Bariatric surgery: studies on its consequences with emphasis on thrombotic and bleeding complications
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Vitamin K antagonists: changes in dosing and time in therapeutic range after bariatric surgery

F. Celik, D.C.W. Poland, S. Bruin, D.P.M. Brandjes, V.E.A. Gerdes

Submitted for publication.
ABSTRACT

Introduction:
Information on the effect of bariatric surgery on treatment with vitamin K antagonists (VKA) and the incidence of vitamin K deficiency after bariatric surgery is limited.

Methods:
All patients who had bariatric surgery at the Slotervaart Hospital and who were using VKA as chronic anticoagulation were included (study 1). Change in VKA dose and percent time in therapeutic range (TTR) after surgery were registered. In study 2, patients were included whose prothrombin time (PT) measurement before surgery and after surgery were known.

Results:
In study 1, 17 patients were included. The mean percent reduction of VKA dose was 13.8% in the first month (p=0.001) and 20.0% in the six months after surgery (p=0.004). Mean TTR decreased from 58.1% before surgery to 39.4% in the first month after surgery (p=0.04) and returned to 51.5% in the six months after surgery (p=0.41). No relation was found between TTR and bleeding complications. In study 2, 200 patients were included. The mean PT prolonged 0.2 seconds: 10.64 ± 0.45 seconds before surgery and 10.85 ± 0.52 seconds six months after surgery (p<0.001).

Conclusion:
In conclusion, there is a VKA dose reduction, especially in the first month after bariatric surgery, but also during the following months. TTR was low in the first month, but returned to preoperative levels. The effect of bariatric surgery on vitamin K status is limited.
INTRODUCTION

Vitamin K antagonist (VKA) therapy is influenced by several factors such as age, diet and concomitant medication [1-6]. Mueller et al. have shown that there is also an association between body mass index (BMI) and the total weekly dose of warfarin [7]. The first months after bariatric surgery are characterized by a dramatic change in the composition and amount of food intake and considerable weight loss. Information on the influence of bariatric surgery on VKA therapy is limited, however, for optimal dosing this information is relevant. Previous studies have shown that different responses to warfarin can occur after any surgical intervention, either increased or decreased sensitivity [8]. We hypothesized that the VKA dose and percent time in therapeutic range (TTR) would decrease after bariatric surgery, at least temporarily. One of the explanations therefore might be the very limited food intake during the first weeks and the effect of dietary changes like intolerance for vitamin K-rich foods during the first months. However, vitamin K intake can be low before surgery and improve as a result of the dietary instructions after surgery. In addition, patients are instructed to take multivitamins every day, which can contain vitamin K. To test the hypothesis, we planned a study to examine the effect of bariatric surgery on VKA dosing and TTR in patients requiring permanent VKA therapy before and after surgery. To evaluate whether bariatric surgery causes vitamin K deficiency, we measured the prothrombin time (PT) in patients without VKA before and after bariatric surgery.

METHODS

Study design and population

All patients who had bariatric surgery at the Slotervaart Hospital between December 2007 and June 2013, and who were using VKA at least one month before and one month after surgery, were eligible for the inclusion in this retrospective study (study 1). Patients who used VKA only before or after surgery were excluded. For the analysis of the change of PT after bariatric surgery, patients who had bariatric surgery between September 2012 and April 2013 were included (study 2). In our hospital PT is included in the routine laboratory measurements before and at six and twelve months after bariatric surgery. For the inclusion in this study, we included all patients who had all PT measurements: PT before surgery, six months after surgery and twelve months after surgery. In case of missing one of these three PT values, patients were excluded. All types of bariatric surgery were included. Patients on VKA were excluded from this study.
Data collection
For study 1, data were obtained from the different anticoagulation services where patients were receiving treatment. All INR values and the VKA dosages six months before surgery and six months after surgery were registered. Digital and paper medical patient files were used to collect clinical and follow-up data: demographics (age, gender), obesity-associated comorbidities (diabetes, hypertension and dyslipidemia), body weight, BMI, total weight loss (TWL), type of bariatric surgery, bleeding complications and data about VKA (type, indication, dosage, and TTR). For the analysis of the change of PT after surgery (study 2), demographics (age, gender), body weight, BMI, TWL, type of bariatric surgery, PT value before surgery, six months and twelve months after surgery were registered (with a maximum varying range of 1 month).

