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A Review of Laparoscopic Ureteral Injury in Pelvic Surgery

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The objective of this study was to review the body of literature in reference to ureteral injury during laparoscopic surgeries and to determine: 1) the reported rates of ureteral injury; 2) the initial laparoscopic surgeries during which ureteral injury occurred; 3) the time of injury recognition (intra- versus postoperative); 4) the type, 5) the location, and 6) the mode of injury repair; and 7) the surgical laparoscopic instruments involved in ureteral injury.

The appropriate medical subject heading (MSH) terms were selected and used in a search of the Medline computerized database and the online American College of Obstetricians and Gynecologists database. World literature published in the English language on ureteral injury during laparoscopic surgery between 1966 and 2003 was reviewed.

A total of 70 reported instances of ureteral injury during laparoscopic surgery were identified among 2491 reported cases in which ureteral laparoscopic complications were discussed. Incidences of injury ranged from <1% to 2%. These 2491 cases of laparoscopy were presented as a mixed group, which included case reports, small series of studies, as well as longer, consecutive studies. In 18 of the 70 (25.7%) cases, the initial laparoscopic procedures during which ureteral injury occurred were not described or specified. In cases in which the type of laparoscopic surgery was specified, 14 of the 70 (20.0%) total cases of ureteral injury occurred during laparoscopically assisted vaginal hysterectomy (LAVH). Ureteral injury was identified intraoperatively in 6 of 70 (8.6%) cases, postoperatively in 49 of 70 (70.0%) cases, and, in 15 of 70 (21.4%) cases, the time of diagnosis was not specified. In 36 of the 70 (51.4%) reported injuries, the type of injury was not specified or described. In instances in which the types of injury were described, transection occurred most commonly, accounting for 14 of 70 (20.0%) injuries. The location of ureteral injury was not specified in 46 of the 70 (65.7%) cases. When location was specified, injuries most often occurred at or above the pelvic brim, accounting for 10 of the total 70 (14.3%). Electrocautery was involved in 17 of the 70 (24.3%) cases of ureteral injury, but in 34 of the 70 (48.6%) cases, the surgical laparoscopic instrument involved was not reported. A laparotomy was used to repair the ureteral injury in 43 of 70 (61.4%) cases.

Ureteral injuries reported in peer-reviewed journals often lack detailed presentation of the initial laparoscopic surgeries during which ureteral injury occurred, or of the type, the location, and the instrumentation involved in ureteral injury. A high incidence of ureteral injury was found among the laparoscopic procedures analyzed in this review. Laparoscopically-assisted vaginal hysterectomy was the leading procedure in which injury occurred, and instruments involved in electrocoagulation were associated with the most injuries incurred during laparoscopic surgery.

Target Audience: Obstetricians & Gynecologists, Family Physicians

Learning Objectives: After completion of this article, the reader should be able to summarize the reported rates of ureteral injury, to identify the location of the more common laparoscopic ureteral injuries, and to list the various types of laparoscopic ureteral injuries.

Analyzing the literature on ureteral injury during laparoscopic surgeries by establishing the appropriate medical subject heading (MSH) terms and using them in a search of the Medline database and the online

American College of Obstetricians and Gynecologists (ACOG) database, it appears that no comprehensive review on this subject exists. Tamussino et al. (1) specifically reviewed ureteral complications in 790 consecutive major laparoscopic procedures and determined an incidence of 0.38%, all of which occurred during laparoscopically assisted vaginal hysterectomy (LAVH). This is one of the only studies to specifically target

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ureteral injury in gynecologic laparoscopic surgery and adequately document the pertinent events surrounding the injury, including time of diagnosis and treatment modality.

In 1971, Engel et al. (2) discussed the history of laparoscopy, the procedure itself, indications, contraindications, and potential complications. In listing the complications, however, these authors did not describe the potential for ureteral injury. The first reported complication of ureteral injury in laparoscopic surgery was presented by Stengel et al. (3) in 1974. They described a patient who underwent laparoscopic tubal sterilization complicated by partial obstruction of the right ureter at the level of the pelvic brim. In 1975, Irvin et al. (4) reported a patient who had transection of the right ureter just above the pelvic brim during laparoscopic tubal sterilization. In both of these reports, the ureteral injuries were repaired using laparotomy. The first ureteral injury repaired laparoscopically was reported as a complication of laparoscopic endometriosis ablation and was presented by Gomel and James (5) in 1991. A transverse laceration over the anterior aspect of the left ureter was diagnosed intraoperatively and repaired using laparoscopic stenting and suturing. In 1992, Nezhat et al. (6), reported a ureteral injury during laparoscopic surgery, which was repaired laparoscopically (an UltraPulse carbon dioxide laser was being used to excise extensive pelvic sidewall endometriosis).

