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Narrative Review

REDUCING THE RISK OF URETERAL INJURIES IN GYNECOLOGIC SURGERY: A NARRATIVE REVIEW.

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Abstract

This narrative review aims to comprehensively investigate strategies and techniques for reducing the risk of ureteral injuries in gynecologic surgery, highlighting the importance of anatomical knowledge and surgical skill.

A thorough review of the existing literature was conducted, including research articles, clinical guidelines, and case studies related to ureteral injuries in gynecologic surgery. Emphasis was placed on identifying risk factors, anatomical considerations, and preventive measures.

The review elucidates that iatrogenic ureteral injuries in gynecologic surgery can occur even in the absence of apparent risk factors. It emphasizes the critical role of surgeons' understanding of ureteral anatomy and susceptibility sites to minimize the risk of injury. Techniques such as intraoperative cystoscopy and ureteral stent placement are explored as valuable preventive tools. Additionally, the importance of surgical skill, recognition of anatomical landmarks, and adherence to established guidelines are underscored.

Preventing ureteral injuries in gynecologic surgery is essential for patient safety and outcomes. Surgeons should possess a thorough knowledge of ureteral anatomy and vulnerable regions, coupled with vigilance during procedures. Intraoperative measures like cystoscopy and stent placement, along with adherence to best practices, contribute to minimizing the risk of ureteral injuries. By prioritizing these strategies, gynecologic surgeons can enhance patient care and reduce the incidence of iatrogenic ureteral injuries.

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Introduction

Ureteral injury is a frequently encountered complication in the context of pelvic surgery. Indeed, it is noteworthy that a significant proportion, specifically 75 percent, of ureteral injuries manifest themselves in the context of gynecologic surgical interventions, predominantly within the realm of abdominal procedures [1]. Prior investigations have documented an incidence of injury ranging from 0.4% - 2.5% in the context of benign pelvic surgery, with a mere one-third of these injuries being identified during the surgical procedure [2]. As a result, the current prevalence of intraoperative ureteral trauma may be significantly elevated. Despite the elevated risk of injury observed in surgeries pertaining to invasive cancer and urogynecologic procedures, it is imperative for all pelvic surgeons to acquire comprehensive knowledge regarding the etiology and risk factors linked to this avoidable difficulty. The present article provides a comprehensive review of the anatomic considerations, risk factors, etiologic factors, management, clinical presentation, and prevention strategies associated with ureteral injuries that occur during pelvic surgery.

Anatomic considerations

In order to mitigate the risk of ureteral injury, it is imperative for pelvic surgeons to possess a comprehensive understanding of ureteral anatomy and the regions that are particularly susceptible to damage. The ureters, which have a length ranging from 25 to 30 cm, extend from the renal pelvis to the bladder, with the right ureter being slightly longer [1, 3]. Within the abdominal region, the ureter is positioned upon the ventral surface of the psoas muscle. It proceeds to descend in a posterolateral direction over the iliac vessels, establishing contact with the descending portion of the duodenum on the right side or traversing posteriorly to the sigmoid colon on the left side. Upon nearing the pelvic region, the anatomical structures traverse the ovarian vasculature. The right ureter traverses the external iliac artery, whereas the left ureter traverses the common iliac artery. Within the pelvic region, the uterine artery traverses anteriorly, intersecting with the cardinal ligament. These structures subsequently penetrate the vicinity of the cervix and vaginal fornices, ultimately reaching the bladder trigone. The ureter is composed of 3 distinct layers, namely the smooth muscle, an adventitial sheath, and transitional epithelium that encompasses its arterial, neural, and lymphatic supply [4]. The preservation of the adventitial sheath is of utmost importance. The vascularization of the ureter is obtained through multiple origins, encompassing the ovarian artery, common iliac artery, aorta, and renal artery. Within the abdominal region,

diminutive arteries exhibit a medial trajectory, whereas within the pelvic region, their course tends to be lateral in nature. The preservation of the peritoneum during the process of dissection is of utmost importance. It is recommended to perform incisions in a lateral direction within the abdomen and in a medial direction within the pelvis, in order to lessen the risk of vessel interference [5].

