

# Major Vascular Injury in Laparoscopic Urology

Nasser Simforoosh, MD, Abbas Basiri, MD, Seyed-Amir-Mohsen Ziaee, MD, Ali Tabibi, MD, Akbar Nouralizadeh, MD, Mohammad Hadi Radfar, MD, Reza Sarhangnejad, MD, Amin Mirsadeghi, MD

## ABSTRACT

**Background and Objectives:** Major vascular injury is the most devastating complication of laparoscopy, occurring most commonly during the laparoscopic entry phase. Our goal is to report our experience with major vascular injury during laparoscopic entry with closed- and open-access techniques in urologic procedures.

**Methods:** All 5347 patients who underwent laparoscopic urologic procedures from 1996 to 2011 at our hospital were included in the study. Laparoscopic entry was carried out by either the closed Veress needle technique or the modified open Hasson technique. Patients' charts were reviewed retrospectively to investigate for access-related major vascular injuries.

**Results:** The closed technique was used in the first 474 operations and the open technique in the remaining 4873 cases. Three cases of major vascular injury were identified among our patients. They were 3 men scheduled for nephrectomy without any history of surgery. All injuries occurred in the closed-access group during the setup phase with insertion of the first trocar. The injury location was the abdominal aorta in 2 patients and the external iliac vein in 1 patient. Management was performed after conversion to open surgery, control of bleeding, and repair of the injured vessel.

**Conclusions:** Given the high morbidity and mortality rates associated with major vascular injury, its clinically higher incidence in laparoscopic urologic procedures with the closed-access technique leads us to suggest using the open technique for the entry phase of laparoscopy. Using the open-access technique may decrease laparophobia and encourage a higher number of urologists to enter the laparoscopy field.

**Key Words:** Laparoscopy, Urology, Vascular system injuries.

## INTRODUCTION

Laparoscopic surgery is currently one of the most common procedures performed for both diagnostic and therapeutic purposes.<sup>1,2</sup> As laparoscopic instruments and technical skills have improved, the use of laparoscopy has expanded to different areas including gynecology, general surgery, and urology. It has replaced the open approach in several procedures because of better cosmetic results, a shorter recovery period, and high efficacy.<sup>3</sup> Although major complications are uncommon in laparoscopy, involving <2% of cases, laparoscopy is not without risk.<sup>4,5</sup>

The first step in laparoscopic surgery is to establish laparoscopic access and pneumoperitoneum. This is the most critical and dangerous phase, in which >50% of major laparoscopic complications occur, with a mortality rate of 0.05% to 0.2%.<sup>6-8</sup> Access-related complications including retroperitoneal vascular injury, intestinal perforation, wound herniation, wound infection, abdominal wall hematoma, and trocar-site metastasis are of particular importance and are uncommon, but they can result in significant morbidity and even death.<sup>9</sup> Major vascular injury is the most life-threatening complication of laparoscopy, occurring most often during laparoscopic entry while one is inserting a Veress needle or especially the first trocar.<sup>10,11</sup> Although the reported incidence of major vascular injury in laparoscopic procedures is as low as 0.05% to 0.26%, it can cause serious morbidity and death in 8% to 17% of patients.<sup>5,12</sup> The incidence rate of this injury is probably under-reported.<sup>13,14</sup> Various technologies and techniques for laparoscopic access have been introduced to decrease the related complications. The closed technique using a Veress needle, the open Hasson technique, and the visual entry method have been used. Although there are multiple reports on major vascular injury during the closed-entry technique, there is no consensus regarding the superiority of one method over the others based on sufficient evidence.<sup>15,16</sup> Veress needle insertion is the most popular method used by gynecologists; the open tech-

Urology and Nephrology Research Center, Shahid Labbafinejad Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran (all authors).

