PREVENTION OF URETERAL INJURIES DURING LAPAROSCOPIC Hysterectomy: A SYSTEMATIC REVIEW OF THE LITERATURE TO IDENTIFY EFFECTIVE STRATEGIES

P.F. Janssen
H.A.M. Bröllmann
J.A.F. Huirne

Submitted
ABSTRACT

Background

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. The objective of this literature review is to identify recommendations that have been evaluated on its effect in reducing ureteral injuries.

Methods

A systematic literature search was performed in MEDLINE, EMBASE and Cochrane Library electronic databases. Inclusion criteria were: full text papers reporting on the effect of recommendation to prevent ureteral injuries during laparoscopic hysterectomy. Methodological quality of comparative studies was evaluated.

Results

23 studies were included, ten had a comparative design, and 13 were single arm studies. Additional six papers described a recommendation without evaluation of its effect. Reported recommendations were routine placement of ureteral stents, ureteral dissection, ureteral lateralization and visualization, early ligation of uterine arteries and recommendations with respect to equipment (coagulating devices, manipulators). Routinely placement of ureteral stents is 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.

Conclusions

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 laparoscopic hysterectomy.
INTRODUCTION

Hysterectomy is the most common elective major gynaecological operation and the implementation of the laparoscopic approach is increasing. Laparoscopic hysterectomy has several advantages over abdominal hysterectomy in terms of less pain, shorter hospitalization and faster resumption of normal activities. However, urinary tract injuries are a major concern in laparoscopic gynaecological surgery, in particular ureteral injuries during laparoscopic hysterectomy (LH). Reported incidence of ureteral injuries during hysterectomies varies between 0 and 2.2%. The applied approach plays a role in the variation of reported incidence of ureteral injuries during hysterectomy. A systematic review including 29 RCT’s comparing the laparoscopic with the abdominal and vaginal approach, reported more ureteral injuries in the group with the laparoscopic approach compared to the abdominal approach (Odds Ratio (OR) of 2.41 [95% CI: 1.21 - 4.82]) and the vaginal approach (OR of 3.69 [95% CI: 1.11 - 12.24]).

How to prevent this serious complication during LH? It is obvious that a learning curve plays a role in the prevalence of ureteral injuries during laparoscopic hysterectomy. The risk on an ureteral injury decreased significantly with increasing experiences of the surgeon with a cut-off level of 30 performed laparoscopic hysterectomies (LH) from 2.2 to 0.5%. Nevertheless, complications also occur in experienced hands, as the indication for laparoscopic hysterectomy becomes more challenging and the difficulty of the surgery is increasing. Reported risk factors for the occurrence of ureteral injuries are the presence of deep infiltrating endometriosis, dense adhesions, very large uteri and excessive bleeding.

As the laparoscopic hysterectomy still has to be implemented in several clinics, many gynaecologists have to complete the learning curve. To prevent complications during the learning curve, (peri) operative recommendations can be of help. However, clear guidelines for indications, surgical experience or surgical techniques to prevent ureteral injuries during LH are lacking. Clinical trials to study the preventive effects of these recommendations on the urinary tract injury rate are scarce. Most recommendations are authority and/or experienced based. The objective of this systematic literature review is to identify evidence based recommendations for the performance of laparoscopic hysterectomy in order to reduce the risk on ureteral injuries, in terms of operative techniques and equipment.

MATERIALS AND METHODS

Search strategy

The MEDLINE, EMBASE, and Cochrane Library electronic databases were searched for articles published from 1989 (when the first laparoscopic hysterectomy was performed) to March 2013, in order to identify all reported literature which described and studied the effect of a recommendation or technique to prevent ureteral injuries during laparoscopic hysterectomy.

Each of the following search terms were used: ureter*[tiab] OR ureters[tiab] OR ureteral[tiab] OR urologic*[tiab] OR “Ureteral Diseases”[Mesh] AND (“Laparoscopy”[Mesh:noexp] OR
Strategies to Prevent Ureteral Injuries During LH

The complete list of search terms is attached as an appendix. All retrieved abstracts, studies and citations were reviewed. Reference lists of the acquired articles were cross-checked for additional relevant studies. The search was not limited by study design, but papers had to be written in English or other European languages and published in peer reviewed journals.

Selection criteria
To be included, papers had to report on a recommendation to prevent ureteral injuries during laparoscopic hysterectomy. The effect of the preventive measurement on the prevalence of ureteral injuries had to be subject of the study. Papers that only mentioned this topic as an opinion (i.e., in discussion of paper) without any empirical evidence, were excluded. Papers with a description of a surgical technique without evaluation of its effect, were reported in a separate table to illustrate the knowledge gaps.

