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Avoiding and managing vascular injury during robotic-assisted radical prostatectomy

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***Abstract*:** There has been an increase in the number of urologic procedures performed robotically assisted; this is the case for radical prostatectomy. Currently, in the USA, 67% of prostatectomies are performed robotically assisted. With this increase in robotic urologic surgery it is clear that there are more surgeons in their learning curve, where most of the complications occur. Among the complications that can occur are vascular injuries. These can occur in the initial stages of surgery, such as in accessing the abdominal cavity, as well as in the intraoperative or postoperative setting. We present the most common vascular injuries in robot-assisted radical prostatectomy, as well as their management and prevention. We believe that it is of vital importance to be able to recognize these injuries so that they can be prevented.

Keywords: robotic prostatectomy, prostate cancer, vascular injury

Introduction

Given the enhanced dexterity and 3D vision afforded by the robotic platform and the relatively short learning curve, the number of radical prostatectomies being performed robotically is rapidly increasing. Since 2010, 67% of prostatectomies have been robotically assisted in the USA [Lowrance *et al.* 2012]. With this increase in robotic urologic surgery, it is clear that more surgeons are in the process of gaining experience with the technique. This change may result in an increase in the complication rate, particularly during a surgeon's learning curve.

Vascular injuries are a potentially devastating complication of robotic-assisted radical prostatectomy (RARP). These injuries can occur in the initial stages of surgery, such as while gaining access to the abdominal cavity, as well as in the intraoperative or postoperative setting. Herein, we present a review of the most common vascular injuries during RARP, and their management and prevention. We believe that it is of vital importance to be able to recognize these injuries so that they can be prevented. The overall complication rate of RARP has been shown to be 4.3–12% [Patel *et al.* 2008; Jeong *et al.* 2010; Lebeau *et al.* 2011].

The cumulative analysis of comparative studies described by Tewari and colleagues revealed a mortality rate of 0.1% for the conventional open radical prostatectomy (ORP) approach, compared with 0.04% for laparoscopic radical prostatectomy (LRP) and robotic-assisted approaches. The researchers also found significant advantages ($p < 0.0001$) for RARP compared with other approaches in terms of the incidence of global perioperative complication rates (17.9%, 11.1%, and 7.8% for ORP, LRP, and RARP, respectively), and they described a lower incidence of vascular injury, obturator nerve damage, ureteral injury, rectal injury, deep vein thrombosis, anastomotic urine leak, hematoma, lymphocele, and wound infection with the robotic approach [Tewari *et al.* 2012].

The complication rate covers the time from gaining access to the abdominal cavity through the surgery and the postoperative period. The modified Clavien classification of surgical complications is used to grade complications as shown below [Lasser *et al.* 2010; Clavien *et al.* 1992; Dindo *et al.* 2004].

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Grade I complications encompass any deviation from the ideal perioperative course not necessitating pharmacologic intervention
Grade II complications require pharmacologic intervention
Grade III complications necessitate surgical, endoscopic, or radiographic intervention
IIIA: without general anesthesia
IIIB: under general anesthesia
Grade IV complications are life threatening, requiring intensive care unit management
IVA: single organ dysfunction
IVB: multi-organ dysfunction
Grade V complications represent patient death

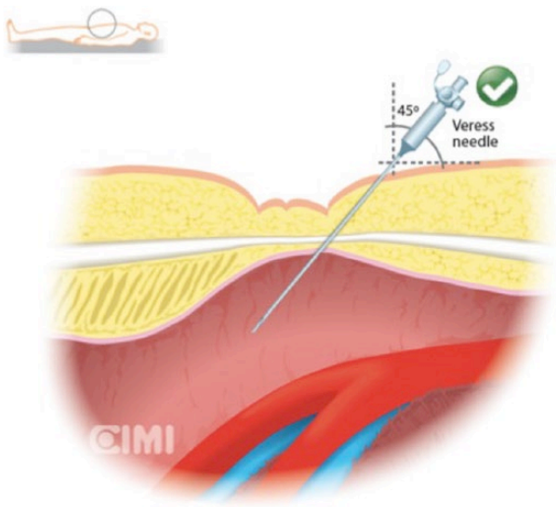

Figure 1. Umbilical access by the Veress technique at 45°.

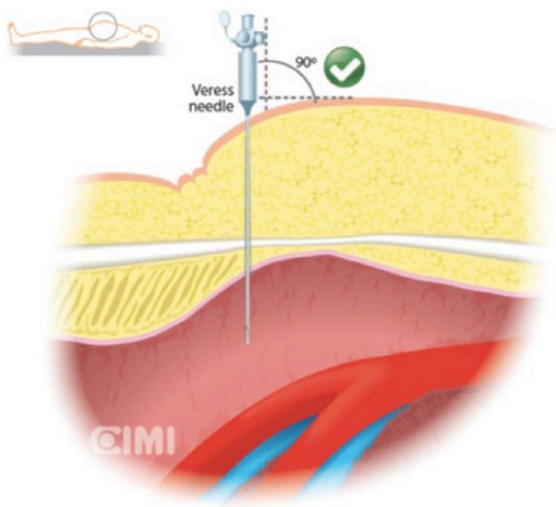

Figure 2. Umbilical access by the Veress technique at 90°.