Address correspondence to: Nasser Simforoosh, MD, Shahid Labbafinejad Hospital, Ninth Boostan, Pasdaran Avenue, Tehran, Iran. Telephone: +98 21 2258 8016, E-mail: simforoosh@iurtc.org.ir

DOI: 10.4293/JSLS.2014.00283

© 2014 by JSLS, Journal of the Society of Laparoendoscopic Surgeons. Published by the Society of Laparoendoscopic Surgeons, Inc.

nique is more commonly applied by the younger generation of general surgeons.<sup>10</sup>

To our knowledge, there is no report on major access-related complications of laparoscopic entry techniques in the urology literature. We report our experience with major vascular injury in 5347 laparoscopic urology surgeries.

## MATERIALS AND METHODS

All patients who underwent laparoscopic surgery over a 15-year period from 1996 to 2011 at our institution were included in the study. Laparoscopic entry was carried out by either the closed Veress needle technique or the modified open Hasson technique. Among the 5347 procedures, the closed technique was used in the first 474 operations and the open technique in the remaining 4873 cases. A full range of urologic laparoscopic surgeries were performed in this series. The closed technique was carried out according to the standard technique described previously.<sup>17</sup> The modified Hasson technique involved a 1-cm semicircular incision just above the umbilicus. After subcutaneous tissue dissection, the fascia was elevated with a clamp and incised. The peritoneum was then incised with scissors under direct vision, and a bladeless 12-mm trocar (10-mm trocar in children) was inserted into the peritoneal cavity. We did not use the Hasson trocar in our patients, and we applied a towel clip or suture to stop gas leakage. All surgeries were performed in academic settings by laparoscopy fellows during their training course under the supervision of 4 attending urolaparoscopists.

Major vascular injury was defined as an injury to the aorta, vena cava, iliac vessels, or mesenteric vessels. On the basis of previous studies, injuries to the epigastric, omentum, and abdominal wall vessels were not considered major vascular injuries.<sup>13</sup> Patients' charts were reviewed retrospectively to investigate for access-related major vascular injuries. Demographic, preoperative, intraoperative, and postoperative features were also studied.

## RESULTS

A total of 5347 patients (3214 men and 2133 women) were included in the study. The mean age of the patients was  $31.6 \pm 5.2$  years in the closed-access group and  $43.2 \pm 8.9$  years in the open-access group. **Table 1** lists the operations performed during the study period.

Three cases of major vascular injury were identified among our patients. They were men aged 29, 32, and 41 years. None of the patients had a history of surgery. The

Operation	Number
Donor nephrectomy	1784
Pyeloplasty	713
Varicocelectomy	646
Radical nephrectomy	470
Undescended testis	452
Adrenalectomy	292
Partial nephrectomy	191
Ureterolithotomy and pyelolithotomy	180
Radical prostatectomy	150
Renal cyst	162
Gil-Vernet technique	48
RPLND <sup>a</sup>	63
Retrocaval ureter	17
Simple nephrectomy	160
Ileocystoplasty	6
Inguinal hernia	5
Radical cystectomy	3
Nephropexy	4
Ureterocystoplasty	1

<sup>a</sup>RPLND = retroperitoneal lymph node dissection.

indication for surgery was nephrectomy in all of them. All of the major vascular injuries occurred in the closed-access group during the setup phase with insertion of the first trocar. The location of the injury was the abdominal aorta in 2 patients and the external iliac vein in 1 patient. The diagnosis was made immediately after the first trocar insertion based on brisk bleeding through the trocar and a sudden decrease in blood pressure. All patients required a blood transfusion. Management was performed after conversion to open surgery, control of bleeding, and repair of the injured vessel by an attending urologist with expertise in vascular surgery. The postoperative course was uneventful.

