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· 临床研究 ·

# 间歇性充气加压治疗在预防静脉血栓形成效果的 Meta 分析

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## 摘要

**目的:** 评价间歇性充气加压 (IPC) 治疗在预防静脉血栓形成的效果。

**方法:** 检索中外文数据库所有关于 IPC 治疗来预防静脉血栓形成的随机对照试验 (RCT)。按照纳入、排除标准纳入文献, 并采用 RevMan 5.2 软件 Meta 分析。

**结果:** 最终纳入 63 个 RCT, 共 15 444 例患者。Meta 分析结果显示, 与无干预组比较, IPC 治疗组深静脉血栓 (DVT) 的发生率 ( $OR=0.34$ ,  $95\% CI=0.26\sim0.45$ ,  $P<0.00001$ ) 和肺栓塞 (PE) 的发生率 ( $OR=0.45$ ,  $95\% CI=0.31\sim0.65$ ,  $P<0.0001$ ) 明显减少; 与压力循环袜 (TEDS) 治疗组比较, IPC 组 DVT 的发生率 ( $OR=0.55$ ,  $95\% CI=0.35\sim0.88$ ,  $P=0.00001$ ) 明显减少; 与抗凝药物治疗组比较, IPC 组在预防 DVT 方面无优势 ( $OR=1.05$ ,  $95\% CI=0.69\sim1.59$ ,  $P=0.82$ ), 但出血风险 ( $OR=0.31$ ,  $95\% CI=0.19\sim0.50$ ,  $P<0.00001$ ) 明显降低。

**结论:** 在预防住院患者静脉血栓方面, IPC 治疗具有明显的疗效, 且无抗凝药物治疗所带来的出血风险。

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## 关键词

静脉血栓形成 / 预防和控制; 间歇性充气加压治疗; Meta 分析  
中图分类号: R654.3

## Efficacy of intermittent pneumatic compression therapy in venous thrombosis prevention: a Meta-analysis

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## ABSTRACT

**Objective:** To evaluate the efficacy of intermittent pneumatic compression (IPC) therapy in thromboprophylaxis.

**Methods:** The randomized controlled trials (RCTs) concerning IPC therapy for thromboprophylaxis were searched from several national and international databases. Meta-analysis was performed by using RevMan 5.2 software after a literature screen for inclusion and exclusion criteria.

**Results:** Sixty-three RCTs were finally selected, with a total of 15 444 patients. Results of Meta-analysis showed that in IPC treatment group, the incidence of deep venous thrombosis (DVT) and pulmonary embolism (PE) were significantly decreased compared with non-intervention group ( $OR=0.34$ ,  $95\% CI=0.26\sim0.45$ ,  $P<0.00001$ ;

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OR=0.45, 95% CI=0.31–0.65,  $P<0.0001$ ); the incidence of DVT was significantly decreased compared with group of treatment with thigh-length thromboembolic deterrent stockings (TEDS) (OR=0.55, 95% CI=0.35–0.88,  $P=0.00001$ ). Compared with the group treated with anticoagulant therapy, IPC treatment had no superiority in thromboprophylaxis (OR=1.05, 95% CI=0.69–1.59,  $P=0.82$ ), but the risk of bleeding was significantly reduced (OR=0.31, 95% CI=0.19–0.50,  $P<0.00001$ ).

**Conclusion:** IPC therapy has demonstrable efficacy in prevention of venous thrombosis in hospitalized patients and does not have the risk of bleeding caused by anticoagulant drugs.

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**KEYWORDS** Venous Thrombosis/prevention & control; Intermittent Pneumatic Compression; Meta-Analysis

**CLC number:** R654.3

静脉血栓主要包括深静脉血栓形成 (DVT) 和肺动脉栓塞 (PE), 是世界性的医学难题。住院患者有很高的静脉血栓形成风险, 根据美国胸内医师学会的统计, 住院患者的 10%~20% 有发生静脉血栓的可能<sup>[1-2]</sup>。尸检数据显示死亡的住院患者中超过 10% 是由静脉血栓引起的<sup>[3-5]</sup>。

有效的预防措施能减少一半住院患者静脉血栓的发生<sup>[6-7]</sup>。虽然很多预防措施能减少静脉血栓的发生率, 但是, 有效的预防措施对外科患者的效果大于内科患者的效果。1966—2000 年, 通过尸检发现外科患者发生致命性肺栓塞的数量减少 71%, 而内科患者仅仅减少 18%<sup>[8-9]</sup>。研究显示有效的预防措施是减少静脉血栓发生率与病死率的主要方法。虽然教育和电子警报系统能提高有效的预防血栓措施的应用, 但是最新研究发现, 很多高危的住院患者仍未能及时接受适合的治疗方案。由于由抗凝药物引发出血是死亡的先兆, 医生意识到因抗凝药引起的出血比静脉血栓的形成更为严重, 从而导致了早期预防措施实施的下降<sup>[10-14]</sup>。

间歇性充气加压 (intermittent pneumatic compression, IPC) 很长时间以来用于深静脉血栓的预防, 尤其以重症患者及长期卧床者。根据美国胸内医师学会最新循证医学关于静脉血栓和抗凝治疗指南中, IPC 和压力循环袜 (TEDS) 被建议为对有出血风险病人最好的预防方法<sup>[15]</sup>。而 IPC 在预防深静脉血栓和肺栓塞方面是否优于无干预组、TEDS、抗凝治疗或 IPC 和抗凝治疗的联合应用是尚未清楚的<sup>[16]</sup>。本文的目的在于进一步评价下肢 IPC 治疗在预防静脉血栓形成的效果, 对目前的随机对照试验 (RCT) 进行 Meta 分析。

## 1 资料与方法

### 1.1 纳入标准

(1) 研究类型: IPC 与无干预组、TEDS、抗凝治疗、IPC 和抗凝治疗的联合应用进行比较的 RCT, 无论是否有分配隐藏和盲法, 无语言限制; (2) 研究对象: 有静脉血栓形成风险的住院患者; (3) 干预措施: 治疗组采取 IPC, 对照组采用无干预、TEDS、抗凝治疗、IPC 和抗凝治疗的联合应用等任何措施之一; (4) 观察指标: 深静脉血栓形成、肺栓塞、出血。

### 1.2 排除标准

(1) 试验设计明显缺乏对照的文献; (2) 随访不全面, 失访人数过多; (3) 相关文献中必需的基本数据缺乏或不全、数据描述不详等; (4) 非 RCT; (5) 应用 IPC 的时间 <1 d 或具体应用时间不清楚; (6) 对不同的 IPC 设备进行比较; (7) 对不同时间段进行比较; (8) 两种抗凝药与 IPC 进行比较; (9) 应用 IPC 与没有应用 IPC 的下肢进行比较。

