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The use of pneumatic tourniquets is safe in Asians undergoing total knee arthroplasty without anticoagulation

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ABSTRACT

Background: There has always been controversy surrounding the use of pneumatic tourniquets in total knee arthroplasty (TKA) as they have been implicated in venous thromboembolic events (VTE). We aimed to evaluate the incidence of clinically significant VTE in Asians who underwent conventional TKA under tourniquet throughout the duration of surgery, without post-operative chemical VTE prophylaxis, but using post-operative pneumatic compression devices.

Methods: Five hundred and thirty-one patients of a single surgeon who underwent elective total knee arthroplasty were retrospectively reviewed. All patients had a tourniquet applied to the operated limb. None of the patients received chemoprophylaxis against VTE. Post-operatively, only symptomatic patients were referred for ultrasonography. The patients were then stratified according to the tourniquet time: <60, 61 to 90, 91 to 120, and >120 min. The overall incidence as well as the incidence of venous thromboembolic events for each group was then calculated.

Results: Of the 531 patients reviewed, 3 patients suffered from deep venous thrombosis (DVT) while 1 patient developed a fatal pulmonary embolism (PE). Hence, the overall incidence of clinically significant VTE was 0.75%. The 3 patients with DVT had tourniquet time of 61 to 90 min while the patient with PE had a tourniquet time of more than 120 min.

Conclusion: With a low overall incidence of VTE, the use of tourniquet in Asians during conventional total knee arthroplasty appears safe when post-operative pneumatic compression devices are used instead of chemical VTE prophylaxis. However, the risk of VTE seems to increase with a tourniquet time of more than 60 min.

Level of evidence: therapeutic studies, level III

1. Introduction

Venous thromboembolic events (VTE) are a significant complication of total knee arthroplasty (TKA). This includes both deep venous thrombosis (DVT) and pulmonary embolism (PE). It has been reported in the Western literature that the incidence of DVT after TKA is relatively high, ranging from 40% to 84% [1–4]. PE has been established as the major cause of mortality after TKA, with its incidence ranging from 0.5% to 1.8% [3–5]. Several studies have emphasized the lower incidence of VTE in Asian patients who undergo TKA [6,7] as compared to their Western counterparts. There is some data, which support genetic polymorphism as a reason for a lower risk of VTE in Asians. Of the known genetic traits, the most prevalent is activated protein C, a mutation known as factor V Leiden [8,9] that increases VTE risk about 7 times in heterozygotes and about 80 times in homozygotes. It is found in approximately 5% of Westerners but is less common in Africans and rare in Asians [10,11]. It is on this premise that some institutions in Asia do not practice routine chemoprophylaxis for patients undergoing TKA.

Pneumatic tourniquets are often used in TKA. They are particularly favoured as they provide a bloodless field and better cement-bone interface during surgery. As with all things in medicine, pneumatic tourniquets come with potential adverse effects as well. They have been associated with nerve palsy [12,13], vascular injury [14], muscular damage [15,16], postoperative swelling and stiffness [17]. In several studies, thrombi have been visualized by transesophageal echocardiography immediately after tourniquet release during TKA [18]. Even in the presence of a large amount of literature, there is still a great deal of controversy surrounding the impact of tourniquets on VTE.

Given the relatively lower incidence of VTE in Asians, this study aimed to evaluate the overall incidence of VTE in Asian patients undergoing conventional TKA with application of pneumatic tourniquets throughout the duration of surgery and without anti-coagulation. We also aimed to explore if duration of tourniquet time had any effect on incidence of VTE.

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Table 1
Patient characteristics.

Characteristics	Distribution ($n = 531$)
Demographics	
Mean Age (range) (*years*)	66 (50–84)
Gender*	
Male	113 (21.3)
Female	418 (78.7)
Race*	
Chinese	469 (88.3)
Malay	34 (6.4)
Indian	28 (5.3)
Mean body mass index (SD) (kg/m^2)	27.8 (±1.6)
Mean number of co-morbidities (SD)	1.7 (±0.8)
Surgical information	
Type of anaesthesia*	
General anaesthesia	194 (36.5)
Regional anaesthesia	337 (63.5)
Mean tourniquet time (SD) (min)	72 (±15.9)
Mean hospital stay (SD) (days)	5.2 (±2.4)

SD = standard deviation.
* Data are given as the number of patients with the percentage in parenthesis.

2. Materials and methods

From January 2006 to May 2009, 558 patients who underwent elective TKA were retrospectively studied. Patients from a single surgeon, the senior author of the paper, were selected for consistency of patient selection, surgical technique and post-operative care. Our institutional review board approved the study.

Patients were excluded from this study if they were already on anticoagulants, had a history of PE and/or DVT, varicose veins or chronic venous insufficiency. A total of 27 patients were excluded based on these criteria, leaving 531 patients for review.

