The first part of this thesis evaluates different haemostatic devices during laparoscopic surgery to prevent bleeding and related complications. The second part evaluates and describes recommendations to prevent ureteral injuries during laparoscopic hysterectomy (LH) based on predisposing factors.

Chapter 1 is a general introduction and describes the outline of this thesis. Besides the advantages of the laparoscopic above the abdominal hysterectomy, the risk of major complications, such as haemorrhage and ureteral injuries seems to be increased, particularly during the learning phase. The most common location of ureteral injury in pelvic surgery, particularly during LH, is at the cardinal ligament, where the ureter passes inferior to the uterine vessels. A reduction in excessive bleeding at this site is expected to reduce the risk on ureteral injuries.

Based on the postulated advantages of vessel sealing devices in terms of improved efficacy of haemostatic action and reduced thermal spread, we tested the hypothesis that vessel sealing devices are in favour of other haemostatic techniques for its use during laparoscopic procedures, particularly during gynaecological procedures. Given the lack of randomized controlled trials on the use of vessel sealing devices in comparison to other haemostatic devices during laparoscopy in gynaecology on haemorrhage and complications, we conducted two randomized controlled trials to study the most optimal device to be used during laparoscopic removal of adnexa and uteri and performed a systematic review.

In the second part of this thesis we tried to identify predisposing factors for the occurrence of ureteral injuries and tried to develop evidence based recommendations for gynaecologists performing LH in order to reduce its incidence, and to improve the early detection of these complications, to reduce undesired outcome of LHs.

In Chapter 2 the effects of LigaSure vessel sealing device versus conventional bipolar technique on operating time and blood loss during laparoscopic salpingo-oophorectomy were compared in a randomized controlled trial. In three teaching hospitals, 100 women undergoing a laparoscopic salpingo-oophorectomy were randomized for Ligasure or conventional bipolar devices. Primary outcome was operating time from initial skin incision to removal of the specimen. Secondary outcome measures were total operating time (from initial skin incision to skin closure), time to dissect the ovarian- and infundibulopelvic ligaments, intraoperative blood loss, and subjective judgment of the device used. There were no differences in operating time using Ligasure versus conventional bipolar devices: 41.0 vs. 39.2 min (p = 0.78; 95% CI = -10.9 to 14.5), and 54.6 vs. 58.6 min (p = 0.46; 95% CI= 14.8 to 6.8), respectively. The mean blood loss using Ligasure versus conventional bipolar was 38 vs. 33 mL (p = 0.73; 95% CI = -22.7 to 32.2). Various subjective efficacy and instrument handling parameters of the two instruments varied among participating centers.

In conclusion, there were no significant differences in operating time and blood loss with the use of LigaSure compared to conventional bipolar instruments during laparoscopic salpingo-oophorectomy, even after correction for potential confounders.
In Chapter 3 the effects of LigaSure versus conventional bipolar technique on operating time and blood loss during laparoscopic hysterectomy were compared in a randomized controlled trial. 140 women undergoing a laparoscopic hysterectomy for benign indications were randomized for Ligasure or conventional bipolar devices. Primary outcome was operating time from initial skin incision till detachment of the uterus. Secondary outcome measures were total operating time (from initial skin incision till final skin closure), time to dissect the adnexal ligaments, intra-operative blood loss and subjective evaluation by the surgeon of the instrument used. No differences in operating time using LigaSure versus conventional bipolar devices: 97.6 versus 91.8 minutes (P = 0.39, 95% CI -7.6 to 19.2), and 148.1 versus 142.1 minutes (P = 0.46, 95% CI -10.1 to 22.3), respectively. The mean blood loss using LigaSure versus conventional bipolar was 234.1 versus 273.1 ml (P = 0.46, 95% CI -39.1 to 52.7). Various subjective efficacy and instrument handling parameters were significantly different between the two instruments and between the different participating centres.

In conclusion, there were no significant differences in operating time and blood loss between the use of Ligasure compared to conventional bipolar devices during LH, even after correction for potential confounders. User satisfaction parameters were assessed significantly different by surgeons of the participating centres.

Chapter 4 describes a systematic search for Randomized Controlled Trials (RCTs) comparing the effectiveness and costs of vessel sealing devices versus other electro thermal or ultrasonic devices in abdominal surgical procedures. Adequate haemostatic techniques are essential for optimal intra- and postoperative results. A number of different haemostatic techniques and devices have been developed over the past few years, but which device should be preferred during laparoscopic and open abdominal procedures?

A systematic review was performed and seven RCTs with 554 patients met the inclusion criteria. Various procedures with the use of vessel sealing devices (Ligasure) (n=264) were compared to ultrasonic devices (n=139), and mono- (n=20) or bipolar devices (n=130). Ligasure was favoured in two studies in terms of lower amount of blood loss, shorter operating time and lower costs. These two studies compared Ligasure devices with ultrasonic and other electro thermal devices in laparoscopic bowel surgery. No differences were observed in the other studies. Considering the relatively low number of complications, all haemostatic devices may be considered as being relatively safe. None of the studies reported on quality of life or cost effectiveness.

