# Symptomatic DVT One Month After TKA Was Associated With Tourniquet Reuse During Operation

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**Research Article**

**Keywords:** TKA, Tourniquet reuse, Symptomatic DVT

**Posted Date:** July 23rd, 2021

**DOI:** https://doi.org/10.21203/rs.3.rs-508087/v1

# Abstract

**Background:** DVT (Deep vein thrombosis) was one of the most common and sever complications after TKA (total knee arthroplasty). When tourniquet use and sometime the reuse was performed for surgery convenient of TKA. There was not sure if tourniquet use or reuse during operation would increase DVT after TKA.

**Methods:** A retrospective study was performed about primarily TKA in our institute continuous 5 years. Univariate analysis was performed and potential intervention variables ($P \leq 0.1$) were included in multiple factor analysis to certain the independent risk factors.

**Results:** 807 patients (431 females and 376 males) were included with mean age was 65 years old. 3.84% (31 patients) were occurred sym-DVT (symptomatic DVT) one month after TKA with median time of diagnosis was 17 days. Incidence of sym-DVT after tourniquet reuse was significant high than once use and no use (7.25% versus 2.54% and 1.86%, $P = 0.014$ and 0.072), mean time of tourniquet use was 90.46 ± 14.28 mins in once and 106.58 ± 16.13 mins in reuse ($P = 0.045$). After multiple analysis, independent risk factors were revealed as history of tumor ($P = 0.021$), history of DVT ($P < 0.001$) and tourniquet reuse ($P = 0.005$).

**Conclusions:** Tourniquet reuse was associated with highly incidence of sym-DVT other than history of tumor and DVT. There should be once use of tourniquet for prevent sym-DVT.


# Background

Deep vein thrombosis (DVT) was one of the most common and sever complications of orthopedic Especially the patients after TKA (total knee arthroplasty) were more susceptible of DVT. There were 36.5 - 60% DVT appeared after TKA without prophylaxis.(1, 2). It was still as high as 16 - 27% even after thrombo-prophylaxis(3, 4) and there were 3-10% of sym-DVT (symptomatic DVT)(5, 6).

The sym-DVT which were needed treatment account almost 70% of all DVT patients.(7) If the sym-DVT was not acceptted proper treatment, half of them would ended with PE.(8) DVT prophylaxis as routine anticoagulation has benefit of low related complications after TKA.(9) TKA was an operation after thorough preoperative assessment, so the surgery technic had a big deal with DVT after procedure. (10) And when tourniquet was used in TKA for better exposure frequently, hemodynamic changes and endothelial injury were theoretically being considered as iatrogenic injuries.

Literatures were not sure if tourniquet reuse (once more tourniquet use in operation) was the risk factor of sym-DVT. So, we performed a retrospective study to evaluate if tourniquet reuse was one of the risk factors.

# Methods

Total knee arthroplasty patients in our institution from 1 January 2010 to 31 December 2016 were reviewed retrospectively. Inclusion criteria: adult patients (≥ 18 years), first time of TKA, inexistence of DVT preoperative (determined by lower extremity deep venous of ultrasonography). Exclude criteria: haemophiliac, revision surgery, limb activity limitation for stroke, sym-DVT occurred at health extremity, and loss to follow-up. The follow-up flowchart was showed in figure 1.

Medical data was included: age, gender, BMI (body mass index), cause of surgery, blood test (CRP (C-reactive protein), albumin, D-dimer, lactic acid), medical history of (diabetes mellitus, hypertension, coronary heart disease, myocardium infarction MI (Myocardial infarction), DVT), drug history of antiplatelet drug (aspirin or clopidogrel), operation and anesthesia data (ASA (American society of anesthesiologists) grade, anesthesia type, procedure time, tourniquet use and time), bleeding during operation, drainage postoperative, postoperative data (low limb swelling (calf perimeter of 10 cm below tibia tuberosity), time of weight bearing. According to WHO (World health organization) described, BMI was divided as: low weight (BMI < 18.5 kg/m$^2$), normal (BMI = 18.5 - 25 kg/m$^2$), over weight (BMI = 25 - 30 kg/m$^2$), obesity I grade (BMI = 30 - 35 kg/m$^2$), obesity II grade (BMI = 35 - 40 kg/m$^2$), obesity III grade (BMI > 40 kg/m$^2$). CCI (Charlson comorbidity index) was used and divide into three level: low level (0 score) means no comorbidity, middle level (1 - 2 scores) and high level (over 3 scores) (11).

