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Ultrasonic instruments and concurrent antithrombotic medication in mastectomy: safe and effective

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Abstract

Background Postoperative bleeding is one of the most common complications after mastectomy. Antithrombotic medications increase the risk of these complications but discontinuing them may predispose the patient to thromboembolic events. This study aimed to evaluate whether antithrombotic medications can be safely continued perioperatively when ultrasonic instrument is used in surgery.

Methods The study included all breast cancer patients who underwent mastectomy with an ultrasonic instrument and were on uninterrupted antithrombotic medication during a 12-year study period (2010–2022) at a single university hospital. The medical records were investigated for patients who had concurrent anticoagulant or antiplatelet therapy at the time of surgery. All bleeding complications during the 30 days following surgery were recorded.

Results In total 315 mastectomies in 299 patients were performed with three different ultrasonic instruments under concurrent antithrombotic medication. The mean age of the patients was 81 years, and 82% (258 of 299) had an ASA Classification of level 3 or 4. The indications for antithrombotic medication varied, with the most prevalent being cardiac arrhythmia (38%) and previously suffered stroke (14%). Warfarin, acetylsalicylic acid (aspirin), and direct oral anticoagulants (DOAC) each accounted for approximately a quarter of the studied patients. Bleeding complications were observed in five cases (1.6%, 5/315) during the 30-day postoperative period. Three patients underwent re-operation. None of the patients underwent reoperation on the day of the mastectomy, and in only one patient the need for reoperation was directly associated with the mastectomy procedure. In the other two patients the bleeding complications were preceded by seroma puncture and a drainage issue. The results indicate a low incidence rate of postoperative bleeding despite the continuation of antithrombotic medication when an ultrasonic instrument is utilized in the operation.

Conclusion The utilization of ultrasonic instruments in mastectomy permits safe continuation of antithrombotic medications, thereby reducing the risk of thromboembolic events and streamlining surgical preparation.

Keywords Mastectomy, Antithrombotic, Ultrasonic instrument, Hematoma, Complications

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Introduction

Although breast-conserving techniques have developed substantially in recent years, mastectomy is still required in various clinical situations. This is especially true when the tumor is large compared to the breast size, the patient has inflammatory breast cancer or carries a high-risk breast cancer gene, and often in elderly patients who may prefer mastectomy. Postoperative bleeding is one of the most common complications after mastectomy [1]. It often necessitates reoperation, which increases the cost of treatment and adds to the patient's discomfort. One of the most prevalent risk factors for bleeding complications has been shown to be the use of antithrombotic medication [2]. Therefore, various measures have been attempted to mitigate the risk of complications, such as discontinuing the medication for a certain period perioperatively or using bridging therapy with low molecular weight heparin (LMWH) [3]. Unfortunately, discontinuing the medication may predispose the patient to thromboembolic complications [4, 5] and evidence suggests that bridging therapy may also increase the risk of bleeding complications without truly decreasing the risk of postoperative thromboembolic complications [6]. Patients with cancer, in particular, have an elevated risk of thromboembolic events compared to the general population, signifying that patients undergoing mastectomy for breast cancer carry multiple risk factors for such events. Cancer-associated venous thrombosis is a major cause of morbidity and mortality, and it is the second leading cause of death in cancer patients after the cancer itself [7–9]. The risk of ischemic stroke is significantly increased after surgery, as studies have shown that 6% of all ischemic stroke patients had undergone surgery prior to the stroke [10]. Additionally, in patients with atrial fibrillation, the risk of ischemic stroke is 0.6% when anticoagulation therapy is interrupted during surgery [11]. The overall risk of major thromboembolic complications ranges from 0.4 to 1.7% [12, 13].

It has been shown that ultrasonic instruments reduce the risk of bleeding complications in patients with good general health [14]. Currently, there exists no data on patients taking antithrombotic medications, but it may be assumed that a similar reduction can also be seen in these patients. Additionally, it remains unclear whether the reduction is sufficient to allow these medications to be safely continued during surgery, as this issue has not been previously investigated.