Vessel sealing devices may be considered as safe and their use may reduce costs due to reduced blood loss and operating time in some abdominal surgical procedures in comparison to mono- or bipolar electro thermal devices.

The objective of Chapter 5 was to identify evidence based recommendations to reduce the risk on ureteral injuries. Ureteral injuries are a major concern in laparoscopic hysterectomy (LH). How to prevent this complication during LH? Clinical trials to study the preventive effect of these recommendations on the urinary tract injury rate are scarce. A systematic literature search on recommendations and preventive
strategies for reduction on ureteral injuries during LH was made. Inclusion criteria were full text papers reporting on a recommendation to prevent ureteral injuries during LH and on its effect on the prevalence of ureteral injuries. Methodological quality of comparative studies were evaluated. Twenty-three studies were included in the systematic review, ten had a comparative design, thirteen were single arm studies. Additional six papers described a recommendation but without evaluation of its effect. Results were presented per operative technique (routine placement of ureteral stents, ureteral dissection and visualization) and equipment used (coagulating device, manipulator). Routinely placement of ureteral stents were not useful in the prevention of ureteral injuries. General conclusions could not be drawn with respect to the other recommendations due to insufficient methodology or sample size of the included studies. This systematic review provides an overview of available evidence and knowledge gaps concerning recommendations to prevent ureteral injuries during LH. Only a limited number of recommendations have been studied in comparative studies, most recommendations are only evaluated in single arm studies or not evaluated at all. More well-designed studies are needed to base appropriate advice in prevention of ureteral injuries during LH.

The aim of Chapter 6 was to reach consensus among experts in the field of laparoscopic hysterectomy in uniform recommendations on the prevention and early detection of urinary tract injuries during LH. A systematic Delphi consensus procedure was performed with international gynaecological experts in the field of LH. The experts were selected according to standard criteria with regard to surgical experience and research. Twenty of 40 experts were willing to participate. Three questionnaires were sent. Each following questionnaire was formulated and based on the answers of the previous one. Fourteen experts completed all three questionnaires. In 40 of 64 proposed recommendations (63%), consensus was achieved. Consensus was achieved with respect to required education, learning curve, equipment, restoration of distorted anatomy and on the application of diagnostic tools in early detection of urinary tract injuries.

The Delphi technique showed to be a useful tool to achieve consensus regarding prevention of urinary tract injuries during LH.

In Chapter 7 all known ureteral injuries which occurred during LH for a benign indication in the Netherlands were analysed in order to identify patient- and surgeon-related risk factors. Ureteral injuries are the most dreaded complication in gynaecological surgery. Some risk factors for the occurrence of urinary tract injuries are known, but clear guidelines to prevent ureteral injuries during LH are lacking. Ninety-five LH-performing gynaecologists were requested to recall all cases of known ureteral injuries during LH in their hospital. After identification of ureteral injuries, an interview was performed, using a structured questionnaire focussing on the identification of predisposing factors which could account for the cause of the injury. Forty-one injuries were detected in 37 patients (4 bilateral ureteral injuries) in a 20-year period. The questionnaire could be completed in 31 cases which were considered well documented. Predisposing factors
were retrospectively assessed and classified in three categories: patient-related (i.e., deep infiltrating endometriosis, intraligamentary located fibroids) \( n = 18 \), surgeon-related (insufficient experience and/or technique) \( n = 16 \), or both (insufficient experience and difficult case) \( n = 8 \). According to earlier mentioned recommendations in our Delphi study among experts, in 48.4% of these ureteral injury cases more than one of the recommended techniques or predisposing conditions were not applied or were available. Only one ureteral injury was diagnosed during the LH; the mean time to diagnose the injury was 29 days.

Incomplete learning curve, insufficient applied technique such as coagulation of the uterine artery without the use of an uterine manipulator and/or from the contralateral side and/or without previously performed ureterolysis in case of distorted anatomy, may be considered as the main predisposing factors.

The general discussion and future perspectives are reported in Chapter 8. Although an increasing number of laparoscopic hysterectomies are performed, current available literature on predisposing factors on ureteral injuries is limited. Based on our systematic review of RCTs comparing vessel seal devices with other electro thermal devices, no studies were performed in laparoscopic gynaecological surgery besides the two RCTs described in this thesis. We can only conclude that routinely placement of ureteral stents are not useful in the prevention of ureteral injuries and general conclusions can not be drawn with respect to other recommendations such as ureteral dissection techniques, preligation or coagulation of the uterine arteries, and the use of various devices to prevent ureteral injuries because they have not been studied sufficiently. It is obvious that the identified knowledge gaps require sufficiently powered well designed studies, ideally with cost effectiveness analysis alongside to enable optimal care for our future patients. These knowledge gaps should be filled up to enable development of evidence based guidelines proclaiming good clinical practice and patient care for performing LH concerning indication, equipment, minimal required technique and postoperative care. The best prevention of ureteral injuries during laparoscopic hysterectomy will be prevention of performing unnecessary hysterectomies.