The senior author performed unilateral TKA for all 531 patients included in this study. A pneumatic tourniquet was applied to the operated limb throughout the duration of the surgery at a pressure of 300 mmHg. The tourniquet was only released when the surgical wound was dressed and a compressive crepe bandage was applied to the operated limb. Conventional TKA was performed in standard fashion for all patients. The medial parapatellar approach was used for patients who presented with genu varum, while the lateral parapatellar approach was used for those who presented with genu valgum. All components were fixed with cement. All patients did not have their patellae re-surfaced. Drains were inserted for all patients and removed on post-operative day 2 or when the drainage was less than 100 millilitres, whichever occurred earlier.

All patients were placed on the post-TKA clinical protocol following surgery, which ensures standardized post-operative care. This includes appropriate analgesia, pneumatic calf pumps, continuous passive motion from first post-operative day and daily physiotherapy assessment. All patients in our study began ambulation on the second post-operative day with the aid of a walking frame. None of the patients received oral chemoprophylaxis against VTE. The pneumatic calf pumps were used when the patient was in bed and not ambulating, till discharge. The surgeon and his team reviewed patients daily and any clinical signs of VTE were recorded in the case sheets. Only symptomatic patients with clinical signs of VTE such as unilateral lower limb swelling, fever, tenderness on palpation, unexplained desaturation with tachycardia, were referred for radiological and/or biochemical evaluation.

Parameters assessed include age, race, gender, body mass index (BMI), type of anaesthesia, tourniquet time and number of co-morbidities. Our study population was similar to that the general population in our country except for gender where there was a higher female preponderance (Table 1). In our study group, 418 patients (78.7%) were females while 113 (21.3%) were males. The mean age (and standard deviation) was 66 years (±7.7 years). The mean BMI was 27.8 kg/m^2 (±1.6 kg/m^2); 194 (36.5%) of our patients underwent general anaesthesia while 337 (63.5%) underwent regional anaesthesia. The mean tourniquet time was 72 min (±15.9 min).

A sample size calculation for achieving an 80% power with $\alpha = 0.05$ and SD = 1.0 showed that we needed a minimum of 155 subjects. Hence, our study is adequately powered. The overall incidence of VTE in the patients was calculated using standard formula. Subsequently, the patients were stratified into four groups based on duration of tourniquet application: Group 1 (<60 min), Group 2 (61 to 90 min), Group 3 (91 to 120 min) and Group 4 (>120 min). The incidence of VTE within each group was then calculated. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 20 (IBM® SPSS Statistics, Armonk, New York, USA).

3. Results

The overall incidence of VTE in our study population was very low at 0.75%. Only 4 patients were found to have clinically significant VTE. Out of these 4 patients, 3 patients had clinically evidence of DVT and were subsequently referred for ultrasonographic confirmation. All 3 patients were then referred to our haematology colleagues for assessment. Only 1 patient was started on anti-coagulation as the other 2 patients had below-knee thrombi that did not warrant anti-coagulation. All 3 patients made an uneventful recovery without any functional impairment. Unfortunately, the fourth patient developed a fatal pulmonary embolism without any clinical or radiological evidence of DVT, which was confirmed on autopsy. All 4 patients were Chinese female with a BMI of more than 25 kg/m^2 (mean: 29.6 kg/m^2). This was significantly higher than the patients with no clinical evidence of VTE (p-value: 0.033).

Table 2
Stratification of patients by duration of tourniquet application.

	Duration of tourniquet application in minutes				*P*-value
	Group 1 <60	Group 2 61 – 90	Group 3 91 – 120	Group 4 >120	
Number of patients	192	293	42	4	
Mean age (range) (years)	66 (50–83)	66 (42–83)	65 (53–78)	64 (60–72)	0.988
Gender*					
Male	31 (18.2)	71 (23.4)	11 (20.4)	0 (0)	
Female	139 (81.8)	232 (76.6)	43 (79.6)	4 (100)	
Race*					
Chinese	171 (89.1)	263 (89.8)	34 (80.9)	1 (25.0)	
Malay	11 (5.7)	18 (6.1)	5 (11.9)	0 (0)	
Indian	10 (5.2)	12 (4.0)	3 (7.2)	3 (75)	
Mean body mass index (SD) (kg/m^2)	26.6 (±2.3)	27.8 (±1.8)	27.2 (±1.5)	29.4 (±2.6)	<0.001
Mean number of co-morbidities (SD)	1.6 (±0.9)	1.7 (±0.7)	1.4 (±0.4)	2.1 (±0.8)	0.048
Number of patients with VTE	0	3	0	1	0.043
Incidence (%)	0	1	0	25	0.043

SD = standard deviation.
* Data are given as the number of patients with the percentage in parenthesis.