

Intermittent pneumatic compression in the prevention of venous thromboembolism in high-risk trauma and surgical ICU patients

Yüksek riskli travma ve cerrahi yoğun bakım hastalarında venöz tromboembolizmi önlemede pnömatik kompresyon uygulaması

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BACKGROUND

Our aim was to evaluate the efficacy and safety of intermittent pneumatic compression methods (IPC) in the prevention of deep venous thrombosis (DVT) and pulmonary embolism (PE) in high-risk patients followed in our intensive care unit (ICU) for whom anticoagulation is contraindicated due to high risk of bleeding.

MATERIALS AND METHODS

This prospective study was conducted between October 2001 and June 2002 at the Trauma and Surgical Emergency Service of Istanbul Medical Faculty. Thirty eight surgical ICU patients who used IPC devices for prophylaxis of venous thromboembolism were evaluated retrospectively..

RESULTS

There were 27 male (71%) and 11 female patients (29%) with a mean age of 49.69 ± 18.61 years. Their diagnoses were as follows; 21 multi-trauma, 11 major abdominal surgery, 11 severe gastrointestinal bleeding. None of the patients had manifested DVT by venous duplex scans. A leg swelling was present in one patient without evidence of DVT by duplex scans. Symptomatic and fatal pulmonary embolism were not detected. Asymptomatic pulmonary embolism was detected by spiral thorax CT examination in one patient (2.6%).

CONCLUSIONS

IPC seems to be an effective and a safe modality in preventing both DVT and PE in high-risk ICU patients with severe trauma and for those undergoing major surgery -

Key Words: Deep venous thrombosis, pulmonary embolism, prevention, intermittent pneumatic compression.

AMAÇ

Bu çalışmada, kanama riski nedeniyle antikoagülasyon tedavisi kontrendike olan ve cerrahi yoğun bakım ünitesinde takip edilen otuz sekiz hastada aralıklı pnömatik kompresyonun (IPC) derin ven trombozunu (DVT) ve pulmoner emboliyi (PE) önlemedeki güvenilirliği ve etkinliğinin değerlendirilmesi amaçlandı.

GEREÇ VE YÖNTEM

Bu çalışma Ekim 2001-Haziran 2002 tarihleri arasında İstanbul Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, Acil Cerrahi ve Travma servisinde yürütüldü. Otuz sekiz yoğun bakım hastasına venöz tromboemboli profilaksisi için aralıklı pnömatik kompresyon uygulanıp sonuçlar değerlendirildi.

BULGULAR

Aralıklı pnömatik kompresyon sonuçlarımızı değerlendirmeyi amaçladığımız bu çalışmaya 27 (%71) erkek ve 11 (%29) kadın hasta alınmıştır. Yaş ortalamaları 49.69 ±18.61 yıl: Hastaların 21'i multi-travma, 11'i majör karın cerrahisi. 6'sı ciddi gastrointestinal sistem kanaması geçirmişti. Hiçbir hastada dupleks sintigrafiyle derin ven trombozu tespit edilemedi. Bir hastada dupleks sintigrafisinde derin ven trombozu bulgusu yok iken bacakta ödem mevcuttu. Semptomatik ya da ölümcül pulmoner emboli izlenmedi. Bir hastada spiral toraks bilgisayarlı tomografi ile asemptomatik akciğer embolisi tespit edildi.

SONUÇ

Bulgularımız ve literatür bilgilerinin ışığı altında ciddi travma ve büyük cerrahi girişim geçirmiş olması nedeniyle yoğun bakım ünitesinde takip edilen riskli hastalarda aralıklı pnömatik kompresyonun, derin ven trombozu ve akciğer embolisini önlemede etkin ve güvenli bir yöntem olduğu sonucuna varmış bulunmaktayız.

Anahtar Sözcükler: Derin ven trombozu, akciğer embolisi, aralıklı pnömatik kompresyon

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INTRODUCTION

Venous thromboembolism (VTE) is a major cause of morbidity and mortality in hospitalized patients, particularly those undergoing major operations and/or with severe traumatic injuries^[1,3] VTE occurs following the onset of one or more abnormalities of Virchow's triad ie. stasis of blood, abnormalities of the vessel wall. and hypercoagulability. Although there is no single modality to modify all of these abnormalities, standard prevention of VTE remains to be a nti coagulation with low-dose subcutaneous heparin (LDH) or low- molecular weight heparin (LMWH). Some of high-risk patients are unable to receive VTE prophylaxis due to contraindication to pharmacologic prophylactic agents. Fourteen percent of trauma patients could not receive anticoagulation owing to bleeding complications.^[4,5] Other modalities for DVT and PE prophylaxis, including vena cava filters placement and intermittent pneumatic compression (IPC) devices have been reportedly led to satisfactory results in high-risk patients.^[6,7]

The purpose of this study is to evaluate the efficacy and safety of IPC in the prevention of DVT and PE in high-risk patients with multi-trauma or patients undergoing major abdominal surgery followed in the intensive care unit (ICU) for whom anticoagulation was contraindicated owing to high risk of bleeding.