### 1.3 检索策略

英文检索以 “pneumatic compression”、“sequential compression”、“external compression”、“intermittent compression”、“pumps” with “venous thromboembolism”、“deep vein thrombosis”、“pulmonary embolism” 为检索词, 检索 PubMed、EMBASE、Cochrane Library、Web of Science 等外文数据库。

中文检索以 “充气加压治疗” 或 “下肢加压治疗” 或 “加压泵” 并 “静脉血栓” 或 “深静脉血栓” 或 “下肢深静脉血栓” 或 “肺栓塞” 为检索词, 检索 CNKI、万方、超星等中文数据库 (图 1)。

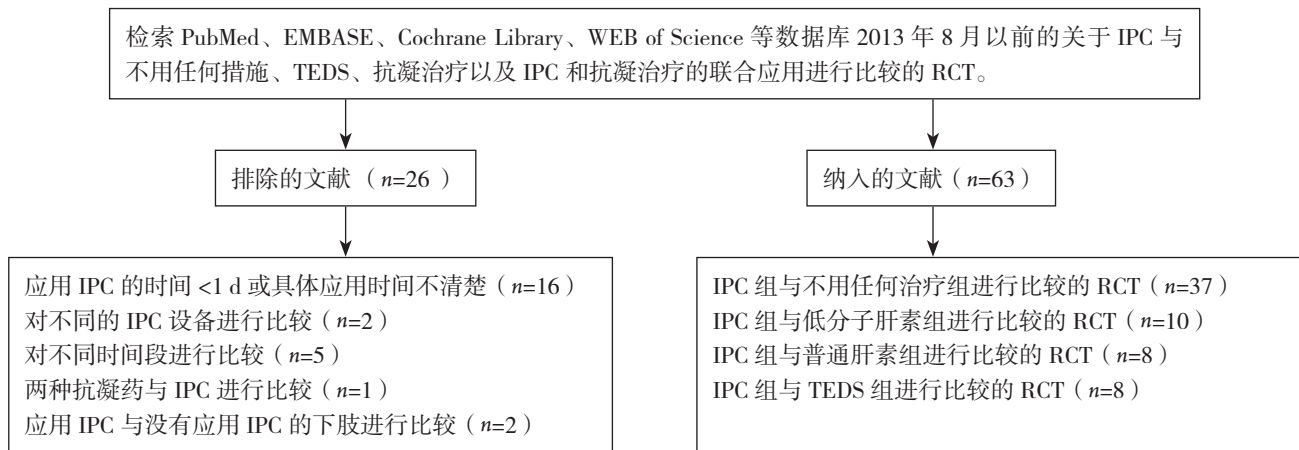


图 1 文献筛选流程图

Figure 1 Literature screening process

### 1.4 文献筛选

按照纳入与排除标准由两位学者独立阅读文题和摘要, 如为 RCT 则阅读全文进行文献筛选, 并根据纳入及排除标准进行筛选, 遇不同意见讨论解决或咨询第 3 位评价者。

### 1.5 质量评价

依据 Jadad 量表对纳入文献质量进行评价, 把评分为 1~3 分评为低质量文献, 4~7 分评为高质量文献 (表 1)。

表 1 Jadad 量表  
Table 1 Jadad scale

评价项目	分值及内容
随机序列产生	
恰当	2分: 计算机产生的随机数字或类似方法
不清楚	1分: 随机试验但未陈述随机分配方法
不恰当	0分: 如采用交替分配的方法, 如单双号
随机化隐藏	
恰当	2分: 中心或药房控制分配方案, 或用序列编号一致的容器、现场计算机控制、密不透光的信封或其他使临床医生和受试者无法预知分配序的方法
不清楚	1分: 只表明使用随机数字表或其他随机分配方案
不恰当	0分: 交替分配、病例号、星期日数、开放式随机号码表、系统编码信封以及任何不能防止分组的可预测性的措施
盲法	
恰当	2分: 采用完全一致的安慰剂片或类似方法
不清楚	1分: 试验陈述为盲法, 但未说明方法
不恰当	0分: 未采用双盲或盲的方法不恰当, 如片剂和注射剂比较
退出与失访	
有	1分: 陈述了退出与失访的数目和理由
无	0分: 未陈述退出与失访的数目或理由

### 1.6 统计学处理

首先采用  $\chi^2$  检验分析纳入研究间的异质性, 检验水准为  $\alpha = 0.05$ ; 同时采用  $I^2$  对异质性进行定量分析, 其检验水平设定为 50%, 即  $I^2 > 50\%$  时, 研究结果间的统计异质性较大。无统计学异质性研究结果的合并分析选择固定效应模型。反之, 可认为多个研究有异质性, 此时使用亚组分析方法使之达到同质后, 再使用固定效应模型。若经异质性分析和处理后, 多个独立研究的结果仍然不具有同质性时, 可选择随机效应模型计算其合并效应量。必要时采用 Meta 回归及混合模型控制混杂因素, 减少异质性。若异质性过大无法合并则放弃 Meta 分析, 只做一般的统计描述。对度量衡单位相同的连续变量采用加权均数差值 (WMD), 对两分类变量采取比值比 (OR) 或相对危险度 (RR) 表示, 区间估计均采用 95% CI, 假设检验采用 U 检验, 用 Z 值或 P 值表示, 当  $P < 0.05$  时表示两组差异有统计学意义, 区间估计和假设检验结果均在森林图中列出。

## 2 结果

### 2.1 纳入研究的一般情况及质量评价

初检出 300 篇文献, 通过阅读文题和摘要, 复筛排除 237 篇不符合纳入标准的文献, 最终纳入 63 篇。均为 RCT, 代表性较好, 研究质量高, 在研究对象年龄、性别、体质量、身高等基线水平上具有相似性。但有 16 个研究未报道随机化方法, 7 个研究未具体报道盲法。其中 A (高质量) 级 44 篇、B 级 (低质量) 16 篇。

2.2 疗效评价

2.2.1 IPC 组与无干预组在预防 DVT 方面的比较

37 个研究<sup>[16-52]</sup>比较了 IPC 组与无干预组在预防 DVT 效果。研究间有异质性 ( $P < 0.0001$ ,

$I^2=58.0%$ )，故用随机效应模型。Meta 分析结果显示：IPC 明显减少 DVT 的发生 ( $OR=0.34$ ,  $95\% CI=0.26\sim 0.45$ ,  $P < 0.00001$ ) (图 2)。