Thrombo-prophylaxis was included chemoprophylaxis and physical prophylaxis. LMWH (low molecular weight heparin) 4000 U was used 12 hours after surgery and once daily last hospitalization. LMWH was used as bridging therapy if patient was used antiplatelet drug. In the meanwhile, pump treatment was used one day after surgery until full weight bearing.

### Fellow-up and diagnosis of symptomatic DVT

If the patient occurred low leg pain and tenderness with swelling, or calf circumference (10 cm under tibia tuberosity) was increased over 2 cm than health limb, or swelling was severing. (12) And deep vein Doppler ultrasound would be performed if patient had positive of Homans sign. Then the patient would be diagnosed had sym-DVT. Pulmonary arterial CTA (computed tomography angiography) would be performed immediately if patient had chest pain, short of breath or dyspnea. All patients had education of DVT and PE, and they would be required go to hospital immediately if the symptoms appeared.

### Statistical method

Student *t*-tests or Wilcoxon rank sum tests were used to compare numerical variables between groups, and chi-square tests were used in categorical variables. Repeated Measures were used to analyze BP parameter at different period. One-sample *t*-tests were used to analyze outlier from base line. Multivariate Covariance analyses were used in variation of BP parameter during procedure. Pearson Correlation analyses were used in two numerical variables. Variables with $P \leq 0.1$ were considered as covariates (potential risk factors) and K-Independent Samples tests were used to analyze correlation between groups. ROC analyses were used in numerical variables (if $P \leq 0.1$) to assess fitness cut-off value, then rounded to the nearest whole number and transform numerical variables to binary variables. Variables

with $P \leq 0.1$ enter in multiple logistic regression analysis (choose Forward: Conditional method). The independent risk factors were showed as OR (odds ratio, 95% CI). P values < 0.05 were considered statistically significant. The statistical analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, Illinois).

The ethics committee approved the study and each participant provided verbal consent.

# Results

842 patients were reviewed. 35 patients were excluded as follows: 13 patients were haemophiliac, 8 were revision surgery, 3 were limb activity limitation for stroke, 2 occurred sym-DVT at health extremity and 9 were loss to follow-up. Then 807 patients were included, 431 females and 376 males with mean age was 65 ± 4.13years old. 31 patients (3.84%) were occurred of sym-DVT one month after TKA, 9 patients were at proximal (above knee), 22 at distal (under knee). Median time of diagnosis was 17 days (range 8-29 days). No patient was died for VTE event or had both low extremity sym-DVT. The demography data between sym-DVT and non-DVT patients was showed in Table 1. The potential intervention variables ($P \leq 0.1$) were as follows: age ($P = 0.032$), BMI ($P = 0.080$), history of tumor ($P = 0.036$), history of DVT ($P = 0.034$), history of operation in six month ($P = 0.064$), history of operation at contralateral limb ($P = 0.020$), postoperative CRP ($P = 0.013$), postoperative lactic acid ($P = 0.062$), postoperative albumin ($P = 0.091$), postoperative D-dimer ($P = 0.087$). Significant difference of sym-DVT incidence was found between BMI groups (low weight 2.4%, normal 2.7%, over weight 3.1%, obesity I grade 5.7%, obesity II grade 12.5%, no obesity III grade patient, $\chi^2 = 2.205$, $P = 0.045$). No significant difference was found among Charlson index (low, middle and high grade each was 2.96%, 3.32% and 3.44%, $\chi^2 = 0.146$, $P = 0.930$). In subgroup, change of lactic acid was also showed significant difference (1.53 ± 0.71 versus 1.03 ± 0.52 mg/L, t = 5.371, $P = 0.039$). No potential intervention difference was found in change of albumin (sym-DVT versus non-DVT: 12.84 ± 6.31 versus 10.75 ± 4.83 g/L, t = -1.706, $P = 0.192$) or in change of D-dimer (sym-DVT versus non-DVT: 8.36 ± 2.01 versus 5.27 ± 1.63, t = -1.045, $P = 0.322$).

