EJA

Eur J Anaesthesiol 2024; **41:**622–626

INFOGRAPHIC

GUIDELINES

European guidelines on peri-operative venous thromboembolism prophylaxis: first update.

Chapter 13: Nonambulatory orthopaedic surgery

Jean-Yves Jenny, Anne Godier, Catherine Heim, Sibylle Langenecker, Emmanuel Thienpont and John Eikelboom

European Journal of Anaesthesiology 2024, **41**:622–626

Rationale

Venous thrombo-embolic events (VTE) are a classic complication of orthopaedic and trauma surgery. Traditionally, their prevention has been based on the routine prescription of potent anticoagulants. More recently, the recognition of the iatrogenic complications of anticoagulant therapy, the advent of rapid recovery or fast-track procedures, and the consequent assumption of reduced risk of postoperative VTE, have led to a more general reflection on the benefit/risk balance of prophylaxis through anticoagulant treatment.

Patient-related VTE risk factors include (but are not limited to):

- previous or family history of venous thromboembolism[1,2]
- major thrombophilia[3]
- age >70 years[4]
- obesity[5]
- hypoalbuminaemia[6]
- active cancer[7]
- oestrogenic oral contraception and oral hormone therapy for the menopause[8]
- renal insufficiency[9]

Risk factors for VTE associated with surgery include (but are not limited to):

- surgery on the lower limb, especially pelvic, hip, knee[10]
- long duration of surgery[11]
- cast immobilisation[12]
- allogenic blood transfusion[13]
- use of tourniquet[14]

Patient-related bleeding risk factors include (but are not limited to):

- coagulopathy[15]
- anticoagulant medication[16]

Bleeding risk factors related to the procedure performed are (but are not limited to):

- duration of procedure[17]
- length of skin incision[18]
- use of drains[19]

The prescription of prophylactic treatment must be based on a synthesis of these different elements. Prescription must be tailored for each patient and each procedure, and no universal approach can be proposed.

Fast-track procedures aim to reduce the duration of a hospital stay by delivering optimised patient-centred care to achieve a pain and risk-free surgery.[20] These pathways reduce the risk of postoperative VTE in orthopaedics[21] and should be used routinely as there are no real contra-indications, particularly to early resumption of walking, which is probably the major factor preventing VTE.[22,23]

From the ELSAN Clinique Sainte Odile, Haguenau, France; ESH (J-YJ), Service d'anesthésie réanimation, Hôpital Européen Georges Pompidou; INSERM UMRS-1140; Université Paris Cité, ESAIC (AG), CHUV – University Hospital Lausanne, Switzerland; Department of Anesthesiology, ESAIC (CH), Department of Anaesthesia and Intensive Care, Evangelical Hospital Vienna and Sigmund Freud Private University, Vienna, Austria; ESAIC (SL), Cliniques universitaires Saint Luc, Bruxelles, Belgique, EKS (ET), and McMaster University, Hamilton, Canada (JE)

Correspondence to Jean-Yves Jenny, ELSAN Clinique Sainte-Odile Haguenau, Haguenau 67500, France.
E-mail: docteur.jenny@free.fr

DOI:10.1097/EJA.0000000000002020

Procedures such as hip or knee arthroscopy, foot surgery or upper limb surgery (a non-exhaustive list) carry a low risk of postoperative VTE.[12,24–26] The risk of iatrogenic bleeding with anticoagulants may be higher. It therefore seems logical to reserve the prescription of anticoagulants for patients at high risk of VTE without a high personal risk of bleeding.

Numerous articles have demonstrated the impact of pharmacological prophylaxis in orthopaedic surgery, particularly after pelvic, hip and knee surgery. In general, however, the literature does not allow us to decide which molecule is the most appropriate. Total hip arthroplasty (THA), total knee arthroplasty (TKA) and hip fractures are the most well documented procedures. Pharmacological prophylaxis is the most well documented form, and probably the most effective, at the cost of a higher risk of bleeding that can lead to periprosthetic infection. An increasing number of articles suggest that aspirin is an interesting alternative for THA and TKA, particularly in fast-track procedures. However, aspirin is not currently validated after hip fracture. The most recent literature does not show any superiority of any drug or any protocol for VTE prevention after orthopaedic and trauma surgery,[27–49] even if some reports come to different conclusions.[50–53] No screening tool is widely used and accepted after orthopaedic surgery.[54]

The advantage of mechanical prophylaxis is its safety, but its actual efficacy is open to debate.[55–62] It may be useful as an adjuvant treatment, particularly when the risk of bleeding with anticoagulants is high.