The actual risk of bleeding complications after mastectomy has been suggested to be 2–11%, but we have previously presented a series of 364 patients undergoing mastectomy with or without axillary surgery, with only one postoperative bleeding complication (0.3%, 1/364) when the patients were operated on with the ultrasonic SonoSurg® (Olympus Corporation, Tokyo, Japan) surgical instrument [14]. In that study, all patients were generally in good health, and those using any antithrombotic medication were excluded from the analysis. At our institute, also patients on antithrombotic medications have been operated on increasingly without discontinuing the medication, when an ultrasonic instrument has been utilized in the operation. Previous research has suggested that concurrent use of antithrombotic medications increases the risk of bleeding complications by more than threefold [2, 15]. However, our clinical experience has been that bleeding complications are extremely rare in this patient group as well, although no previous study has specifically addressed this subject.

The aim of this retrospective study was to evaluate the actual risk of bleeding complications during the 30-day postoperative period in patients undergoing mastectomy for breast cancer, who were on concurrent antithrombotic medication and who were operated on with an ultrasonic surgical instrument.

Materials and methods

The data for all patients who underwent mastectomy for invasive breast cancer or ductal carcinoma in situ (DCIS) at Turku University Hospital between 2010 and 2022 were collected from the Clinical Informatics Register of Auria Biobank and the patient records at Turku University Hospital. The clinical notes from the preoperative appointments were reviewed to identify patients who were on antithrombotic medications or had a previous diagnosis that commonly warrants such medication. Additionally, the details of prescribed medications were examined and cross-referenced with the clinical notes to ensure that no patients on such medication were neglected. The patient characteristics, including indications for antithrombotic medications, details of the surgical procedure, and the management of anticoagulant and antiplatelet medications perioperatively were examined in detail. The patient was considered to have been operated on with concurrent antithrombotic (anticoagulant or antiplatelet) medication if they had taken their normal dose of the medication on the day before the surgery. If the patient had more than one indication for such medication, the one which was evaluated to be the most significant was recorded. If the surgery was scheduled for the morning, medications normally taken at that time were usually skipped and then resumed at their regular dosage after the surgery.

The type of surgical instrument used in the mastectomy was recorded. During the study period, the instruments commonly used in mastectomy at Turku University Hospital for patients on continuous antithrombotic medications were those based on ultrasonic energy, namely SonoSurg® (Olympus Corporation, Tokyo, Japan), ThunderBeat® (Olympus Corporation, Tokyo, Japan), and

Harmonic Focus® (Ethicon Inc., Cincinnati, OH, USA). Patients operated on with instruments not utilizing ultrasonic energy, or whose instrument data were missing, were excluded from the dataset.

The treatment of patients who experienced a postoperative bleeding complication was investigated on an individual basis. Information on any deviations from the normal course was collected from electronic records. Patient records were evaluated for any return to care (RTC) within 30 days postoperatively. Information of any laboratory tests indicating bleeding complication (such as hemoglobin, hematocrit and blood transfusions) were collected and evaluated. Patients requiring seroma punctures, regardless of the rate or colour of the seroma, were not recorded as cases with complications if the patient required no unplanned admissions to the surgical unit.

The research protocol of the study was approved in Hospital District of Southwest Finland (T537/2022).

Statistical analysis

The data were analysed using JMP 16 Pro (SAS Institute, Cary, North Carolina, USA) analysis software. The distribution of patient characteristics was assessed, and frequency tables were generated to facilitate an understanding of the patient cohort. For patients' age and body-mass index (BMI), median and interquartile ranges were defined. For assessing the risk of bleeding complications, a 95% confidence interval for the risk was determined.