Operation factors between sym-DVT and non-DVT patients was showed in Table 2. The potential intervention variables ($P \leq 0.1$) were as follows: tourniquet use ($P = 0.065$), tourniquet reuse ($P = 0.043$), length of operation ($P = 0.093$), length of tourniquet use ($P = 0.080$), length of tourniquet reuse ($P = 0.008$). Incidence of sym-DVT after tourniquet reuse was significant high than once use and no use (7.25% versus 2.54% and 1.86%, P = 0.014 and 0.072). Length of operation and tourniquet use were found have positive correlation with change of CRP (Pearson Correlation = 0.649, $P = 0.047$, and Pearson Correlation = 0.735, $P = 0.039$). Length of operation and tourniquet use were found have positive correlation with change of lactic acid (Pearson Correlation = 0.437, $P = 0.068$, Pearson Correlation = 0.526, $P = 0.053$). Length of operation and tourniquet use were found have positive correlation with change of bleeding intraoperative (Pearson Correlation = 0.395, $P = 0.073$, Pearson Correlation = 0.482, $P = 0.067$).

ROC analysis was used to evaluate the cutoff value of numerical variables ($P \leq 0.1$) and transformed to binary variables (showed in Table 3) as follows: age, BMI, length of operation and so on. The incidence difference of sym-DVT between them were also estimated and showed that each $P < 0.1$. Then these binary variables were moved to multiple logistic regression analysis. And independent risk factors were displayed as follows (showed in Table 4): history of tumor ($P = 0.021$, OR = 2.073), history of DVT ($P < 0.001$, OR = 5.078) and tourniquet reuse ($P = 0.026$, OR = 2.436). (figure 1).

# Discussion

This study found that tourniquet reuse was one of independent risk factors of sym-DVT one month after TKA (OR was 2.43), along with factors of history of tumor and history of DVT. Sym-DVT was more likely had longer tourniquet use (93.46 ± 16.75 versus 88.71 ± 14.28, $P = 0.060$) and longer operation time (75.37 ± 14.39 versus 60.12 ± 13.81, $P = 0.073$). Longer use of tourniquet had positive correlation with high lactic, CRP (C-reactive protein), D-dimer, low limb swelling and negative correlation with albumin.

Studies were found many risk factors of VTE in TKA patients(1, 11, 13–16). Longer procedure was markedly associated with more complications, VTE was one of them(1, 17, 18). Operation length was related with VTE, but without statistics difference(11). Meanwhile, tourniquet was normally used around TKA operation and would increase incidence of VTE(19). Sym-DVT was found higher in patients with longer operation and tourniquet reuse. The reason might be the pathological factors of Virchow's triad were aggravated and eventually caused DVT.

Obesity patients were at risk of increased operation difficulty, prolong procedure time and more possibly had complications(20). VTE event would increase 2.0-3.3% more in obese patients six month after TKA(14). The increased relevance with the BMI was showed in our study, and the independent risk factor was found obesity over II grade. History of VTE was considered increase VTE markly after TKA(15, 21), but studies were not always in the same opinion(22–24). In our study, patients with history of DVT were at almost 4 times higher risk of sym-DVT. Also old age was a high risk factor for sym-DVT(11, 13), especially when patient was older than 80 years, there would be 1.58 times more than under 55 years(11). Old age patients were showed more likely occurred sym-DVT in this study, but it was not an independent risk factor.

Charlson index was indicated internal medical condition and higher score would cause 1.4–1.73 times more VTE(11, 15), especially the history of cardiovascular disease(7, 25) and tumor(26, 27). These patients might be in irritable state and more susceptible to thromboembolism. For studies considered that VTE after operation was strongly associated with inflammatory state, for fibrinolysis activity was decreased under inflammation and increased VTE(28–30). And this study indicated tourniquet used in patients with history of tumor and DVT were caused significant more sym-DVT.