Recommendations

- Foreword 1: The term 'Non-ambulatory orthopaedic surgery' refers to patients remaining in hospital for at least one night post-surgery, without defining the total length of stay. This term does not define the type of postoperative rehabilitation, which may or may not include a fast-track procedure. The risk of VTE increases with the length of stay, whereas fast-track procedures are presumed to reduce this risk. It is therefore not possible to define unique recommendations.
- Foreword 2: The term 'pharmacological VTE prophylaxis' includes (by alphabetic order) aspirin, coumarin, direct oral anticoagulants (DOAC), low molecular weight heparins (LMWH) and unfractionated heparin (UFH) in the case of renal failure. The term 'mechanical prophylaxis' included (by alphabetical order) fast-track procedures, graduate compression stockings and intermittent pneumatic compression.
- Foreword 3: There no generally accepted classification for low or high VTE risk surgery and low or high risk of bleeding. These points should be assessed with a surgery- and patient-specific policy (Supplementary Table 1, http://links.lww.com/EJA/A981

Preoperative period

(1) We suggest routine patient-specific rather than population-based preoperative evaluation of the risk of VTE and bleeding according to the type of procedure and the planned postoperative course (fast-track or standard postoperative procedure) (Grade 2B)

Postoperative period

(1) We recommend routine fast-track procedures including early ambulation and joint mobilisation over timing of procedures based on convenience (Grade 1B).

(2) Low VTE risk surgery
   (a) No patient-related risk factor: We suggest no pharmacological VTE prophylaxis for procedures with low VTE risk for a patient without high personal risk of VTE (Grade 2B).
   (b) Additional patient-related risk factor for VTE:
      (i) No high risk of bleeding: We suggest pharmacological VTE prophylaxis with either LMWH or DOAC over no VTE prophylaxis for procedures with low VTE risk for a patient with high personal risk of VTE (Grade 2B). We are unable to make a recommendation for or against the use of aspirin.
      (ii) High risk of bleeding: We suggest mechanical prophylaxis over no VTE prophylaxis for procedures with low VTE risk for a patient with high personal risk of VTE (Grade 2C).

(3) High VTE risk surgery:

   (a) No high risk of bleeding: We suggest VTE prophylaxis with either LMWH or DOAC rather than no VTE prophylaxis for procedures with high VTE risk without high risk of bleeding (Grade 2B). We are unable to make a recommendation for or against the use of aspirin.
   (b) High risk of bleeding: We suggest mechanical VTE prophylaxis rather than pharmacological prophylaxis for procedures with high VTE risk with high risk of bleeding (Grade 2C).

(4) Specific procedures

   (a) We recommend pharmacological VTE prophylaxis rather than no prophylaxis after THA, TKA and hip fractures (Grade 1A).
   (b) We recommend pharmacological VTE prophylaxis with either LMWH or DOAC rather than no prophylaxis after fast-track THA, TKA or hip fracture (Grade 1B).
   (c) We recommend pharmacological VTE prophylaxis with aspirin rather than no prophylaxis after fast-track THA and TKA (Grade 1C).

(d) We recommend pharmacological VTE prophylaxis with either LMWH or DOAC rather than no prophylaxis after THA, TKA and hip fractures (Grade 1A)
(e) We recommend pharmacological VTE prophylaxis with LMWH (Grade 1B), DOAC (Grade 1B) or aspirin (Grade 1C) rather than no prophylaxis after fast-track THA or TKA.

Acknowledgements relating to this article

Assistance with Editorial: none.

Financial Support and sponsorship: the work was funded by ESAIC, EACTAIC, EACTS, ISTH, EURAPS and EKS.