Preoperative protocol

All patients underwent mammography and ultrasound imaging. Suspicious axillary lymph nodes were biopsied, and if metastasis was detected, the patients underwent axillary lymph node dissection (ALND). If no metastasis was detected preoperatively, sentinel lymph node biopsy (SLNB) was performed on most patients. Until 2018, a frozen section study was performed for all patients, and ALND was carried out if metastasis was detected. After 2018, the frozen sections have been performed only under specific clinical circumstances, according to the updated treatment guidelines.

The patient's medication information was recorded during the preoperative consultation with the surgeon, where the decision to continue or pause the medication was usually made. Before the operation, the surgical ward's nurse telephoned the patient to confirm the medication, which was also documented in the electronic patient records.

Surgical procedure

An elliptical incision was planned. The skin incision was made with a scalpel, and the skin flaps were prepared with the ultrasound instrument. The use of surgical instrument was recorded. Non-ultrasonic instruments, such as diathermy, were not systematically recorded, and thereby only patients operated on with ultrasonic instruments could be reliably identified. The skin flaps were left approximately 5–10 mm in thickness. The breast tissue, along with the pectoral fascia, was removed. If ALND was performed, the same ultrasonic instrument was utilized. The thoracodorsal pedicle and long thoracic nerve were carefully preserved. Level II lymph nodes were dissected in all patients undergoing ALND. Level III lymph nodes were dissected if multiple lymph node metastases were known preoperatively, or if macroscopically suspicious lymph nodes were detected. A drain was inserted through a separate stab incision and secured to the skin with a suture. For wound closure, the subdermal tissue was approximated with absorbable sutures, and the skin was closed with an intracutaneous continuous absorbable suture. A drain was applied in all patients unless there was a specific reason for omitting it.

Postoperative protocol

Most patients were admitted to the surgical ward for one night, but several were eligible for discharge under the same-day discharge protocol, while others required longer follow-up on the ward. The antithrombotic medication was continued on the evening of the operation (when administered twice a day) or the following morning (when administered once a day), provided there were no signs of bleeding complications. The drain was removed when the amount of exudation was less than 80 ml per day, but no earlier than four days and no later than seven days postoperatively. Patients had a postoperative check 2–3 weeks after surgery. Upon discharge, they received a specific date and time for this follow-up visit. Additionally, patients were provided with contact information for the surgical unit should they have any further questions, concerns, or problems.

Results

In total, 2621 patients underwent mastectomy for invasive breast cancer or DCIS during the study period. Of these patients, 299 underwent surgery with concurrent antithrombotic (anticoagulant or antiplatelet) medication and the surgery was performed with an ultrasonic instrument (Fig. 1). Sixteen patients underwent a bilateral mastectomy, totalling 315 breasts at risk for complications. No patients undergoing skin-sparing mastectomy or immediate breast reconstruction were included in this study. In addition to the mastectomy, SLNB was performed in 156 (50%) cases and ALND in 131 (42%) cases. No axillary surgery was performed in 28 (8.9%) cases. The operations were performed by 18 different surgeons, most of whom had extensive experience in breast surgery.