There were some limits that need further research. First of all, for the disadvantage of retrospective study, the awareness of low limb swelling and medical knowledge of patient might cause some artificial bias. Secondly, some inappropriate daily activity or living habit might influence the occurrence of sym-DVT.

Thirdly, prothrombin or clotting factor gene mutation might crucial in thrombosis, and it was designed to measure it in further research.

# Conclusions

Tourniquet reuse was associated with highly incidence of sym-DVT other than history of tumor and DVT. Longer tourniquet use was associated with more possibility of sym-DVT. There should be once use or no use of tourniquet would be helpful for prevent DVT after TKA operation.

# Abbreviations

DVT: Deep vein thrombosis. TKA: total knee arthroplasty. sym-DVT: symptomatic DVT. BMI: Body mass index. CRP: C-reactive protein. MI: Myocardial infarction. ASA: American society of anesthesiologists. WHO: World health organization. CCI: Charlson comorbidity index. LMWH: Low molecular weight heparin. CTA: Computed tomography angiography.

# Declarations

### Ethics approval and consent to participate

This manuscript report research had approved by the ethics committee of The First Affiliated Hospital of Zhejiang Chinese Medical University and each participant provided verbal consent.

### Consent for publication

We declaring our consent for the manuscript to be considered for publication. There had no personal medical information in the text or images of this manuscript.

### Availability of data and materials

Not applicable

### Competing interests

This manuscript is not currently under consideration by any other journal. None of the authors have interests in any company or institution that might benefit from the publication of this manuscript.

### Funding

We are confirming that this study was supported by National Natural Science Foundation of China (No. 81974576) and Zhejiang Chinese Medical University scientific research (No. 2019ZG07).

### Authors' contributions

Each author was equal contributed to the manuscript.

**Acknowledgements**

We would like to give our great gratitude to Dr. Yang Zhang and Dr. Guisong Yu for their invaluable assistance.

# References

1. Leizorovicz A. Epidemiology of post-operative venous thromboembolism in Asian patients. Results of the SMART venography study. Haematologica. 2007;92(9):1194–200.
2. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008;133(6 Suppl):381S-453S.
3. Douketis JD, Eikelboom JW, Quinlan DJ, Willan AR, Crowther MA. Short-duration prophylaxis against venous thromboembolism after total hip or knee replacement: a meta-analysis of prospective studies investigating symptomatic outcomes. Arch Intern Med. 2002;162(13):1465–71.
4. Francis CW, Berkowitz SD, Comp PC, Lieberman JR, Ginsberg JS, Paiement G, et al. Comparison of ximelagatran with warfarin for the prevention of venous thromboembolism after total knee replacement. N Engl J Med. 2003;349(18):1703–12.
5. Selby R, Borah BJ, McDonald HP, Henk HJ, Crowther M, Wells PS. Impact of thromboprophylaxis guidelines on clinical outcomes following total hip and total knee replacement. Thromb Res. 2012;130(2):166–72.
6. Warwick DJ, Whitehouse S. Symptomatic venous thromboembolism after total knee replacement. J Bone Joint Surg Br. 1997;79(5):780–6.
7. Wang CJ, Wang JW, Chen LM, Chen HS, Yang BY, Cheng SM. Deep vein thrombosis after total knee arthroplasty. J Formos Med Assoc. 2000;99(11):848–53.
8. Kearon C. Natural history of venous thromboembolism. Circulation. 2003;107(23 Suppl 1):I22–30.
9. Kulshrestha V, Kumar S. DVT prophylaxis after TKA: routine anticoagulation vs risk screening approach - a randomized study. J Arthroplasty. 2013;28(10):1868–73.
10. Cuker A. ACP Journal Club. Risk-stratified vs routine antithrombotics for TKA: fewer wound complications without increasing DVT. Ann Intern Med. 2013;159(12):JC5.
11. Pedersen AB, Mehnert F, Johnsen SP, Husted S, Sorensen HT. Venous thromboembolism in patients having knee replacement and receiving thromboprophylaxis: a Danish population-based follow-up study. J Bone Joint Surg Am. 2011;93(14):1281–7.
12. Barg A, Henninger HB, Hintermann B. Risk factors for symptomatic deep-vein thrombosis in patients after total ankle replacement who received routine chemical thromboprophylaxis. J Bone Joint Surg Br. 2011;93(7):921–7.