More recently, cases of ureteral injury have been reported with greater frequency. In a review of 452 cases of laparoscopic surgeries, published in 1996, Saidi et al. (7) reported a 10.4% rate of incidence of complications encountered during major operative laparoscopy. Of the total cases, 5.3% included complications that were considered serious such as hemorrhage, intestinal obstruction, fistula formation, and ureteral injury. Ureteral injury accounted for 4.3% of the total complications, which represented an overall rate of injury of only 0.44% of the total patients who underwent laparoscopic surgery. In "A Nationwide [Finland] Analysis of Laparoscopic Complications," published in 1997, Härkki-Sirén et al. (8) reported that 18 of the 256 (7.0%) complications that were analyzed involved ureteral injuries. Overall, these 18 cases occurred in a total series of 70,607 gynecologic laparoscopic procedures (1 per 4000 laparoscopic surgeries [0.025%]). Generally, the lack of uniformity in the gathering of data and in its presentation makes accurate determinations of the rate of ureteral injury difficult.

In this review, we have examined the available literature on ureteral injury associated with gynecologic laparoscopic surgery in an attempt to determine: 1) the reported rates of ureteral injury; 2) the initial laparoscopic surgeries during which ureteral injury occurred; 3) the time of injury recognition (intra- versus postoperative); 4) the type, 5) the location, and 6) the mode of injury repair; and 7) the surgical laparoscopic instruments involved in ureteral injury.

MATERIALS AND METHODS

To conduct this review, terms were established using the appropriate MSH. Initially, the abstracts of these articles were analyzed to determine their compatibility with this review, followed by a review of the full text of the pertinent article. A search of the literature published between 1966 and 2003 was conducted using the Medline computerized database and the online ACOG database and was then supplemented by a manual search of bibliographies. The key terms used to conduct the search were "laparoscopic complications" and "ureter."

RESULTS

A total of 3344 articles describing complications during laparoscopic surgeries in peer-reviewed journals were analyzed after a search of the Medline computerized database. This search was supplemented with an online search of the ACOG database in which 3690 articles were reviewed. A supplementary manual search of bibliographies was performed as well to reference pertinent articles and publications involving ureteral injury and laparoscopic surgery. Of these articles, 30 (3–32) discussed ureteral injury during laparoscopic surgery. The 70 individual cases contained in these 30 articles were analyzed for the purposes of this review.

Rate of Injury and Initial Procedure

In our review of the literature, 70 cases of ureteral injury were identified with incidence rates reported ranging from <1% to 2%. In 18 of our 70 (25.7%) cases, the initial laparoscopic procedure during which ureteral injury occurred was not described. In 14 of the 70 (20.0%) cases, ureteral injury occurred during LAVH, 8 (11.4%) during oophorectomy, 7 (10.0%) during laparoscopic pelvic lymphadenectomy, 5 (7.1%) during laparoscopic sterilization, 5 (7.1%) during excision of endometriosis, 4 (5.7%)

during endometriosis ablation, and 3 (4.3%) during each of the following: drainage of lymphoceles, electrocoagulation, and laparoscopic adhesiolysis.

Time of Injury Recognition

Six cases (8.6%) of ureteral injury were diagnosed intraoperatively during the initial laparoscopic surgery, 49 (70.0%) postoperatively, and in 15 (21.4%), the time of ureteral injury was not specified.

Type of Injury

In 36 of the 70 (51.4%) cases of ureteral injury, the type of injury was not described. In 14 cases (20.0%), transection was the reported type of injury. Laceration, obstruction, and stenosis were each reported in 4 cases (5.71%). Fistula formation, necrosis, and ligation were each documented in 2 of the 70 cases (2.9%). Resection and burn injury each accounted for 1 case (1.4%) of injury.

Location of Injury

In 46 cases (65.7%), the location of ureteral injury was not specified. Injury occurred at or above the pelvic brim in 10 of the 70 cases (14.3%). Eight cases (11.4%) described injury at or above the uterine artery, and 6 cases (8.6%) reported injury at or above the bladder (but below the uterine artery).