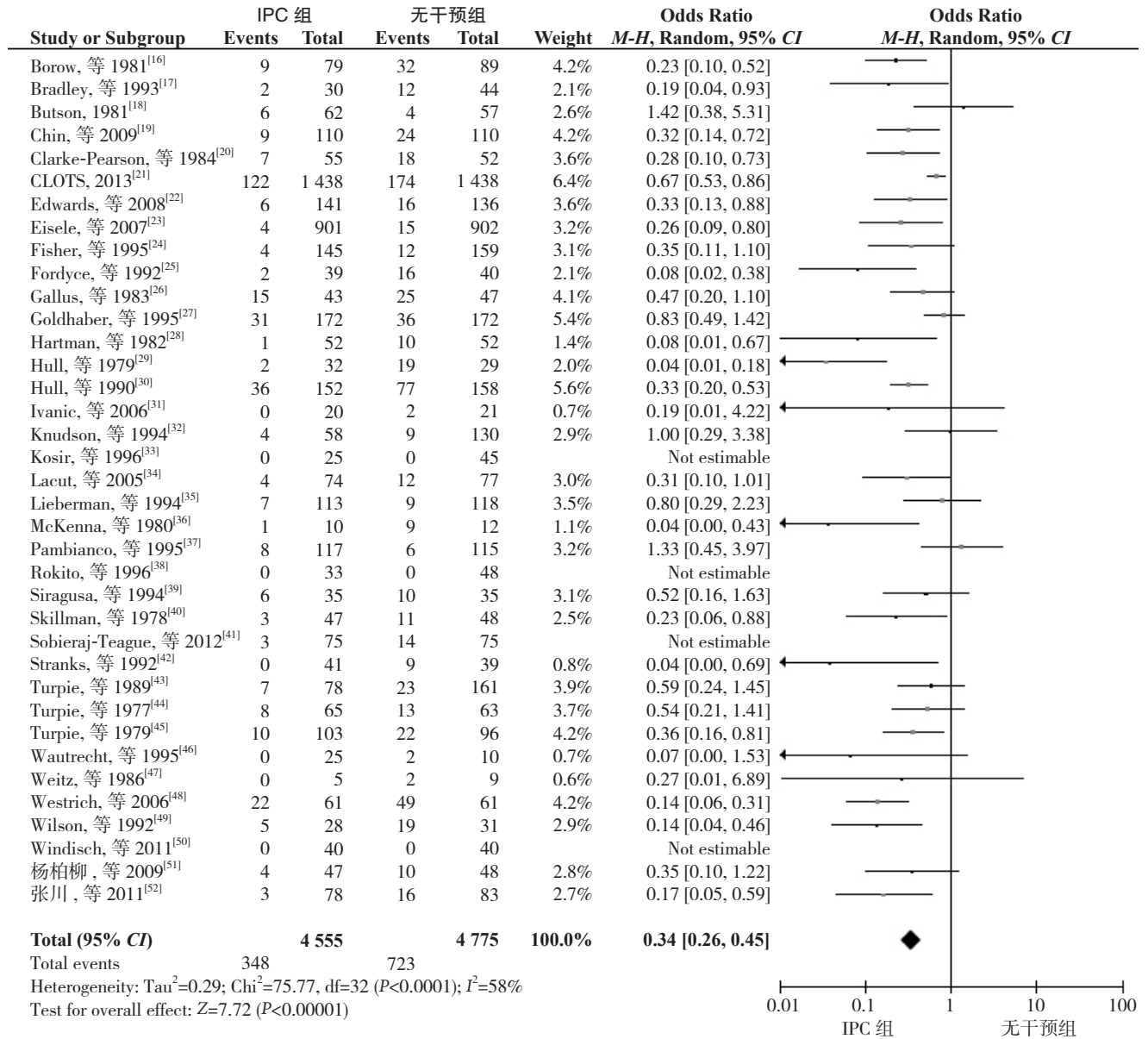


图 2 IPC 组与无干预组 DVT 发生率比较

Figure 2 Comparison of the incidence of DVT between IPC group and non-intervention group

2.2.2 IPC 组与无干预组在预防 PE 方面的比较

24 个研究<sup>[16, 18-20, 22, 24, 27-32, 35-36, 38, 40-43, 46, 49-50, 52-53]</sup>比较了 IPC 组与无干预组在预防 PE 效果。研究间无异质性 ( $P=0.91$ ,  $I^2=0%$ )，故用固定效应模型。

Meta 分析结果显示：IPC 组明显减少 PE 的发生 ( $OR=0.45$ ,  $95\% CI=0.31\sim 0.65$ ,  $P < 0.0001$ ) (图 3)。

2.2.3 IPC 组与 TEDS 组在预防 DVT 方面的效果

8 个研究<sup>[16, 19, 54-59]</sup>比较了 IPC 与 TEDS 在预

防 DVT 的效果。研究间无异质性 ( $P=0.53$ ,  $I^2=0%$ )，故用固定效应模型。Meta 分析结果显示：在预防 DVT 发生方面，IPC 组优于 TEDS 组 ( $OR=0.55$ ,  $95\% CI=0.35\sim 0.88$ ,  $P=0.01$ ) (图 4)。

2.2.4 IPC 组与抗凝药物治疗组在预防 DVT 方面的效果

27 个研究<sup>[16, 19, 33, 37-38, 51, 56, 58, 60-78]</sup>比较了 IPC 与抗凝药物治疗组在预防深静脉血栓形成的效果。研究间有异质性 ( $P=0.0003$ ,  $I^2=57%$ )，



故用随机效应模型。Meta 分析结果显示: 在预防 DVT 发生方面, IPC 组比抗凝药物治疗组没有明显优越性, 两组之间无明显统计学差异 ( $OR=1.05$ ,  $95\% CI=0.69\sim 1.59$ ,  $P=0.82$ ) (图 5)。19 个研究<sup>[19, 36, 38, 51, 56, 60-63, 65-66, 68-69, 71-73, 75-76, 78]</sup>比较了

IPC 组与抗凝药物治疗组出血风险。研究间无异质性 ( $P=0.80$ ,  $I^2=0\%$ ), 故用固定效应模型。Meta 分析结果显示: IPC 引起出血的风险明显低于抗凝药物治疗 ( $OR=0.31$ ,  $95\% CI=0.19\sim 0.50$ ,  $P<0.00001$ ) (图 6)。