Conflict of interests: J-YJ: Stock shareholder: Lynckx, Other support: B-Braun, United Orthopedics, Heraeus; SL: Receipt of honoraria or consultation fees: Baxter, CSL Behring, Norgine, Werfen; AG: Receipt of honoraria or consultation fees: Aguettant, Bayer Healthcare, BMS-Pfizer, Boehringer Ingelheim, Sanofi, CSL Behring, LFB, Octapharma, Stago; JE: Receipt of grants/research supports: Anthos, Bayer, BI, BMS, Daiichi-Sankyo, Ionis, Janssen, Merck, Pfizer, USV; Receipt of honoraria or consultation fees: Anthos, Bayer, BI, BMS, Daiichi-Sankyo, Ionis, Janssen, Merck, Pfizer, USV

Presentation: none.

References

1 Bezemer ID, van der Meer FJM, Eikenboom JCJ, *et al.* The value of family history as a risk indicator for venous thrombosis. *Arch Intern Med* 2009; **169**:610–615.
2 Nemeth B, Lijfering WM, Nelissen RGHH, *et al.* Risk and risk factors associated with recurrent venous thromboembolism following surgery in patients with history of venous thromboembolism. *JAMA Netw Open* 2019; **2**:e193690.
3 Zöller B, Svensson PJ, Dahlbäck B, *et al.* Genetic risk factors for venous thromboembolism. *Expert Rev Hematol* 2020; **13**:971–981.
4 Keller K, Hobohm L, Ebner M, *et al.* Trends in thrombolytic treatment and outcomes of acute pulmonary embolism in Germany. *Eur Heart J* 2020; **41**:522–529.
5 Pahlkotter MK, Mohidul S, Moen MR, *et al.* BMI and VTE risk in emergency general surgery, does size matter?: an ACS-NSQIP database analysis. *Am Surg* 2020; **86**:1660–1665.
6 Lung BE, Kanjiya S, Bisogno M, *et al.* Risk factors for venous thromboembolism in total shoulder arthroplasty. *JSES Open Access* 2019; **3**:183–188.
7 Kemp M, Chan AHY, Harrison J, *et al.* Formal and informal venous thromboembolism risk assessment and impact on prescribing of thromboprophylaxis: a retrospective cohort study. *Int J Clin Pharm* 2023; **45**:864–874.
8 van Adrichem RA, Nemeth B, Algra A, *et al.*, POT-KAST and POT-CAST Group. Thromboprophylaxis after knee arthroscopy and lower-leg casting. *N Engl J Med* 2017; **376**:515–525.
9 Brennan J, Keblish D, Friedmann E, *et al.* Postoperative venous thromboembolism risk-prediction in foot and ankle fracture surgery. *Foot (Edinb)* 2023; **17**:56.
10 Parvizi J, Huang R, Raphael IJ, *et al.* Symptomatic pulmonary embolus after joint arthroplasty: stratification of risk factors. *Clin Orthop Relat Res* 2014; **472**:903–912.
11 Zhang ZH, Shen B, Yang J, *et al.* Risk factors for venous thromboembolism of total hip arthroplasty and total knee arthroplasty: a systematic review of evidences in ten years. *BMC Musculoskelet Disord* 2015; **16**:24.
12 Samama CM, Laporte S, Rosencher N, *et al.*, for the PRONOMOS Investigators. Rivaroxaban or enoxaparin in nonmajor orthopedic surgery. *N Engl J Med* 2020; **382**:1916–1925.
13 Acuña AJ, Grits D, Samuel LT, *et al.* Perioperative blood transfusions are associated with a higher incidence of thromboembolic events after TKA: an analysis of 333,463 TKAs. *Clin Orthop Relat Res* 2021; **479**:589–600.
14 Xie J, Yu H, Wang F, *et al.* A comparison of thrombosis in total knee arthroplasty with and without a tourniquet: a meta-analysis of randomized controlled trials. *J Orthop Surg Res* 2021; **16**:408.
15 Kotela I, Żbikowski P, Ambroziak P, *et al.* Orthopedic procedures in patients with congenital coagulation disorders: single center experience. *Ortop Traumatol Rehabil* 2013; **15**:601–616.
16 Spyropoulos AC, Brohi K, Caprini J, *et al.*, SSC Subcommittee on Perioperative and Critical CareThrombosis and Haemostasis of the International Society on Thrombosis and Haemostasis. Scientific and Standardization Committee Communication: guidance document on the periprocedural management of patients on chronic oral anticoagulant therapy: recommendations for standardized reporting of procedural/surgical bleed risk and patient-specific thromboembolic risk. *J Thromb Haemost* 2019; **17**:1966–1972.