Mode of Approach to Injury Treatment

Laparotomy was the mode of repair in 43 cases (61.4%) of ureteral injury. In 15 cases (21.4%), the mode of treatment was not described. Repair through laparoscopy was reported in 8 cases (11.4%), whereas conservative, nonsurgical management was used in 4 cases (5.7%).

Instrumentation Involved in the Injury

Of the 70 cases, 34 (48.6%) did not specify the surgical laparoscopic instrument(s) involved in ureteral injury. Instrument(s) involved in electrocautery accounted for 17 cases (24.3%), whereas endoscopic stapling was documented in 12 cases (17.1%). CO₂ laser was reported in 4 cases (5.7%), forceps were described in 2 cases (2.9%), and an aspirating needle was involved in 1 case (1.4%).

DISCUSSION

The incidence of major complications in laparoscopic hysterectomy in several studies was determined to be 3.5%, whereas the incidence of ureteral injuries was reported as falling between 0.3% and 2% (33–39). Namnoum and Murphy (40, 41) described the incidence of bowel or urinary tract injury at a rate of 5.5 per 1000 in a study of 49,697 operative laparoscopic procedures. Hirsch et al. (42, 43) reported a general rate of incidence of laparoscopic complications as ranging from 3.5 to 4.2 per 1000 during operative laparoscopy procedures. Melotti et al. (44–46), Milsom (47), and Spinelli (48, 49) mentioned a minimal occurrence of ureteral injury in their discussions of laparoscopic complications, whereas Soderstrom et al. (50, 51) only briefly mentioned ureteral injury as a possible laparoscopic complication. None of these articles presented specific data on the subject of ureteral injury, however. Clearly, the rate of laparoscopic ureteral injury is not comprehensively described and documented in the literature, and the collection and presentation of the data does not seem uniform, probably accounting for the disparities in the reported rates of incidence.

“Ureteral injury is becoming more common as a result of the increased numbers of laparoscopic hysterectomies and retroperitoneal laparoscopic procedures that are being performed.” (52, 53–55) Härkki-Sirén et al. (8) stated that the ureters are particularly vulnerable to injury during major operative laparoscopy and that incidence of ureteral injury during minor procedures is rare. This statement is consistent with this review in that all of the cases in which the initial laparoscopic surgery was defined and reported involved major operative laparoscopy. An actual statistical breakdown, however, is impossible to compare because our review finds that in 25.7% of our 70 cases, the initial type of laparoscopic surgery was not reported. Generally, as with overall rates of injury, when the initial laparoscopic procedures during which ureteral injuries occurred were reported, widely disparate procedure-specific rates of incidence have been reported.

Intraoperative diagnoses of ureteral injury were made in only 6 of the 70 (8.6%) total cases. Most of the literature notes that many diagnoses of ureteral injury are made postoperatively, but papers on classic (nonlaparoscopic) gynecologic procedures primarily describe the methods of detection of ureteral injury rather than the time of injury diagnosis. Hurt et al. (56) discuss 5 methods to identify ureteral injury: 1) retrograde ureteral dye injection; 2) intravenous

dye injection; 3) intraoperative ureteral catheterization; 4) intravenous excretory urography; and 5) dissection of the ureter. Because 15 of the 70 (21.4%) cases did not report a specific time of diagnosis of laparoscopic ureteral injury, the comprehensiveness of many of the reports is lacking.

The mode of approach most often used to repair ureteral injury during laparoscopic surgeries was laparotomy, accounting for 43 of the 70 (61.4%) cases of injury. Of the 70 total cases of injury, however, 15 (21.4%) did not report the mode of treatment. Gordon and Lewis (57–65) noted that focal ureteral injuries occurring during laparoscopy can be usually treated using a double J-shaped catheter passed into the ureter, which stops urine leakage and supports the ureter, allowing for spontaneous healing. Additionally, these authors describe instances in which treatment of more extensive damage was necessary, requiring laparotomy to perform an end-to-end anastomosis or ureteral implantation. The preferred technique of ureteral injury repair is often dependent on the time of injury diagnosis. In the 59 cases in which both time of ureteral injury diagnosis and mode of treatment were reported, laparotomy was the mode of repair in 38 of the 49 (77.6%) cases in which a postoperative diagnosis was made. Of the 5 cases of ureteral injury that were not treated using laparotomy, 4 of these cases involved conservative treatment and 1 case was approached laparoscopically. The data indicates a trend in which injuries that are diagnosed postoperatively are most often repaired using laparotomy. When injuries are diagnosed intraoperatively, the likelihood of a laparoscopic repair is increased. In 6 of the 70 (8.6%) cases, diagnoses were made intraoperatively. Two of these cases were treated by laparotomy and 4 were treated using laparoscopy.