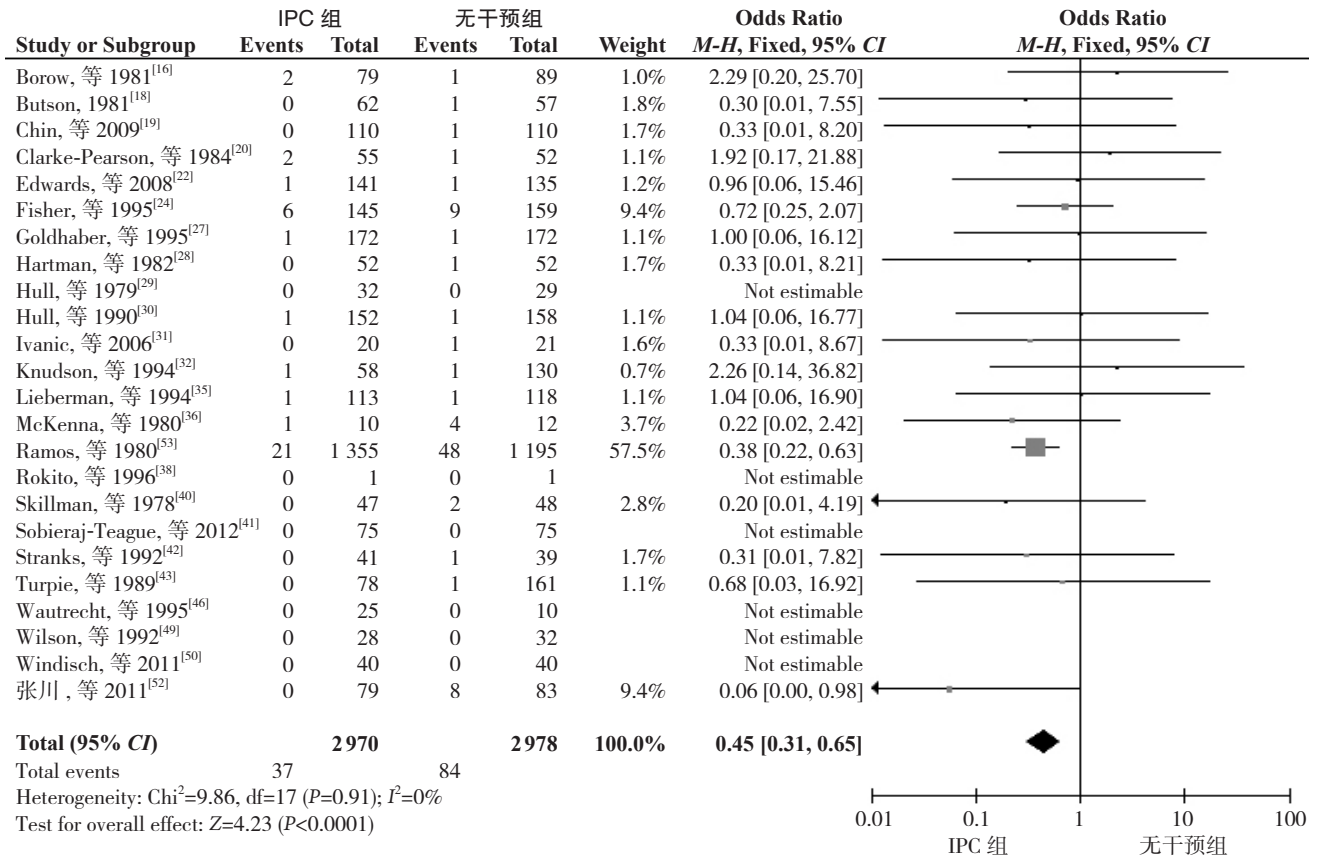


图 3 IPC 组与无干预组 PE 发生率比较

Figure 3 Comparison of the incidence of PE between IPC group and non-intervention group

