Thromboprophylaxis in orthopaedic surgery
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SUMMARY

This thesis describes the use of thromboprophylactic modalities after total hip and total knee arthroplasty by Dutch orthopedic departments over a period of ten years and several uncertainties regarding thromboprophylaxis in other areas of orthopedic surgery. In this thesis some of these uncertainties are addressed: the incidence of venous thromboembolism after arthroscopic cruciate ligament reconstruction, lower extremity amputation, and shoulder arthroplasty and a case of pulmonary embolism during trial hip plaster cast immobilization.

In chapter 1 a general introduction and a short overview of the history of thromboprophylactic regimens in patients undergoing orthopedic surgery is presented.

Thromboprophylaxis and blood management in the Netherlands

To assess changes in patterns in Dutch Orthopedic thromboprophylaxis practices, three surveys were conducted. In chapter 2, the results of the second survey, conducted in 2007, are described. The use of pharmacological prophylaxis after arthroplasty of the hip and knee as well as after fracture surgery around the hip and knee was common practice in the Netherlands in 2007. In five years time the widely used coumarin-derivates have largely been replaced by LMWH. Low molecular weight heparin was most frequently used (79%), followed by fondaparinux (13%).

Chapter 3 summarizes the results of the third survey, performed in 2012. The use of thromboprophylaxis in and out of hospital was still the standard of care in the Netherlands after hip and knee surgery. Although currently low molecular weight heparin remains the most commonly used thromboprophylactic agent, the new oral anticoagulants are now used in 25% of all departments. In day-care surgery and arthroscopies either no prophylaxis was given (68% and 56% respectively), or a single shot of LMWH (23% and 39% respectively) was employed. There is a significant increase in the use of thromboprophylaxis during plaster cast immobilization and in the use of extended thromboprophylaxis after ACL surgery.

In chapter 4, the use of blood saving modalities among Dutch orthopedic departments during a 10-year follow-up period is described. The use of intraoperative autologous retransfusion in revision hip (56 vs. 54%) as well as revision knee arthroplasty (26 vs. 24%) was virtually unchanged in 2012 compared to five years earlier. Postoperative autologous retransfusion is still used by the majority of departments after both primary arthroplasty and revision of hip (58/53%) and knee (65/61%). Currently, just as in 2007, the majority of Dutch orthopedic departments use erythropoietin, normothermia and postoperative autologous retransfusion with hip and knee arthroplasty. Other effective
blood management modalities such as tranexamic acid have not been widely implemented.

**International guidelines regarding thromboprophylaxis**

In Chapter 5 eleven (inter)national guidelines on thromboprophylaxis from different countries are compared, and their differences analyzed. Eleven guidelines from nine different countries and one international guideline were included. Few guidelines advise on thrombosis prophylaxis after plaster cast immobilization, (prolonged) arthroscopic surgery and isolated lower extremity trauma. Different opinions exist on the sole use of aspirin and mechanical prophylaxis and on the use of Vitamin K antagonists after major hip- and knee surgery. The grade of recommendation should ideally be based on the same level of evidence worldwide. It will be impossible to reach a consensus as long as there is no agreement on the relevance of different outcomes (e.g. asymptomatic DVT).

**Arthroscopic cruciate ligament reconstruction**

In Chapter 6, the results of our study regarding the incidence of deep venous thrombosis after arthroscopic cruciate ligament reconstruction are described. In total 9 of 100 patients (incidence 9%; 95% CI: 4.2-16.4) showed asymptomatic proximal or distal deep vein thrombosis on compression ultrasound, of whom 4 (incidence 4%; 95% CI: 1.1-9.9) were symptomatic. One patient developed a non-fatal pulmonary embolus during the 8-week follow-up period. This study shows that the incidence of VTE following arthroscopic ACL reconstruction is relatively high. Further research is recommended to assess the need for thromboprophylaxis in patients undergoing ACL reconstruction, especially when risk factors are present.

**Lower extremity amputation**

In the study, described in Chapter 7, we prospectively determined the occurrence of deep venous thrombosis and pulmonary embolism both pre- and post-operatively after lower extremity amputation by means of duplex-ultrasonography and ventilation-perfusion lung scintigraphy. Forty-nine patients (53 amputations) were ultimately included in the intention-to-treat analysis. The total mortality rate was 12 of 53 amputations (22.6%, 95% confidence interval (CI) 12.3-36.2). Six patients developed pulmonary embolisms (of which two were fatal) and one patient developed an asymptomatic contra lateral distal deep venous thrombosis resulting in a total VTE rate of 7 out of 53 amputations (13.2%, 95% CI 5.47-25.3). Lower extremity amputation is accompanied by a high mortality rate from sepsis, respiratory and vascular causes. This study shows that VTE substantially contributes to the morbidity and mortality after lower extremity amputation despite adequate pharmacological thromboprophylaxis in this vulnerable population.
Plaster cast immobilization

In chapter 8 a case of pulmonary embolism during trial hip plaster cast immobilization to simulate lumbosacral fusion is described and a review of literature is presented. Generally, immobilization is considered a major risk factor for VTE. In our case the immobilization induced by the hip plaster cast, combined with the use of oral contraceptive medication (OCM) puts our patient in the high-risk category. Therefore we recommend that patients who are fitted with a hip plaster cast should be routinely screened for additional risk factors such as OCM use and a history of VTE. When risk factors are present, patients should be considered for pharmacological thromboprophylaxis.

Shoulder arthroplasty

In chapter 9 a systematic review of literature regarding symptomatic thrombosis after shoulder arthroplasty is presented. The incidence of VTE was relatively low: 0.59% in 47,998 shoulder arthroplasties. The VTE rate for arthroplasty after fractures of the proximal humerus was almost three times as high as the VTE rate for elective, non-traumatic indications; 0.95% vs. 0.33% respectively. The 90-day incidence of PE was comparable to the 90-day incidence of DVT. The mortality rate after shoulder arthroplasty was 0.49%; 0.43% for elective procedures and 3.0% in traumatic indications. The most common statistically significant risk factors for VTE were comorbidities, traumatic indication for arthroplasty and advanced age.

Chapter 10 describes our study protocol regarding the incidence of asymptomatic venous thromboembolic complications as detected by bilateral complete compression ultrasonography of both legs and the operated arm after shoulder arthroplasty without thromboprophylaxis. The first ten included patients did not show any DVT or pulmonary embolism. This study aims to establish the incidence of asymptomatic deep venous thrombosis as detected by ultrasound. If DVT is frequently encountered, a randomized controlled clinical trial comparing thromboprophylaxis and placebo will follow, to determine risk factors for VTE patients undergoing shoulder arthroplasty and to investigate the need for thromboprophylaxis.