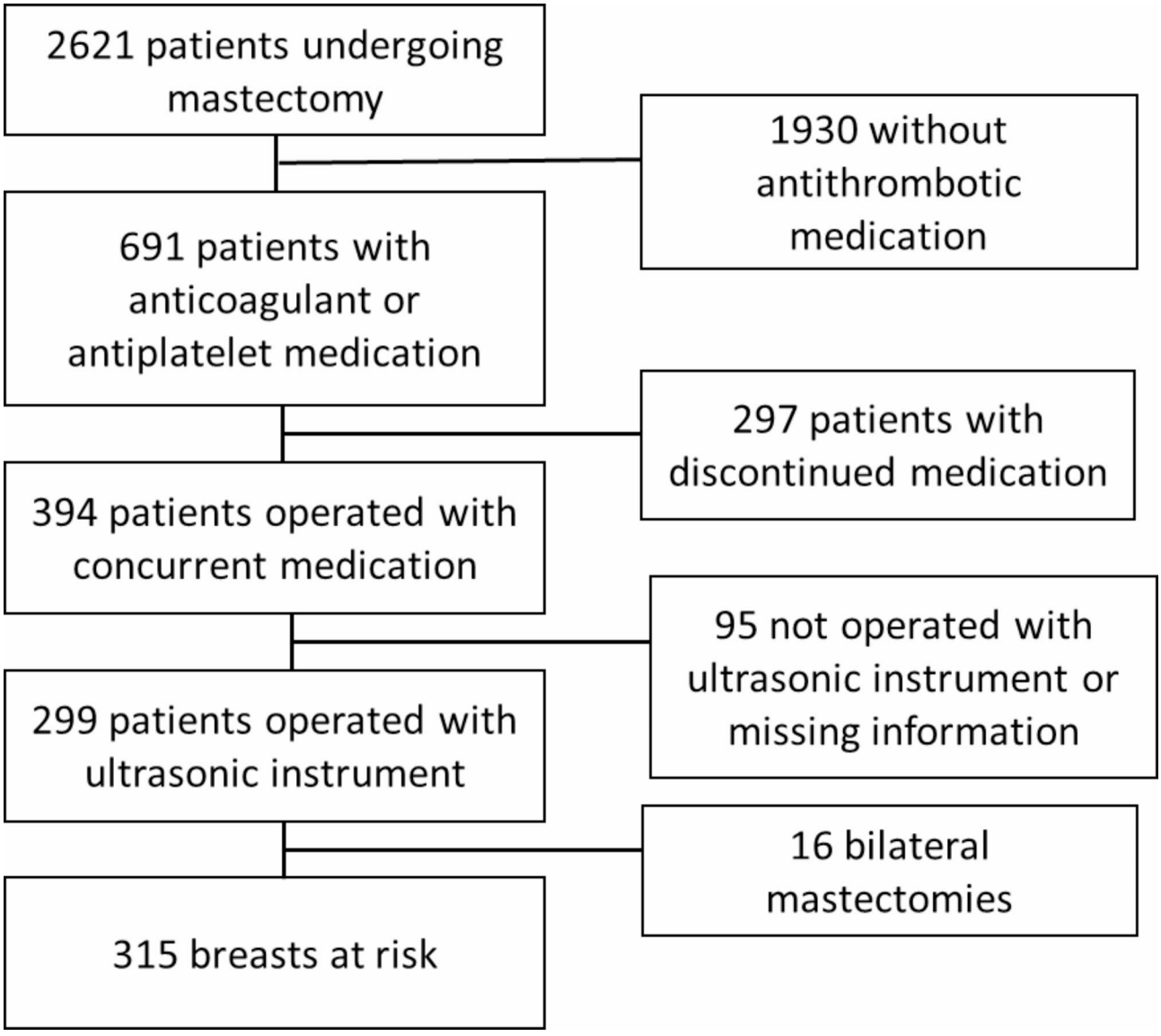

Fig. 1 Flow chart of the patient selection

There were also several resident surgeons who had performed fewer than twenty mastectomies previously.

The characteristic data for the patients are presented in Table 1. As expected, the patients in the cohort are older than breast cancer patients in general (median age 81 years), and none of the patients were classified as ASA Class 1 (0/315). Antithrombotic medications and the indications for the treatment are listed in table 1. Details of the surgical procedure are presented in table 2.

During the postoperative 30 days, only three bleeding complications requiring re-operation occurred (1.0%, 3/315, 95% CI 0.2%-2.7%). Two patients presented with hematoma which was managed by conservative treatment, totaling five bleeding complications (1.6%, 5/315, 95% CI, 0.5-3.7%). The number of cases proved to be too low for detailed statistical analysis.

The cases are presented in Table 3.

According to the patient records, patient 1 had been doing physical exercises on the fifth day after the operation, when the drainage got accidentally pulled, and soon thereafter, the operative area had become swollen. The patient underwent reoperation, in which active bleeding was detected from an intercostal branch of the mammary artery. Hemoglobin levels dropped from 109 g/l to 92 g/l. The patient had a mechanical heart valve prosthesis and consumed warfarin with an INR (international normalized ratio) target level 2.5–3.5. INR level was 2.5 on the day of the operation and 3.1 on the fifth postoperative day when the complication occurred.

