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Numerous Diseases Can Affect the Ureters

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Abstract:

Ureters are smooth muscle tubes that transport urine from the kidneys to the bladder. Various medical conditions can impact the ureters. The ureter begins at the renal pelvis, descends through the retroperitoneal space within the abdominal cavity, and enters the pelvic region, ultimately draining into the urinary bladder. Consequently, it can be categorized into abdominal and pelvic segments. As the ureter enters the pelvic cavity, it creates a curved shape, and in this narrowed section, a kidney stone can become lodged.

keywords: pelvic; ureter; woman; surgery; health

Introduction

Injury to the ureters is an uncommon occurrence, predominantly caused by iatrogenic factors during open, minimally invasive, or endoscopic surgeries [1]. Most non-iatrogenic ureteral injuries result from penetrating traumas. The aftermath of undetected ureteral injuries can vary, leading to issues such as urine leakage and abscess formation, as well as more serious complications like ureteral stricture, renal function loss, sepsis, urinary fistula, or even fatality. Often presenting subtly, ureteral injuries necessitate a keen awareness to prevent severe complications from unnoticed or improperly treated injuries. Iatrogenic injuries to the pelvic ureters frequently occur during hysterectomies and colorectal surgeries; urological and vascular surgeries also significantly contribute, although at a lower rate, to pelvic ureteral injuries. Injuries to the ureters from external traumas are unusual, seen in less than 4% of penetrating injuries and under 1% of blunt injuries. In cases of penetrating trauma, injuries may result not only from direct cuts but also indirectly from damage to the ureter's blood supply. Over 90% of individuals with ureteral injuries also have concurrent damage to abdominal or retroperitoneal organs, with a mortality rate associated with these injuries reaching around 30%.

Pelvic Floor

Pelvic floor disorders affect approximately 25-30% of women, posing a significant social issue, particularly with the increasing average age and life expectancy [2]. Numerous conditions can influence pelvic anatomy and function, including pelvic organ prolapse, bladder and bowel dysfunction (such as incontinence, urinary retention, constipation, etc.), weakness of pelvic muscles and connective tissues, pelvic pain, sexual dysfunction, and neurogenic changes. Various treatment options have been documented for pelvic floor disorders, encompassing pharmacological, rehabilitative, surgical, and behavioral strategies, highlighting the complexity of this interconnected anatomical and functional system. Sacral neuromodulation (SNM) employs electrical modulation to influence the bladder, rectum, and other pelvic organs' physiological functioning. Initially used for bladder dysfunction, its previously unexamined beneficial impact on intestinal functionality has led to its potential application in bowel function as well. Currently, specific indications for SNM are well defined and included in clinical guidelines, though its broader implementation is still restricted by costs and the need for specialized expertise. For alternative conditions, research is ongoing, with some findings indicating promising outcomes. To achieve similar results from neural modulation, percutaneous tibial nerve stimulation (PTNS) has been suggested. However, when compared to SNM, PTNS appears to be less effective and has less supporting evidence for its application. The surgical intervention of sacral neuromodulation involves placing the electrode through one of the openings in the sacrum, typically at the S3 level, following bilateral assessments of sensitive and motor responses. The electrode is then connected to either a subcutaneous or external pulse generator. Although a complete comprehension of how sacral neuromodulation works is not fully established, various possible effects have been noted that engage the brain, spinal cord, peripheral pathways, and reflex systems. Nonetheless, having treated over 300,000 patients globally with sacral neuromodulation, this treatment modality is poised to become a significant option in the future, as part of the growing array of therapeutic methods utilizing a neural-computer interface.