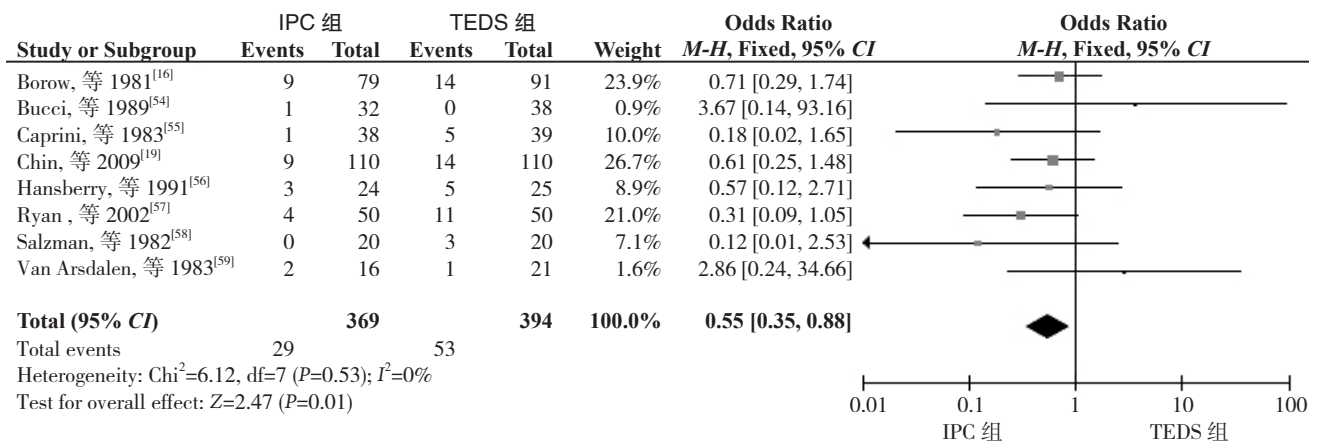


图 4 IPC 组与 TEDS 组 DVT 发生率比较

Figure 4 Comparison of the incidence of DVT between IPC group and TEDS group

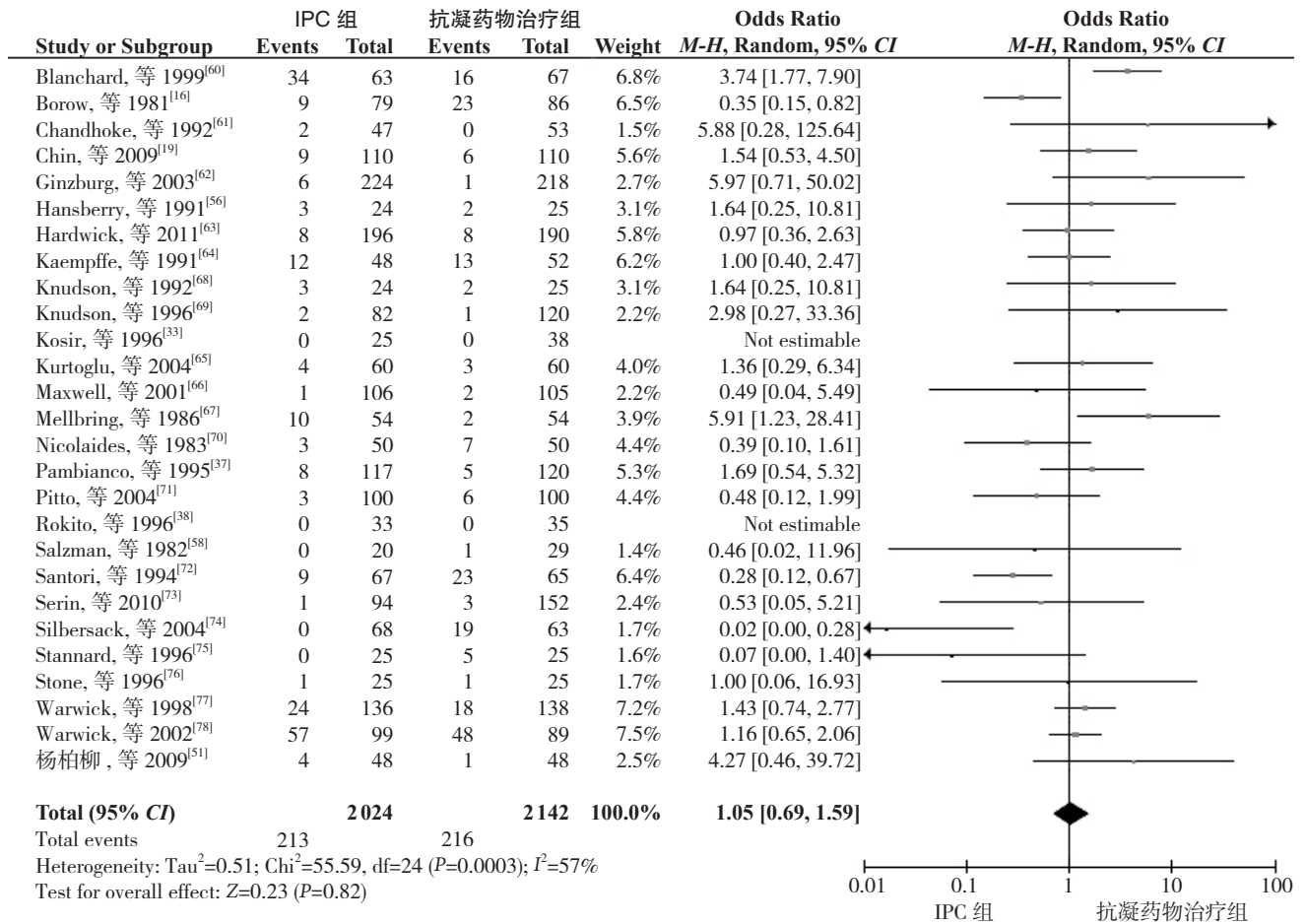


图 5 IPC 组与与抗凝药物组 DVT 发生率比较

Figure 5 Comparison of the incidence of DVT between IPC group and anticoagulation group

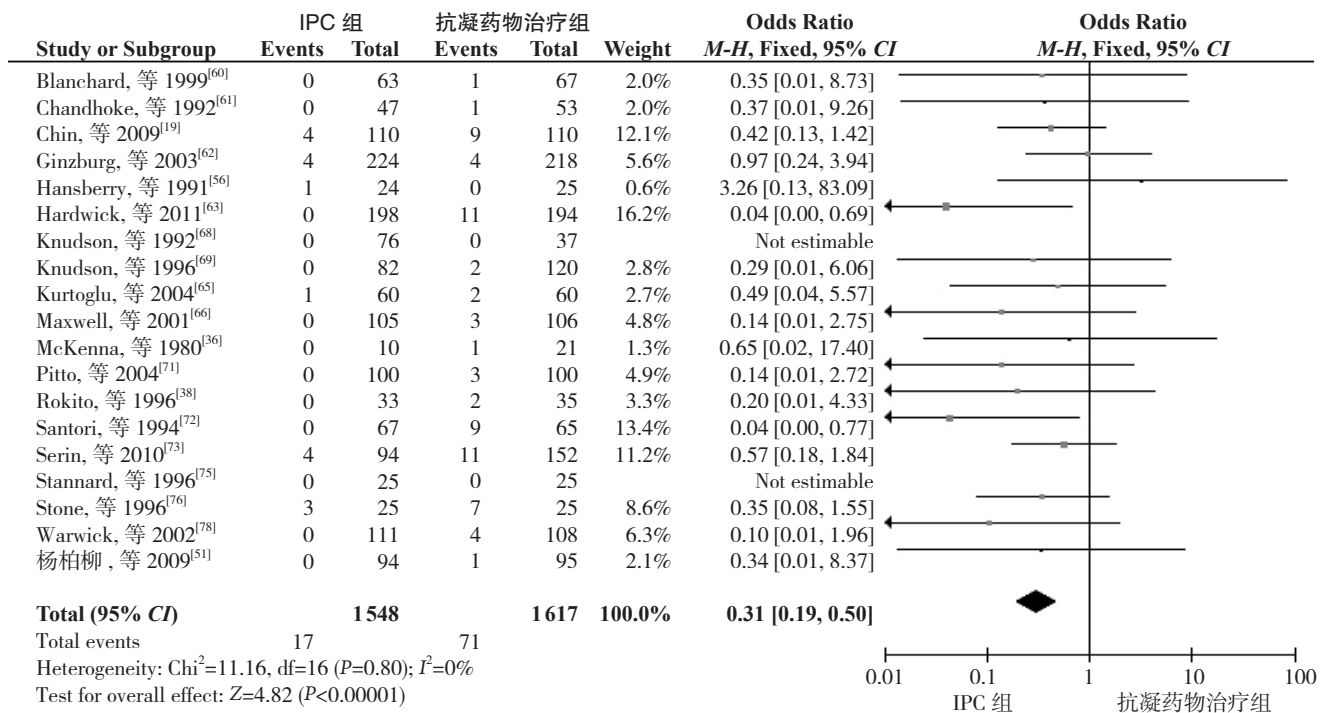


图 6 IPC 组与抗凝药物组在出血风险比较

Figure 6 Comparison of the risk of bleeding between IPC group and anticoagulation group

### 3 讨论

#### 3.1 研究质量

有些研究所给的数据不全。因此,纳入研究存在选择性、实施性及测量性偏倚的中度可能。

#### 3.2 预防效果

本研究主要针对于住院患者的深静脉血栓形成的防治,研究结果表明,在预防住院患者静脉血栓方面,IPC效果显著于无干预组及TEDS组,IPC与抗凝药比较没有明显差别,但IPC的出血风险明显低于抗凝药物治疗。因此,有出血风险的患者、有抗凝药物禁忌症的患者,IPC可以考虑是首要的预防血栓形成的方法。

#### 3.3 本研究的局限性

以前的研究报道,在预防静脉血栓形成来说,TEDS的优越性较大<sup>[80]</sup>,但本研究结果表明,在预防DVT方面IPC更有效,而对于预防PE方面缺乏统计数据。故此方面还需要进一步研究。IPC与无干预比较、IPC与抗凝药物治疗的比较时,研究间有异质性,虽然采用随机效应模型,但结果的说服力较低。IPC与抗凝药物治疗联合应用和单独用IPC效果的方面研究数量较少,故无法进行Meta分析。

总而言之,在预防住院患者静脉血栓方面,IPC效果显著于无干预与TEDS,IPC与抗凝药物在预防DVT方面没有明显差别,但IPC的出血风险明显低于抗凝药物治疗。目前很多高危的住院患者仍未能及时接受适合的治疗方案,主要是因为医生意识到因抗凝药引起的出血比静脉血栓的形成更为严重,而IPC是对有出血风险的住院患者来说较为安全的预防静脉血栓的方法,可广泛推广。

#### 参考文献

[1] Cohen AT, Tapson VF, Bergmann JF, et al. Venous thromboembolism risk and prophylaxis in the acute hospital care setting (ENDORSE study): a multinational cross-sectional study[J]. *Lancet*, 2008, 371(9610):387-394.