Study Selection
Two reviewers (P.J. and J.H.) evaluated each of the eligible papers and decided whether to include or exclude them according to the selection criteria. Differences between the two reviewers were resolved by re-examination of the original article by a third reviewer (HB) until consensus was attained about the paper's content.

Data Extraction
Two reviewers (P.J. and J.H.) independently extracted the following information from each article: first author, year of publication, study design, reported information and described preventive measurements and most relevant primary and secondary outcomes. In case of comparative studies, we additional reported the methodological quality of the paper based on the most relevant items of the STROBE checklist (such as clear description of used definitions, setting, methods and procedures, risk on confirmation bias, correction for confounders and follow-up).

RESULTS
Quality and characteristics of eligible studies
The search yielded 827 titles in PUBMED and 850 titles in EMBASE and none in the Cochrane Library database. After removal of the duplicates, 980 titles were identified as potential relevant and abstracts were studied. After reviewing the abstracts, 202 papers were identified as potentially eligible and full papers were assessed, 173 papers did not meet the selection criteria and were excluded (see Figure 1). 29 Papers reported on recommendations to prevent ureteral injuries during LH related to surgical techniques (25 papers) or equipment (four papers). Of these 29 papers, six papers described a technique without evaluation of its effect on the prevalence of ureteral injuries (see Table 1). Finally, 23 papers were included. Ten of these studies compared an intervention...
Records identified through database searching (n = 1677)

Additional records identified through other sources (n = 20)

Records after duplicates removed (n = 980)

Records screened (title and abstract) (n = 620)

excluded: 360 no gynaecological topic

Full-text articles assessed for eligibility (n = 202)

excluded: 418
- other operative procedure
- other (e.g. no full text article, poster presentation)

excluded: 127
- description ureteral injuries 53
- management ureteral injuries 17
- recommendation other complication 17
- diagnosis ureteral injury 19
- design (review, case report) 21

Potentially eligible articles (n = 75)

excluded: 52
- recommendation in discussion 19
- effect not evaluated 6
- no laparoscopic hysterectomy 13
- education 14

Studies included in systematic review (n = 23)

Figure 1. Flow diagram of reviewed studies

The included studies varied in design and number of evaluated patients; from a well designed RCT of 3141 included patients to a single arm evaluation of a recommendation without comparison to a control group (see Table 2-4).

There was a large variation in methodological quality of the ten included comparative studies according to the evaluated parameters as reported in the STROBE checklist (see Table 5). In some studies the quality of the trial was poorly described or evaluated as poor.

**Recommended techniques**

Reported recommendations were ureteral handling, including ureteral stent placement, ureteral visualization, lateralization and dissection, uterine artery preligation, uterine manipulator use and use of coagulating devices.
Table 1. Study characteristics of papers reporting on techniques to prevent ureteral injuries during LH without evaluation of its effect

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Design</th>
<th>Intervention</th>
<th>Objective</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kadar 1994</td>
<td>Description technique</td>
<td>systematic dissection retroperitoneum</td>
<td>complete control operative field and visualization all important retroperitoneal structures</td>
<td>LH</td>
</tr>
<tr>
<td>Shirk et al. 2006</td>
<td>Description techniques</td>
<td>two approaches to ureteral identification and dissection</td>
<td>how to avoid complications</td>
<td>Laparoscopic surgery</td>
</tr>
<tr>
<td>Henley et al. 1994</td>
<td>Description technique</td>
<td>opening post. side broad lig. to skeletonise uterine art. and lateralize ureter</td>
<td>bloodless dissection well away from any risk of injury to ureter</td>
<td>TLH and LAVH</td>
</tr>
<tr>
<td>Nassif et al. 2010</td>
<td>Device description</td>
<td>Clermont Ferrand uterine manipulator (Karl Storz Endoscopy, Tuttingen, Germany)</td>
<td>avoid complications by pulling the ureter away from operative field</td>
<td>TLH</td>
</tr>
<tr>
<td>López-Zepeda 2008</td>
<td>Device description</td>
<td>using López-Zepeda uterine manipulator</td>
<td>optimize attack angles to vulnerable structures and facilitate their dissection, avoids dissection and mobilization bladder and therefore its innervation</td>
<td>TLH</td>
</tr>
<tr>
<td>Koh 1998</td>
<td>Description technique</td>
<td>technique with use of a RUMI Koh Colpotomizer system (Cooper Surgical, Shelton, CT)</td>
<td>by pushing vaginal fornices upwards, steps of vessel desiccation and colpotomy consistently occur more than 2cm from ureters, ensuring safe desiccation and avoiding ureteral dissection</td>
<td>TLH</td>
</tr>
</tbody>
</table>

Papers without included patients, only description of technique or device.
LH laparoscopic hysterectomy, TLH total laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy

Ureteral stent placement
The use of ureteral stent placement has been evaluated in eight studies: one RCT, three prospective cohort studies, two retrospective cohort studies, and one single arm prospective cohort. The study characteristics and results are specified in Table 2.

