Contents lists available at ScienceDirect

Asian Pacific Journal of Reproduction

Journal homepage: www.elsevier.com/locate/apjr

Document heading 10.1016/S2305-0500(13)60057-3

Gaseous distension of the urinary bag during CO_2 laparoscopy in the usual operative settings: Does the CO_2 diffuse into the urinary bladder or is it a sign of urinary tract injury?

Kahraman Ülker[1*], Tuncay Ok[2], İsmail Temur[1], Ürfettin Hüseyinoğlu[3], Kemal Kılıç[4], Barlas Sülü[4]

[1]Kafkas University School of Medicine, Department of Obstetrics and Gynaecology, Kars, Turkey
[2]Private Obstetrician and Gynaecologist, Kars, Turkey
[3]Kafkas University School of Medicine, Department of Anaesthesia and Reanimation, Kars, Turkey
[4]Kafkas University School of Medicine, Department of General Surgery, Kars, Turkey

ARTICLE INFO

Article history:
Received 25 February 2012
Received in revised form 5 March 2012
Accepted 5 May 2012
Available online 20 June 2012

Keywords:
Surgical injuries
Intra operative
Laparoscopy
Laparoscopic surgery
Urinary tract
Urinary bladder
Urinary catheterization

ABSTRACT

Objective: To compare the amounts of any clinically detectable gas passage into the urinary bag in laparoscopic and open surgeries. **Methods:** Seventy-nine women were allocated into two surgical groups; Group 1: carbon dioxide (CO_2) laparoscopy (n=37) and Group 2: gasless laparoscopy or laparotomy (n=42). All patients had urinary catheter during the surgeries. After checking the tightness of the connection of the urinary catheter and bag operations were performed. At the end of each surgery the urine volumes were recorded. The bags were immersed into a water containing container with a volume scale. The volume rise of the container was recorded. The valve of the outlet of the bag was turned on under the water and any leakage of air bubbles was observed. The final volume of the container was recorded once again while the bag was still in the water. The two groups were compared by using the Student's t or Mann Whitney U tests. **Results:** We did not observe and hence measure any gas accumulation in the urine bags of both groups. The women's ages, total intraoperative urine volume, urine production rate and total operative times of the groups were not significantly different. The mean operative time was (82.98±62.14) min in open surgeries and (73.46±52.74) minutes in CO_2 laparoscopic surgeries. The difference between the groups was not significant (P=0.468). **Conclusions:** Any gas accumulation in the urine bag during CO_2 laparoscopic surgery should raise the suspicion of urinary tract injury. Urinary catheterization helps to diagnose the unnoticed bladder injuries.

1. Introduction

Most of the lower urinary tract injuries occurred during "routine" laparoscopic benign pelvic surgery and 50%-80% of them were estimated to occur during gynaecologic surgery[1]. The injury rates varied between 1.0%-8.3%[2-4].

Lafay Pillet MC *et al*. noticed a urinary bladder injury rate of 1% (15 cases) out of 1 501 laparoscopic hysterectomies. Although they did not mention their diagnostic tool, they diagnosed all of the injuries intra operatively[2]. However, in another study composed of 126 total laparoscopic hysterectomies, Jelovsek JA *et al*. could detect two of the four (50%) cystotomies intraoperatively prior to cystoscopic examination[5].

During a total laparoscopic hysterectomy at the stage of vaginal removal of the uterus we noticed the fully distended urine bag connected to the urinary catheter. In order to diagnose the location and the severity of the suspected urinary tract injury we performed a serious of diagnostic examinations.