Bleeding

Managing bleeding in the right upper quadrant, situated behind the liver, is often very challenging, and it is considered acceptable to pack this area for a duration of 24 to 48 hours [3]. Should recurrent bleeding occur upon the removal of packs, the liver may need to be moved out of its fossa, potentially requiring the placement of a chest tube from the inferior vena cava to the right atrium to facilitate repairs to the retrohepatic vena cava's posterior aspect. Damage to the right renal vein typically leads to the loss of that kidney (assuming the left one is functioning normally); if repair is necessary, the simplest method is to autotransplant it to the right iliac artery and vein after cooling it with iced heparinized saline to extend the tolerable ischemia time of 4 to 6 hours. Any hematomas affecting the kidneys should be assessed prior to making decisions. Arterial reconstruction can be performed using an interposition graft fashioned from either the saphenous or jugular vein (in the absence of a prosthetic graft), connecting the renal artery to the hepatic artery on the right and to the splenic artery on the left. Injuries to the iliac vessels can be revealed by extending the midline incision, and following control of any bleeding, the internal iliac artery can be utilized to bypass damage to the external iliac artery or be ligated and divided, which will provide better access to the iliac veins. It is preferable to ligate the iliac veins at the common iliac rather than the external iliac to better preserve the pelvic collateral circulation. Repairing these veins carries risks of stenosis with the potential for thrombosis and pulmonary embolisms. Distal injuries to the internal iliac vein can be best managed with packing. Throughout these dissection procedures, it is crucial to handle the femoral nerve located laterally next to the vein and the ureter situated medially as it traverses the common iliac artery with great care. Vessels measuring less than 3 mm may be ligated, whereas those exceeding 3 mm should be suture-ligated; vessels larger than 5 mm may be closed with a continuous suture for low-pressure vessels and two layers for those in high-pressure situations. During repair work, it is essential to only minimally contact the intima or avoid it altogether entirely, utilizing stay sutures instead. Proper sizing of the patch is vital to prevent oversizing, aneurysmal dilation, and thrombus formation. For smaller vessels, both ends should be spatulated, and employing a sterile angiocath or feeding tube at both ends of the anastomoses will assist in preventing the suturing of two walls together.

Pain

Pelvic pain may be linked with either regular or irregular menstrual cycles and can arise from issues within the pelvis or be felt as referred pain from other body parts [4]. A strong suspicion should be maintained for non-pelvic conditions that might cause pain in the pelvic region, such as appendicitis, diverticulitis, cholecystitis, bowel obstruction, and infections in the urinary tract. A comprehensive patient history detailing the nature, location, radiation, and changes in intensity of the pain will assist in determining the origins of acute pelvic discomfort. It is important to assess whether the pain coincides with vaginal bleeding, sexual intercourse, bowel movements, urination, physical activity, or eating. Distinguishing between acute or chronic pain, and whether it is consistent or intermittent, as well as cyclic or noncyclic, will guide subsequent examinations. Pelvic inflammatory disease typically manifests as pain in the lower abdomen on both sides. Testing for C. trachomatis and N. gonorrhea is advisable for women who are at a higher risk. If the pain is unilateral, it may indicate issues with the adnexa, such as rupture, bleeding, or twisting of ovarian cysts, or, although less often, tumors in the ovaries, fallopian tubes, or surrounding areas. Ectopic pregnancy is characterized by lower abdominal pain on one side, accompanied by vaginal bleeding and irregular menstrual cycles, with clinical symptoms appearing 6 to 8 weeks after the last normal period. Signs of orthostatic changes and fever may also present. Pathologies affecting the uterus include endometritis and degenerating leiomyomas. Many females notice discomfort in the lower abdomen during ovulation (mittelschmerz), described as a dull, aching sensation occurring around the middle of the cycle lasting from several minutes to a few hours. Women who ovulate may also have physical symptoms in the days leading up to menstruation, such as swelling, breast fullness, and bloating or unease in the abdomen. A collection of symptoms comprising cyclic irritability, sadness, and fatigue is referred to as premenstrual syndrome (PMS). Severe cramping associated with ovulatory periods, where no obvious pelvic disorders are present, is identified as primary dysmenorrhea. In contrast, secondary dysmenorrhea results from underlying pelvic issues like endometriosis, adenomyosis, or cervical narrowing. Assessment involves taking a detailed history, conducting a pelvic examination, measuring hCG levels, performing tests for chlamydial and gonococcal infections, and utilizing pelvic ultrasound. In certain situations where the cause of pelvic pain is unclear, laparoscopy or laparotomy may be warranted.