## DISCUSSION

The use of laparoscopy has increasingly expanded in gynecology, general surgery, and urology for several diagnostic and therapeutic procedures. In urologic procedures, laparoscopy is currently used in ablative and reconstructive operations such as donor nephrectomy, radical nephrectomy, radical prostatectomy, partial ne-

phrectomy, adrenalectomy, pyeloplasty, and ureterolithotomy. The first step of all laparoscopic procedures is to establish laparoscopic access. Because a substantial number of the major complications of laparoscopy occur during the laparoscopic access phase, evaluating the most serious complications of this phase is particularly important in assessing laparoscopic safety.<sup>10</sup> Several studies have focused on the safety of laparoscopic entry techniques, but they have mostly been reported by gynecologists and, to some extent, general surgeons.<sup>17</sup> To our knowledge, there is no report on laparoscopic access techniques in the urology literature. We focused on studying major vascular injury in patients undergoing the two most commonly used laparoscopic entry techniques in urologic surgery.

Major vascular injury is the most devastating and dangerous complication of laparoscopy, and it was rarely reported before the laparoscopy era.<sup>18</sup> Although the reported incidence of major vascular injury in laparoscopy is 0.01% to 0.64%, it is believed to be under-reported.<sup>19–21</sup>

Penfield<sup>22</sup> asked 25 expert laparoscopists about major vascular injuries that occurred in their experience. Twelve of the respondents reported 19 vascular injuries; the aorta was injured in 8 cases.<sup>22,23</sup> In our own observations, we have witnessed several unreported major vascular injuries in gynecology and general surgery operations performed by the closed-access technique. The most common location of the injury was the distal aorta or inferior vena cava and the major branches of these vessels.<sup>23</sup> Because of substantial associated morbidity and mortality rates, it is the most feared complication of laparoscopy.<sup>3,24</sup>

Chapron et al<sup>13</sup> reported that major vascular injury resulted in death in 11.8% of patients and significant vascular complications in another 11.8%. In a study on bleeding complications in laparoscopic surgery by Opitz et al,<sup>14</sup> among different intraoperative and postoperative bleeding complications, major vascular injury had the highest mortality rate (2.4%), as well as the highest rate of conversion to open surgery (45%). Most authors accept major vascular injury as an absolute indication for immediate conversion to open surgery.<sup>25</sup> Although the surgeon's experience is claimed to be an important risk factor for major vascular injury, Opitz et al showed that experience correlates with the incidence of intraoperative bleeding complications but not with major vascular injury. Prior abdominal surgery has also been described as a risk factor in some studies. Mayol et al<sup>17</sup> assessed several factors that could be correlated with access-related complications and

showed that the closed-access technique was the only significant factor in multivariate analysis.<sup>26</sup>

The vast majority of major vascular injuries occur during the access phase of laparoscopy. Several authors have reported that 75% to 87.5% of major vascular injuries occurred during the insertion of the Veress needle or the first trocar.<sup>13,14,27</sup> The largest series of open laparoscopies, by Penfield,<sup>28</sup> reported 10 840 procedures with no major vascular injury. Given the lack of sufficient comparative studies, several authors have mentioned the lack of significant evidence on the greater safety of one laparoscopic entry technique over the others.<sup>15,16</sup> Although the difference in the incidence of major vascular injuries between open- and closed-access techniques has not been statistically significant, given the high rates of morbidity and even mortality caused by this complication, even a small difference in its incidence has substantial clinical importance.

Major vascular injury is a preventable, unacceptable, and potentially lethal complication, and its incidence should be reduced as much as possible. Insertion of the Veress needle and the first trocar is the most dangerous phase of laparoscopy, accounting for 40% of laparoscopy complications and most of the deaths.<sup>3,24</sup> In a literature review by Bonjer et al,<sup>29</sup> 489 335 cases of closed laparoscopy and 12 444 cases of open laparoscopy were reviewed. They found a vascular injury incidence rate of 0.075% with a mortality rate of 0.8% in closed laparoscopy cases and no incidence of vascular injury in open laparoscopy cases.<sup>10,29</sup> Merlin et al<sup>30</sup> published a meta-analysis of studies comparing the open- and closed-access techniques, and they showed a trend toward a decreased risk of major complications for the open-access technique. The incidence rate of vascular injury was 0% to 0.03% for the open-access technique and 0.003% to 1.33% for the closed-access technique. Merlin et al emphasized that, given the low incidence of vascular injury in both groups, the evidence is not clear. Nevertheless, they prefer the open technique.