MATERIALS AND METHODS

This prospective study was conducted between October 2001 and June 2002 at the Trauma and Surgical Emergency Service of Istanbul Medical Faculty. Approval to conduct this study was obtained from our institutional review board. Thirty-eight surgical ICU patients who used IPC devices for prophylaxis of VTE were evaluated. Patients in whom anticoagulation was contraindicated due to high-risk of bleeding were eligible for enrollment into the study. Patients who were admitted with diagnoses of DVT or PE were excluded from the study. Calf IPC device (Flowtron Excel Prophylactic D.V.T System Model AC 550. Bedfordshire. UK) applied to the lower extremities of the patients (Fig. 1). Each leg cuff inflated once for 90 seconds up to 40 mmHg. The inflated cuff

Table 1: Characteristic features of the patients

	Values
No. of patients	38
Gender (F/M)	11/27
Mean (\pm SD) age (years)	49.69 \pm 18.61
Mean (\pm SD) duration of IPC (days)	6.3 \pm 4.20
Multi-traumas	21
Major abdominal surgery	11
Gastrointestinal bleeding	6
Fatal PE	-
Asymptomatic PE	1 (2.6 %)
DVT	-

PE. pulmonary embolism; DVT. deep venous thrombosis.

was applied for 30 seconds. IPC devices were almost applied routinely.

For the investigation of DVT, venous duplex ultrasonography of lower extremities was performed by radiologists at 3., 7. days, and the time of discharge Spiral thorax CT scanning for PE was performed at the first weeks. The onset of DVT and PE, age and gender of the patients and diagnoses were also assessed.

RESULTS

During nine months of the study period, there were 27 male (71%) and 11 female patients (29%) with mean age of 49.69 \pm 18.61 years (Table 1) The

Table 2: Diagnostic classification of the patients

Main diagnosis	No of patients
Intracranial bleeding	14
Grade III spleen injury	4
Grade III liver injury	2
Gastrointestinal bleeding	6
Necrotizing pancreatitis	4
Colon cancer	3
Spinal cord injury	2
Grade IV spleen injury	2
Intestinal ischemia	2
Ruptured liver hemangioma	1
Hemothorax	1
Grade IV renal injury	1
Grade IV liver injury	1
Cholechololithiasis	1
Miscellaneous fractures	12



Figure 1: Application of calf IPC devices.

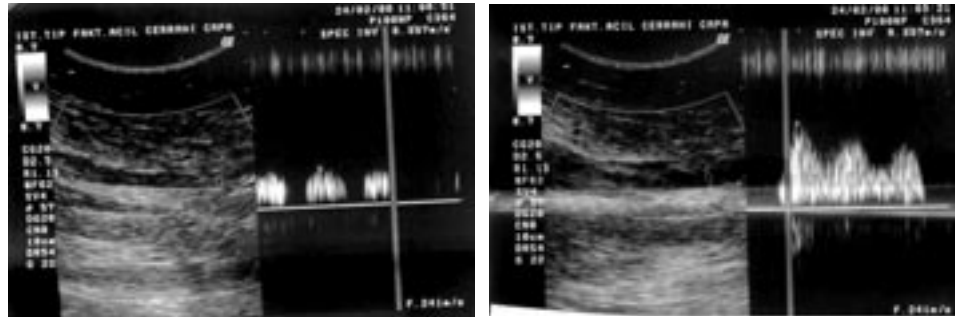


Figure 2: Venous blood flow before and after IPC.

mean duration of IPC was 6.30 ± 4.20 days. The primary diagnoses of the patients hospitalised were as follows; 21 multi-traumas, 11 major abdominal operations- 11 cases with severe gastrointestinal bleeding (Table 2).

Venous duplex scans did not detect any evidence of DVT. Leg edema was present in one patient without any evidence of DVT by duplex scans. There was no evidence of symptomatic pulmonary embolisms. The symptomatic PE was detected by spiral thorax CT in one patient (2.6%).