17 Hanreich C, Cushner F, Krell E, *et al.* Blood management following total joint arthroplasty in an aging population: can we do better? *J Arthroplasty* 2022; **37**:642–651.
18 Ioannidis A, Arvanitidis K, Filidou E, *et al.* The length of surgical skin incision in postoperative inflammatory reaction. *JSLS* 2018; **22**:e2018.00045.
19 Xu H, Xie J, Lei Y, *et al.* Closed suction drainage following routine primary total joint arthroplasty is associated with a higher transfusion rate and longer postoperative length of stay: a retrospective cohort study. *J Orthop Surg Res* 2019; **14**:163.
20 Sivaloganathan S, Blakeney WG, Vendittoli PA. Modernizing total hip arthroplasty perioperative pathways: the implementation of ERAS-outpatient protocol. *J Clin Med* 2022; **11**:3293.
21 Petersen PB, Kehlet H, Jørgensen CC, Lundbeck Foundation Centre for Fast-track Hip and Knee Replacement Collaborative Group. Safety of in-hospital only thromboprophylaxis after fast-track total hip and knee arthroplasty: a prospective follow-up study in 17,582 procedures. *Thromb Haemost* 2018; **118**:2152–2161.
22 De Ladoucette A, Mertl P, Henry MP, *et al.*, French Society of Orthopaedic Surgery and Traumatology (SoFCOT). Fast track protocol for primary total hip arthroplasty in nontrauma cases reduces the length of hospital stay: prospective French multicenter study. *Orthop Traumatol Surg Res* 2020; **106**:1527–1531.
23 Jenny JY, Courtin C, Boisrenoult P, *et al.*, Société Française de Chirurgie Orthopédique et Traumatologique (SOFCOT). Fast-track procedures after primary total knee arthroplasty reduce hospital stay by unselected patients: a prospective national multicentre study. *Int Orthop* 2021; **45**:133–138.
24 Aufwerber S, Heijne A, Edman G, *et al.* Early mobilization does not reduce the risk of deep venous thrombosis after Achilles tendon rupture: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc* 2020; **28**:312–319.
25 Bikdeli B, Visvanathan R, Weinberg I, *et al.* Clinical characteristics and outcomes of venous thromboembolic events after hallux valgus surgery: insights from the RIETE registry. *J Thrombosis Thrombolysis* 2020; **49**:651–658.
26 Lameire DL, Abdel Khalik H, Phillips M, *et al.* Thromboprophylaxis after knee arthroscopy does not decrease the risk of deep vein thrombosis: a network meta–analysis. *Knee Surg Sports Traumatol Arthrosc* 2022; **30**:3264–3276.
27 Alfarhan MAA. Efficacy and safety of enoxaparin versus new oral anticoagulants to prevent venous thromboembolism after total hip replacement: a systematic review and meta-analysis. *J Pers Med* 2022; **12**:107.
28 An VVG, Levy YD, Walker PM, Bruce WJM. Thrombosis rates using aspirin and a compression device as multimodal prophylaxis for lower limb arthroplasty in a screened population. *J Clin Orthop Trauma* 2020; **11**: S187–S191.
29 Anderson DR, Dunbar M, Murnaghan J, *et al.* Aspirin or rivaroxaban for VTE prophylaxis after hip or knee arthroplasty. *New Engl J Med* 2018; **378**:699–707.
30 Baumgartner C, Maselli J, Auerbach AD, Fang MC. Aspirin compared with anticoagulation to prevent venous thromboembolism after knee or hip arthroplasty: a large retrospective cohort study. *J Gen Intern Med* 2019; **34**:2038–2046.
31 Colleoni JL, Ribeiro FN, Mos PAC, *et al.* Venous thromboembolism prophylaxis after total knee arthroplasty (TKA): aspirin vs. rivaroxaban. *Rev Bras Ortop* 2018; **5**:22–27.
32 Cortes-De la Fuente AA, Villalobos-Campuzano C, Bucio-Paticio B, *et al.* Comparative study between enoxaparin and salicylic acetyl acid in antithrombotic prophylaxis for patients undergoing total knee arthroplasty. *Acta Ortop Mex* 2021; **35**:163–168.
33 Fiasconaro M, Poeran J, Liu J, *et al.* Venous thromboembolism and prophylaxis therapy after spine surgery: a population-based study. *Can J Anesth* 2021; **68**:345–357.

