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Original Article

Effect of venous sampling methods and sites on thromboelastography for patients underwent thoracic surgery

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Abstract: This study was assigned to assess the influence of different blood collection methods and sites on the results of thromboelastography (TEG) in patients underwent thoracic surgery. Forty patients, who underwent lobectomy or esophagectomy in our hospital from May 2014 to March 2015, were randomly divided into two groups (group A and group B; n = 20 in each group). In group A, blood was collected from femoral vein and internal jugular vein by direct venipuncture. In group B, femoral vein blood was sampled by direct venipuncture, and then blood from internal jugular vein was drawn via a deep venous catheter. Kaolin-activated TEG analyses were performed, and clotting time (R), clot kinetics (K), α angle and maximal amplitude (MA) were compared using paired t-test. All tested parameters were within the normal range. In group A, no significant differences in R, K, α angle and MA values were found between samples obtained by direct venipuncture from femoral and jugular vein ($P > 0.05$). In group B, however, the R value of blood sample collected by femoral vein puncture was significantly lower than that of sample captured via an indwelling internal jugular vein catheter ($P < 0.05$), while differences in K, α angle and MA values did not reach statistical significant ($P > 0.05$). In summary, all of these sampling routes were acceptable for thromboelastographic analysis. Howbeit, to avoid bias, the sampling method and site should be the same when conducting clinical dynamic observation.

Keywords: Thrombelastogram, direct venipuncture, an indwelling catheter

Introduction

Deep venous thrombosis (DVT) refers to an abnormal blood agglutination within the blood vessel. As one of the most common causes of in-hospital morbidity, DVT may progress to post thrombotic syndrome, lead to the development of pulmonary embolism and even threaten the life [1]. Cancer patients are at high risk of venous thromboembolisms (VTEs) [2] due to activated the blood clotting cascade by pro-coagulants and induced vascular endothelial cell damage [3, 4]. Thus, it is very important to monitor the coagulation function of cancer patients to decrease occurrence of thrombosis.

Currently, activated partial thromboplastin time (APTT), prothrombin time (PT), fibrinogen (Fib) and international normalized ratio (INR) are commonly detected to reflect the coagulation function in the hospital. Thromboelastography (TEG) is considered as a valuable detection method for coagulation function, which can reveal all blood components as well as evaluate whole-clot formation and dissolution. Besides, TEG can also dynamically monitor the entire process of coagulation and may detect coagulopathy that cannot be detected by conventional coagulation tests [5, 6]. However, the detection results of coagulation function can be disturbed by many factors, such as rest temperature, contact activation and even the type of needle [7]. Several studies have investigated the impact of blood collection system on TEG analysis had been performed in animals [8-10]; however, the conclusions are inconsistent. In addition, few studies have focused on the clinical investigation. Hence, in this present study, we enrolled 40 cancer patients who underwent thoracic surgery, aimed to analyze whether there were differences in TEG values when the blood was drawn from different sites (femoral vein or internal jugular vein) by different sam-