13. Joseph JE, Low J, Courtenay B, Neil MJ, McGrath M, Ma D. A single-centre prospective study of clinical and haemostatic risk factors for venous thromboembolism following lower limb arthroplasty. Br J Haematol. 2005;129(1):87–92.
14. Wallace G, Judge A, Prieto-Alhambra D, de Vries F, Arden NK, Cooper C. The effect of body mass index on the risk of post-operative complications during the 6 months following total hip replacement or total knee replacement surgery. Osteoarthritis Cartilage. 2014.
15. Pedersen AB, Sorensen HT, Mehnert F, Overgaard S, Johnsen SP. Risk factors for venous thromboembolism in patients undergoing total hip replacement and receiving routine thromboprophylaxis. J Bone Joint Surg Am. 2010;92(12):2156–64.
16. Nathan S, Aleem MA, Thiagarajan P, Das De S. The incidence of proximal deep vein thrombosis following total knee arthroplasty in an Asian population: a Doppler ultrasound study. J Orthop Surg (Hong Kong). 2003;11(2):184–9.
17. Gangireddy C, Rectenwald JR, Upchurch GR, Wakefield TW, Khuri S, Henderson WG, et al. Risk factors and clinical impact of postoperative symptomatic venous thromboembolism. Journal of vascular surgery: official publication, the Society for Vascular Surgery [and] International Society for Cardiovascular Surgery. North American Chap. 2007;45(2):335. :– 41; discussion 41 – 2..
18. Agnelli G, Bolis G, Capussotti L, Scarpa RM, Tonelli F, Bonizzoni E, et al. A clinical outcome-based prospective study on venous thromboembolism after cancer surgery: the @RISTOS project. Ann Surg. 2006;243(1):89–95.
19. Parmet JL, Horrow JC, Berman AT, Miller F, Pharo G, Collins L. The incidence of large venous emboli during total knee arthroplasty without pneumatic tourniquet use. Anesth Analg. 1998;87(2):439–44.
20. Horan F. Obesity and joint replacement. J Bone Joint Surg Br. 2006;88(10):1269–71.
21. Warwick D, Friedman RJ, Agnelli G, Gil-Garay E, Johnson K, FitzGerald G, et al. Insufficient duration of venous thromboembolism prophylaxis after total hip or knee replacement when compared with the time course of thromboembolic events: findings from the Global Orthopaedic Registry. J Bone Joint Surg Br. 2007;89(6):799–807.
22. Comp PC, Spiro TE, Friedman RJ, Whitsett TL, Johnson GJ, Gardiner GA Jr, et al. Prolonged enoxaparin therapy to prevent venous thromboembolism after primary hip or knee replacement. Enoxaparin Clinical Trial Group. J Bone Joint Surg Am. 2001;83-A(3):336–45.
23. Mantilla CB, Horlocker TT, Schroeder DR, Berry DJ, Brown DL. Risk factors for clinically relevant pulmonary embolism and deep venous thrombosis in patients undergoing primary hip or knee arthroplasty. Anesthesiology. 2003;99(3):552–60. discussion 5A.
24. Schiff RL, Kahn SR, Shrier I, Strulovitch C, Hammouda W, Cohen E, et al. Identifying orthopedic patients at high risk for venous thromboembolism despite thromboprophylaxis. Chest. 2005;128(5):3364–71.
25. Kikura M, Takada T, Sato S. Preexisting morbidity as an independent risk factor for perioperative acute thromboembolism syndrome. Arch Surg. 2005;140(12):1210–7. discussion 8.