Ours is the first series of laparoscopic urologic procedures studying the incidence of access-related major vascular injury. Because 3 cases of major vascular injury occurred among our first 474 patients with the closed-access technique and because several cases of major vascular injury during the closed-access phase were reported in the gynecologic and general surgery literature, we decided to substitute the closed-access technique with open-access laparoscopy to avoid the life-threatening vascular complications of the closed technique.<sup>3,17</sup> The safety profile of

each technique could not be overemphasized in an academic setting where fellows who have not completed their learning curve carry out the procedure. The modified Hasson technique has some disadvantages. Applying the technique might be difficult in obese patients and require a larger incision, with its inherent associated problems such as a higher incidence of gas leakage. Although there seems to be a higher risk of postoperative hernia, there were no patients with incisional hernia because of meticulous fascial closure in our series.

Considerable differences in the number of patients in the 2 groups and the retrospective nature of the study are its drawbacks. However, the 0% incidence of major vascular injury during the open-access technique in 4873 patients favors the greater safety of the technique, particularly in an academic setting.

## CONCLUSIONS

Major vascular injury is the most life-threatening complication of laparoscopy. Although the difference in its incidence has not been statistically significant between closed and open techniques, it should be noted that it is a preventable, unacceptable, and potentially lethal complication that should be abolished from the laparoscopy field. Regarding its clinically lower incidence in urologic procedures performed by the open-access technique, it seems that using the open technique may be safer, particularly in an academic setting.

## References:

1. Park JH, Park YH, Park K, Choi H. Diagnostic laparoscopy for the management of impalpable testes. *Korean J Urol*. 2011; 52:355–358.
2. Simforoosh N, Basiri A, Tabibi A, Shakhssalim N, Hosseini Moghaddam SM. Comparison of laparoscopic and open donor nephrectomy: a randomized controlled trial. *BJU Int*. 2005;95:851–855.
3. Pickett SD, Rodewald KJ, Billow MR, Giannios NM, Hurd WW. Avoiding major vessel injury during laparoscopic instrument insertion. *Obstet Gynecol Clin North Am*. 2010;37:387–397.
4. Vilos GA, Ternamian A, Dempster J, Laberge PY, The Society of Obstetricians and Gynaecologists of Canada. Laparoscopic entry: a review of techniques, technologies, and complications. *J Obstet Gynaecol Can*. 2007;29:433–465.
5. Azevedo JL, Azevedo OC, Miyahira SA, et al. Injuries caused by Veress needle insertion for creation of pneumoperitoneum: a systematic literature review. *Surg Endosc*. 2009;23:1428–1432.