DISCUSSION

DVT is a clinically silent disease, and the primary prevention is the key to decrease morbidity and mortality. Any clear-cut consensus has not been attained for the optimal approach in the prevention from DVT. A variety of pharmacological and mechanical measures have been proposed for prophylaxis. The purpose of VTE prophylaxis is not only to prevent DVT, but also reduce the incidence of fatal PE. However a lower incidence of DVT means a lower incidence of PE. Furthermore DVT in the lower extremities leads to PE in 90% of the cases.^[8]

ICU patients are often bleeding overtly or hospitalised with thrombocytopenia. The incidence of DVT in a high-risk group of ICU patients receiving DVT prophylaxis either by IPC or LDH has been 11.7 percent.^[9] Hirsch et al reported similar incidence rates of DVT in ICU patients treated with IPC and LDH^[10]. DVT occurred in 13% of ICU patients receiving heparin prophylaxis.^[11] Even with adequate DVT prophylaxis, DVT and PE occur in up to 10% of high-risk, multitrauma patients.^[1,12,13] PE may develop without any evidence of DVT of the

lower extremities. Thus in such cases IPC fails to prevent PE as observed in one patient in the present study.

IPC is a mechanical method of delivering compression to the limbs. The exact physiological mechanisms of IPC are only partly understood. Beside mechanical effects of enhancing venous blood flow in the legs (Figure. 2), IPC devices cause an increase in endogenous fibrinolysis owing to the stimulation of vascular endothelial walls and reductions in the calibre of veins^[14,15] IPC modifies two of Virchow's triad, in other words overcomes venous stasis by increasing venous blood flow and improves hypercoagulability by stimulating fibrinolytic activity in normal and postthrombotic subjects.^[16,18] Comerota et al.^[19] suggested that the increase in fibrinolytic activity is related to the reduction in plasminogen activator inhibitor-1 levels which leads to an increase in tissue plasminogen activator.

Mixed modalities for prophylaxis have been studied in high risk patients. Combined use of IPC and LDH has been demonstrated to cause a reduction of 62% in the risk of developing PE after cardiac surgery compared with the use of LDH alone.³ Okuda et al.^[20] has shown that a combination of LMWH and IPC is more effective in the prevention of DVT after laparoscopic cholecystectomy. IPC combined with LDH provides and maintains a more effective prophylaxis of DVT and PE than LDH alone in hospitalized stroke patients.^[21] It might be interesting to compare IPC and anticoagulant monotherapy in high-risk trauma patients.

IPC devices have been employed to treat vascular and lymphatic disorders for more than four decades. IPC is also an accepted method for the treatment of peripheral lymphedema^[22] improve-

ment of circulation in patients with arterial insufficiency in the lower extremities^[23,24] and the resolution of venous ulcers^[25] via enhancing venous outflow and arterial inflow. In a study performed in healthy volunteers, IPC reportedly enhanced popliteal blood flow by lowering peripheral vascular resistance.^[26] In comparative studies conducted with IPC devices (foot, calf, calf and foot) used to improve arterial inflow, IPCs employed for feet and calves were found to be the most effective means of acutely augmenting arterial calf inflow in arteriopathic and normal subjects^[27] IPC (foot and calf) applied at 120-140 mmHg, and at a frequency of 3-4 impulses per minute and one-second delay provided the optimal IPC stimulus.^[28] When traumatic injury of the extremities precludes application of calf devices, foot devices may be employed instead.

Several IPC devices are available. Devices have different effects on venous blood-flow augmentation in healthy subjects.^[29] A clinical comparison of IPC devices by Proctor et al.^[30] showed no difference in DVT incidence based on the duration and/ or the method of compression.

Although it is thought that IPC is contraindicated in patients with congestive heart failure owing to an increase in venous return to the heart, Ringley et al.^[31] demonstrated that the application of IPC does not significantly change central hemodynamic parameters in these patients. Few complications relevant to the usage of IPC devices have been reported in the literature. To our knowledge, two cases with peroneal neuropathy, two patients with compartment syndrome and one with PE due to the application of IPC devices have been reported.^[32-35] In an experimental study done by Gilbert et al.^[24] compartment pressures had risen above 70 mmHg for 110 to 130 seconds without any adverse effects. There was no complication related to the IPC devices used in the present study.

IPC seems to be an effective and a safe modality in the prevention of both deep venous thrombosis and fatal pulmonary embolism in high-risk ICU patients with severe trauma and those undergoing major surgery. Based on this small number of patients, we concluded that IPC should be performed in high-risk patients when there is a clear contraindication to the pharmacologic therapy. Further studies are warranted to define the precise

role of IPC in fibrinolytic process. Before accurate conclusions can be drawn, prospective randomized comparative studies with IPC and anticoagulant agents should be performed.

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