Described techniques of ureteral stent placement and required time
Ureteral stents were placed pre- or intra-operatively by cystoscopy. In two studies lighted stents were used; illuminated or infrared. The ureteral stents were commonly removed at the completion of the operative procedure. Reported time needed for placement of two stents during surgery varied between 2 and 15 minutes. Mean time spent to place two stents was 9.35 minutes (5-14 min) in the study of Tanaka et al., and five minutes (range 2-15) in the study of Redan et al.
Prevention of ureteral injuries and reported complications related to ureteral stent placement

In the RCT including 3141 patients without previous surgery and undergoing major gynaecologic operations, randomization was performed into preoperative stent placement or a control group. Ureteral stent placement did not affect the incidence of ureteral injury and was not related to complications \(^\text{10}\).

In a prospective study of 492 LH procedures, ureteral stents were placed in the first 92 LH procedures. The practice was ceased with the last 400, when further reports suggested lack of reduced risk of ureteral injuries during LH after stent placement (see Table 2) \(^\text{13}\).

In a retrospective study including 94 patients undergoing LH in one year, ureteral stent placement during the last six months of the study period were compared with a control group of 34 LH's without stent placement in the first six months. One ureteral injury was reported in the latter group \(^\text{15}\).

Another retrospective study examined the incidence of urinary tract injuries in relation to stent placement in 3071 major gynaecologic operations performed between 1992 and 1994. Ureteral stent had been placed in 469 of 3071 patients. Two ureteral injuries occurred in two of the 469 patients after stent placement versus two in the control group without stent placement \(^\text{14}\).

Paulson placed in half of the 85 LAVH procedures (without randomization) an illuminated ureteral stent and evaluated the protocol, but reported scarcely on indication or results \(^\text{11}\).

Ureteral dissection and lateralization

Seven papers described ureteral dissection and lateralization during LH; one RCT comparing ureteral dissection vs. no ureteral dissection \(^\text{17}\), two retrospective cohort studies of respectively 1253 TLH and 2006 LAVH procedures \(^\text{18,19}\) and one retrospective cohort study including 30 LAVH procedures \(^\text{20}\) (see Table 3). Description of ureteral dissection and lateralization without further evaluation in three papers \(^\text{21-23}\). The applied interventions are described in more detail in Table 3, and a schematic presentation of the intervention is seen in Figure 2.

The effect of ureteral dissection or lateralization on ureteral injuries and other complications

The authors of these papers suggest that dissection and lateral release of the ureter may prevent ureteral injuries during LH (see Table 3). The effect of ureteral dissection and lateralization has been evaluated in 3537 patients in three single arms studies and one RCT. The latter compared the effect of dissection versus no dissection in 60 patients. Dissection of the ureter did not affect operation time, blood loss, and no ureteral injuries were identified in both arms \(^\text{17}\).

Major complications were reported in 24 patients (1.91%) of the 1253 TLH procedures applying the early ureteral identification technique. Reported complications include five cases of postoperative hydronephrosis, four ureteral injuries and one ureterovaginal fistula \(^\text{18}\).
Table 2. Study characteristics and results of included studies on ureteral stent placement

