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Bladder Injury During Laparoscopic Surgery

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The objective of this review is to present the incidence of iatrogenic bladder injury associated with diagnostic and/or operative laparoscopic surgery; to determine the type of primary laparoscopic operation, the time at which the reported injuries occurred, the location of injuries, and the method(s) used to repair those injuries; to decide which laparoscopic procedure carries the highest risk for bladder injury; and to establish the most frequent surgical instruments with which injuries happened. World literature published between 1970 and 1996 was reviewed. The appropriate Medical Subject Heading (MeSH) terms were selected and used in a search of the MEDLINE, ACOGNET, OVID Compact Disk Version database. A total of 1372 articles on laparoscopic surgery complications were reviewed. Of that number, a total of 77 articles identified bladder injuries, and these were analyzed for the objectives of this study. There are a wide range of bladder injuries during laparoscopic procedures. In the studied articles, the incidence of bladder injury during laparoscopic procedures ranged from 0.02 to 8.3 percent of cases. Most frequently, these injuries occurred during laparoscopic-assisted vaginal hysterectomy. Sharp electrosurgical dissection was the leading instrument causing injury. An intraoperative diagnosis of bladder injury was made in 53.24 percent of all bladder injury cases. The bladder dome was the most commonly injured structure. Less than half (29.87 percent) of the bladder injuries were corrected laparoscopically.

The incidence, location, primary procedure, type of instruments, and the method to repair of bladder injuries during laparoscopic surgery are unknown (1-58). The bladder is the most common site of injury during classic gynecological surgery (59, 60). But regardless of the advantages of operative laparoscopy (61), it too has great potential for serious complications. New technology has led to new creative laparoscopic techniques (62), and as the complexity of these procedures increases, so does the

seriousness of potential complications. The laparoscopic approach itself exposes the bladder to the Veress needle, trocars (primary or secondary), and complications associated with pneumoperitoneum. Laparoscopic surgical techniques expose the bladder to surgical incisions, lacerations, and thermoenergy injuries. These injuries can be classified as anticipated or unanticipated incisions or unintended lacerations (63-65).

The objectives of this study were to establish:

1. The incidence of iatrogenic bladder injury during diagnostic and/or operative laparoscopic pelvic surgery.
2. The time, intraoperative or postoperative, at which the reported injury was diagnosed.
3. The location of the bladder injury.
4. The most frequent laparoscopic instrument with which surgical injury was inflicted.

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5. The laparoscopic primary procedure being used when the injury occurred.
6. The method and route of approach to repair bladder injury,

copy (13 cases), bladder neck suspension (8 cases), and endometriosis ablation (6 cases) (Table 5). Injury to the persistent urachal sinus during laparoscopic surgery was found in one case. The injury was diagnosed postoperatively and was managed conservatively (65).

MATERIALS AND METHODS

The appropriate Medical Subject Heading (MeSH) terms were selected and used in a search of the MEDLINE, ACOGNET, and OVID Compact Disk Version database. A review of world literature published between 1970 and 1996 was conducted. A total of 1372 articles on laparoscopic surgery complications were reviewed. Of the 1372, 77 articles identified bladder injuries and were analyzed for the objectives of this study.

RESULTS

The incidence of bladder injury during laparoscopic procedures ranged from 0.02 to 8.3 percent in the relevant studies. Intraoperative diagnosis of bladder injury was made in 41 of 77 cases (Tables 1 and 2). The location of the bladder injury was determined in 29 cases; the bladder dome was the most commonly injured structure (26 cases), followed by damage to the posterior bladder base (3 cases) (Table 3). Of the 77 cases, 23 were corrected laparoscopically, 10 transvaginally, 9 via laparotomy, and 2 were managed conservatively. The remaining 33 cases did not specify the method of repair (Table 4). The most common laparoscopic procedure in which bladder injury occurred was laparoscopic-assisted vaginal hysterectomy (31 cases), during which the sharp electro-surgical dissection (a laparoscopic instrument connected to a electrocautery unit with which the sharp dissection was performed) was the leading instrument causing injury (eight cases), followed by blunt dissection (six cases), laser (three cases), and the laparoscopic scissors or 5-mm trocar (one case each). The remaining laparoscopic procedures in which bladder injury was reported were as follows: diagnostic laparoscopy (19 cases), operative laparos-

DISCUSSION

Many predisposing risk factors increase the chance for bladder injury during laparoscopic procedures. Any bladder pathology or any contiguous pelvic process (such as inflammation whether acute or chronic, endometriosis, malignant infiltration, previous surgery, adhesions, bladder wall diverticula, previous radiation, or amyloidosis) may put the patient at increased risk for bladder injury (55, 59, 66). An overly distended bladder, as well as a thin (less than 3 mm) bladder wall, may predispose the bladder to injury during surgical manipulation (67). Any compromise to bladder mobility (68), or surgery during the postpartum and lactation periods, carries an increased risk for bladder injury during surgery (63). Compressive erosions created by a vaginal pessary, which may cause thinning of the bladder wall (69) as well as erosions around permanent sutures, may also pose as risk factors (70). It is also pertinent to mention that in infants and children (up to the age of 6 years), the bladder is primarily in the abdominal cavity (71) and therefore, is more exposed to injury during laparoscopy.