26. Anderson FA Jr, Spencer FA. Risk factors for venous thromboembolism. Circulation. 2003;107(23 Suppl 1):I9–16.
27. Guijarro R, Montes J, San Roman C, Arcelus JI, Barillari G, Granero X, et al. Venous thromboembolism and bleeding after total knee and hip arthroplasty. Findings from the Spanish National Discharge Database Thrombosis haemostasis. 2011;105(4):610–5.
28. Rectenwald JE, Myers DD Jr, Hawley AE, Longo C, Henke PK, Guire KE, et al. D-dimer, P-selectin, and microparticles: novel markers to predict deep venous thrombosis. A pilot study. Thromb Haemost. 2005;94(6):1312–7.
29. Henke PK, Varma MR, Deatrick KB, Dewyer NA, Lynch EM, Moore AJ, et al. Neutrophils modulate post-thrombotic vein wall remodeling but not thrombus neovascularization. Thromb Haemost. 2006;95(2):272–81.
30. Wagner DD. New links between inflammation and thrombosis. Arteriosclerosis, thrombosis, and vascular biology. 2005;25(7):1321–4.

# Tables

Table 1 Demography data between sym-DVT and non sym-DVT patients

| Variables | Sym-DVT N/Mean±SD/Med(range) | | Statistical value ($\chi^2$/T) | P value |
|---|---|---|---|---|
| | YES (31) | NO (776) | | |
| Age (years) | 66.81±6.51 | 62.32±6.05 | 2.483 | 0.032 |
| Gender (Male/Female) | 18/13 | 421/355 | 2.424 | 0.120 |
| BMI | 27.58 ±2.03 | 26.82 ±2.61 | 1.7542 | 0.080 |
| OA knee (Y/N) | 25/6 | 668/108 | 1.474 | 0.162 |
| Charlson index | | | 0.146 | 0.930 |
| Low | 15 | 351 | | |
| Middle | 12 | 341 | | |
| High | 4 | 84 | | |
| History of medicine (Y/N) | 21/10 | 512/264 | 1.249 | 0.264 |
| COPD | 5/26 | 118/659 | 0.236 | 0.627 |
| Diabetes mellitus | 7/24 | 143/633 | 0.083 | 0.773 |
| Hypertension | 6/25 | 106/670 | 1.588 | 0.208 |
| Heart failure | 4/27 | 91/685 | 0.256 | 0.613 |
| Coronary heart disease | 8/23 | 138/638 | 0.386 | 0.535 |
| Tumor | 6/25 | 67/709 | 4.319 | 0.036 |
| Antiplatelet drug (Y/N) | 5/26 | 158/618 | 1.290 | 0.152 |
| History of DVT (Y/N) | 8/23 | 108/668 | 4.404 | 0.034 |
| History of operation (in six month) (Y/N) | 3/28 | 65/711 | 3.433 | 0.064 |
| At contralateral limb (Y/N) | 1/30 | 19/757 | 5.389 | 0.020 |
| Low limb swelling (cm) | 5.26 ± 1.12 | 4.21 ± 1.01 | 1.687 | 0.061 |
| Lactic acid | | | | |
| Preoperation | 0.58 ± 0.13 | 0.61 ± 0.15 | -0.941 | 0.314 |
| Postoperation | 1.86 ± 0.74 | 1.75 ± 0.62 | 2.125 | 0.062 |
| CRP (mg/L) | | | | |
| Preoperation | 7.36 ± 2.13 | 5.77 ± 1.73 | -1.372 | 0.121 |

| | | | | |
|---|---|---|---|---|
| Postoperation | 137.36 ± 26.15 | 111.77 ± 14.73 | 3.072 | 0.013 |
| Albumin (g/L) | | | | |
| Preoperation | 38.95 ± 7.41 | 43.05 ± 9.83 | -0.875 | 0.358 |
| Postoperation | 28.64 ± 5.12 | 31.27 ± 6.35 | -2.125 | 0.091 |
| D-dimer (mg/L) | | | | |
| Preoperation | 0.42 ± 0.13 | 0.36 ± 0.11 | 1.053 | 0.246 |
| Postoperation | 9.54 ± 2.01 | 7.18 ± 1.74 | 2.304 | 0.087 |