Injury

The ureters are structures located behind the peritoneum that transport urine from the kidneys' renal pelvis to the bladder [5]. They begin at the ureteropelvic junction (UPJ), situated behind the renal artery and vein. Moving towards the pelvis, the ureters follow the path along the psoas muscle. Before connecting to the bladder’s trigone, the ureter crosses over the iliac bifurcation. The ureter can be categorized into three anatomical parts: the proximal ureter, which stretches from the UPJ to the sacroiliac (SI) joint; the middle ureter, which is located between the SI joint and the pelvic brim; and the distal ureter, which runs from the iliac vessels to the bladder. Although ureteral injuries are not frequent, they can occur as a complication during any surgical procedures in the abdominal or pelvic regions. It is understandable that injuries to the distal ureter are common, given their close association with the pelvic blood vessels, which include the iliac vessels, uterine artery, and rectal arteries. The upper third of the ureter receives its blood supply from the aorta and renal vessels, which can be found medial to the ureter. The lower two-thirds of the ureter are supplied by vessels from the iliac, sacral, and lumbar regions, located lateral to the ureter. The positioning of the blood supply to the ureter is essential to consider, as devascularization is a frequent type of injury and typically manifests later. The severity of ureteral injuries can be assessed using a grading system from I to V. A grade I injury is characterized by a hematoma or contusion that does not involve devascularization, while a grade II injury indicates less than 50% transection. A grade III injury refers to more than 50% transection, a grade IV injury consists of a complete transection with less than 2 cm of devascularization, and a grade V injury denotes an avulsion with over 2 cm of devascularization.

Recognition

The prompt identification of a ureteral injury is vital to reduce potential long-term complications [1]. The most immediate detection of an iatrogenic ureteral injury occurs during the operation itself. Strategies to prevent such injuries include the placement of ureteral stents during surgery to assist in locating the ureters. These ureteral stents are frequently requested or utilized by surgeons in gynecology, colorectal, and vascular specialties, due to the anatomical closeness to the ureters. Although the preventive use of these stents may help with identifying ureteral injuries, their effectiveness in reducing the overall incidence of injuries remains uncertain. However, a recent analysis of the National Surgical Quality Improvement Program indicated a reduced frequency of ureteral injury following colectomy when ureteral stents were employed. In numerous cases, anatomical alterations of the ureter arise due to mass effects from gynecological or colorectal tumors, or fibrosis caused by aortic aneurysms, which complicate the recognition or dissection of the ureter, thus elevating the risk of injury. Postoperative diagnosis and localization of ureteral injuries demand a keen level of awareness, as these injuries can present with various signs and symptoms. This vigilance becomes even more crucial in laparoscopic or robotic surgeries; while approximately one-third of ureteral injuries are identified during open surgical procedures, fewer are detected through minimally invasive techniques. Depending on the clinical condition of the patient, the identification of ureteral injuries can occur immediately or at a later stage. Indications such as fever, ileus, hematuria, leukocytosis, tenderness, or expansion of the abdomen, along with an increase in serum creatinine due to the peritoneal absorption of urine or an obstructed kidney, can point towards a ureteral injury that leads to peritoneal irritation, urinoma, or abscesses. If a surgical drain has been inserted during surgery, fluid can be evaluated for spot creatinine levels; urine leakage may be indicated if spot creatinine exceeds serum creatinine. If renal function allows for the use of intravenous contrast, a CT scan of the abdomen and pelvis with contrast and a delayed urographic phase serves as an efficient method for identifying the site of the ureteral injury. A retrograde pyelogram is the most precise tool available to determine the injury's location and may facilitate the concurrent cystoscopic placement of a ureteral stent, depending on the severity of the injury.

Repair

The process of repairing ureteral injuries is intricate and necessitates excellent judgment, skill, and experience [6]. A surgeon who has comprehensive understanding and familiarity with this repair type should conduct it. Typically, injuries identified during surgery or within the initial days of recovery in a stable patient are addressed immediately. In cases where the patient is unstable or if the detection of the injury is postponed for days or weeks, immediate proximal urinary diversion should occur, followed by a delayed repair. Generally, proximal urinary diversion can be accomplished through the insertion of a percutaneous nephrostomy catheter. In situations where the ureter has been unintentionally ligated during surgery, simply removing the suture may be sufficient. Conversely, if the ureter has suffered crushing due to a clamp, the chance of injury is significantly higher. A thorough examination of the adventitia for discoloration is essential, as ischemic damage can take several days to become fully apparent. If the adventitia is found to be nonviable, a repair should be undertaken. Fundamental principles governing ureteral repair include the removal of nonviable tissue, achieving tension-free anastomosis, and approximating the mucosa-to-mucosa. Partial transections are typically managed with direct closure using interrupted 4-0 or 5-0 absorbable sutures. Complete transections and cases involving ischemic injury may necessitate resecting the damaged section followed by ureteroureterostomy. All ureteral repairs, whether primary closures or ureteroureterostomies, should be drained extraperitoneally. All complete transections and the majority of partial transections should be stented, such as with a double J stent. Complete transection of the pelvic ureter or significant ischemic damage is often best treated through ureteral reimplantation. When anticipating a challenging surgery, such as with a significant cancerous tumor, an inflammatory mass in the pelvic region, or cases involving extensive radiation therapy, the likelihood of damage to the ureters can be reduced by placing ureteral catheters before the operation. This strategy facilitates the identification of the ureters, though it does not completely guarantee the prevention of injury.