Outcome and data definitions
The main outcomes of the study were the change in the dosage of VKA and TTR after bariatric surgery in study 1 and PT after bariatric surgery in study 2. Major bleeding complications were the secondary outcome of the study. Because of the varying time of blood sampling for INR measurements and subsequent dose adjustments, time periods of eight weeks were defined for the calculations of these changes. The last two weeks before surgery and the first two weeks after surgery were excluded because of peri-operative bridging therapy of anticoagulation. Given the enormous change in intake and sometimes also problems with intake of tablets after surgery, we chose to evaluate also a shorter time period of only 1 month after surgery. For the computation of TTR, the linear interpolation method of Rosendaal was used [9]. Age at the date of surgery was registered. Diabetes was defined as an HbA1c ≥6.5% and/or use of antidiabetic drugs. Hypertension was defined as a blood pressure of above 140/90 mmHg and/or use of antihypertensive therapy. Dyslipidemia was defined as use of statins and/or a raised total cholesterol level, LDL or triglycerides above the 95st percentile according to the definition proposed by the American Heart Association [10]. TWL was defined as the percent difference between the weight before and after surgery. Major bleeding complications were defined according to the ISTH criteria for major bleeding in surgical studies [11]. The reference values for PT at the Slotervaart Hospital are 9.9 - 12.5 seconds. Vacuette® tubes (Greiner Bio-One GmbH, Kremsmünster, Austria) containing 3,2% sodium citrate were used for venous blood collection. After collection, the blood specimens were transported to the laboratory and centrifuged. PT was assessed by using reagent from Innovin (Siemens Healthcare Diagnostics Products, Marburg, Germany) on a Sysmex CA-1500 instrument (Toa Medical Electronics, Kobe, Japan).
Statistical analysis
Baseline characteristics of the patients are summarized using descriptive statistics. Data are presented as mean ± standard deviation (SD) or median (range) dependent on the distribution. Continuous variables are compared by Wilcoxon signed ranks test (study 1) or paired t-test (study 2). The mean dose of VKA and TTR after surgery were compared with the last six months before surgery. The first month after surgery was analyzed separately and was also compared with the last six months before surgery. This percentage change in VKA dose was calculated for each time period and the first time period was taken as the reference (100%). The same analyses were also done separately for patients who used acenocoumarol and patients who used phenprocoumon. All tests were two-tailed and a p value <0.05 was considered statistically significant. Statistical analyses were performed using SPSS software package (version 19).

RESULTS

Study 1. Characteristics of patients on vitamin K antagonists.
A total of 1499 bariatric surgeries were performed between December 2007 and June 2013. 23 patients (1.5%) who used chronic VKA were approached. Six patients were excluded because of missing data, so finally 17 patients were included for the analyses. Nine patients used acenocoumarol and eight patients phenprocoumon. These patients had a mean age of 51.4 ± 6.8 years and 10 (59%) were female. Before surgery, 6 patients had diabetes, 10 hypertension and 4 dyslipidemia. Mean weight before surgery was 136.9 ± 21.1 kg and BMI 45.2 ± 8.6 kg/m2. Mean TWL was 22.4 ± 3.9 %. The majority of bariatric surgeries consisted of laparoscopic gastric bypass (GBP) (14), followed by laparoscopic banded bypass (2) and laparoscopic adjustable gastric banding (1). The most common indication for VKA was atrial fibrillation. The INR target range was 2.5-3.5 in most cases. Three patients had an INR target range of 3.0-4.0. The indications for a higher target range were sagittal sinus thrombosis with protein C deficiency, dilating cardiomyopathy and arterial thrombus of the arm. The mean follow up time was 158 ± 33 days (range 35-168) before surgery and 168 ± 0 days after surgery. There were an average of three INR measurements per time period. There was no difference between acenocoumarol and phenprocoumon concerning number of measurements per time period. Characteristics of the patients are shown in table 1.
Table 1. Patient characteristics of patients who use acenocoumarol or phenprocoumon as chronic anticoagulation (study 1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients n=17</th>
<th>Acenocoumarol n=9</th>
<th>Phenprocoumon n=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>51.4 ± 6.8</td>
<td>52.6 ± 6.4</td>
<td>50.1 ± 7.4</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>10 (59)</td>
<td>5 (56)</td>
<td>5 (63)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6 (35)</td>
<td>4 (44)</td>
<td>2 (25)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>10 (59)</td>
<td>6 (67)</td>
<td>4 (50)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>4 (24)</td>
<td>3 (33)</td>
<td>1 (13)</td>
</tr>
<tr>
<td>Body weight before (kg)</td>
<td>136.9 ± 21.1</td>
<td>147.3 ± 18.1</td>
<td>125.3 ± 18.5</td>
</tr>
<tr>
<td>Body weight after</td>
<td>106.8 ± 18.9</td>
<td>116.9 ± 18.3</td>
<td>96.7 ± 14.3</td>
</tr>
<tr>
<td>BMI before (kg/m2)</td>
<td>45.2 ± 8.6</td>
<td>48.3 ± 10.3</td>
<td>41.8 ± 5.3</td>
</tr>
<tr>
<td>BMI after</td>
<td>35.2 ± 7.9</td>
<td>38.3 ± 9.8</td>
<td>32.2 ± 4.0</td>
</tr>
<tr>
<td>%TWL</td>
<td>22.4 ± 3.9</td>
<td>22.0 ± 5.2</td>
<td>22.8 ± 2.2</td>
</tr>
<tr>
<td>GBP</td>
<td>14 (82)</td>
<td>6 (67)</td>
<td>8 (100)</td>
</tr>
<tr>
<td>Banded bypass</td>
<td>2 (12)</td>
<td>2 (22)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>LAGB</td>
<td>1 (6)</td>
<td>1 (11)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>17 (100)</td>
<td>9 (100)</td>
<td>8 (100)</td>
</tr>
</tbody>
</table>