Access complications

Veress needle injuries

The prevalence of injuries caused by the Veress needle, or the 'blind access' described in the reviewed literature, is 0.23% [Azevedo *et al.* 2009]. A meta-analysis revealed a mean rate of 0.044% for vascular injury during laparoscopic access [Larobina and Nottle, 2005].

For umbilical access by the Veress technique, the needle should be placed at a 45° angle in the horizontal plane of the patient. In obese patients, the angle of the Veress needle should be changed from 45° to 90° in order to avoid vascular injury (Figures 1 and 2).

The umbilicus usually coincides with the sacral promontory, which in turn coincides with the bifurcation of the great vessels, so it is important to take great care to avoid injuring these vessels. In obese patients, the umbilicus will be located lower anatomically, which should be kept in mind while accessing the abdomen.

Most of the complications due to the Veress needle can be recognized by direct visualization, such as observing free blood in the abdominal cavity or, more commonly, a retroperitoneal hematoma. In the latter case, there will be a visible bruise that can be monitored for expansion.

Often, a hematoma may bleed if it is opened, so the surgeon must be prepared for this possibility. The assistance of a vascular surgeon may be required, and an open laparotomy may also be required.

If vascular injury is present, its management should be tailored to the specific situation. If there is a small, nonexpanding hematoma, it can be outlined with clips and monitored while continuing the surgery. At the end of the surgery, re-inspect the size

of the hematoma. If the hematoma has expanded, open the hematoma and amply expose the bleeding site. Laparoscopic or robotic techniques can be used for the repair. Additional trocars may be inserted and a small gauze can be introduced to tamponade the bleeding.

If the injury cannot be easily repaired laparoscopically or robotically, apply compression and perform prompt laparotomy. Doing this is preferable to losing time trying to repair laparoscopically a vascular injury, which could potentially lead to undesired consequences.

A useful method to gain access with the Veress needle is to insert it while it is connected to the pneumoperitoneum machine. In this way, it is possible to observe how the pressure rises as the needle is slowly advanced through the abdominal wall, with constant pressure. If the pressure constantly changes, with wide fluctuations, try to go slightly deeper. If there is doubt about the position of the Veress needle, the needle can be aspirated. If there is blood, leave the needle in place, gain open access and then inspect the zone for damage. If the Veress needle is in the correct position, the pressure will fall below 5 cm H_2O, coinciding with a click of the needle. At this time, you should not go deeper, and the pressure should begin to rise slowly. As the peritoneum is more firmly adherent underneath the umbilicus, obtaining access at this level could avoid insufflating the preperitoneal space [Ahmad *et al.* 2007].

Hasson open technique

Another way to access the abdominal cavity is by using the Hasson open technique, which was described in 1971 [Hasson, 1971]. This technique can be used in patients with prior surgeries in whom adhesions are expected. To avoid damage, perform the open access away from the scar, where adhesions are most likely to be found. A meta-analysis published in 2003 reported a 0.03% incidence of vascular lesions when using this technique [Merlin *et al.* 2003]. Caution should be taken in patients with prior surgeries or atypical anatomy. Preoperative imaging is helpful in identifying any variations.

Trocar injury

The average incidence of major vascular injuries from trocars and Veress needles is approximately 0.1%. A study from the US Food and Drug Administration carried out from 1993 to 1996 reported a total of 32 deaths out of 629 trocar injuries, with 81% of the deaths due to major vascular injuries, and 19 resulting from bowel injuries. Most of the cases of trocar injuries were nonfatal vascular injuries, followed by nonfatal visceral injuries such as bowel and abdominal wall hematomas [Bhoyrul *et al.* 2001]. Among the vascular injuries, the most common vessels injured were the aorta, the inferior vena cava, the iliac vessels [Castillo *et al.* 2008], and the epigastric vessels (lateral trocars) [Pereira Arias *et al.* 2010].

To avoid damage to intra-abdominal structures, ensure that the pneumoperitoneum is between 16 mmHg and 20 mmHg before inserting the first trocar. Make a skin incision long enough to allow the trocar to pass and then apply mild force. If the safe button on the trocar activates after inserting it, remember to reset it. For surgeons new to the technique, inserting the trocar while controlling it with both hands is recommended. One hand should apply pressure to progress the trocar, with the index finger over the body of the trocar, and the other hand should act as a top. This maneuver allows better control of depth, avoiding sudden progression of the tip of the trocar.

Injury to the aorta, vena cava, or iliac vessels is a life-threatening situation in which visualization of the damage and quick decision making regarding whether to convert to open surgery are needed. This decision should take into consideration the amount of bleeding and the surgeon's laparoscopic skills. Surgeons experienced in laparoscopy may try to repair the injury using this method. In such cases, elevate the pneumoperitoneum to 20–25 mmHg, insert additional trocars if needed, apply pressure with a sponge or gauze, widely expose the site of injury, clamp above or below the lesion, and repair. Injury to the inferior epigastric vessels is the most common vascular complication, often recognized intraoperatively, and is usually caused during insertion of the pararectal trocars [Stolzenburg and Truss, 2003]. Bipolar coagulation and clipping are often effective in controlling any bleeding. If the bleeding is persistent, suturing through the abdominal wall with the aid of a straight needle, encaging the bleeding vessel, is very useful. The suture should be released 2 days after the initial operative procedure [Stolzenburg *et al.* 2006]. Remember to inspect all trocar sites after removal because bleeding may not be apparent until trocar removal and lowering the pneumoperitoneal pressure [Stolzenburg *et al.* 2006].