34 Goh EL, Gurung PK, Ma S, *et al.* Direct oral anticoagulants in the prevention of venous thromboembolism following surgery for hip fracture in older adults: a population-based cohort study. *Ger Orthop Surg Rehab* 2020; **11**:1–5.
35 Haac BE, O'Haral NN, Manson TT, *et al.*, ADAPT Investigators. Aspirin versus low-molecular-weight heparin for venous thromboembolism prophylaxis in orthopaedic trauma patients: a patient centered randomized controlled trial. *PLoS One* 2020; **15**:e0235628.
36 Haykal T, Kheiria B, Zayeda Y, *et al.* Aspirin for venous thromboembolism prophylaxis after hip or knee arthroplasty: an updated meta-analysis of randomized controlled trials. *J Orthop* 2019; **16**:312–319.
37 He T, Han F, Wang J, *et al.* Efficacy and safety of anticoagulants for postoperative thrombophylaxis in total hip and knee arthroplasty: a PRISMA-compliant Bayesian network meta-analysis. *PLoS One* 2021; **16**: e0250096.
38 Hood BR, Cowen ME, Zheng HT, *et al.* Association of aspirin with prevention of venous thromboembolism in patients after total knee arthroplasty compared with other anticoagulants a non inferiority analysis. *JAMA Surg* 2019; **154**:65–72.
39 Hovik O, Amlie EJ, Jenssen KK. No increased risk of venous thromboembolism in high-risk patients continuing their dose of 75 mg aspirin compared to healthier patients given low-molecular-weight heparin. *J Arthroplasty* 2021; **36**:3589–3592.
40 Itou J, Kuwashima U, Itoh M, Okazaki K. No difference in the incidence or location of deep venous thrombosis according to use of pharmacological prophylaxis following total knee arthroplasty. *BMC Musculoskelet Disord* 2021; **22**:819.
41 Jang S, Shin WC, Song MK, *et al.* Which orally administered antithrombotic agent is most effective for preventing venous thromboembolism after total knee arthroplasty? A propensity score-matching analysis. *Knee Surg Rel Res* 2021; **33**:10.
42 Jenny JY, Bulaid Y, Boisrenoult P, *et al.*, the French Society of Orthopaedic Surgery, Traumatology (SofCOT). Bleeding and thromboembolism risk of standard antithrombotic prophylaxis after hip or knee replacement within an enhanced recovery program. *Orthop Traumatol Surg Res* 2020; **106**:1533–1538.
43 Marrannes S, Victor K, Arnout N, *et al.* Prevention of venous thromboembolism with aspirin following knee surgery: a systematic review and meta-analysis. *EFFORT Open Rev* 2021; **6**:892–904.
44 Matharu GS, Kunutsor SK, Judge A, *et al.* Clinical effectiveness and safety of aspirin for venous thromboembolism prophylaxis after total hip and knee replacement. A systematic review and meta-analysis of randomized clinical trials. *JAMA Intern Med* 2020; **180**:376–384.
45 Merkow DB, Tang A, Iorio R, *et al.* Low dose aspirin is effective in preventing venous thromboembolism in patients undergoing primary total knee arthroplasty. *J Orthop* 2021; **24**:26–28.
46 Cheallaigh SN, Fleming A, Dahly D, *et al.* Aspirin compared to enoxaparin or rivaroxaban for thromboprophylaxis following hip and knee replacement. *Int J Clin Pharm* 2020; **42**:853–860.
47 Ren Y, Cao SL, Li Z, *et al.* Comparable efficacy of 100 mg aspirin twice daily and rivaroxaban for venous thromboembolism prophylaxis following primary total hip arthroplasty: a randomized controlled trial. *Chin Med J* 2021; **1**:134.