<table>
<thead>
<tr>
<th>Author Year</th>
<th>Design</th>
<th>Intervention</th>
<th>Control (n)</th>
<th>Number of Patients</th>
<th>Outcome/Objective</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chou et al. 2009</td>
<td>RCT</td>
<td>prophylactic placement of ureteral stents (1583)</td>
<td>no placement of ureteral stents (1558)</td>
<td>all 3141 major gynaecologic operations (792 LAVH)</td>
<td>prevention ureteral injury</td>
<td>1.2% vs. 1.09% ureteral injury (p=0.77)</td>
</tr>
<tr>
<td>Wood et al. 1996</td>
<td>Prospective cohort</td>
<td>routine placement of ureteral stents (92)</td>
<td>no ureteral stents (400)</td>
<td>492 LH</td>
<td>to test their use in preventing ureteral trauma</td>
<td>7/92 oliguria or anuria, no ureteral trauma in patients without stent placement</td>
</tr>
<tr>
<td>Paulson 1996</td>
<td>Prospective cohort</td>
<td>placement of illuminated ureteral stents (50%)</td>
<td>no ureteral stent (50%)</td>
<td>85 LAVH</td>
<td>reducing urinary tract injuries</td>
<td>besides one infection of vaginal cuff, no complications noted</td>
</tr>
<tr>
<td>Kuno et al. 1998</td>
<td>Retrospective cohort</td>
<td>preoperative placement of ureteral stents (469)</td>
<td>no ureteral stent placement (2602)</td>
<td>all 3071 major gynaecologic operations (256 LAVH)</td>
<td>examine frequency of its usage, efficacy in preventing injury and related complications</td>
<td>ureteral injury only in exploratory laparotomy group: 2/322 vs. 2/2016 (p=0.09)</td>
</tr>
<tr>
<td>Tanaka et al. 2007</td>
<td>Retrospective cohort, comparison with a historical cohort</td>
<td>preoperative placement of ureteral stents (60)</td>
<td>no ureteral stent placement (34)</td>
<td>94 LH</td>
<td>to prevent ureteral injury</td>
<td>0/60 vs. 1/34 ureteral injury (p=0.18); minor complaints from stent placement: low back pain, urinary discomfort, transient haematuria</td>
</tr>
<tr>
<td>Redan and McCarus 2009</td>
<td>Retrospective cohort</td>
<td>placement of lighted ureteral stents (151)</td>
<td>control group of other pelvic operations during same time period (number not reported)</td>
<td>patients with complex pelvic pathology (49 LH)</td>
<td>safely performing complex pelvic surgery</td>
<td>no ureteral injury in group of ureteral stents, two ureteral injuries in other group</td>
</tr>
<tr>
<td>Terzbachian et al. 2001</td>
<td>Retrospective cohort</td>
<td>ureteral stent placement when evidence ureteral adhesiolysis (9)</td>
<td>no ureteral stent placement (1712)</td>
<td>1722 operative gynaecologic laparoscopy</td>
<td>to describe indications and procedures of ureteral retrograde stent placement</td>
<td>besides no ureteral injuries, no other results described</td>
</tr>
<tr>
<td>Phipps 1995</td>
<td>Expert opinion</td>
<td>placement of transilluminating ureteral stents</td>
<td>no control</td>
<td>&gt;500 LH</td>
<td>prevention ureteral injury</td>
<td>no ureteral injuries</td>
</tr>
</tbody>
</table>

NA not analysed, LH laparoscopic hysterectomy, TLH total laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, LASH laparoscopic supracervical hysterectomy
### Table 3. Study characteristics and results of included studies on ureteral dissection/lateralization and uterine artery preligation techniques