**Indication anticoagulation**

- Atrial fibrillation: 10 (59) in Acenocoumarol, 6 (67) in Phenprocoumon, 4 (50)
- History of VTE: 4 (24) in Acenocoumarol, 1 (11) in Phenprocoumon, 3 (38)
- Arterial thrombosis: 1 (6) in Acenocoumarol, 0 (0) in Phenprocoumon, 1 (13)
- Cardiomyopathy: 2 (12) in Acenocoumarol, 2 (22) in Phenprocoumon, 0 (0)

**INR target range**

- 2.0 - 3.5: 1 (6) in Acenocoumarol, 1 (11) in Phenprocoumon, 0 (0)
- 2.5 - 3.5: 13 (76) in Acenocoumarol, 6 (67) in Phenprocoumon, 7 (88)
- 3.0 - 4.0: 3 (18) in Acenocoumarol, 2 (22) in Phenprocoumon, 1 (13)

Data are presented as mean ± standard deviation or as number (percentages).

Abbreviations: BMI=body mass index, TWL=total weight loss, GBP=gastric bypass, LAGB=laparoscopic adjustable gastric banding, VTE=venous thromboembolism.

Change in vitamin K antagonist dose and TTR after bariatric surgery.

Compared with the six months before surgery, the total percentage reduction in VKA dose was 13.8% in the first month (p=0.001) and 20.0% in the six months after surgery (p=0.004) (Figure 1). Mean TTR decreased from 58.1% in the six months before surgery to 39.4% in the first month after surgery (p=0.04) and increased to 51.5% in the six months after surgery (p=0.41) (Figure 2). Percentage time below therapeutic INR range was 25.4% before surgery. This percentage decreased to 19.7% in the first month (p=0.50) and increased further to 29.8% six months after surgery (p=0.46). Time above therapeutic range before surgery was 1.1%.
surgery was 16.5%. This percentage increased to 40.9% in the first month after surgery (p=0.02) and decreased thereafter to 18.7% (p=0.65).

**Figure 1.** Percentage change in vitamin K antagonist (VKA) dose in each time period before and after bariatric surgery compared to the reference value (100% in the first time period, -26/-19 weeks). The last two weeks before and the first two weeks after surgery are excluded (dotted lines). – means before surgery and + after surgery.