48 Sang CQ, Zhao N, Zhang J, *et al.* Different combination strategies for prophylaxis of venous thromboembolism in patients: a prospective multicenter randomized controlled study. *Scie Rep* 2018; **8**:8277.
49 Yu Z, Shan P, Yang X, Lou XJ. Comparison of efficiency and safety of rivaroxaban, apixaban and enoxaparin for thromboprophylaxis after arthroplastic surgery: a meta-analysis. *Biosci Rep* 2018; **38**: BSR20180423.
50 Cai JY, Cui CM, Min JK, *et al.* Comparison between use of direct oral anticoagulants and aspirin for risk of thromboembolism complications in patients undergoing total knee and hip arthroplasty: a systematic review and meta-analysis. *Eur Rev Med Pharmacol Sci* 2021; **25**:6245–6259.
51 Farey JE, An VVG, Sidhu V, *et al.* Aspirin versus enoxaparin for the initial prevention of venous thromboembolism following elective arthroplasty of the hip or knee: a systematic review and meta-analysis. *Orthop Traumatol Surg Res* 2021; **107**:102606.
52 Jiang H, Meng J, Guo T, *et al.* Comparison of apixaban and low molecular weight heparin in preventing deep venous thrombosis after total knee arthroplasty in older adults. Yonsei Med J 20119;60:626–32.
53 Kasina P, Wall A, Lapidus LJ, *et al.* Postoperative thromboprophylaxis with new oral anticoagulants is superior to LMWH in hip arthroplasty surgery: findings from the Swedish Registry. *Clin Orthop Relat Res* 2019; **477**:1335–1343.
54 Gold PA, Ng TY, Coury JR, *et al.* Can the Caprini score predict thromboembolism and guide pharmacologic prophylaxis after primary joint arthroplasty? *J Orthopedics* 2020; **21**:345–349.
55 Arabi YM, Al–Hameed F, Burns KEA, *et al.*, Saudi Critical Care Trials Group. Adjunctive intermittent pneumatic compression for venous thromboprophylaxis. *N Engl J Med* 2019; **380**:1305–1315.
56 Chang MJ, Song MK, Kyung MG, *et al.* Incidence of deep vein thrombosis before and after total knee arthroplasty without pharmacologic prophylaxis: a 128-row multidetector CT indirect venography study. *BMC Musculoskelet Disord* 2018; **19**:274.
57 Kakkos SK, Caprini JA, Geroulakos G, *et al.* Combined intermittent pneumatic leg compression and pharmacological prophylaxis for prevention of venous thromboembolism (review). *Cochrane Database Syst Rev* 2016; **9**:CD005258.
58 Kim KI, Kim DK, Song SJ, *et al.* Pneumatic compression device does not show effective thromboprophylaxis following total knee arthroplasty in a low incidence population. *Orthop Traumatol Surg Res* 2019; **105**:71–75.
59 Matthews CN, Chen AF, Daryoush T, *et al.* Does an elastic compression bandage provide any benefit after primary TKA? *Clin Orthop Relat Res* 2019; **477**:134–144.
60 Milinis K, Shalhoub J, Coupland AP, *et al.* The effectiveness of graduated compression stockings for prevention of venous thromboembolism in orthopedic and abdominal surgery patients requiring extended pharmacological thromboprophylaxis. *J Vasc Surg Venous Lymphat Disord* 2018; **6**:766–777.e2.
61 Oka T, Wada O, Nitta S, *et al.* Effect of self-calf massage on the prevention of deep vein thrombosis after total knee arthroplasty: a randomized clinical trial. *Phys Ther Res* 2020; **23**:66–71.
62 Wang S, Lu H, Li S. Prevention of deep venous thrombosis in patients undergoing knee arthroplasty by intermittent pneumatic compression apparatus. *Am J Transl Res* 2021; **13**:10765–10770.

GRAPHICAL ABSTRACT