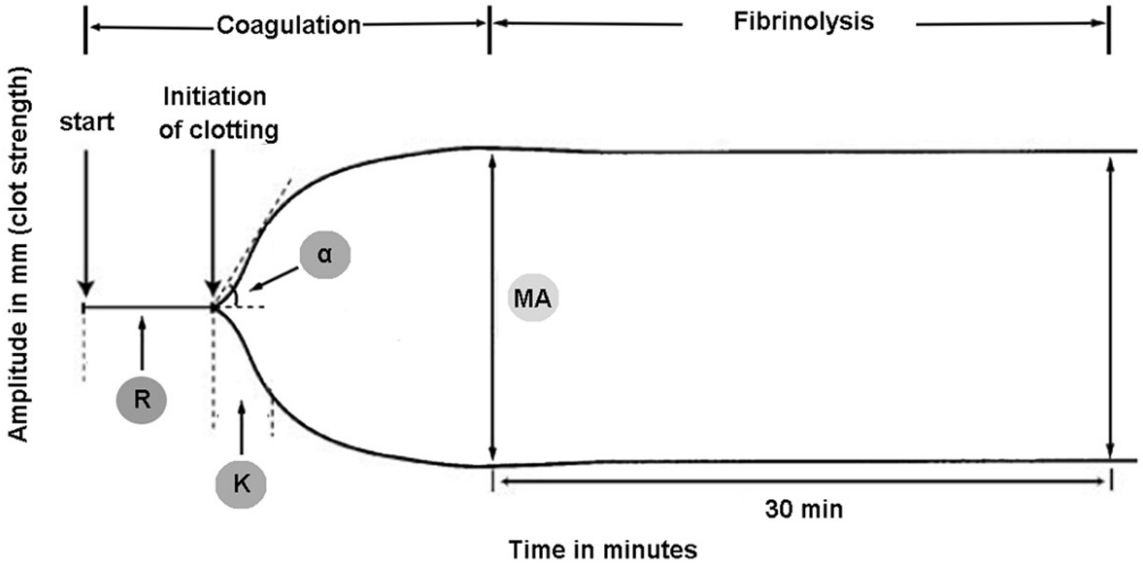

Figure 1. Typical appearance of thromboelastographs tracing with major parameters. Clotting Time (R): the time of latency until initial fibrin formation, reference interval 3-8 min; (2) Clot Kinetics (K): the speed at which a specific level of clot strength is achieved (20 mm amplitude), reference interval 1-3 min; (3) Angle (α): the rapidity of clot strengthening, reference interval 55-78°; (4) Maximum Amplitude (MA): the ultimate strength of the clot, reference interval 51-69 mm.

Table 1. Thromboelastography results of 20 patients for whom the blood samples were collected from femoral vein and internal jugular vein by syringe aspiration via direct venipuncture with a needle in succession

	R value	K value	α angle value	MA value
Femoral vein	5.57±1.20	1.57±0.54	66.89±8.49	63.89±6.32
Internal jugular vein	5.51±1.04	1.60±0.49	65.42±8.14	62.29±6.55

R: clotting time; K: clot kinetics; MA: maximum amplitude. Comparisons between groups were conducted using paired t-test, and no significant difference was found in R, K, α angle and MA values.

pling methods (vein puncture or indwelling catheter).

Materials and methods

Patients

The malignancy patients who underwent lobectomy or esophagectomy in General thoracic surgery in our hospital (Chongqing, China) from May 2014 to March 2015 were enrolled in this study. Inclusion criteria were: 1) the patients with American Society of Anesthesiologists (ASA) grade I or ASA grade II; 2) no history of thrombosis; 3) no treatment history with anticoagulants; 4) no history of long-term use of contraceptives for female patients; 5) preoperatively normal coagulation function ; 6) normal body temperature. Exclusion criteria: 1) the patients refused to sign the informed consent; 2) blood loss during operation was greater than 10% of total body blood volume; 3) electrolyte was disorder and the acid-base balance was disrupt; 4) blood sample was collected and processed with non-standard manner. As a result, a total of 40 patients (29 males and 11 females, 42-75 years old) were collected, including 27 lung cancers and 13 esophageal cancers.

All the experiments were licensed and approved by the Ethics Committee of our hospital. Also, the written, informed consent of each patient was obtained.

Grouping and sample collection

These 40 patients were divided into two groups with 20 patients per group, which were named as group A (15 males and 5 females, 44-74 years old, 14 lung cancers and 6 esophageal cancers) and group B (14 males and 6 females, 42-75 years old, 13 lung cancers and 7 esophageal cancers). After surgery, the position of patients in group B was changed from lateral position to supine position, and the blood was

Table 2. Thromboelastography results of 20 patients for whom the blood was successionally sampled from femoral vein by syringe aspiration and internal jugular vein via a double lumen deep venous catheter

	R value	K value	α angle value	MA value
Femoral vein	4.6±1.14*	1.6±0.54	65.0±6.55	60.5±6.33
Internal jugular vein through catheter	5.4±1.04	1.8±0.53	64.2±5.80	59.2±5.58

R: clotting time; K: clot kinetics; MA: maximum amplitude. Comparisons between groups were conducted using paired t-test. *$P < 0.05$.

immediately collected via femoral vein puncture using 10 ml syringe (Weigao Group Medical Polymer Co. Ltd., Shandong, China) guided by ultrasound to make blood unobstructed. Then a total of 2.7 ml blood was drawn using a new 5 ml syringe (Weigao Group Medical Polymer Co. Ltd.) and transferred into a BD Vacutainer (Becton, Dickinson and Company, Franklin Lakes, NJ). One minute after pausing infusion, 20 ml blood was collected via a catheter in internal jugular vein of patients. Then a total of 2.7 ml blood was obtained by a new needle and transferred into a BD Vacutainer tube (Becton, Dickinson and Company). The collected blood samples were gently mixed. The intervals between these two procedures were controlled no more than five minutes. For the patients in group A, the blood was drawn by direct venipuncture from femoral vein and internal jugular vein as the same method described above.