Origin of damage

Intraoperative injury to the ureter may occur as a result of multiple factors, encompassing, but not restricted to, angulation, ligation, transection, crush, laceration, resection, and ischemia [6]. The pelvic brim is the predominant anatomical location for operative damage to the ureter through regular abdominal adnexectomy or hysterectomy. This region is specifically characterized by the presence of the ureters underneath the point of insertion of the infundibulopelvic ligament. The iliac arteries are frequently observed in other typical sites, including the cardinal ligament at the internal cervical os level where the uterine artery intersects the ureter, as well as the anterolateral fornix of the vagina where the ureter enters the bladder. Ureteral injuries commonly manifest in the vicinity of the ureterovesical junction during urogynecologic interventions, such as Marshall-Marchetti-Krantz cystourethropexy or retropubic urethropexy. During the procedure of vaginal hysterectomy, there is a potential risk of ureteral trauma in close proximity to the internal cervical os and vaginal fornices, specifically as it traverses into the trigone region of the bladder [7]. During laparoscopic surgery, specifically in the context of endometriosis ablation, the uterosacral ligaments have been identified as the predominant location for ureteral injury. This occurrence is frequently observed due to the thickening of these ligaments as a consequence of endometriosis [8]. Ureteral injury may manifest in obstetric patients due to the suturing of an elongated uterine incision, undertaken to manage hemorrhage within the wide ligament through a cesarean hysterectomy or during the execution of a hypogastric artery ligation procedure.

Risk factors

While the majority of ureteral injuries manifest in patients without discernible risk factors, there exist specific circumstances that heighten the probability of such damage, specifically those that perturb the customary anatomy and structure of the ureters. The aforementioned situations encompass endometriosis, pelvic inflammatory disease, and voluminous ovarian masses [6]. Two extensive studies have conducted a retrospective analysis on the prevalence of ureteral injuries and the corresponding risk factors. The researchers discovered that pelvic malignancies were observed in 44 percent of the cases, indicating a notable association with ureteral injury and suggesting a significant risk factor. The observed symptoms are highly indicative of the existence of tense adhesions, which are characterized by the formation of substantial masses that cause displacement of the ureter. Additionally, there are notable anatomic alterations that contribute to the distortion of the ureters' position. Additional risk factors for the condition under consideration encompass a history of prior pelvic surgery, the presence of broad ligament fibroids, and a previous medical intervention involving pelvic radiation [9,10]. Less frequently encountered factors that contribute to individual's susceptibility to ureteral injury encompass congenital anomalies, namely megaureter, ectopic ureter or kidney, and ureteral duplication. Nevertheless, it is imperative to highlight that a significant proportion, specifically 50%, of ureteral injuries were observed without any discernible pre-disposing factors [6,9].

Avoiding damage to the ureter

Surgery of the abdominal and pelvic region

In order to mitigate the risk of ureteral injury during surgical procedures, it is imperative to accurately delineate the trajectory of the ureter and ascertain the locations within the pelvic region that are particularly susceptible to damage. The identification of the ureter necessitates the implementation of an incision that affords an adequate degree of exposure. Commence the procedure by initiating an incision in the peritoneum, specifically in a lateral orientation relative to the infundibulopelvic ligament. Proceed to identify the ureter, which can be found on the medial aspect of the peritoneal leaf. An efficacious modality encompasses the subsequent procedural measures: Following the division of the round ligament in proximity to the pelvic sidewall, proceed to carefully incise the lateral peritoneum in a cephalad direction spanning a length of 10 to 15 cm. The external iliac artery can be located by placing an index finger upon it, followed by an upward motion. Subsequently, the ureter can be identified as it intersects and comes into contact with the iliac artery [11]. This technique enables the secure clamping of the infundibulopelvic ligament in conjunction with the ureter while maintaining direct visualization. Proceed along the course of the ureter in the direction of the cardinal ligament, wherein it traverses beneath the uterine artery.