We identified the traces of the right and left ureters and found them intact and far away from the operative field. We inflated the urinary bladder by using 300 mL methylene blue and examined the abdominal viscera for any dye leakage, however could not demonstrate any. At the end of the surgery a consultant urologist performed a cystoscopic and an ureteroscopic examination, however could not reveal any sign of urinary tract injury. Following a continuous urinary catheterization for three days, the cystoscopic

*Corresponding author: Kahraman Ülker, Kafkas Üniversitesi Tıp Fakültesi Kadın Hastalıkları ve Doğum anabilim Dalı, 36200, Kars, Turkey.
Tel: 0090 474 2251150
Fax: 0090 474 2251193
E-mail: kahramanulker@hotmail.com

and ureteroscopic examinations were repeated. On the demonstration of the urinary tract without any sign of injury, the patient was discharged after the removal of the urinary catheter on the same day and has been symptom free for the last 15 months.

Although we could not demonstrate any urinary tract injury, we could not rule out it completely. The gaseous distension of the urinary bag would result from a minor injury of the urinary tract, particularly the urinary bladder, which might be indemonstrable following the alteration of the position of the injury site. In addition an injury sparing the mucosa of the bladder might be permeable to CO_2 but unpermeable to liquids like methylene blue.

In case where there was not an injury, the explanation would be the diffusion of the highly concentrated intra abdominal CO_2 into the bladder with the contribution of the increased intra abdominal pressure. Another possible explanation was the accumulation of the gas produced during urine production. However, could we demonstrate the diffused CO_2 or any gas produced during urine production in the usual operative settings by using the urinary catheter and the urine bag? In order to answer the question we designed a prospective clinical study to demonstrate any clinically detectable gas passage into urine. Besides we aimed to compare the amount of gas accumulated in the urine bag (if any) during the surgeries performed by CO_2 laparoscopy and laparotomy.

2. Material and methods

The ethics committee of Kafkas University School of Medicine in Kars approved this study. Recruitment, with informed consent from participants, took place in the last six months of 2010. Analysis and patient follow up continued till the first three months of 2012.

The study population involved 79 women admitted to the Obstetrics and Gynaecology and General Surgery Departments of Kafkas University, of whom had an indication for intra abdominal surgery.

The women were allocated into two groups. The first group involved 37 women operated by using the conventional CO_2 laparoscopy or single incision laparoscopic surgery techniques. The second group involved 42 women operated by using either a novel gasless laparoscopy (KARS)[6] technique or a conventional laparotomy technique.

All included women were instructed to stop any hydration and alimentation for the least eight hours before the surgery. All the surgeries were performed between 8:30 and 11:30 a.m. All participants used laxatives and purgatives for bowel preparation on the previous day of the surgery. Parenteral hydration by using lactated Ringer solution was started at the beginning of the anaesthesia induction and carried on till the patient was discharged from the operative theatre at a rate of 20 mL/min. The male patients, the patients having disabilities to obey the study protocol or the patients with a chronic renal, circulatory and pulmonary disease were excluded. Conversion of a laparoscopic procedure to a laparotomy or conversion of a CO_2 laparoscopy to a gasless procedure or vice verse, and intra or post operative blood transfusions also caused exclusions.

At the beginning of the surgery all participants were catheterized by using a Foley catheter and the bladders were emptied. The balloon of the catheter was inflated by the injection of a 10 mL serum. In order to achieve a temporary obstruction between the bladder and the urine we clamped the Foley catheter between the jaws of a Kelly clamp. The urine bag was inflated by injecting gas from its emptying tap. Then the bag, its line and the connection with the Foley catheter were checked for their integrity and tightness by an underwater inspection. After checking the tightness and the insulation, the bag was deflated by using an aspiration device and the outlet valve was turned off tightly.

The intra-abdominal pressures created during CO_2 laparoscopies were maintained between the levels of 12-16 mmHg.

At the end of each surgery the urine volume of the bags was recorded. The bags were immersed into a water containing container which has a volume scale. The volume rise of the container was recorded. The valve of the outlet of the bag was turned on under the water and any leakage of air bubbles was observed. The final volume of the container was recorded once again while the bag was still in the water. The difference between the first and the second volumes was assumed as the accumulated gas.

