Thrombosis Research (2005) **115**, 271–276

ELSEVIER

THROMBOSIS RESEARCH

intl.elsevierhealth.com/journals/thre

REGULAR ARTICLE

Pilot study on the use of tourniquet: a risk factor for pulmonary thromboembolism after total knee arthroplasty?

Masahiko Nishiguchi[a,b], Noboru Takamura[b,*], Yasuyo Abe[b], Masafumi Kono[c], Hiroyuki Shindo[a], Kiyoshi Aoyagi[b]

[a]*Department of Orthopaedic Surgery, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan*
[b]*Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan*
[c]*Department of Orthopaedic Surgery, Nagasaki Red Cross Atomic Bomb Memorial Hospital, Nagasaki, Japan*

Received 7 June 2004; received in revised form 4 August 2004; accepted 10 August 2004
Available online 11 September 2004

KEYWORDS
D-dimer;
Pulmonary thromboembolism (PTE);
Total knee arthroplasty (TKA);
Pneumatic tourniquet (tourniquet)

Abstract The risk of pulmonary thromboembolism (PTE) after total knee arthroplasty (TKA) with tourniquet is still controversial. In this study, we determined whether plasma D-dimer could be used as a marker of PTE, and whether intraoperative use of tourniquet is a risk factor for symptomatic PTE after TKA. We divided 86 patients (12 males and 74 females) who underwent primary TKA into four groups based on (i) operation method (unilateral/bilateral) and (ii) use of pneumatic tourniquet during surgery (with/without). Plasma D-dimer values were measured preoperatively and on Day 1 postoperatively. "D1-value" was defined as the difference between postoperative and preoperative plasma D-dimer levels. We determined the cutoff level of "D1-value" for symptomatic PTE, monitored by O_2 saturation (SAT) and lung scintigraphy. "D1-values" for patients with PTE symptoms were higher than those without symptoms ($p<0.001$). Furthermore, "D1-values" for TKA without tourniquet procedures were significantly lower than those with tourniquet both in unilateral ($p=0.003$) and bilateral groups ($p=0.004$). At a cutoff level of ≥ 8.6 μg/mL, the sensitivity, specificity, and positive and negative predictive values were 100%, 82.5%, 30.0% and 100% for symptomatic PTE, respectively. The results of our pilot study showed that elevated plasma "D1 value" is a sensitive marker for detection of PTE. Further studies will be needed, in order to evaluate the risk of tourniquet, and to reduce PTE after TKA.

* Corresponding author. Tel.: +81 95 849 7066; fax: +81 95 849 7069.
E-mail address: takamura@net.nagasaki-u.ac.jp (N. Takamura).

0049-3848/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.thromres.2004.08.018

Introduction

Pulmonary thromboembolism (PTE) is one of the most serious postoperative complications in orthopaedic surgery, and particularly occurs after major joint surgery such as total knee arthroplasty (TKA) and total hip arthroplasty (THA). Furthermore, TKA itself has been reported as a strong risk factor for venous thrombembolism (VTE), which is defined as the combination of deep vein thrombosis (DVT) and PTE [1].

Apart from prior VTE and aging, no other risk factors of VTE with TKA have been identified [2]. Since the severity of PTE varies from fatal to asymptomatic, its early and accurate diagnosis is very important. Evaluation by cardiac ultrasound is widely used [3–6], but no serum marker for prediction of PTE is currently available.

For effective prophylaxis of VTE after TKA, the American Heart Association (AHA) recommended the use of low-molecular-weight heparin and foot pump [7]. Recently, oral administration of ximelagatran, a direct thrombin inhibitor, has been shown to be more effective than subcutaneous injection of low-molecular-weight heparin [8] and oral administration of warfarin [9] for prevention of VTE after TKA.

However, in the above studies, a tourniquet was used in all patients during the operation, and VTE occurred in >20% of the patients [10]. Clinically, the use of pneumatic tourniquet is considered one of the most important risk factors for the occurrence of symptomatic VTE. Parmet et al. [11] suggested that the use of a tourniquet during TKA was associated with a greater risk of ultrasound-detected VTE. Furthermore, Kato et al. [12] recommended that TKA should be performed without tourniquet to reduce the risk of large venous emboli.

D-dimer is a specific terminal degradation product of closslinked fibrin [13]. Elevated plasma D-dimer levels are observed in patients with acute thrombosis, and D-dimer is more sensitive than other markers of thrombin generation, such as thrombin–antithrombin complexes and prothrombin fragment 1+2. The usefulness of D-dimer for the diagnosis of VTE is still controversial. Bounameaux et al. [14] reported that measurement of D-dimer was useful for the diagnosis of PTE but not for the diagnosis of DVT after TKA. [15] On the other hand, recent studies suggested that measurement of plasma D-dimer concentration might be also useful for the diagnosis of DVT after TKA [16–19]. However, the problem is that D-dimer levels are increased non-specifically in many clinical conditions, such as infections, cancers, coronary and cerebrovascular diseases, rheumatologic conditions, postoperative changes and certain physiologic states, such as pregnancy and aging [13]. In order to evaluate the specific changes of D-dimer by TKA, we established the standardized D-dimer value, so-called "D1-value", which accurately reflects the postoperative coagulation state.

The present study was designed to determine whether: (1) plasma D-dimer can be used as a marker of symptomatic PTE, and (2) the intraoperative use of tourniquet is a risk factor for symptomatic PTE after TKA as assessed by the "D1-value". The results emphasize the need for a monitoring system for effective prevention of PTE, and for the identification of the risk factor(s) of PTE after TKA.

Materials and methods

Patients

The study was performed after obtaining informed consent form each subject. The subjects were 86 patients [29 with rheumatoid arthritis (3 men and 26 women) and 57 with osteoarthritis (9 men and 48 women)] who underwent primary TKA via cementless procedures at Nagasaki Red Cross Atomic Bomb Memorial Hospital (Nagasaki, Japan) from May 2000 to June 2002. The mean age of patients was 70 (range: 29–86) years. No postoperative infection was observed in all 86 patients. Cases who had pulmonary dysfunction preoperatively were excluded from this study. According to the operation procedures, patients were assigned as the following four groups. (1) Bilateral TKAs with tourniquet and (2) bilateral TKAs without tourniquet, (3) unilateral TKA with tourniquet and (4) unilateral TKA without tourniquet. In bilateral TKAs, we assigned patients, who underwent from May 2000 to February 2001, to (1) and who underwent from March 2001 to June 2002, to (2). In unilateral TKAs, we assigned patients to (3) and (4), according to a similar manner.

All procedures were performed by two surgeons (MN and MK) using similar surgical techniques of intramedullary guide to the femur and extramedullary guide to the tibia. The NexGen Total Knee System (Zimmer, USA) was used in 40 cases (21 unilateral and 19 bilateral) with the posterior cruciate ligament (PCL) retained, and the LCS Total Knee System (Depuy International, Leeds, UK) was used in 46 cases (18 unilateral and 28 bilateral) with PCL sacrificed.