The literature concerning the type and location of ureteral injuries incurred during laparoscopic surgeries is scarce. The type of ureteral injury was not specifically described in more than half of the reviewed cases (51.4%), and the location of the injury

was specified in even fewer cases. In describing potential locations for ureteral injury in classic gynecologic procedures, Hurt et al. (56) note 3 when discussing classic, nonlaparoscopic pelvic surgeries: 1) at the pelvic brim, where the ureters lie beneath the insertions of the infundibulopelvic ligaments and over the bifurcations of the common iliac arteries; 2) where the ureters pass under the uterine arteries lateral to the cervix; and 3) where the ureters are lateral to the vaginal fornices, about to enter the bladder. Gordon and Lewis (57–64) indicate 3 potential locations for ureteral injury during laparoscopic surgeries: 1) at the infundibulopelvic ligament; 2) where the ureter passes deep to the ovarian fossa; and 3) at the ureteral canal. Our review finds that, when specified, the first of these locations (at or above the pelvic brim) is the most common site of injury.

Most of the papers we reviewed offer only brief discussions of instruments involved in ureteral injuries during laparoscopic surgeries. In 34 of the 70 cases (48.6%) of ureteral injury, the surgical laparoscopic instruments involved were not defined or specified. LAVH and instruments involved in electrocautery were identified as leading causes of laparoscopic ureteral injury when data was available for analysis and review, but instrumentation involved in injury was unspecified in almost half of the reviewed cases. In more than 50% of the cases, location and type of injury were also not specified (Table 1). Although electrocautery instrumentation, transection injuries, and injuries at or above the pelvic brim were the most common findings in this review, this conclusion is derived from the data available in the relatively few papers that were specific about this information. Approximately half of the locations, types, and instruments involved in injury are not mentioned and hence cannot be categorized. This unfortunate lack of specificity in a large proportion of patients with laparoscopic ureteral injury makes it difficult to draw firm conclusions. Accurate informa-

TABLE 1 Most common associations with ureteral injury and a comparison with the number of unspecified associations in total reviewed cases

Reviewed Category	Most Commonly Associated With Injury*	Specified Instances	Unspecified Instances
Procedure	LAVH	14 (20%)	18 (25.7%)
Time of diagnosis	Postoperative	49 (70%)	15 (21.4%)
Type	Transection	14 (20%)	36 (51.4%)
Location	At or above pelvic brim	10 (14.3%)	46 (65.7%)
Mode of repair	Laparotomy	43 (61.4%)	15 (21.4%)
Instrumentation	Electrocautery	17 (24.3%)	34 (48.6%)

* When data has been available for review.

LAVH, laparoscopically assisted vaginal hysterectomy.

tion about the site of injury and the type of instrument that caused it can lead to prevention of future injuries. More detailed reporting of this relatively uncommon type of laparoscopic complication is needed. Despite a lack of complete information about laparoscopic ureteral injury, some steps can be taken to decrease the risk of this complication. Ostrzenski published his data on laparoscopic total abdominal hysterectomy (66), laparoscopic radical hysterectomy with lymphadenectomy (67), and laparoscopic colposuspension (68), which indicated that laparoscopic ureteral injury can be minimized by using a laparoscopic suturing and tying method. Dorsey et al. (69) have demonstrated that a 2-turn flat square knot is as strong when tied laparoscopically as when executed during laparotomy. Laparoscopic suturing technique and the tying of an intracorporeal or extracorporeal knot can be considered as an alternate and possibly safer method than the use of staplers or electrocautery. More general steps in the prevention of injury would also include improved training in laparoscopic technique, especially in the recognition of intra- and retroperitoneal gross and functional anatomy. The establishment of intraoperative protocols to verify the integrity of the lower urinary tract (using some of the previously mentioned techniques (56)) and obtaining a urology consultation intraoperatively as needed might serve to decrease the delay in recognition of ureteral injury and, in turn, increase the likelihood of their intraoperative repair.

Generally, data and discussion concerning injuries of the ureter during laparoscopic surgeries were lacking in both breadth and depth. Much of the reviewed literature on existing information concerning this type of ureteral injury seems cursory and incomplete.

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