**Figure 2.** Change of % time in therapeutic INR range (TTR) in each time period before and after bariatric surgery. The last two weeks before and the first two weeks after surgery are excluded (dotted lines). – means before surgery and + after surgery.
Chapter 5

The mean dose of acenocoumarol decreased from 4.4 mg before surgery to 3.7 mg in the first month after surgery (p=0.02). In the six months after surgery, the mean dose decreased further to 3.4 mg (p=0.03). Mean TTR remained stable after surgery (57.1% before surgery and 46.4% after surgery, p=0.52). TTR decreased temporarily in the first month to 34.3% (p=0.04).

The decrease in the mean dosage of phenprocoumon was less pronounced (3.0 mg before surgery to 2.5 mg after surgery, p=0.13). The decrease was only significant in the first month after surgery from 3.0 to 2.7 mg (p=0.02). No differences were noted in TTR before and after surgery (59.3% vs. 57.3%, p=0.78). Also among these patients, TTR decreased in the first month after surgery (from 59.3% to 45.1%, p=0.40).

Postoperative bleeding complications and association with TTR.
Five patients (29.4%) developed a major bleeding complication within the first month after bariatric surgery. Table 2 shows information about the bridging therapy of all patients. Two patients used acenocoumarol and three phenprocoumon. Three patients had a hematoma, one patient a gastro-intestinal bleeding and one an intra-abdominal bleeding. These patients used no other anticoagulation. Three patients with a bleeding complication had higher than prophylactic doses of thromboprophylaxis (enoxaparin 100 mg or 80 mg twice daily as bridging therapy, instead of 40 mg twice daily, the usual dose in the local protocol). VKA was stopped in three patients because of the bleeding complication (during two days in two patients and during five days in one patient). One patient had an INR of 6.7 at the time of diagnosing the bleeding complication, however, no relation was found between the bleeding complications and the mean percentage time above INR target range after bariatric surgery for the patients who developed a bleeding complication.

Study 2. Change in prothrombin time after bariatric surgery.
In this study, 200 patients were included. Mean age was 43.3 ± 10.3 years and 173 (87%) were female. Mean weight before surgery was 124.0 ± 19.4 kg and BMI 43.2 ± 5.8 kg/m2. The majority of patients had a laparoscopic GBP (n=173, 86.5%). A revisional procedure was performed in 26 patients (13%) and 1 patient had a sleeve gastrectomy (0.5%). The laparoscopic approach was used in 99.5% of the cases. The mean follow up time between surgery and the first PT measurement was 5.8 ± 0.6 months (range 5-7) and the second PT measurement was 11.6 ± 0.6 months (range 11-13). PT prolonged 0.2 seconds after surgery: 10.64 ± 0.45 seconds before surgery and 10.85 ± 0.52 seconds six months after surgery (p<0.001).
### Table 2. Patient characteristics and data about VKA bridging therapy.

<table>
<thead>
<tr>
<th>Pt nr</th>
<th>Sex</th>
<th>Age (yrs)</th>
<th>Surg</th>
<th>VKA</th>
<th>Indication</th>
<th>Target Stop VKA pre-op (day)</th>
<th>Stop VKA pre-op (mg)</th>
<th>Start Clex pre-op (day)</th>
<th>Clex post-op*</th>
<th>Dur Clex (wk)</th>
<th>Restart VKA post-op (day)</th>
<th>Bleeding post-op (day)</th>
<th>Med at time of bleeding</th>
<th>Stop VKA during (days)</th>
<th>INR at time of bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>51</td>
<td>bGBP</td>
<td>Ace</td>
<td>SST+Cdef</td>
<td>3.0-4.0</td>
<td>4</td>
<td>100(2x)</td>
<td>3</td>
<td>100(2x)</td>
<td>TAI</td>
<td>1</td>
<td>9</td>
<td>Ace/Clex</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>58</td>
<td>GBP</td>
<td>Ace</td>
<td>AF</td>
<td>2.5-3.5</td>
<td>4</td>
<td>none</td>
<td>none</td>
<td>60(2x)</td>
<td>TAI</td>
<td>1.5</td>
<td>9</td>
<td>Clex</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
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<td>55</td>
<td>bGBP</td>
<td>Ace</td>
<td>PAF</td>
<td>2.5-3.5</td>
<td>4</td>
<td>none</td>
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<td>40(2x)</td>
<td>TAI</td>
<td>1.5</td>
<td>9</td>
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<tr>
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<td>9</td>
<td>Clex</td>
<td>NA</td>
</tr>
<tr>
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<td>F</td>
<td>51</td>
<td>GBP</td>
<td>Ace</td>
<td>AF</td>
<td>2.0-3.5</td>
<td>7</td>
<td>60(2x)</td>
<td>1</td>
<td>7</td>
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<td>NA</td>
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<td>TAI</td>
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<td>9</td>
<td>Clex</td>
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<tr>
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<td>CM</td>
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<td>48h40/80(2x)</td>
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<td>CM</td>
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<td>1</td>
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<td>1</td>
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<tr>
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<td>100(2x)</td>
<td>7</td>
<td>100(2x)</td>
<td>TAI</td>
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<td>2</td>
<td>Clex/Phe</td>
<td>2</td>
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<tr>
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<td>Phe</td>
<td>PAF</td>
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<td>none</td>
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<td>TAI</td>
<td>1.5</td>
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<td>Clex</td>
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<tr>
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<td>PAF</td>
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<td>none</td>
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<td>TAI</td>
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<td>Clex</td>
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<td>Phe</td>
<td>PAF</td>
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<td>Phe</td>
<td>AT</td>
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<td>8</td>
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<td>none</td>
<td>48h40/100(2x)</td>
<td>TAI</td>
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<td>9</td>
<td>Clex</td>
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<td>F</td>
<td>57</td>
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<td>Phe</td>
<td>pVTE</td>
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<td>4</td>
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<tr>
<td>16</td>
<td>F</td>
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<td>TAI</td>
<td>1</td>
<td>9</td>
<td>Clex</td>
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<tr>
<td>17</td>
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<td>TAI</td>
<td>3</td>
<td>9</td>
<td>Clex</td>
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</tr>
</tbody>
</table>