TEG determinations

Kaolin-activated TEG determinations were performed by a trained technologist using Thrombelastograph Hemostasis Analyzer Model 5000 (Haemoscope Corporation, Chicago, Illinois, USA) according to the manufacturer's instructions. Briefly, the citrated whole blood (1 ml) was mixed with 1 % kaolin in a vial and the mixture was inverted several times. Then, the citrated whole blood was transferred to the TEG cup containing $CaCl_2$ for recalcification. After reaching maximum amplitude at 37°C for 40-60 min, TEG analyzer was conducted. The changes in the blood sample with the formation, retraction and dissolution of blood clots were automatically recorded to reflect changes in coagulation and fibrinolysis. The transmitted rotation was transduced into the computer analyzer to produce a tracing. There were four variables directly measured (**Figure 1**), namely (1) Clotting Time (R): the time of latency until initial fibrin formation, reference interval 3-8 min; (2) Clot Kinetics (K): the speed at which a specific level of clot strength is achieved (20 mm amplitude), reference interval 1-3 min; (3) Angle (α): the rapidity of clot strengthening, reference interval 55-78°; (4) Maximum Amplitude (MA): the ultimate strength of the clot, reference interval 51-69 mm.

Statistical analysis

The data were expressed as mean ± standard deviation (SD) and analyzed using Statistical Package for Social Science (SPSS) version 19.0 (SPSS Inc., Chicago, IL, USA). Comparisons were conducted using paired Student's t test and a value with $P < 0.05$ was considered as statistically significant.

Results

All TEG parameters of the enrolled patients were within the reference range. The TEG results of patients in group A are shown in **Table 1**. No significant differences in R, K, α angle and MA values were found between the samples collected from femoral vein and internal jugular vein by syringe aspiration via direct venipuncture with a needle ($P > 0.05$).

However, in group B, a lower R value was detected in samples from femoral vein by syringe aspiration compared with internal jugular vein blood that was collected via a double lumen deep venous catheter (4.6±1.14 vs 5.4±1.04, $P < 0.05$, **Table 2**). No significant differences in K, α angle and MA were found in samples of patients in group B ($P > 0.05$, **Table 2**).

Discussion

DVT is common in patients underwent severe trauma or brake owing to slower blood flow in lower limb than other parts. Nowadays, catheter is often indwelled in deep venous in patients underwent major surgery, and coagula-

tion function test for these patients is often detected using blood from the deep venous through the indwelling catheter tube. Compared with the traditional syringe aspiration way, whether sampling via catheter influence the results of TEG analysis?

In this present study, the patients underwent thoracic cancer surgery were included as they were with high risk of DVT. According to the TEG determinations, all the tested parameters were without significant differences between direct venipuncture from femoral and jugular vein. However, the Clotting Time was significant longer in blood sample via an indwelling catheter than that from direct venipuncture. The similar TEG results of the blood samples from different sites might be explained by that the intravascular coagulation function of blood was the same in different sites through the blood circulation. However, different blood collection methods, whether via an indwelling catheter or direct venipuncture, had an effect on the results of TEG.

Increasing researches had been conducted to investigate the differences of the blood samples drawn by different methods. Zengin *et al.* reported that no clinically significant differences of APTT and PT values were found in the blood samples drawn by peripheral venous catheter and venipuncture methods [11]. Meanwhile, May and his collogues suggested that blood samples aspirated from an intravenous catheter had clinically equivalent values to those obtained by direct venipuncture in adult horse by analyzing complete blood count, packed-cell volume, total protein concentration, stall side plasma glucose concentration, and plasma chemistry [12]. However, the values of Fib, PT and APTT in cancer patients were significantly different between the blood samples obtained through tunneled venous access devices and direct venipuncture [13]. Similarly, this study demonstrated that TEG results were different in the blood samples obtained from direct venipuncture and extracted through an indwelling catheter. Our study also certified a different blood status by using different blood collection methods.

TEG was considered as an index for coagulation function to reflect the body's clotting status, carrying out a comprehensive testing and evaluation for coagulation factors, fibrinogen, platelet aggregation and fibrinolysis etc., which was not affected by heparin substance [14, 15]. The variables of TEG were identified to be associated with the degree of organ failure, bleeding, and the risk of death in severe sepsis patients even when the values were remained within the reference ranges [6, 16]. The R value of the blood samples collected from direct venipuncture was obvious lower than that of the blood samples via an indwelling catheter in internal jugular vein. The R value reflected the intrinsic pathway activity, and a decrease in R value indicated that the activation of thrombosis is increased [17, 18]. Besides, compared with blood samples extracted through an indwelling catheter in internal jugular vein, a slight decrease of K value and a weak growth of α angle and MA were also found in the blood extracted through direct venipuncture though no significant differences existed. Shortening of the K, accompanied with a larger α angle, had been reported to indicate an accelerated formation of blood clot, which might also indicate the disorder of coagulation factors or the hypercoagulability [19]. Thus, when coagulation function tests were dynamically conducted for the patients with highly suspected risks of DVT, various disturbances should be taken into consideration when collecting blood samples in order to avoid misdiagnosis of coagulation function.