Patient 2 was given 4000 IU of enoxaparin subcutaneously twice daily for deep venous thrombosis. The medicine was not given on the morning of the surgery and the

Table 1 Patient characteristics, indications for antithrombotic medications and consumed medications. Values are n (%) unless otherwise indicated. (IQR = interquartile range, BMI = body-mass index, ASA = American Society of Anesthesiologists, DVT = deep vein thrombosis, DOAC = direct oral anticoagulants, LMWH = low-molecular-weight heparin)

299 patients	
Age (years), median (IQR)	81.0 (74.0–86.1)
BMI (kg/m^2), median (IQR)	27.5 (23.4–31.6)
ASA Classification	
ASA Class 1	0 (0%)
ASA Class 2	41 (13%)
ASA Class 3	229 (73%)
ASA Class 4	29 (9%)
Patients with diabetes	60 (19%)
Neoadjuvant treatment	15 (5.0%)
Smoking status	
Never	215 (72%)
Not for years	45 (15%)
Current	18 (6.0%)
Information missing	21 (7.0%)
Primary indication for antithrombotic medication	
Prior stroke	44 (14%)
Other cerebrovascular disorder	22 (7%)
Prior myocardial infarction	14 (4.4%)
Other cardiovascular disorders	24 (7.6%)
Atrial fibrillation or any other cardiac arrhythmia	121 (38%)
Heart valve prosthesis	8 (2.5%)
Prior pulmonary embolism	20 (6.3%)
Prior deep vein thrombosis	17 (5.4%)
Antiplatelets prescribed as primary prevention	
In patients with diabetes	12 (6.7%)
in otherwise healthy patients	23 (7.3%)
Various other indications	9 (2.9%)
Antithrombotic medication	
Warfarin	79 (25%)
DOAC	78 (25%)
LMWH	19 (6.0%)
-as a bridging therapy	5 (1.7%)
Acetylsalicylic acid	84 (27%)
Clopidogrel	25 (7.9%)
Dipyridamole (as monotherapy)	2 (0.6%)
Combination therapy (most commonly dipyridamole with acetylsalicylic acid)	28 (8.9%)

Patient characteristics, indications for antithrombotic medications and consumed medications. Values are n (%) unless otherwise indicated. (IQR= interquartile range, BMI = body-mass index, ASA = American Society of Anesthesiologists, DVT =deep vein thrombosis, DOAC= direct oral anticoagulants, LMWH= Low-molecular-weight heparin)

given dose in the evening of the preoperative day had been reduced to 2000 IU. Recovery after surgery initially proceeded uneventfully, but seroma formation persisted after removal of the drainage tube. Seroma puncture was performed on the 13th postoperative day, yielding clear and yellowish fluid. However, shortly after the puncture, the operative field became swollen. The patient underwent reoperation in which the hematoma was evacuated, but no definitive bleeding site was identified. Hemoglobin levels dropped from 110 g/l to 73 g/l.

Patient 3 was taking rivaroxaban due to atrial fibrillation. The patient underwent a bilateral mastectomy, with one side being treated for cancer and the contralateral breast undergoing a symmetry procedure for balance. After the operation, the operative field on the contralateral side gradually became swollen, and the drain produced reddish seroma. The condition was monitored for two days, after which the patient was taken back to the operating room for reoperation. An active bleeding site was found at the edge of the pectoral muscle.