**Abbreviations:**
- Pt: patient number
- F: female
- m: male
- yrs: years
- Surg: surgery
- bGBP: banded gastric bypass
- GBP: gastric bypass
- LAGB: laparoscopic adjustable gastric banding
- VKA: vitamin K antagonist
- Ace: acenocoumarol
- Phe: phenprocoumon
- SST: sagittal sinus thrombosis
- Cdef: protein C deficiency
- AF: atrial fibrillation
- PAF: paroxysmal atrial fibrillation
- CM: cardiomyopathy
- AT: arterial thrombosis
- pVTE: prior VTE
- pre-op: pre-operative
- unk: unknown
- Clex: Clexane
- post-op: post-operative
- dur: duration
- wk: weeks
- TAI: till adequate INR
- Med: medication

*Clexane post-op. 48h40/100(2x) means: Clexane 40 mg twice a day during the first 48 hours and thereafter 100 mg twice a day during the following 12 days.
(2x)=twice a day.
Just one patient had a PT above the reference value of 12.5 sec (13.1 sec) after six months. Twelve months after surgery, PT stabilized around 10.82 ± 0.50 seconds (p<0.001 compared to PT before surgery). TWL at six months was 24.7 ± 6.2 % and at twelve months 31.2 ± 7.8%. There was no association between TWL and prolonged PT after bariatric surgery.

**DISCUSSION**

This study shows that the mean VKA dose decreased with weight loss after bariatric surgery and remained lower during the following months. The moderate decrease of the VKA dose in the first month after surgery was accompanied by a decrease in TTR. Mean TTR returned to preoperative levels thereafter. We showed that the mean PT value prolonged only 0.2 seconds after bariatric surgery, and only one patient developed a slightly prolonged PT.

Information on the effect of bariatric surgery on VKA management in patients receiving long-term anticoagulation is limited. One case report described a 71-year-old woman receiving warfarin therapy for chronic atrial fibrillation who underwent a completion gastrectomy and Roux-en-Y esophagojejunostomy for an invasive adenocarcinoma of her gastric remnant [12]. After surgery, there was an increased resistance for warfarin. The INR values decreased despite higher doses of medication. Irwin et al. showed that the mean warfarin dose reduced after bariatric surgery, especially in week 8, however the mean dose increased to preoperative levels on the longer term [13]. Previous research has shown that different responses to warfarin can occur after any type of surgery, either increased or decreased sensitivity [8]. In patients undergoing heart valve surgery, an increased sensitivity for warfarin was shown [14-16], while other research has concluded the opposite [17]. Different hypotheses are formulated as possible explanations for these differences like the change in cardiac output, interaction with medication, hepatic congestion, albumin level concentrations, adherence to therapy, and dietary intake of vitamin K.