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Design</th>
<th>Intervention (n)</th>
<th>Control (n)</th>
<th>Number of Patients</th>
<th>Outcome/ Objective</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ureteral dissection</strong></td>
<td></td>
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</tr>
<tr>
<td>Lee and Soong</td>
<td>1995</td>
<td>RCT</td>
<td>dissecting ureter at initiation of LH (30)</td>
<td>no dissection ureter (30)</td>
<td>60 LH</td>
<td>uterine arteries may be confidently desiccated once path ureter near uterosacral ligament is identified</td>
<td>no major compl., four minor compl. (two in each group); two cases of fever and two patients had lower abdominal distension</td>
</tr>
<tr>
<td>Kobayashi et al.</td>
<td>2012</td>
<td>Retrospective Cohort</td>
<td>early ureter identification technique (1253)</td>
<td>no control</td>
<td>1253 TLH</td>
<td>minimization of uterine injury</td>
<td>24 major complications (1.91%) (16 urinary tract injuries)</td>
</tr>
<tr>
<td>Kadar</td>
<td>1995</td>
<td>Description technique</td>
<td>dissecting pelvic retroperitoneum and ureteral identification (48)</td>
<td>no control</td>
<td>48 major laparoscopic operations (30 LH for benign indication)</td>
<td>ureter identification and dissection at critical points</td>
<td>complete dissection 16 times, 10 min. approximately on each side</td>
</tr>
<tr>
<td><strong>Ureteral lateralization</strong></td>
<td></td>
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</tr>
<tr>
<td>Koh et al.</td>
<td>2004</td>
<td>Retrospective Cohort</td>
<td>creating a “window” over broad ligament to push inferolaterally areolar tissue (2006)</td>
<td>no control</td>
<td>2006 LAVH</td>
<td>to minimize chance of ureteral injury during LAVH</td>
<td>no ureteral injury, 5 bladder injuries, 3 nerve pareses, minor complications in &lt;5% of patients</td>
</tr>
<tr>
<td><strong>Uterine artery preligation</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Sinha et al.</td>
<td>2008</td>
<td>RCT</td>
<td>early uterine artery ligation at beginning TLH (175)</td>
<td>suturing uterine arteries after cornual pedicles are sutured (175)</td>
<td>350 TLH</td>
<td>to compare feasibility, blood loss, duration of surgery and complications</td>
<td>reduction of blood loss and decrease time taken for procedure (p&lt;0.01)</td>
</tr>
<tr>
<td>Hsu et al.</td>
<td>2007</td>
<td>Retrospective Cohort</td>
<td>uterine artery ligation through retroperitoneal downstream ureter tracking when unexpected extensive pelvic adhesions (23)</td>
<td>uterine arteries routinely ligated through retrograde umbilical ligament tracking (213)</td>
<td>236 LAVH</td>
<td>minimise conversion to laparotomy</td>
<td>longer operation time (p&lt;0.05), more blood loss (p&lt;0.05), no ureteral injuries, no conversion</td>
</tr>
<tr>
<td>Chang et al.</td>
<td>2005</td>
<td>Prospective Cohort</td>
<td>uterine artery identification and ligation through retrograde umbilical ligament (RUL) tracking (225)</td>
<td>no control</td>
<td>225 LAVH with myomas or adenomyosis</td>
<td>operation time/blood loss</td>
<td>no complications related to RUL, no blood transfusions needed</td>
</tr>
<tr>
<td>Köhler et al.</td>
<td>2003</td>
<td>Retrospective Cohort</td>
<td>selective coagulation and transection of uterine vessels at their origin (267)</td>
<td>no control</td>
<td>267 LAVH</td>
<td>increasing safety and diminished blood loss</td>
<td>mean operation time 121 min, 8.4 min. to identify and coagulate uterine artery, no ureteral injury</td>
</tr>
<tr>
<td>Roman et al.</td>
<td>2008</td>
<td>Retrospective Cohort</td>
<td>early uterine artery coagulation at its origin (18)</td>
<td>no control</td>
<td>18 TLH with enlarged benign uteri (&gt;280 gr)</td>
<td>to avoid intraoperative haemorrhage requiring conversion and optimal protection for ureter</td>
<td>median duration 185 min., no correlation between uterine size and operation time, no intra- or postoperative complications</td>
</tr>
</tbody>
</table>

NA not analysed, LH laparoscopic hysterectomy, TLH total laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, LASH laparoscopic supracervical hysterectomy

* cornual is uterine vessel pedicle
Figure 2. Schematic overview of ureteral dissection and lateralization techniques.

Ureteral dissection and lateralization techniques:

1. Ureteral lateralization
   1a. Creating a “window” over the anterior and posterior broad ligaments by pushing the areolar tissue (in which the ureter is embedded) on the posterior broad ligament away inferolaterally, the remaining thin broad ligament is gently dissected and cut up to the level of uterosacral ligament; dividing posterior part of broad ligament to move ureter laterally to prevent thermal injury.
   1b. After transecting infundibulopelvic or utero-ovarian ligament, posterior peritoneum dissected down posterior side of the broad ligament adjacent to the uterus to the level of the uterosacral ligament.
   1c. Transperitoneal release incision: if course ureter can be identified visually transperitoneally, incision of the peritoneum adjacent to its course provides release from entrapping pathology; if the ureter is not visualized, retroperitoneal dissection is necessary: peritoneal incision lateral to infundibulopelvic ligament and separate medial peritoneum from lateral.

2. Dissection
   2a. Partial (early) dissection of the ureter in its course: grasping peritoneum of pelvic cavity just above ureteral canal and dissection of ureter all the way to level of ureteral canal.
   2b. Complete retroperitoneal dissection: uterovesical peritoneum is opened from cervix to round ligament; course ureter is exposed until entrance ureteral tunnel at beginning surgery.
   2c. Enter retroperitoneum without dividing round or infundibulopelvic ligament to expose the ureter at the pelvic brim; peritoneum is desiccated and opened further for a systematic dissection of the retroperitoneum.
   2d. Dissection of retroperitoneum by tracing the obliterated hypogastric and dissected free of bladder and surrounding areolar tissues and traced proximally to where they are joined by uterine arteries; blunt dissection just proximal and medial to the uterine artery will open the pararectal space.