Patient 4 underwent mastectomy with axillary lymph node dissection. A hematoma developed gradually during ten days following the surgery. On the 10th postoperative day, the patient presented at an additional, unplanned

Table 2 Details of surgical procedure and used instruments. Values are n (%) unless otherwise indicated. (SLNB = sentinel lymph node biopsy, ALND = axillary lymph node dissection, BCS = breast conserving surgery, IQR = interquartile range)

Number of Mastectomies	315
Axillary procedure	
ALND	131 (42%)
SLNB	156 (50%)
None	28 (8.9%)
Ablation as re-operation for BCS	11 (3.5%)
Bilateral mastectomy	16 (5.1%)
Operation time in minutes (median, IQR)	95 (80–118)
Intraoperative bleeding, ml (median, IQR)	50 (20–100)
Patients with bleeding > 200 ml	26 (8.7%)
Patients with bleeding > 500 ml	2 (0.7%)
Patients operated using same-day surgery protocol	33 (11%)
Patients hospitalized after surgery	266 (89%)
Surgeon's experience (defined as number of previous mastectomies performed)	
More than 50 mastectomies	268 (85%)
20–50 mastectomies	31 (10%)
Less than 20 mastectomies	16 (5.1%)
Utilized surgical instrument	
Thunderbeat®	60 (19%)
Sonosurg®	214 (68%)
Harmonic Focus®	41 (13%)

Table 3 Details of the patients presenting with bleeding complications. (SLNB = sentinel lymph node biopsy, ALND = axillary lymph node dissection, INR = international normalized ratio)

Patient number	**1**	**2**	**3**	**4**	**5**
Age	86 years	90 years	89 years	75 years	74 years
Axillary procedure	SLNB	ALND	SLNB	ALND	SLNB
Bilateral surgery	no	yes, bilateral cancer, mastectomy and ALND	yes, contralateral mastectomy for symmetry	no	no
Instrument	Harmonic Focus®	SonoSurg®	Harmonic Focus®	ThunderBeat®	SonoSurg®
Bridging therapy	no	no	no	no	yes
antithrombotic medication	warfarin	enoxaparin	rivaroxaban	apixaban	enoxaparin (warfarin)
Indication	heart valve prosthesis	previous deep vein thrombosis	Atrial fibrillation	Atrial fibrillation	heart valve prosthesis
Bleeding occurred on	5th postoperative day	13th postoperative day	3rd postoperative day	10th postoperative day	on the day of the operation
Treatment	Re-operation	Re-operation	Re-operation	Single puncture	single red blood cell transfusion
Bleeding site	Intercostal branch of mammary artery	No specific site detected	Pectoral muscle of the contralateral side	not known	not known

appointment, and "half a litre of dark blood" was drained from the surgical site. No further measures were required to treat the condition.

Patient 5 was one of only five patients undergoing bridging therapy during the study period. The patient was taking warfarin due to a mechanical heart valve prosthesis and received 6000 IU of subcutaneous enoxaparin twice daily for five days prior to the surgery, with concurrent cessation of previous warfarin. INR level was 1.4 on the day of the surgery. The drain started to produce bloody fluid on the evening following the operation. The patient received two units of red blood cells, and the enoxaparin dose was reduced to 4000 IU twice daily. Hemoglobin levels dropped from 112 g/l to 89 g/l. A reoperation was planned but eventually not performed. The reason for not proceeding with the reoperation was not recorded. The drain collected a total of 1305 ml of bloody fluid over the first five postoperative days, but the discharge suddenly reduced and was only 20 ml on both the sixth and seventh day. Thus, no re-operation was eventually required, and the patient was discharged on the seventh day after the mastectomy.

None of the patients died during the 30-day follow-up period.

Discussion

This retrospective analysis of 315 cases demonstrates that breast cancer surgery can be performed safely and effectively in patients on concurrent antithrombotic medication when an ultrasonic instrument is used. The low number of bleeding episodes (5/315) was insufficient for a meaningful statistical analysis to identify any additional risk factors. Interestingly, two of the three complications requiring re-operation occurred after an external causative factor (seroma puncture and a pull on the surgical drain) had predisposed the patients to these complications.