[2] Geerts WH, Bergqvist D, Pineo GF, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition)[J]. *Chest*, 2008, 133(6 Suppl):381S-453S.

[3] Lindblad B, Sternby NH, Bergqvist D. Incidence of venous thromboembolism verified by necropsy over 30 years[J]. *BMJ*, 1991, 302(6778):709-711.

[4] Kakkar N, Vasishta RK. Pulmonary embolism in medical patients: an autopsy-based study[J]. *Clin Appl Thromb Hemost*, 2008, 14(2):159-167.

[5] Heriot GS, Pitman AG, Gonzales M, et al. The four horsemen: clinicopathological correlation in 407 hospital autopsies[J]. *Intern Med J*, 2010, 40(9):626-632.

[6] Lloyd NS, Douketis JD, Moinuddin I, et al. Anticoagulant prophylaxis to prevent asymptomatic deep vein thrombosis in hospitalized medical patients: a systematic review and meta-analysis[J]. *J Thromb Haemost*, 2008, 6(3):405-414.

[7] Kahn SR, Lim W, Dunn AS, et al. Prevention of VTE in nonsurgical patients: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines[J]. *Chest*, 2012, 141(2 Suppl):e195S-226S.

[8] Cohen AT, Edmondson RA, Phillips MJ, et al. The changing pattern of venous thromboembolic disease[J]. *Haemostasis*, 1996, 26(2):65-71.

[9] Alikhan R, Peters F, Wilmott R, et al. Fatal pulmonary embolism in hospitalised patients: a necropsy review[J]. *J Clin Pathol*, 2004, 57(12):1254-1257.

[10] Faraj AA. Implementing National Institute of Clinical Excellence guidelines for venous thromboembolism prophylaxis[J]. *Am J Med Sci*, 2012, 343(3):131-135.

[11] Amin AN, Lin J, Yang G, et al. Are there any differences in the clinical and economic outcomes between US cancer patients receiving appropriate or inappropriate venous thromboembolism prophylaxis?[J]. *J Oncol Pract*, 2009, 5(4):159-164.

[12] Cohen AT, Alikhan R, Arcelus JJ, et al. Assessment of venous thromboembolism risk and the benefits of thromboprophylaxis in medical patients[J]. *Thromb Haemost*, 2005, 94(4):750-759.

[13] Spyropoulos AC, Anderson FA Jr, Fitzgerald G, et al. Predictive and associative models to identify hospitalized medical patients at risk for VTE[J]. *Chest*, 2011, 140(3):706-714.

[14] Alonso Ortiz del Rio C, Medrano Ortega F, Romero Alonso A, et al. Prevention of thromboembolic venous disease in medical patients (PRETEMED). 2003. <http://www.guidcentral.com/guidelines-1/prevention-of-thromboembolic-venous-disease-in-medical-patients-pretemed>. Accessed February 29, 2012.

[15] Guyatt GH, Akl EA, Crowther M, et al. Executive summary: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines[J]. *Chest*, 2012, 141(2 Suppl):7S-47S.

[16] Borow M, Goldson H. Postoperative venous thrombosis. Evaluation of five methods of treatment[J]. *Am J Surg*, 1981, 141(2):245-251.

[17] Bradley JG, Krugener GH, Jager HJ. The effectiveness of intermittent plantar venous compression in prevention of deep venous thrombosis