We think that the sudden change in vitamin K intake is the most likely cause of VKA dose reduction directly after bariatric surgery in this study. The difference in vitamin K intake can be influenced by many factors, like dietary supplements and differences in absorption of vitamin K [18]. During the first months after bariatric surgery the composition and amount of food intake have changed and there is considerable weight loss. After bariatric surgery, dietary intake is reduced to liquids in the first two weeks after bariatric surgery. The diet is then gradually advanced under the supervision of a dietitian. The intake of many vitamin
K-rich food including vegetables such as broccoli is low because it tends to be difficult to digest and is therefore discouraged. Also, patients are more likely to experience gastrointestinal symptoms that can lead to a lower intake of vitamin K. A recent study suggested that the total daily amount of vegetable intake in Roux-en-Y gastric bypass patients remains lower than their preoperative intake even 1 year postoperatively [18]. The reduction of the VKA dose in the first month could be (partially) because of stopping the medication for a couple of days because of bleeding or starting with VKA at a later moment and not direct after surgery. This could also explain the varying TTR in the first month. However, the finding that PT prolonged only 0.2 seconds suggest that vitamin K as a cause of the lower VKA dose six months after surgery is unlikely. We think that the significant loss of body mass is the most likely reason for the decrease in VKA dose on the longer term.

The incidence of major bleeding complications was high in this study (29%). The incidence of postsurgical bleeding complications after bariatric surgery varies in the literature from 0% [20] tot 6% [21,22]. Increased risk of bleeding is always a concern when bridging anticoagulation for surgery. We know from the literature that patients on VKA receiving bridging therapy with LMWH have an increased bleeding risk [23-25]. In this study, we could not detect an association between the percent time above therapeutic INR range and the bleeding complications. Ageno et al. could also not find an association between bleeding and TTR [15]. However, such an association cannot be excluded. The most likely explanation for the bleeding risk may be the timing of restarting therapeutic dose anticoagulation after surgery. Excessive anticoagulation in addition to increased warfarin sensitivity following bariatric surgery may also increase both bleeding rate and severity [26].

There are some limitations of this study that we have to address. The study was too small to evaluate differences between treatment with acenocoumarol and phenprocoumon. However, the same trend was noted for the VKA dose reduction for both groups and the change of TTR in the first month after surgery. The finding that the patients had an INR above the therapeutic range in the first month after surgery suggests that the initial reduction of VKA dose was not enough. In addition, the limited sample size implicates that the relation between bleeding complications and the percentage time above INR target range cannot be excluded. Another issue is that the type of surgery may influence the pharmacokinetics of VKA, however, only three patients did not have a laparoscopic gastric bypass. Because of the retrospective nature of this study, we were not able to identify all factors that can influence VKA therapy, like compliance of the patients, interactions of VKA with other medica-
tion, gastro-intestinal symptoms and the daily vitamin K intake. Another limitation is that we do not have PT measurement in study 2 on the short-term (6 weeks) after surgery.

The strength of this study is that we have checked the gradual change over a long term before and after bariatric surgery of the VKA dose but also the association with TTR, in particular the first month. Furthermore, we have analyzed the change in PT value to evaluate our hypothesis of vitamin K status as a possible cause of VKA dose reduction.

**CONCLUSION**

This study identified that bariatric surgery leads to an increase in VKA sensitivity manifested by the need for significant reduction in the postoperative VKA dose, especially during the first month. TTR decreased only in the first month. Balancing the underlying thromboembolic risk against hemorrhagic surgical complications is very important and managing of patients who are receiving long-term VKA after bariatric surgery can be difficult. Perioperative anticoagulation management requires discontinuing VKA prior to the procedure and reinitiating therapy at the same or an adjusted dose afterward. Whether longer continuation of heparins instead of starting VKA in the first weeks in cases of varying TTR is beneficial to prevent VTE or bleeding, has to be evaluated. Therefore, more prospective studies are needed to improve TTR after bariatric surgery, and to evaluate the effect of adjustments in bridging on the outcomes stroke and bleeding.

**CONFLICT OF INTEREST DISCLOSURE STATEMENT**

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.
REFERENCE LIST