The third complication requiring re-operation occurred in a patient undergoing bilateral mastectomy, specifically in the contralateral breast that was operated on for symmetry reasons. The risk of complications in the contralateral breast surgery should not be neglected, and when bilateral surgery is considered for symmetry, the risks and benefits of the procedure must be carefully weighed. This is true especially if the patient's disease stage warrants initiating adjuvant treatment without any additional delay, which has been shown to correlate unfavorably with the patient's prognosis [16].

Two patients experiencing bleeding complications did not undergo reoperation, but it may be questioned why patient 5 was not operated on. A reoperation was planned but not carried out, and the reason was not recorded. It has been suggested that such cases should be counted as "major" bleeding complications only if the patient presents with at least a 20 g/l decrease in hemoglobin level [17]. Neither of the patients fulfilled the criteria, totaling only three major bleeding complications in the present study. Minor complications, which do not require the patient to admit to care, are of little interest as they are unlikely to have clinical significance.

According to the results of the present study, it appears that the operating principle of ultrasonic instruments can provide excellent and permanent hemostasis, even in patients on antithrombotic medications. In an ultrasonic instrument, the operating principle is not to heat the tissue directly, as with electrocautery, but rather to vibrate the instrument's cutting blade while grasping the tissue. The vibration is then transmitted to the tissue, effectively denaturing the collagen molecules and causing the fusion of the remaining cutting surface. The shear mechanism of the instrument allows to bluntly grasp the tissue, particularly blood vessels, enabling complete occlusion and bringing the opposite walls into direct contact during the sealing phase. The walls are fused together, leaving the remaining ends of the blood vessels tightly sealed.

Previous studies have demonstrated that the burst pressure required to regenerate bleeding after occlusion with ultrasonic instruments is 900 ± 579 mmHg in arteries with a diameter of 4–5 mm and 734 mmHg for arteries with a diameter of 5–7 mm [18, 19]. These levels greatly exceed what is present in the patient's circulatory system. It is reported that these mechanisms together enable reliable obliteration of blood vessels up to 7 mm in diameter, exceeding what is typically encountered in the breast.

Multiple studies have investigated the effect of ultrasonic instruments in various surgical procedures, but these studies include a variety of research subjects, and the results are highly heterogeneous. Based on a recent meta-analysis, utilizing ultrasonic instruments appears to be beneficial only in certain procedures, highlighting the need for surgery-specific research on the subject [20].

A systematic review and meta-analysis comparing the harmonic scalpel with conventional techniques in breast cancer surgery concluded that intraoperative bleeding is lower in patients treated with the harmonic scalpel than in those undergoing conventional techniques. However, it is noteworthy that the amount of intraoperative bleeding in multiple studies exceeds what is considered customary in modern surgery, questioning the applicability of the results to the current conditions. The studies often report the amount of intraoperative bleeding, but the risk of postoperative bleeding complications, which is of greater clinical significance, is usually left unaddressed. Additionally, breast-conserving surgery and mastectomy are often examined as if they were comparable procedures, although it is obvious that mastectomy carries a greater risk of complications. Importantly, none of the studies examine the use of the instrument in patients who have taken antithrombotic medications perioperatively, leaving this area of research completely unexplored [21].

Based on the present study, continuing antithrombotic medications perioperatively does not compromise the hemostatic effect of ultrasonic instruments, allowing safe continuation of the medications. The study included three different ultrasonic instruments, suggesting that each provides equally effective hemostasis.

Allowing antithrombotic medication to be used concurrently with surgery offers several benefits. First, pausing antithrombotic medication increases the risk of thromboembolic complications, especially in patients with a history of deep vein thrombosis or pulmonary embolism. Continuing the treatment, however, decreases this risk [22, 23]. Patients with a history of cerebrovascular incidents also face an increased risk of stroke after surgery, especially when antithrombotic treatment is discontinued before the operation. In the patients with previous cerebrovascular incidents, it would therefore be beneficial to continue the antithrombotic medication [24–26].