- after total hip arthroplasty[J]. *J Arthroplasty*, 1993, 8(1):57-61.
- [18] Butson AR. Intermittent pneumatic calf compression for prevention of deep venous thrombosis in general abdominal surgery[J]. *Am J Surg*, 1981, 142(4):525-527.
- [19] Chin PL, Amin MS, Yang KY, et al. Thromboembolic prophylaxis for total knee arthroplasty in Asian patients: a randomised controlled trial[J]. *J Orthop Surg (Hong Kong)*, 2009, 17(1):1-5.
- [20] Clarke-Pearson DL, Synan IS, Hinshaw WM, et al. Prevention of postoperative venous thromboembolism by external pneumatic calf compression in patients with gynecologic malignancy[J]. *Obstet Gynecol*, 1984, 63(1):92-98.
- [21] CLOTS (Clots in Legs Or sTockings after Stroke) Trials Collaboration, Dennis M, Sandercock P, et al. Effectiveness of intermittent pneumatic compression in reduction of risk of deep vein thrombosis in patients who have had a stroke (CLOTS 3): a multicentre randomised controlled trial[J]. *Lancet*, 2013, 382(9891):516-524.
- [22] Edwards JZ, Pulido PA, Ezzet KA, et al. Portable compression device and low-molecular-weight heparin compared with low-molecular-weight heparin for thromboprophylaxis after total joint arthroplasty[J]. *J Arthroplasty*, 2008, 23(8):1122-1127.
- [23] Eisele R, Kinzl L, Koelsch T. Rapid-inflation intermittent pneumatic compression for prevention of deep venous thrombosis[J]. *J Bone Joint Surg Am*, 2007, 89(5):1050-1056.
- [24] Fisher CG, Blachut PA, Salvian AJ, et al. Effectiveness of pneumatic leg compression devices for the prevention of thromboembolic disease in orthopaedic trauma patients: a prospective, randomized study of compression alone versus no prophylaxis[J]. *J Orthop Trauma*, 1995, 9(1):1-7.
- [25] Fordyce MJ, Ling RS. A venous foot pump reduces thrombosis after total hip replacement[J]. *J Bone Joint Surg Br*, 1992, 74(1):45-49.
- [26] Gallus A, Raman K, Darby T. Venous thrombosis after elective hip replacement--the influence of preventive intermittent calf compression and of surgical technique[J]. *Br J Surg*, 1983, 70(1):17-19.
- [27] Goldhaber SZ, Hirsch DR, MacDougall RC, et al. Prevention of venous thrombosis after coronary artery bypass surgery (a randomized trial comparing two mechanical prophylaxis strategies) [J]. *Am J Cardiol*, 1995, 76(14):993-996.
- [28] Hartman JT, Pugh JL, Smith RD, et al. Cyclic sequential compression of the lower limb in prevention of deep venous thrombosis[J]. *J Bone Joint Surg Am*, 1982, 64(7):1059-1062.
- [29] Hull R, Delmore TJ, Hirsh J, et al. Effectiveness of intermittent pulsatile elastic stockings for the prevention of calf and thigh vein thrombosis in patients undergoing elective knee surgery[J]. *Thromb Res*, 1979, 16(1/2):37-45.
- [30] Hull RD, Raskob GE, Gent M, et al. Effectiveness of intermittent pneumatic leg compression for preventing deep vein thrombosis after total hip replacement[J]. *JAMA*, 1990, 263(17):2313-2317.
- [31] Ivancic GM, Moser I, Homann NC, et al. Intermittent compression devices for swelling reduction and thrombosis prophylaxis--a pilot study after total hip replacement. Is the 2 hour daily minimum application sufficient?[J]. *Unfallchirurg*, 2006, 109(9):786-792.
- [32] Knudson MM, Lewis FR, Clinton A, et al. Prevention of venous thromboembolism in trauma patients[J]. *J Trauma*, 1994, 37(3):480-487.
- [33] Kosir MA, Kozol RA, Perales A, et al. Is DVT prophylaxis overemphasized? A randomized prospective study[J]. *J Surg Res*, 1996, 60(2):289-292.
- [34] Lacut K, Bressollette L, Le Gal G, et al. Prevention of venous thrombosis in patients with acute intracerebral hemorrhage[J]. *Neurology*, 2005, 65(6):865-869.
- [35] Lieberman JR, Huo MM, Hanway J, et al. The prevalence of deep venous thrombosis after total hip arthroplasty with hypotensive epidural anesthesia[J]. *J Bone Joint Surg Am*, 1994, 76(3):341-348.
- [36] McKenna R, Galante J, Bachmann F, et al. Prevention of venous thromboembolism after total knee replacement by high-dose aspirin or intermittent calf and thigh compression[J]. *Br Med J*, 1980, 280(6213):514-517.
- [37] Pambianco G, Orchard T, Landau P. Deep vein thrombosis: prevention in stroke patients during rehabilitation[J]. *Arch Phys Med Rehabil*, 1995, 76(4):324-330.
- [38] Rokito SE, Schwartz MC, Neuwirth MG. Deep vein thrombosis after major reconstructive spinal surgery[J]. *Spine (Phila Pa 1976)*, 1996, 21(7):853-858.
- [39] Siragusa S, Vicentini L, Carbone S, et al. Intermittent pneumatic leg compression (IPLC) and unfractionated heparin (UFH) in the prevention of postoperative deep vein thrombosis in hip surgery: a randomized clinical trial[J]. *Br J Haematol*, 1994, 87(Suppl 1):186.
- [40] Skillman JJ, Collins RE, Coe NP, et al. Prevention of deep vein thrombosis in neurosurgical patients: a controlled, randomized trial of external pneumatic compression boots[J]. *Surgery*, 1978, 83(3):354-358.
- [41] Sobieraj-Teague M, Hirsh J, Yip G, et al. Randomized controlled trial of a new portable calf compression device (Venowave) for prevention of venous thrombosis in high-risk neurosurgical patients[J]. *J Thromb Haemost*, 2012, 10(2):229-235.
- [42] Stranks GJ, MacKenzie NA, Grover ML, et al. The A-V Impulse System reduces deep-vein thrombosis and swelling after hemiarthroplasty for hip fracture[J]. *J Bone Joint Surg Br*, 1992, 74(5):775-778.
- [43] Turpie AG, Hirsh J, Gent M, et al. Prevention of deep vein thrombosis in potential neurosurgical patients. A randomized trial comparing graduated compression stockings alone or graduated compression stockings plus intermittent pneumatic compression with control[J]. *Arch Intern Med*, 1989, 149(3):679-681.
- [44] Turpie AG, Gallus A, Beattie WS, et al. Prevention of venous thrombosis in patients with intracranial disease by intermittent