Koh et al. introduced and evaluated his technique of creating a “window” over the broad ligament in 2006 LAVH procedures (see Table 3). No ureteral injuries occurred and the technique was described as simple and very effective in preventing ureteral injuries during LAVH.

**Uterine artery preligation**

Uterine artery preligation is evaluated in five studies; one RCT (350 patients), one controlled retrospective study in 236 patients, and three single arms studies including in total 510 patients: one prospective, and two retrospective cohort studies. The applied interventions are described in more detail in Table 3, and a schematic presentation of the intervention is seen in Figure 3.

**Effect of preligation of the uterine arteries on ureteral injuries and other complications**

Suturing of both uterine arteries at the beginning of TLH compared to suturing after coagulation of cornual pedicles in a RCT of 350 patients showed that total blood loss and duration of surgery was significantly less in the group of early ligation without major complications.

In a controlled retrospective study including 236 LAVH procedures, the technique of uterine artery preligation through retroperitoneal downstream ureter tracking in case of unexpected extensive pelvic adhesions was compared with uterine arteries routinely ligated through retrograde umbilical ligament (RUL) tracking. No ureteral injuries or conversions to laparotomies occurred in both groups, with or without preligation (see Table 3).

Köhler et al. evaluated the clinical outcomes of the RUL technique in 267 LAVH procedures and Chang et al. in 225 LAVH with myomas or adenomyosis. No complications were reported in relation to RUL.

**Uterus manipulator**

The use of a uterus manipulator is described in five studies, but evaluated in two. Two retrospective cohort studies including a total of 556 patients (see Table 4). There are no controlled studies of the preventive effect on ureteral injuries concerning the use of a uterine manipulator.

Techniques with respect to uterus manipulator use during LH

Uterine manipulators assist the surgeon to improve good exposure of pelvic anatomical structures by stretching the uterine pedicle and to deal with inherent problems of some surgical techniques to avoid complications, to find some important landmarks, and to avoid gas leakage when the vagina is open. Various manipulators are available, such as the Clermont Ferrand uterus manipulator, BISWAS uterovaginal elevator, Hohl instrument, Lopez Zepeda Uterus manipulator, Rumy Koh manipulator. Most devices are mentioned and technique of use is described without evaluation of their effect.

Evaluated effect of the use of a uterus manipulator on ureteral injuries

Two retrospective studies evaluated the outcome after the use of a uterus manipulator during LH. The use of BISWA uterovaginal elevator was evaluated in 512 LAVH procedures,
Table 4. Study characteristics and results of included studies on devices used

<table>
<thead>
<tr>
<th>Author Year</th>
<th>Design</th>
<th>Intervention (n)</th>
<th>Control (n)</th>
<th>Number of Patients</th>
<th>Outcome/ Objective</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee et al. 2009</td>
<td>Retrospective Cohort</td>
<td>using Biswas uterovaginal elevator (512)</td>
<td>no control</td>
<td>512 LAVH</td>
<td>safe and easy dissection of bladder and precise colpotomy, prevention ureteral injury by moving surgical field away from ureter</td>
<td>overall complication rate 6.25%, 3 bladder injuries (0.58%), no ureteral injury or major vessel injury, no conversion</td>
</tr>
<tr>
<td>Mueller et al. 2005</td>
<td>Retrospective Cohort analysis</td>
<td>using Hohl instrument (Karl Storz, Ltd., Tuttlingen, Germany) (44)</td>
<td>no control</td>
<td>44 TLH</td>
<td>evaluate feasibility of TLH using Hohl instrument</td>
<td>no ureteral or bladder injury, complication rate was zero</td>
</tr>
<tr>
<td>Janssen et al. 2011</td>
<td>RCT</td>
<td>LH with Ligasure (5mm) instrument (70)</td>
<td>LH with conventional bipolar instruments (70)</td>
<td>140 TLH, LAVH, LASH</td>
<td>Primary outcome surgery time; secondary outcome blood loss</td>
<td>no significant difference in blood loss, surgery time or complications</td>
</tr>
<tr>
<td>Karaman et al. 2007</td>
<td>Prospective Cohort</td>
<td>LH with bipolar forceps for haemostasis and laser for vaporization and excision (1120)</td>
<td>no control</td>
<td>1120 LAVH or LH</td>
<td>safe and effective technique</td>
<td>overall major complication rate 1% (e.g. abdominal bleeding, intestinal perforation), no ureteral or bladder injury</td>
</tr>
<tr>
<td>Khampitak et al. 2012</td>
<td>Prospective Cohort</td>
<td>using Heany clamps as metal guard during electro coagulation uterosacral, cardinal and broad ligaments</td>
<td>no control</td>
<td>102 modified LAVH</td>
<td>description technique and results of modified LAVH, to prevent urinary tract injury</td>
<td>no bowel or urinary tract injuries, one repeated laparoscopic uterine artery coagulation</td>
</tr>
<tr>
<td>Pelosi and Pelosi 1993</td>
<td>Retrospective Cohort</td>
<td>use of endoscopic Doppler probe (12)</td>
<td>no control</td>
<td>12 complicated single port LH</td>
<td>reducing probability of ureteral injury</td>
<td>no intraoperative complications</td>
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NA not analysed, LH laparoscopic hysterectomy, TLH total laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, LASH laparoscopic supracervical hysterectomy
an ureteral injury or conversion did not occur \(^{29}\). Ureteral injuries or other complications were also not reported during 44 TLH procedures using the Hohl manipulator \(^{30}\).