It has been estimated that half of the perioperative mortality is attributed to cardiovascular complications, particularly in elderly patients, who usually have underlying atherosclerosis-associated comorbidities. Myocardial

injury associated with surgery is independently and strongly associated with both short-term and long-term mortality, even in the absence of clinical symptoms. Although continuing antithrombotic medication has not been shown to reduce the risk of myocardial complications, the severity of potential complications supports the continuation of the medication if there is no additional benefit to discontinuing it [27].

In addition to reducing the risk of complications, continuing antithrombotic medications at a normal dosage simplifies the perioperative protocol, saves time for the hospital staff, and reduces the risks of medication errors. In the era of growing interest in same-day surgery, safer procedures could also allow for same-day discharge in patients often not considered candidates for outpatient surgery. The downside of ultrasonic instruments is the high price, but the possibility to increase the number of patients treated in same-day discharge and decreased number of re-operations for complications mitigates the total cost of the treatment [14].

It has been previously shown that certain minor surgical procedures, such as pacemaker insertion and certain endoscopic procedures may be executed without discontinuing concurrent antithrombotic treatment [3]. In our hospital, we have successfully added mastectomy to that list, when the surgery is performed with an ultrasonic instrument. Further research should be conducted to evaluate whether concurrent antithrombotic medication can also be safely administered in other types of surgery.

Limitations

Due to the retrospective nature of this study, several uncertainties need addressing. Firstly, there may be unrecognized selection bias, as over half of the patients during the study period were operated on with concurrent antithrombotic medication. Secondly, only three-quarters of these patients were included in the study due to the use of instruments other than ultrasonic or missing information about the instrument used.

It is uncertain how accurately conservatively treated hematomas and ecchymoses were recorded in the patient records. If it was clear that no re-operation would be necessary, this kind of finding may have been overlooked and not necessarily recorded accurately. However, our clinical experience is that such occasions are very rarely encountered during postoperative follow-up visits.

The study has several potential confounding factors, such as varying surgeon experience, unrecorded comorbidities in patients, uncertainty regarding the implementation of patients' medication regimens, the different effect profiles of various antithrombotic medications, and the risk that some complications may not have been detected in the analysis. However, it can be stated that since the overall risk for bleeding complications was very low (1.6%), these confounders would primarily be relevant in situations where the actual bleeding risk in a certain patient group would be significantly higher. In a retrospective study, the existence of such factors cannot be completely ruled out, but considering the very low number of complications, it can be concluded that if there were a group with a higher bleeding risk, it is likely that some indication of this would be observable in the study as well, given the reasonably large sample size.

Additionally, the number of patients presenting with a complication was too low for detailed analysis for additional risk factors. A prospective study with a larger patient sample or a multicenter study would allow for a more detailed analysis of these factors.

Additionally, patient compliance with medication orders varies, making it difficult to retrospectively estimate the accuracy of the executed medical treatment. Prospective studies are needed to validate the findings of the present study.

Conclusion

We conclude that the utilization of ultrasonic instruments in mastectomy, regardless of the axillary procedure involved, permits safe continuation of antithrombotic medications, thereby reducing the risk of thromboembolic events and streamlining surgical preparation.

Author contributions

Author contributions: Conception and design (AT, MR, RA), Analysis and interpretation (AT, MR, RA), data collection (AT), writing the article (AT), critical revision of the article (MR, RA), obtaining funding (AT).

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Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Ethics approval and consent to participate

This research study was conducted retrospectively from data obtained for clinical purposes. The research protocol of the study was approved by the Hospital District of Southwest Finland (T537/2022). No additional preregistration was performed. No ethical approval was required for this retrospective study and informed consent was waived.

Competing interests

The authors declare no competing interests.

Consent to publish

All authors of the manuscript have read and agreed to its content and are accountable for all aspects of the accuracy and integrity of the manuscript in accordance with ICMJE criteria. All authors have agreed to publish the article in World Journal of Surgical Oncology.

Conflict interest
None of the authors has any conflict of interest with respect to this manuscript.

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