We used SPSS version 16.0 packet program for data collection and statistical analysis. The parameters of the groups were compared by using Student t test in case where the intra-group distributions were normal. Parameters with non-normal distributions were compared by using Mann Whitney U test. A P value <0.05 was considered as statistically significant.

3. Results

There were 37 women in the first group operated by using CO_2 laparoscopy. Six of the CO_2 operations were single incision laparoscopic surgery and the remaining 31 of them were conventional laparoscopic surgery. The gynaecologists performed 22 operations and the general surgeons performed the remaining 15 operations.

There were 42 women in the second group operated by using a gasless approach. Nine women were operated by using keyless abdominal rope-lifting surgery (KARS) and the remaining 33 women were operated by using conventional laparotomy. The gynaecologists performed 33 operations and the general surgeons performed the remaining 9 operations. The details of the operations and the operative times are summarized in Table 1.

We did not observe and hence measure any gas accumulation in the urine bags of both groups. In addition, the means of the age of the patients, total amount of urine production during surgery, minutely urine production rate and the total operative times were not significantly different in the comparison of the two groups. The detailed comparison data of the groups was summarized in Table 2.

We did not witness any intra operative complication. All urinary catheters were removed following the postoperative collection of 600 mL urine. None of the women had a urinary catheter at the 8th hour postoperatively. All patients were discharged without any unpredicted delays. In the last visit one year after the surgery, none of the patients had any urinary complication and complaint.

Table 1

Specific operation types and times.

Operations	Number of cases	Operative time (min)
Abdominal hysterectomy	3	186.67±22.55
Laparoscopic hysterectomy (1 KARS)	2	179.00±62.23
Cesarean section	21	47.24±19.41
Fallopian tube ligation	12	36.25±4.47
Gasless laparoscopy (KARS)	2	34.00±1.41
CO_2 laparoscopy	10	36.70±4.78
Ovarian cystectomy	10	80.00±73.50
Gasless laparoscopy (KARS)	4	95.50±44.38
CO_2 laparoscopy	6	69.67±9.81
Diagnostic laparoscopy (CO_2)	5	30.60±11.80
Unilateral salpingectomy	3	51.67±15.28
Gasless laparoscopy (KARS)	2	60.00±7.07
CO_2 laparoscopy	1	35.00
Cholecystectomy	17	99.12±48.68
Gasless (laparotomy)	4	74.50±7.31
CO_2 (5 SILS) laparoscopy	13	106.69±14.79
Extirpation of hydatid cyst (gasless)	2	110.00±70.71
Laparoscopic (SILS) Nissen fundoplication	1	195.00
Cholecystectomy + hepaticojejunostomy	1	175.00
Total colectomy	2	237.50±45.96
Total	79	78.52±57.76
Gasless	42	82.98±62.14
CO_2 laparoscopy	37	73.46±52.74

The data was presented as mean±SD. KARS: Keyless abdominal rope–lifting surgery; SILS: Single incision laparoscopic surgery.

Table 2

Comparison of the selected properties of the two surgical techniques according to CO_2 use.

	Surgery using CO_2 (*n*=37)	Gasless surgery (*n*=42)	*P* value
Age	43.30±12.20	38.14±13.72	0.083[a]
Operation duration (min)	73.46±52.74	82.98±62.14	0.468[a]
Urine volume (mL)	166.76±151.64	173.45±160.25	0.671[b]
Urine production rate (mL/min)	2.06±0.75	2.11±0.89	0.767[a]
Gas in the urine bag (mL)	0.00±0.00	0.00±0.00	Not applicable

[a]Student *t* test; [b]Mann Whitney *U* test.

4. Discussion

Gas accumulation in the urine bag during surgery should not be considered as "normal". In addition, the use of CO_2 to create pneumo–peritoneum which in turn increases the intra abdominal pressure does not lead to the passage of gas into the urinary bladder, which is detectable by a urinary catheter connected to a urinary bag.