The preservation of the blood supply to the ureter, particularly in the lower pelvis or in close proximity to the intravesical wall, necessitates a meticulous dissection from the pelvic wall while ensuring its continued attachment to the peritoneum. The present study elucidates that the slender mesentery, accompanied by diminutive blood vessels, plays a significant role in providing vascular support to the ureter [12]. The identification of the ureter is of utmost importance, especially in regions that are susceptible to potential harm. The structure in question can be discerned from other anatomical components through the induction of peristalsis

upon the application of gentle stroking or by the manifestation of a distinctive snapping sensation upon gentle palpation, as indicated by reference [13]. Prior investigations have demonstrated that directing attention towards the anatomic trajectory of the ureter during surgical procedures yields superior efficacy in averting injury compared to preoperative assessments such as intravenous pyelograms (IVP) or placements of ureteral stents [14, 15]. The utility of preoperative intravenous pyelograms (IVPs) is constrained, and the implementation of prophylactic ureteral catheterization does not completely mitigate the potential for ureteral injuries. The implementation of a meticulous surgical technique, coupled with the precise identification of the ureter's trajectory and regions of susceptibility, represents the most effective measures for preventing ureteral injury in the context of abdominal hysterectomy [16].

Vaginal surgery

A comprehensive illustration has been furnished, delineating the precise anatomical regions where the ureter is particularly prone to damage during vaginal surgical procedures. During the performance of a transvaginal hysterectomy or surgical intervention for pelvic floor relaxation, it is imperative to establish a sufficient vescicouterine space in order to safeguard the ureters against potential harm caused by Medical clamps and ligatures. The desired outcome is attained through the application of inferior pull on the cervix, coupled with countertraction in an upward direction below the bladder. The meticulous execution of clamping, cutting, and ligating should be limited to minute increments of pericervical and periuterine tissue in close proximity to the uterine region. The implementation of these procedural measures is of extreme significance in order to guarantee the secure and appropriate positioning of the ureters, thereby minimizing the risk of inadvertent involvement within the surgical site [1]. The ureters may be palpated through the application of mild pull on the cervix, in conjunction with superior pull on the proximal vagina, thereby revealing the point of entry of the ureter into the trigone [17].

Frontal vaginal wall repair

During the procedure of anterior colporrhaphy, it is imperative for the surgeon to exercise caution in order to avoid commencing the surgical incision in a lateral direction or inserting the sutures excessively deep. This precautionary measure is taken to prevent any potential harm to the ureters due to needle injury while performing the act of plicating the bladder. Indeed, Hofmeister (18) observed that the separation between the ureter and the surgeon's needle within the superior portion of the vaginal canal measures a mere 0.9 cm when conducting anterior colporrhaphy with the aid of fluoroscopic imaging.

Diagnosis of ureteral damage during surgery

In the event that there is suspicion of ureteral injury during intraoperative procedures, it is imperative for the surgeon to expeditiously ascertain the location of the ureter and assess the extent and characteristics of the injury. In cases where visualizing the injury proves to be inadequate, the administration of intravenous indigo carmine can serve as a valuable tool in confirming and localizing the ureteral injury. The presence of blue-colored urine in the Foley catheter provides assurance that at least one of the ureters has not been ligated. Moreover, the absence of visual confirmation of blue urine passage into the bladder via cystoscopy indicates potential obstruction of one or both ureters.

