Review

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Major Vascular Injuries in Laparoscopic Urological Surgeries

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Major Vascular Injuries in Laparoscopic Urological Surgeries

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Abstract: Laparoscopic urological surgery has become a cornerstone in the treatment of various urological conditions, offering significant advantages over traditional open surgical approaches. These include smaller incisions, less tissue trauma, reduced intraoperative bleeding, less postoperative pain, shorter hospital stays, better cosmetic outcomes, and faster recovery times. Despite these benefits, laparoscopic surgery is not without risks, and major vascular injury (MVI) is one of the most severe and potentially life-threatening complications. This review explores the incidence, causes, and management strategies for MVI in laparoscopic urological surgery, highlighting the importance of early recognition, standardized protocols, and surgical expertise to optimize patient outcomes.

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1. Introduction

Laparoscopic urological surgery has undergone significant advancements and is now the standard approach for managing a wide range of urological conditions. Compared to open surgery, laparoscopic techniques offer numerous benefits, including reduced morbidity, less postoperative pain, shorter hospital stays, and superior cosmetic outcomes. These advantages have led to the widespread adoption of laparoscopic surgery by both urologists and patients. However, this approach is not without risks, and complications, though rare, can be severe [1,2]. Among these, major vascular injury (MVI) is the most critical, often requiring immediate intervention and conversion to open surgery [3–5]. This review focuses on the incidence, risk factors, and management strategies for MVI in laparoscopic urological surgery.

2. Incidence and Risk Factors

Vascular injuries are a common complication in laparoscopic urological surgeries, accounting for about half of all laparoscopic complications [6]. MVI, though rare, is the most serious of these injuries, with an incidence ranging from 0.01% to 0.64% 7,8 . Despite its low frequency, MVI can be life-threatening and requires prompt recognition and management. The most commonly affected vessels include the abdominal aorta, inferior vena cava, and their major branches, such as the iliac and mesenteric vessels [9,10].

Studies suggest that major complications in laparoscopic surgery are uncommon, with an overall incidence of about 2% [7,8,11,12]. Among these, vascular injuries are relatively rare, with an incidence ranging from 0.22% to 1.1% [13]. However, they have a high mortality rate, accounting for 8% to 17% of deaths [14]. Furthermore, most vascular injuries require immediate conversion to open surgery for repair [15].

A study involving 5,347 patients who underwent laparoscopic urological surgery reported MVI in the abdominal aorta (2 patients) and the external iliac vein (1 patient) [16]. Additionally, Cheng et al. identified MVI cases involving the renal artery (1 case), inferior mesenteric artery (2 cases),

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external iliac artery (1 case), common iliac artery (1 case), superior mesenteric artery (1 case), and the vena cava (7 cases) [17].

MVI in laparoscopic urological surgeries most frequently occurs during initial laparoscopic entry, particularly with the insertion of the Veress needle or the first trocar [18]. This can result in Veress needle puncture, significant blood loss, and air embolism [19]. Other reported causes of MVI include excessive traction, ultrasonic scalpel injuries, Hem-o-lock clip disconnection or malfunction, and Endo-GIA stapler failure.

3. Management Strategies

Cheng et al. propose a systematic approach to managing MVI in laparoscopic urological surgery to minimize adverse outcomes [17]. The following steps are recommended:

1. Rapid Identification and Control of Bleeding: Locate the injury site and control hemorrhage through clamping or compression.

2. Maintenance of Clear Visualization: Clear the surgical field to ensure optimal visibility after controlling bleeding.

3. Preparation for Resuscitation: Coordinate with support staff and prepare for fluid resuscitation and blood transfusion.

4. Adjustment of Pneumoperitoneum Pressure: Increase pneumoperitoneum pressure to reduce venous bleeding in certain cases.