It is critical for the well being of the patient both to recognize and to repair the injury intraoperatively. Postponing diagnosis of an injury to the bladder dome with a 5-mm trocar exposes the patient to surgical manipulation through the initial trocar perforation, in which case the injury size will be increased (72).

The oliguria is one of the cardinal postoperative symptoms of bladder injury (73, 74), and therefore serves as a critical clue for possible injuries to the bladder. Proper hydration and adequate fluid intake-output monitoring during the operation is essential to detect such complications.

A sequel of bladder injury is fistula formation (33). Among the 77 cases reviewed, 4 fistulas were reported. Three of the fistulas resulted from injury during a laparoscopic-assisted vaginal hysterectomy (LAVH) procedure, and one resulted from ablation of endometriosis. Techniques chosen for the repair of these fistulas varied and included transvaginal, laparotomy, and laparoscopic methods (17, 25).

TABLE 1 Total number of injuries

Type of surgery performed	Total no. of bladder injuries
Laparoscopic hysterectomy	31
Diagnostic laparoscopy	19
Operative laparoscopy	13
Bladder neck suspension	8
Endometriosis ablation	6
Total	77

TABLE 2 Time of injury diagnosis

Type of surgery performed	Diagnosis		
	Intraoperative	Postoperative	Unspecified
Laparoscopic hysterectomy	21	4	6
Diagnostic laparoscopy	5	2	12
Operative laparoscopy	5	6	2
Bladder neck suspension	4	N/R	4
Endometriosis ablation	6	0	0
Total	41	12	24

TABLE 3 Location of injury

Type of surgery performed	Bladder		Unspecified
	Dome	Base	
Laparoscopic hysterectomy	2	1	28
Diagnostic laparoscopy	10	1	8
Operative laparoscopy	2	1	10
Bladder neck suspension	7	N/R	1
Endometriosis ablation	5	N/R	1
Total	26	3	48

Bladder repair can be executed via a laparoscope by adapting classic gynecological surgery technique (28, 31, 48, 49, 60), with fine, absorbable polydioxanone sutures tied with a two-turn flat square knot [this type of laparoscopic knot is comparable in strength with conventional knots (75)]. It has been reported that bladder dome injuries were repaired via laparoscopic suturing techniques successfully in one layer (43, 44, 50), and in three layers (31, 49). Recently, Lee et al. (26) reported a one-layer closure of bladder defects with laparoscopic staplers. In two cases, Nezhat and Nezhat (50) laparoscopically closed the bladder dome defect with an interrupted through-and-through single layer and quoted Smith's (76) technique as the one used by their group. Smith (76) described cystotomy/vesicostomy and seromuscular temporary closure, with an interrupted 2-0 catgut suture, of excessive bladder openings surrounding a suprapubic catheter. It is conceivable that laparoscopic one-layer with an interrupted through-and-through single-layer bladder dome laceration closure during the initial surgery will become the laparoscopic surgical technique of choice. However, at this stage, such an approach will make many experienced pelvic surgeons uneasy, until randomized study confirmation is available.

In 1990, Reich et al. (72) described a laparoscopic bladder injury repair procedure as follows: "a mattress pursestring suture was placed to close the bladder muscularis, after which no leakage was discernible. A second figure-of-eight stitch was placed through the anterior abdominal-wall peritoneum and

bladder muscularis." Mattress and pursestring are two distinct suturing methods (28); combining these two sutures in one has not been identified in any literature or text (28, 60). Furthermore, suturing the "abdominal-wall peritoneum to the bladder muscularis" creates a artificial connection between two different anatomical structures, a connection that matches neither the gross nor the functional anatomy. The bladder wall muscle layer is a contracting organ, and the abdominal-wall parietal peritoneum is not. Such repair will partially suspend the fragment of the bladder muscle and possibly reduce its contractility and mobility. This may cause a predisposition to complications such as tissue necrosis and fistula formation.

Lee et al. (26) repaired bladder injury in one layer with the Endo GIA™ (30) stapler. However, permanent non absorbable sutures placed through the urinary bladder may produce calculus, granulomas (which may result in incontinence), fistulas, vesicle instability, recurrent tract infections (77-80), and possible tissue erosion (81).