6. Nuzzo G, Giuliante F, Tebala GD, Vellone M, Cavicchioni C. Routine use of open technique in laparoscopic operations. *J Am Coll Surg*. 1997;184:58–62.
7. Jansen FW, Kolkman W, Bakkum EA, de Kroon CD, Trimbos-Kemper TC, Trimbos JB. Complications of laparoscopy: an inquiry about closed- versus open-entry technique. *Am J Obstet Gynecol*. 2004;190:634–638.
8. Magrina JF. Complications of laparoscopic surgery. *Clin Obstet Gynecol*. 2002;45:469–480.
9. Munro MG. Laparoscopic access: complications, technologies, and techniques. *Curr Opin Obstet Gynecol*. 2002;14:365–374.
10. Dunne N, Booth MI, Dehn TC. Establishing pneumoperitoneum: Verres or Hasson? The debate continues. *Ann R Coll Surg Engl*. 2011;93:22–24.
11. Makai G, Isaacson K. Complications of gynecologic laparoscopy. *Clin Obstet Gynecol*. 2009;52:401–411.
12. Sotelo RJ, Giedelman C, Moncaleano G, Canes D. Difficulties in urologic laparoscopy complications. In: Al-kandari A, Gill IS, eds. *Difficult Conditions in Laparoscopic Urologic Surgery*. London: Springer; 2011:405–431.
13. Chapron CM, Pierre F, Lacroix S, Querleu D, Lansac J, Dubuisson JB. Major vascular injuries during gynecologic laparoscopy. *J Am Coll Surg*. 1997;185:461–465.
14. Opitz I, Gantert W, Giger U, Kocher T, Krähenbühl L. Bleeding remains a major complication during laparoscopic surgery: analysis of the SALTS database. *Langenbecks Arch Surg*. 2005; 390:128–133.
15. Tinelli A, Malvasi A, Istre O, Keckstein J, Stark M, Mettler L. Abdominal access in gynaecological laparoscopy: a comparison between direct optical and blind closed access by Verres needle. *Eur J Obstet Gynecol Reprod Biol*. 2010;148:191–194.
16. Ahmad G, Duffy JM, Phillips K, Watson A. Laparoscopic entry techniques. *Cochrane Database Syst Rev*. 2008;16:CD006583.
17. Mayol J, Garcia-Aguilar J, Ortiz-Oshiro E, De-Diego Carmona JA, Fernandez-Represa JA. Risks of the minimal access approach for laparoscopic surgery: multivariate analysis of morbidity related to umbilical trocar insertion. *World J Surg*. 1997; 21:529–533.
18. McDonald PT, Rich NM, Collins GJ Jr, Andersen CA, Kozloff L. Vascular trauma secondary to diagnostic and therapeutic procedures: laparoscopy. *Am J Surg*. 1978;135:651–655.
19. Saidi MH, Vancaillie TG, White AJ, Sadler RK, Akright BD, Farhart SA. Complications of major operative laparoscopy. A review of 452 cases. *J Reprod Med*. 1996;41:471–476.
20. Härkki-Sirén P, Kurki T. A nationwide analysis of laparoscopic complications. *Obstet Gynecol*. 1997;89:108–112.

21. Chapron C, Querleu D, Bruhat MA, et al. Surgical complications of diagnostic and operative gynaecological laparoscopy: a series of 29,966 cases. *Hum Reprod.* 1998;13:867–872.
22. Penfield AJ. Trocar and needle injury. In: Phillips JM, ed. *Laparoscopy*. Baltimore: Williams & Wilkins; 1977:236–241.
23. Nordestgaard AG, Bodily KC, Osborne RW Jr, Buttorff JD. Major vascular injuries during laparoscopic procedures. *Am J Surg.* 1995;169:543–545.
24. Fuller J, Ashar BS, Carey-Corrado J. Trocar-associated injuries and fatalities: an analysis of 1399 reports to the FDA. *J Minim Invasive Gynecol.* 2005;12:302–307.
25. Sandadi S, Johannigman JA, Wong VL, Blebea J, Altose MD, Hurd WW. Recognition and management of major vessel injury during laparoscopy. *J Minim Invasive Gynecol.* 2010;17:692–702.
26. Schirmer BD, Dix J, Schmiege RE Jr, Aguilar M, Urch S. The impact of previous abdominal surgery on outcome following laparoscopic cholecystectomy. *Surg Endosc.* 1995;9:1085–1089.
27. Hashizume M, Sugimachi K. Needle and trocar injury during laparoscopic surgery in Japan. *Surg Endosc.* 1997;11:1198–1201.
28. Penfield AJ. How to prevent complications of open laparoscopy. *J Reprod Med.* 1985;30:660–663.
29. Bonjer HJ, Hazebroek EJ, Kazemier G, Giuffrida MC, Meijer WS, Lange JF. Open versus closed establishment of pneumoperitoneum in laparoscopic surgery. *Br J Surg.* 1997;84:599–602.
30. Merlin TL, Hiller JE, Maddern GJ, Jamieson GG, Brown AR, Kolbe A. Systematic review of the safety and effectiveness of methods used to establish pneumoperitoneum in laparoscopic surgery. *Br J Surg.* 2003;90:668–679.