OA: Osteoarthritis

BMI: Body Mass Index

COPD: Chronic Obstructive Pulmonary Disease

Table 2 Operation factors between sym-DVT and non sym-DVT patients

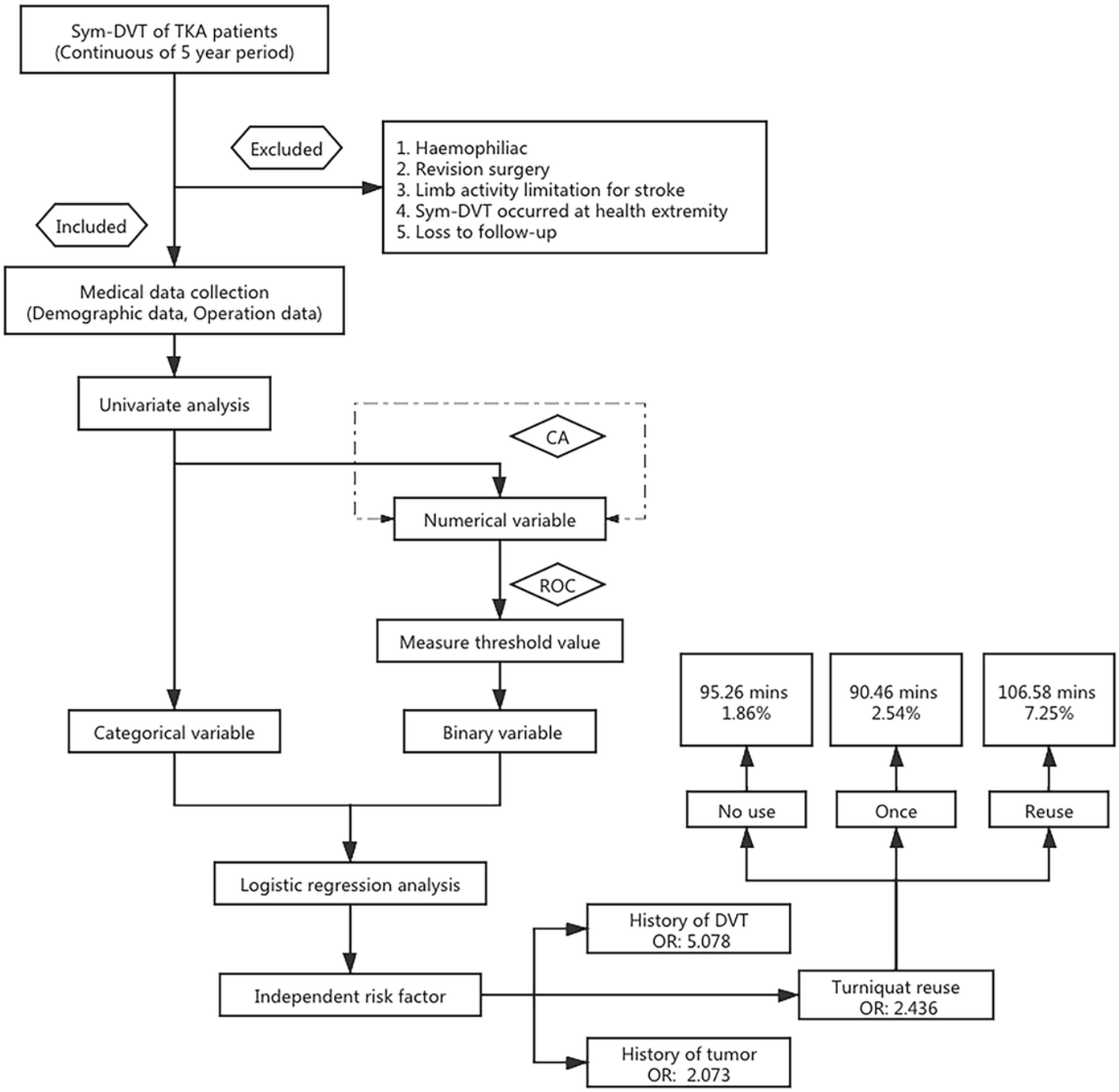
| Variables | Sym-DVT N/Mean(±SD)/Med(range) | | Statistical value ($\chi^2$/T) | P value |
|---|---|---|---|---|
| | YES (31) | NO (776) | | |
| ASA grade | | | 2.970 | 0.227 |
| I grade | 11 | 316 | | |
| II grade | 16 | 371 | | |
| III grade | 4 | 89 | | |
| Anesthesia | | | 1.698 | 0.428 |
| General anesthesia | 14 | 352 | | |
| Spinal anesthesia | 13 | 327 | | |
| Nerve block | 4 | 97 | | |
| Incision | | | 1.040 | 0.308 |
| Median | 23 | 601 | | |
| Medial parapatellar | 8 | 175 | | |
| Length of operation | 101.37 (14.39) | 93.12 (13.81) | 1.542 | 0.073 |
| Tourniquet use (Y/N) | 24/7 | 562/214 | 1.698 | 0.065 |
| Tourniquet reuse (Y/N) | 19/5 | 311/251 | 3.751 | 0.043 |
| Length of tourniquet use | | | | |
| Once (mins) | 87.46 (14.75) | 81.71 (13.35) | 1.755 | 0.060 |
| Reuse (mins) | 106.58 (16.13) | 90.46 (14.28) | 1.906 | 0.045 |
| Bleeding intraoperative (ml) | 372.59(28.45) | 368.92(30.29) | 0.727 | 0.467 |
| Red blood cells transfusion (Y/N) | 5/26 | 147/629 | 0.028 | 0.867 |