To our knowledge, this is the first study searching for demonstrable intra–operative gas accumulation in the urinary bag of the patients who do not have any known urinary tract injury. We observed the urinary bags during laparotomy, CO_2 laparoscopy and gasless laparoscopy while the patients were prepared in the usual operative settings. The study was also the first one aiming to demonstrate the higher (if any) amount of gas accumulation in the urinary bags of the patients operated following the creation of a high pressure pneumo–peritoneum.

The study could not demonstrate any gas accumulation in the urinary bags of the operated women. However, this finding did not prove the absence of gas in the urinary bags, because the study was designed to demonstrate the accumulation of gas (either produced naturally or diffused from the intra abdominal compartment by the aid of the elevated pressure) in the usual operative settings.

Although the women included in the study were grouped into two according to their exposure to CO_2, the operations were not unique and the study included 12 different types of operations.

We could not find a clinical or experimental study directly dealing with the gas accumulation in the urinary bag during laparoscopic or conventional surgeries. However there were a few cases demonstrated the gaseous distension of the urinary bag during laparoscopic surgery[7–12]. All cases were associated with the bladder injury and most of the injuries were noticed intraoperatively after the gaseous distension of the urinary bags. In one of the cases, the gaseous distension of the urinary bag was not recognized to be associated with the bladder injury; however it resulted with the peritonitis[9]. Although we could not demonstrate any urinary tract injury in our case defined in the introduction section, we could not rule out it completely. Reviewing the existing medical literature we can conclude that the distension of the urinary bag of our case should have been resulted from a minor bladder injury, probably resulted during the insertion of the Verress needle or the first trocar. Establishment of the pneumo-peritoneum whether open or closed, is related to a potential danger of perforating lesions. However, inserting the first trocar under direct vision allows early recognition and immediate repair[13]. In our case, the closed establishment of the pneumo-peritoneum might obscure the small bladder injury. In addition, the angulations of the pathway of the needle through the layers of the bladder wall might prevent the passage of the gas in the later stages of the operation following the shift of the axis of the bladder.

In a review it was stated that the bladder injuries were more frequent in gynaecological procedures. In addition, only 53% of the injuries were diagnosed during operations[4]. Intraoperative signs of bladder injury are bloody urine and the presence of gaseous distension of the urine bag. However, the cases unnoticed intraoperatively may present with dysuria, oliguria, haematuria, pyrexia, abdominal distension, nausea and vomiting[12]. Moreover ascites and peritonitis secondary to the formation of urinoma as early as 1 to 2 days after the incident may complicate the situation[14]. In rare cases accumulated peritoneal urine may shift into the pleural cavity and result in respiratory distress[15]. In long term undiagnosed injuries may potentially lead to stone formation, recurrent urinary tract infection, renal damage, voiding dysfunction, and urogenital fistula formation[16].

Ostrzenski and Ostrzenska[4] found that 4 of 77 cases developed a vesicovaginal fistula in their review of laparoscopic bladder injuries. Nezhat *et al.* found 1 case of vesicovaginal fistula after 19 cases of laparoscopic cystotomy repairs[17].

In suspicious delayed cases abdominal ultrasound, conventional retrograde or CT cystograms and cystoscopy may help the diagnosis[18,19].

In order to prevent bladder injuries surgeons should be familiar with the pelvic anatomy. The bladder should be emptied before starting the procedure preferably with indwelling Foley's catheter, particularly in long operations with bladder dissection requirements[20].

In our study we could not demonstrate any gas accumulation in the urinary bags of the patients which leaded us to the conclusion; any gas accumulation in the urine bag during CO_2 laparoscopic surgery should raise the suspicion of urinary tract injury. In the usual operative settings it is unlikely to demonstrate any gas in the urine bag, and urinary catheterization connected to a urinary bag helps to diagnose the unnoticed bladder injuries.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

We would like to thank the consultant urologist Dr. Kürşat Çeçen for his gracious efforts during cystoscopic examinations.

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