**Coagulation devices**
Various coagulation devices are being used during laparoscopic procedures. However, only a few have been evaluated (see Table 4). One RCT of 140 patients \(^{34}\), two single arm prospective studies including a total of 1222 patients \(^{35,36}\) (and one single arm retrospective study of 12 patients \(^{37}\)).

**Effect of coagulation devices on ureteral injuries**
In the RCT, comparing the effect of a bipolar vessel sealing device (Ligasure, Covidien, Boulder, CO) with conventional bipolar devices (during 140 LH procedures) on time to achieve haemostasis, no significant differences were reported in operating time, blood loss or complications \(^{34}\). No ureteral injuries occurred, but the study was underpowered to study the preventive effect on ureteral injuries.

No ureteral injuries were reported in a prospective study of 1120 women with a planned LAVH or LH, using bipolar forceps for haemostasis at all stages, and a CO2 laser for vaporization and excision \(^{35}\).

No ureteral injuries were reported either during 102 LAVH procedures using the Heany clamps as a metal guard during electro coagulation of the uterosacral ligaments and the uterine arteries \(^{36}\).

**DISCUSSION**

**Main findings**
Only a limited number of papers evaluated the effect of recommendations on the prevention of ureteral injuries during LH. Most reported recommendations were authority or experienced based without any evaluation. However, some conclusions can be made.

Routinely preoperative placement of ureteral stents does not reduce the occurrence of ureteral injuries during LH \(^{10,11,14,16}\), but may cause minor to moderate complications such as low back pain, urinary discomfort, transient haematuria, oliguria and transient anuria \(^{13,15}\). Other identified recommendations were ureteral dissection and visualization, ureteral lateralization, uterine artery preligations, use of vessel sealing devices for coagulation or the use of a uterine manipulator. Ureteral dissection or lateralization is evaluated in four studies \(^{18-20}\), of which only 60 patients in a random way \(^{17}\), this is insufficient to study the effect on ureteral injuries. The same accounts for uterine artery preligation or coagulating devices used, none of the comparative studies reported a ureteral injury in the intervention or the control group \(^{24,25,34}\).

**Strengths and limitations of the study**
To the best of our knowledge, this is the first systematic review evaluating the effect of recommendations to prevent ureteral injuries during laparoscopic hysterectomy.
STRATEGIES TO PREVENT URETERAL INJURIES DURING LH

Figure 3. Anatomical overview of uterine artery preligation techniques.

Uterine artery preligation techniques:

1. Window is created in broad ligament close to uterine vessels after opening of uterovesical peritoneum from round ligaments.

2. Preligation with sutures of the uterine artery at its origin through:
   a. retrograde tracking of the umbilical ligament (RUL technique).
   b. downstream of the ureter.

3. Complete isolation, coagulation and transsection of uterine artery after identification of its origin; internal iliac artery is followed after opening of pararectal space and identification of external and internal iliac arteries.

This figure was published in Atlas of Pelvic Anatomy and Gynecologic Surgery. Baggish & Karam. From chapter "Identifying and Avoiding Ureteral Injury". Copyright Elsevier 2006.

