuclear scan). In total, 1514 patients were included in the final analysis. The papers and their results are shown in Tables 1 and 2 [16–28].

#### The Outcome or Treatment

##### Total Hip Arthroplasty (Table 2, Figs. 1 and 2)

The total rate of deep vein thrombosis, major thrombotic event and pulmonary emboli was reported to be higher in patients treated with venous foot pump in 1 out of 6 studies (Warwick-1998 [19]). In

**Table 2**

The Clinical Results of Comparison of Venous Foot Pump and Chemoprophylaxis in Studies in Meta-Analysis.

Authors	Total DVT Rate		Major DVT Rate		PE Rate	
	Case	Control	Case	Control	Case	Control
<i>Total Hip arthroplasty</i>						
Santori et al.	13.4%	35.4%	4.5%	24.6%	0%	1.5%
Pitto et al.	3%	6%	0%	2%	0%	0%
Fordyce et al.	10.3%	40%	5.1%	20%	0%	0%
Warwick et al.	18%	13%	13%	9%	0.7%	0%
Stannard et al.	0%	25%	0%	25%	0%	4%
Pietsch et al.	0%	8%	0%	6%	0%	2%
<i>Total Knee arthroplasty</i>						
Hass et al.	22%	47%	6%	31%	0%	0%
Tamir et al.	0%	0%	0%	0%	0%	0%
Windisch et al.	0%	0%	0%	0%	0%	0%
Blanchard et al.	53%	23.9%	6.3%	3%	0%	0%
Warwick et al.	48.7%	42.9%	13.7%	14.3%	1.7%	0%
Westrich et al.	26.9%	66.7%	0%	12.9%	<sup>a</sup>	<sup>a</sup>
Norgren et al.	19%	0%	0%	0%	4.8%	0%

<sup>a</sup> Not mentioned.

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