5. Placement of Additional Trocars: Insert additional trocars to facilitate further intervention and repair.

6. Exposure and Dissection of Vessels: Adequately expose the injured vessel to prepare for subsequent repair.

7. Clamping and Suturing: Identify the exact bleeding site and perform clamping or suturing to achieve hemostasis.

8. Vessel Occlusion: Temporarily occlude the vessel using a bulldog clamp before repair.

Conversion to Open Surgery: Convert to open surgery if laparoscopic repair is not feasible or secure

MVI is an absolute surgical indication for immediate conversion to open surgery [15]. Immediate laparoscopic or open repair of injured vessels is the most critical intervention [20], while compression or clamping serves as an effective temporary measure [21]. Therefore, the primary management strategies for MVI include rapid control of bleeding, repair of the injured vessel, and conversion to open surgery when necessary.

4. Prevention

Knowledge of anatomy in urological surgeries is one of the cornerstones in the prevention of vascular complications, especially in highly complex surgeries performed through minimally invasive approaches [22]. This knowledge stems from both the surgeo**n'**s experience and their skill. Therefore, we believe that due to the complexity of surgeries involving vascular components, such as retroperitoneal rescues and large renal masses [23], these procedures should be performed by experienced surgeons. This situation underscores the need for residents and fellows to receive training for such scenarios, including simulation, artificial models, and assisting in surgeries [24].

The concept of precision surgery has widely entered the urologic field. Urology encompasses interventions whose technique may differ according to individual features. These include not only the patient's characteristics, which may vary and prompt different approaches, but also disease features (stage and invasion of closer structures) that should be preoperatively known to plan the most accurate and tailored strategy. During the last decade, three-dimensional (3D) reconstruction from 2D cross-sectional imaging has been given widespread attention and gained popularity among the urological scientific community [25–27]. Three-dimensional models embody the concept of personalized precision surgery [28], since they are derived from individual features and developed to tailor the intervention to the singular patient. The 3D virtual models provide the surgeon with a better understanding of the surgical anatomy of each case and also an opportunity to highlight anatomical details of interest.

Surgical planning is one of the primary roles of 3D imaging; it involves the creation of a customized surgical roadmap that increases the surgeons' confidence and guides the decision-making process [29].

5. Recommendation for Training and Simulation

To further reduce the risk of MVI, surgical training should incorporate advanced simulation techniques, such as using 3D models for rehearsal and planning (Figure 1). These programs can help improve surgical skills and reduce the likelihood of vascular injuries, particularly in high-risk procedures. Incorporating simulation-based learning, as well as providing hands-on experience in real surgeries, would be beneficial for residents and fellows [25].

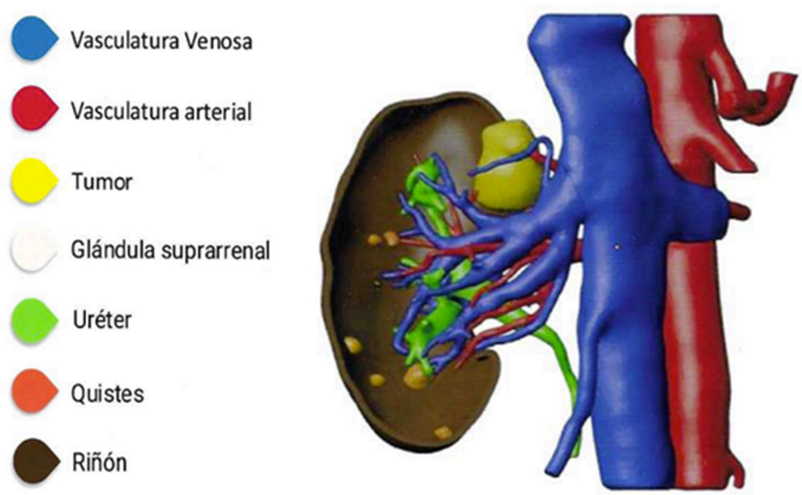

Figure 1. 3D modelling of renal tumor.

6. Conclusion.

Major vascular injuries during laparoscopic urological surgery, though rare, represent a significant clinical challenge due to their potential for severe complications and high mortality rates. Early identification of the injury site, adherence to a structured management protocol, and consideration of the surgeon's expertise are crucial to improving patient outcomes. Continued advancements in laparoscopic techniques, combined with enhanced training and awareness, are essential to further reduce the incidence and impact of MVI in urological practice. By prioritizing early recognition and systematic management, the risks associated with MVI can be minimized, ensuring safer and more effective laparoscopic urological surgeries.

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