We tried to minimize potential bias by performing a precise search for published studies through the use of explicit methods for study selection and data extraction. However, according to the STROBE checklist, in general the methodological quality of the ten identified comparative papers can be evaluated as suboptimal in five of the published papers (less than half of the criteria items reported). Given the large variation of the reported recommendations and the methodological quality of the included studies, it was not possible to perform a meta-analysis. The individual sample sizes of included studies were, apart from one studying the effect of ureteral stents, insufficient to draw
solid conclusions concerning the preventive effect of recommendations during LH on ureteral injuries. However, studies which are designed to reduce a low complication rate need many patients to reach sufficient power. For instance, to reduce the rate of ureteral injuries from 0.01% to 0.002%, approximately 3000 patients in each arm should be included. Therefore, randomized studies to examine all recommendations are difficult to conduct and we sometimes have to rely on large prospective cohort studies or large databases. However, in our study many of the recommendations were authority based without any further evaluation. We provided an overview of these recommendations so that they may serve as a base for future research.

**Interpretations/relation to other publications**

Based on our findings there seems to be no place for routine preoperative placement of ureteral stent in case of a LH. Based on our review, we have to conclude that the effect of ureteral dissection or pre-operative uterine artery ligation on a routine base during LH has not been studied sufficiently. Dissection of the ureter takes time and in theory it may increase the risk on intraoperative bleeding and devascularisation of the ureters and as a consequence reflected ureteral ischemia and necrosis at a later stage. Less then 1.0% (10/1235) ureteral injuries were reported after routine ureteral dissection during TLH in a large single arm study. Except that this procedure does not prevent ureteral injuries in all cases, it can not be concluded yet that it reduces the risk on ureteral injuries. However, the reported incidence is lower then the far end of the reported number of ureteral injuries during TLH in most prospective studies or databases.

Given the lack of evidence based recommendations we have to fall back on experts opinions. Recently it was consented that ureteral dissection is not required on a routine base, but should be performed in case of distorted anatomy (endometriosis, large sized uterus) only. The systematic Delphi consensus procedure was established among international gynaecologic experts in the field of LH to reach consensus in uniform recommendations on the prevention of urinary tract injuries during LH. Furthermore, the consensus procedure recommended also to use a uterine manipulator during all LH procedures, no recommendations were formulated on type of manipulator used or type of coagulating devices. They considered the level of experience of more importance than the type of device used. In a retrospective analysis of 31 ureteral injury cases during LH in the Netherlands, it was reported that the Delphi recommendations were followed in only 16 cases (51.6%). In five of the eight cases of distorted anatomy, no ureteral dissection was applied and in two cases no uterine manipulator was used.

Two previous papers reported on various recommendations to prevent ureteral injuries during laparoscopic gynaecological surgery. Manoucheri et al. described an operator’s manual concerning ureteral injuries in laparoscopic gynaecologic surgery and Hasson and Parker provided a more general overview of prevention and management of urinary tract injury in laparoscopic surgery. Both papers did not apply a systematic literature search and focused on gynaecological surgery in general. We focussed on LH only. However, their main conclusion that one should be aware of
Table 5. STROBE Statement- checklist. Itemised reporting criteria of the comparative studies in the systematic review of items that should be included in reports of observational studies

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Summary

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NA not applicable, STROBE Strengthening the Reporting of Observational Studies in Epidemiology
the anatomy of the ureter and that a technique should be applied to identify the ureter before the operative procedure is continued in case of distortion of the anatomy is similar to the before mentioned Delphi study among experts. However, we could not find evidence to base these conclusions in our systematic review. Future studies should be performed to base these expert opinions with evidence.

Future research
We have chosen to report all identified recommendations even if they were not evaluated, in order to provide a complete overview and to encourage future studies on this topic by reporting the knowledge gaps. Despite the fact that LH is a frequent performed procedure and its implementation is increasing (from 1648 LH procedures in 1990 to 59294 in 1997 in the USA, and in the Netherlands from 215 procedures in 2002, to 929 in 2007 and approximately 1200 nowadays in the Netherlands), it is obvious that future research is needed to achieve more evidence based recommendations in order to optimize our surgical technique and to reduce the risk on ureteral injuries during LH. It is surprising that only 29 articles reported on this topic. Considering the low frequency of ureteral injuries during LH, a large volume observational study design may be preferred over randomized trials. In particular, prospective databases may serve this objective well.

Conclusion
Given the fact that a LH is one of the most common performed major laparoscopic procedure in gynaecology, it is unfortunate that most available evidence on prevention of major complications is still authority rather than evidence based. Various published recommendations on ureteral dissection techniques, preligation or coagulation of the uterine arteries and the use of various devices to prevent ureteral injuries, 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. As the ureteral injury is classified as an uncommon but major complication of benign gynaecologic surgery and associated with a high risk of litigation, this should be an important subject for future research.

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