Conclusion

In this present study, we demonstrated that TEG results were different in the blood samples obtained from direct venipuncture in femoral vein and through an indwelling catheter in internal jugular vein, which certified a different blood status by using different blood collection methods. However, a further study with large number of patients should be conducted to confirm this result and some other coagulation factors also should be detected.

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Disclosure of conflict of interest

None.

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References

[1] Aziz F and Comerota AJ. Deep venous thrombosis. J Radiol Nurs 2013; 32: 160-164.

[2] Sawaya RE and Ligon BL. Thromboembolic complications associated with brain tumors. J Neuro-oncol 1994; 22: 173-181.

[3] Bick RL. Cancer-associated thrombosis. N Engl J Med 2003; 349: 109-110.

[4] Lip GY, Chin BS and Blann AD. Cancer and the prothrombotic state. Lancet Oncol 2002; 3: 27-34.

[5] Muller MC, Meijers JC, Vroom MB and Juffermans NP. Utility of thromboelastography and/or thromboelastometry in adults with sepsis: a systematic review. Crit Care 2014; 18: R30.

[6] Haase N, Ostrowski SR, Wetterslev J, Lange T, Møller MH, Tousi H, Steensen M, Pott F, Søe-Jensen P and Nielsen J. Thromboelastography in patients with severe sepsis: a prospective cohort study. Intensive Care Med 2015; 41: 77-85.

[7] Greenwell C, Epstein S and Brain P. Influence of needle gauge used for venipuncture on automated platelet count and coagulation profile in dogs. Aust Vet J 2014; 92: 71-74.

[8] Walker JM, Hanel RM, Hansen BD and Motsinger-Reif AA. Comparison of venous sampling methods for thromboelastography in clinically normal dogs. Am J Vet Res 2012; 73: 1864-1870.

[9] Koenigshof AM, Scott MA and Brown AJ. Effects of delayed anticoagulation and use of evacuated tubes on non-activated thrombelastography in dogs. Vet Clin Pathol 2012; 41: 63-70.

[10] Ralph AG, Brainard BM, Pittman JR, Babski DM and Koenig A. Effects of rest temperature, contact activation, and sample technique on canine thrombelastography. J Vet Emerg Crit Care 2012; 22: 320-326.

[11] Reneke J, Etzell J, Leslie S, Ng VL and Gottfried EL. Prolonged prothrombin time and activated partial thromboplastin time due to underfilled specimen tubes with 109 mmol/L (3.2%) citrate anticoagulant. Am J Clin Pathol 1998; 109: 754-757.

[12] May M, Nolen-Walston R, Utter M and Boston R. Comparison of hematologic and biochemical results on blood obtained by jugular venipuncture as compared with intravenous catheter in adult horses. J Vet Intern Med 2010; 24: 1462-1466.

[13] Hinds PS, Quargnenti A, Gattuso J, Kumar SD, Tong X, Penn L, West N, Cathey P, Hawkins D, Wilimas J, Starr M, Head D. Comparing the results of coagulation tests on blood drawn by venipuncture and through heparinized tunneled venous access devices in pediatric patients with cancer. Oncol Nurs Forum 2002; 29: E26-34.

[14] Karon BS. Why is everyone so excited about thromboelastrography (TEG)? Clin Chim Acta 2014; 436: 143-148.

[15] Karlsson O, Sporrong T, Hillarp A, Jeppsson A and Hellgren M. Prospective longitudinal study of thromboelastography and standard hemostatic laboratory tests in healthy women during normal pregnancy. Anesth Analg 2012; 115: 890-898.

[16] Spiess BD, Tuman KJ, McCarthy RJ, DeLaria GA, Schillo R and Ivankovich AD. Thromboelastography as an indicator of post-cardiopulmonary bypass coagulopathies. J Clin Monit 1987; 3: 25-30.

[17] Chandler WL. The thromboelastography and the thromboelastograph technique. Semin Thromb Hemost 1995; 21 Suppl 4: 1-6.

[18] Stammers A and Bruda N. Point-of-care coagulation monitoring: applications of the thromboelastograph. Anaesthesia 1998; 53: 58-59.

[19] Bose E and Hravnak M. Thromboelastography: a practice summary for nurse practitioners treating hemorrhage. J Nurse Pract 2015; 11: 702-709.