Post-surgical clinical assessment

Ureteral trauma may potentially evade prompt detection, particularly in instances of unilateral injury. In the event of a healthy contralateral kidney, it shall undertake compensatory measures to address the loss, resulting in a temporary elevation in creatinine levels [7]. Ultimately, the renal organ in question will experience a progressive decline in its physiological capacity. The early postoperative diagnosis of ureteral injury is commonly observed within a time frame of 7 to 10 days following surgical intervention [1]. The presenting symptoms encompass tenderness in the costovertebral angle, ileus, elevated body temperature, and pain in the flank region, suggestive of a hematoma, inflammatory response, or infection localized at the site of trauma. In cases where there is suspicion of ureteral injury, it is recommended to conduct an intravenous pyelogram (IVP) and cystoscopy. These diagnostic procedures serve the purpose of identifying and describing the nature of the injury. Due to potential challenges associated with prompt dissection, the implementation of retro-grade ureteral catheter placement and nephrostomy drainage may serve to eliminate the necessity for surgical intervention [4].

Effective management of ureteral damage

The management strategy for ureteral repair is contingent upon the etiology, anatomical site, and magnitude of the injury. In the realm of medical practice, it is worth noting that minor trauma, encompassing ligature or crush injuries, can be effectively addressed through the implementation of stent placement and subsequent drainage of the affected region. The stents are typically retained for a duration of approximately six weeks, after which an intravenous pyelogram (IVP) is performed to verify the unobstructed flow of urine through the ureter. Partial transections are commonly managed through the implementation of suture repair or resection of the implicated segment. Evidently, the presence of extensive ureteral injury necessitates a more intricate surgical intervention. A crush damage or the transection that transpires within the central segment of the

ureter can be efficiently managed by employing the end-to-end anastomosis technique [1,7]. In order to attain a free of stress anastomosis, it is essential to release the ureter from the peritoneal adhesions or by encouraging the kidney. Moreover, it is noteworthy that the utilization of a psoas hitch technique holds the potential to enhance the ureter's length by a substantial measurement in centimeters. Throughout the duration of this surgical procedure, the meticulous suturing of the bladder to the psoas tendon is performed, while simultaneously ensuring the reimplantation of the ureter into the bladder via a sub-mucosal tunnel. Injuries occurring in close proximity to the bladder can be efficiently managed through two main surgical methodologies: direct implementation of the ureter inside the bladder or through the utilization of a sub-mucosal tunnel. The aforementioned technique presents the benefit of decreased probability of vesicoureteral reflux, a plausible complication. Injuries located in the central or the upper 3rd of the ureter can be appropriately managed through the implementation of a surgical intervention commonly referred to as ureteroileoneocystotomy. The procedure entails the establishment of a conduit that establishes a connection between the ureter and the bladder. This is achieved by utilizing a section of the terminal part of the ileum as a connecting material.

Outcomes of ureteral injury

Intraoperatively, it is possible to reverse minor injuries to the ureter with-out any subsequent long-term sequelae. Necrotic section of the ureters may give rise to a compromised integrity of the ureteral wall, thereby leading to the leakage of urine into the surrounding periureteral tissues. The formation of a urinoma may ensue, potentially progressing towards bacterial colonization and subsequent abscess formation. Urinary ascites and peritonitis may occur as a result of the accumulation of urine within the peritoneal cavity [7]. Ureterovaginal fistulas may potentially arise as a consequence of injuries sustained during vaginal surgical procedures. Uremia commonly arises as a consequence of bilateral ureteral injury. The occurrence of two-sided ureteral ligation manifests as anuria within the initial 24 - 48 hrs following the surgical procedure, subsequently leading to an elevation in blood urea nitrogen and creatinine levels. Prompt urinary drainage, facilitated by nephrostomies, may be imperative for the prompt restoration of optimal renal function.

Conclusion

Ureteral injuries are predominantly observed in the context of pelvic surgical procedures. The gynecologic surgeon is required to acquire a comprehensive understanding of the anatomical structure of the abdominal and pelvic ureter, as well as the specific sites where it is particularly prone to damage. Undoubtedly, the most effective strategy in mitigating ureteral trauma is through proactive preventive measures.

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