- pneumatic compression of the calf[J]. *Neurology*, 1977, 27(5):435-438.
- [45] Turpie AG, Delmore T, Hirsh J, et al. Prevention of venous thrombosis by intermittent sequential calf compression in patients with intracranial disease[J]. *Thromb Res*, 1979, 15(5/6):611-616.
- [46] Wautrecht JC, Macquaire V, Vandesteene A, et al. Prevention of deep vein thrombosis in neurosurgical patients with brain tumors: a controlled, randomized study comparing graded compression stockings alone and intermittent sequential compression. Correlation with Preoperative and postoperative fibrinolysis: preliminary results[C]//17th World Congress of the International Union of Angiology, London, England: International Angiology, 1995: 5-10.
- [47] Weitz J, Michelsen J, Gold K, et al. Effects of intermittent pneumatic calf compression on postoperative thrombin and plasmin activity[J]. *Thromb Haemost*, 1986, 56(2):198-201.
- [48] Westrich GH, Bottner F, Windsor RE, et al. VenaFlow plus Lovenox vs VenaFlow plus aspirin for thromboembolic disease prophylaxis in total knee arthroplasty[J]. *J Arthroplasty*, 2006, 21(6 Suppl 2):139-143.
- [49] Wilson NV, Das SK, Kakkar VV, et al. Thrombo-embolic prophylaxis in total knee replacement. Evaluation of the A-V Impulse System[J]. *J Bone Joint Surg Br*, 1992, 74(1):50-52.
- [50] Windisch C, Kolb W, Kolb K, et al. Pneumatic compression with foot pumps facilitates early postoperative mobilisation in total knee arthroplasty[J]. *Int Orthop*, 2011, 35(7):995-1000.
- [51] 杨柏柳, 张震宇, 郭淑丽. 有高危因素的妇科手术患者预防性血栓治疗的临床意义 [J]. *中华妇产科杂志*, 2009, 44(8):570-573.
- [52] 张川, 曾薇, 周红, 等. 间歇充气加压治疗预防内科重症患者静脉血栓栓塞症 [J]. *中国危重病急救医学*, 2011, 23(9):563-565.
- [53] Ramos R, Salem BI, De Pawlikowski MP, et al. The efficacy of pneumatic compression stockings in the prevention of pulmonary embolism after cardiac surgery[J]. *Chest*, 1996, 109(1):82-85.
- [54] Bucci MN, Papadopoulos SM, Chen JC, et al. Mechanical prophylaxis of venous thrombosis in patients undergoing craniotomy: a randomized trial[J]. *Surg Neurol*, 1989, 32(4):285-288.
- [55] Caprini JA, Chucker JL, Zuckerman L, et al. Thrombosis prophylaxis using external compression[J]. *Surg Gynecol Obstet*, 1983, 156(5):599-604.
- [56] Hansberry KL, Thompson IM Jr, Bauman J, et al. A prospective comparison of thromboembolic stockings, external sequential pneumatic compression stockings and heparin sodium/dihydroergotamine mesylate for the prevention of thromboembolic complications in urological surgery[J]. *J Urol*, 1991, 145(6):1205-1208.
- [57] Ryan MG, Westrich GH, Potter HG, et al. Effect of mechanical compression on the prevalence of proximal deep venous thrombosis as assessed by magnetic resonance venography[J]. *J Bone Joint Surg Am*, 2002, 84-A(11):1998-2004.
- [58] Salzman EW, Sobel M, Lewis J, et al. Prevention of venous thromboembolism in unstable angina pectoris[J]. *N Engl J Med*, 1982, 306(16):991.
- [59] Van Arsdalen KN, Barnes RW, Clarke G, et al. Deep vein thrombosis and prostatectomy[J]. *Urology*, 1983, 21(5):461-463.
- [60] Blanchard J, Meuwly JY, Leyvraz PF, et al. Prevention of deep-vein thrombosis after total knee replacement. Randomised comparison between a low-molecular-weight heparin (nadroparin) and mechanical prophylaxis with a foot-pump system[J]. *J Bone Joint Surg Br*, 1999, 81(4):654-659.
- [61] Chandhoke PS, Gooding GA, Narayan P. Prospective randomized trial of warfarin and intermittent pneumatic leg compression as prophylaxis for postoperative deep venous thrombosis in major urological surgery[J]. *J Urol*, 1992, 147(4):1056-1059.
- [62] Ginzburg E, Cohn SM, Lopez J, et al. Randomized clinical trial of intermittent pneumatic compression and low molecular weight heparin in trauma[J]. *Br J Surg*, 2003, 90(11):1338-1344.
- [63] Hardwick ME, Pulido PA, Colwell CW Jr. A mobile compression device compared with low-molecular-weight heparin for prevention of venous thromboembolism in total hip arthroplasty[J]. *Orthop Nurs*, 2011, 30(5):312-316.
- [64] Kaempffe FA, Lifeso RM, Meinking C. Intermittent pneumatic compression versus coumadin. Prevention of deep vein thrombosis in lower-extremity total joint arthroplasty[J]. *Clin Orthop Relat Res*, 1991, 269:89-97.
- [65] Kurtoglu M, Yanar H, Bilsel Y, et al. Venous thromboembolism prophylaxis after head and spinal trauma: intermittent pneumatic compression devices versus low molecular weight heparin[J]. *World J Surg*, 2004, 28(8):807-811.
- [66] Maxwell GL, Synan I, Dodge R, et al. Pneumatic compression versus low molecular weight heparin in gynecologic oncology surgery: a randomized trial[J]. *Obstet Gynecol*, 2001, 98(6):989-995.
- [67] Mellbring G, Palm é r K. Prophylaxis of deep vein thrombosis after major abdominal surgery. Comparison between dihydroergotamine-heparin and intermittent pneumatic calf compression and evaluation of added graduated static compression[J]. *Acta Chir Scand*, 1986, 152:597-600.
- [68] Knudson MM, Collins JA, Goodman SB, et al. Thromboembolism following multiple trauma[J]. *J Trauma*, 1992, 32(1):2-11.
- [69] Knudson MM, Morabito D, Paiement GD, et al. Use of low molecular weight heparin in preventing thromboembolism in trauma patients[J]. *J Trauma*, 1996, 41(3):446-459.
- [70] Nicolaides AN, Miles C, Hoare M, et al. Intermittent sequential pneumatic compression of the legs and thromboembolism-deterrent stockings in the prevention of postoperative deep venous thrombosis[J]. *Surgery*, 1983, 94(1):21-25.
- [71] Pitto RP, Hamer H, Heiss-Dunlop W, et al. Mechanical prophylaxis of deep-vein thrombosis after total hip replacement a randomised

- clinical trial[J]. J Bone Joint Surg Br, 2004, 86(5):639-642.
- [72] Santori FS, Vitullo A, Stopponi M, et al. Prophylaxis against deep-vein thrombosis in total hip replacement. Comparison of heparin and foot impulse pump[J]. J Bone Joint Surg Br, 1994, 76(4):579-583.
- [73] Serin K, Yanar H, Ozdenkaya Y, et al. Venous thromboembolism prophylaxis methods in trauma and emergency surgery intensive care unit patients: low molecular weight heparin versus elastic stockings + intermittent pneumatic compression[J]. Ulus Travma Acil Cerrahi Derg, 2010, 16(2):130-134.
- [74] Silbersack Y, Taute BM, Hein W, et al. Prevention of deep-vein thrombosis after total hip and knee replacement. Low-molecular-weight heparin in combination with intermittent pneumatic compression[J]. J Bone Joint Surg Br, 2004, 86(6):809-812.
- [75] Stannard JP, Harris RM, Bucknell AL, et al. Prophylaxis of deep venous thrombosis after total hip arthroplasty by using intermittent compression of the plantar venous plexus[J]. Am J Orthop (Belle Mead NJ), 1996, 25(2):127-134.
- [76] Stone MH, Limb D, Campbell P, et al. A comparison of intermittent calf compression and enoxaparin for thromboprophylaxis in total hip replacement. A pilot study[J]. Int Orthop, 1996, 20(6):367-369.
- [77] Warwick D, Harrison J, Glew D, et al. Comparison of the use of a foot pump with the use of low-molecular-weight heparin for the prevention of deep-vein thrombosis after total hip replacement. A prospective, randomized trial[J]. J Bone Joint Surg Am, 1998, 80(8):1158-1166.
- [78] Warwick D, Harrison J, Whitehouse S, et al. A randomised comparison of a foot pump and low-molecular-weight heparin in the prevention of deep-vein thrombosis after total knee replacement[J]. J Bone Joint Surg Br, 2002, 84(3):344-350.
- [79] Urbankova J, Quiroz R, Kucher N, et al. Intermittent pneumatic compression and deep vein thrombosis prevention. A meta-analysis in postoperative patients[J]. Thromb Haemost, 2005, 94(6):1181-1185.
- [80] Sachdeva A, Dalton M, Amaragiri SV, et al. Elastic compression stockings for prevention of deep vein thrombosis[J]. Cochrane Database Syst Rev, 2010, 7:CD001484. doi: 10.1002/14651858.CD001484.

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