Table 3 Cutoff value of numerical variables after ROC analysis and difference of sym-DVT incidence

| Variables | Cutoff value | Devided groups | Sym-DVT (%) | $\chi^2$ | P value |
|---|---|---|---|---|---|
| Age | 63.47 | ≤64 | 2.24 | -1.887 | 0.059 |
| | | >64 | 4.25 | | |
| BMI | 33.18 | ≤ II grade | 2.37 | -1.896 | 0.058 |
| | | > II grade | 4.70 | | |
| Length of operation (mins) | 95.53 | ≤96 | 2.28 | -2.09 | 0.037 |
| | | >96 | 4.84 | | |
| Length of tourniquet use (mins) | 80.78 | ≤81 | 2.08 | -2.374 | 0.018 |
| | | >81 | 4.79 | | |
| Change of CRP | 56.23 | ≤56.23 | 2.16 | -2.126 | 0.034 |
| | | >56.23 | 4.50 | | |
| Change of lactic acid | 1.03 | ≤1.03 | 2.00 | -2.271 | 0.023 |
| | | >1.03 | 4.32 | | |
| Low limb swelling (cm) | 4.12 | ≤4.2 | 2.19 | -1.831 | 0.067 |
| | | >4.2 | 4.04 | | |

| Table 4 Multiple logistic regression analysis of potential risk factors | | | | | |
|---|---|---|---|---|---|
| Variables | B | SE | Wald | P value | OR (95% CI) |
| Age (>64 years) | 0.435 | 0.018 | 3.074 | 0.057 | 1.545(0.851-3.072) |
| BMI (>II grade) | 1.108 | 0.925 | 3.625 | 0.054 | 3.028(0.906-3.125) |
| History of tumor | 0.071 | 0.031 | 5.340 | 0.021 | 2.073(2.011-2.340) |
| History of DVT | 1.625 | 0.113 | 30.635 | <0.001 | 5.078(2.497-8.331) |
| History of operation | 0.876 | 1.294 | 0.459 | 0.498 | 2.406(0.133-5.257) |
| At contralateral limb | 0.952 | 0.928 | 0.662 | 0.416 | 2.591(0.824-2.003) |
| Length of operation (>58 mins) | 0.733 | 0.372 | 1.674 | 0.125 | 2.081(0.671-3.104) |
| Length of tourniquet use (>81 mins) | 1.035 | 0.918 | 4.074 | 0.056 | 2.815(0.926-7.125) |
| Low limb swelling (>1.6cm) | 0.952 | 1.126 | 1.946 | 0.091 | 2.491(0.730-3.576) |

# Figures




## Figure 1

The follow-up flowchart Sym-DVT: Symptomatic DVT ROC: Receiver Operating Characteristic Curve CA: Correlation analysis OR: odds ratio