This review makes clear that the LAVH procedure was associated with a significantly increased risk of bladder injury. When searching for the cause of this adverse laparoscopic event, articles referring to the technique of LAVH showed that laparoscopic bladder mobilization from cervical attachment (26, 82, 83) was adapted in most cases from Reich et al. (84), who stated that the bladder "could be easily dissected bluntly, and reflected off the anterior uterine surface." Contrary to his description, a classic hysterectomy technique (28, 85) strongly suggests that blunt dissection by pushing "the bladder down, may cause unnecessary trauma to the bladder musculature" (28). This blunt dissection technique forcefully pushes the bladder down against the pubovesicocervical fascia and the vesicocervical ligament, which may weaken the bladder wall integrity, causing possible vesicovaginal fistula formation and potentially tearing the bladder wall. These classic surgery data suggest that the technique of laparoscopic blunt bladder mobili-

TABLE 4 Method of injury repair

Type of surgery performed	Laparoscopic	Laparotomy	Vaginal repair	Conservative	Unspecified
Laparoscopic hysterectomy	10	5	9	N/R*	6
Diagnostic laparoscopy	N/R	2	1	N/R	15
Operative laparoscopy	3	2	N/R	N/R	8
Bladder neck suspension	4	N/R	N/R	N/R	4
Endometriosis ablation	6	0	0	0	0
Total	23	9	10	2	33

* N/R, not reported.

TABLE 5 Laparoscopic instruments with which injury occurred

Type of surgery performed	Sharp electrocoagulation dissection	Blunt dissection	Laser	Scissors	Trocar		Unspecified
					5 mm	10 mm	
Laparoscopic hysterectomy	8	6	3	1	1	N/R	12
Diagnostic laparoscopy	N/R	N/R	N/R	N/R	4	5	10
Operative laparoscopy	3	N/R	1	N/R	2	N/R	7
Bladder neck suspension	N/R	1	N/R	4	N/R	N/R	3
Endometriosis ablation	0	0	6	0	0	0	0
Total	11	7	10	5	7	5	32

* N/R, not reported.

zation during LAVH should be avoided, and sharp dissection via laparoscope should be used to reduce the rate of bladder injury, unless clinical studies prove otherwise.

It has been documented that a sharp dissection of the pubovesicocervical fascia and the vesicocervical ligament can be performed during laparoscopic total abdominal hysterectomy (49, 86, 87) or other types of laparoscopic hysterectomies (27, 88-92). Most importantly, the rate of complications associated with laparoscopic procedures can be greatly reduced by implementing mandatory continuing education in laparoscopic procedures and techniques. Additional physician training is crucial, although it would require a revision in the credential process recommended by the American College of Obstetricians and Gynecologists (ACOG) (90).

To avoid urachal sinus injury, the surgeon must be aware of the possibility of congenital abnormalities, which fall into four categories (82): 1) Urachal sinus communicating with the umbilicus and the urinary bladder, 2) urachal sinus communicating with the umbilicus alone, 3) vesicourethral diverticulum between the bladder and urachus, and 4) urachal cyst obliterated proximally and distally.

There is no laparoscopic intraoperative management procedure available for such an injury in the literature, although it could be handled by laparoscopy in ways similar to that of laparotomy. A postoperative, conservative therapy, with bladder drain-

age using a Foley catheter and bacteriostatic medication, was presented (65).

SUMMARY

A comprehensive review of the literature indicates that the incidence of bladder injuries during laparoscopic hysterectomy ranged from 0.02 to 8.3 percent in the relevant studies. The highest percentage of bladder injury is noticed during laparoscopic-assisted vaginal hysterectomy. In contrast, during classic hysterectomy, bladder injury occurred in 0.5 to 1 percent of the cases.

We think that the rate of complications associated with laparoscopic operation(s) can be greatly reduced by well-designed (according to technique and technology requirements) physician training.

CONCLUSIONS

The following conclusions were derived from our review of the 1372 articles in the world literature between 1970 and 1996.

1. The incidence of bladder injury during laparoscopic surgery is much higher when compared with classic pelvic surgery.
2. The ability to make intraoperative diagnosis of bladder injury by laparoscopic pelvic surgeons is low.

3. The bladder dome was the most common location of bladder injury during laparoscopic surgery.
4. Laparoscopic instruments connected to electrocautery unit were identified as leading participant in bladder injury, followed by blunt dissection.
5. The highest incidence of laparoscopic bladder injury is associated with laparoscopic-assisted vaginal hysterectomy
6. Execution of laparoscopic repair of bladder injury is low and the technique of repair was not unified.

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