Surgery

A urological surgeon dealing with ureteral injuries must possess a comprehensive knowledge of the ureters' anatomy and trajectory [1]. The ureter can be categorized into three separate portions: (1) the proximal ureter, which spans from the junction of the ureteropelvic area to the upper section of the sacrum; (2) the middle ureter, which travels from the upper part of the sacrum to the iliac blood vessels; and (3) the distal ureter, which ranges from the iliac vessels down to the urinary bladder. Moreover, familiarity with the ureter's closeness to adjacent anatomical structures is essential for preventing, recognizing, and effectively treating ureteral injuries. Originating in the upper retroperitoneum, the ureters are positioned atop the psoas muscle in the retroperitoneal area, taking a medial path as they enter anteriorly over the common iliac arteries and passing behind the gonadal vessels before reaching the bladder base in the pelvic region. In males, the ureter runs inward to the medial umbilical ligament and goes behind the vas deferens; in females, the ureter's proximity to the uterine artery at the ureterovesical junction poses a risk of harm during gynecological procedures.

Robotic Approach

Abdominal sacrocolpopexy (ASC) is regarded as the optimum solution for addressing apical vaginal prolapse, demonstrating long-lasting success rates between 68% and 100% [7]. Additionally, an abdominal technique permits the concurrent repair of defects in all three compartments of the pelvic floor: anterior, apical, and posterior, while maintaining vaginal structure. The robotic or laparoscopic method offers a substitute to traditional open surgery, providing similar results and catering to patients who benefit from the established advantages of minimally invasive techniques. The features of this fully minimally invasive surgery, along with its potential positive impact on sexual health (such as maintaining vaginal length and orientation and reducing cases of dyspareunia), render this procedure particularly appealing for younger women who are sexually active. Laparoscopic sacrocolpopexy and sacrohysteropexy is a complex procedure that has a significant learning curve, leading to fewer surgeons adopting this technique more broadly. Robot-assisted sacrocolpopexy (RSC) assists in addressing challenges faced during laparoscopic sacrocolpopexy (LSC) by enhancing deep dissection and suturing capabilities. RSC proves to be a safe and effective choice for individuals suffering from pelvic organ prolapse (POP). It provides numerous advantages, which include a high rate of anatomical cures, enhancements in sexual function, a decrease in perioperative complications, and a minimal chance of recurrence. Furthermore, it emerges as a safe alternative for senior patients. The introduction of robotic/laparoscopic pectopexy in 2011 showcased it as a viable, secure, and easier alternative for surgeries addressing apical prolapse. Pectopexy also has benefits when compared to sacrocolpopexy, especially in the context of patients with obesity. In sacrocolpopexy, there are critical anatomical structures such as the right ureter, hypogastric nerves, middle sacral vessels, and the left common iliac vein located near the sacral promontory. In obese patients, retroperitoneal dissection to prepare the anterior longitudinal ligament and manage the bowel is particularly challenging due to the difficulties in identifying essential landmarks. Obesity compounds surgical difficulty by constraining the surgical environment while trying to balance adequate abdominal pressure and sufficient ventilation. In contrast, pectopexy confines the surgical area to the anterior pelvic space, making it less affected by obesity. Several studies have assessed the clinical effectiveness of pectopexy against sacrocolpopexy, demonstrating its superior efficacy. Since the arrival of the daVinci robotic system in urogynaecology in 2005, it has proven to offer significant advantages over traditional laparoscopy. The robotic system enhances manual precision by providing multiple degrees of freedom and eliminates hand tremors. It also delivers superior visualization with its three-dimensional viewing capabilities. Furthermore, it has a more accessible learning curve for those transitioning from laparoscopic or abdominal surgeries to robotics. Robotic sacrocolpopexy and pectopexy are considered safe and yield outcomes comparable to both open and laparoscopic approaches. Their popularity has surged rapidly since the surgical morbidity associated with these techniques is lower than that found in abdominal and sacral dissections. Knot-tying is also more straightforward in robotic procedures compared to laparoscopic techniques, primarily due to the advantages of three-dimensional visualization.

Evaluation

The approach to managing ureteral injuries resulting from endoscopic procedures differs depending on the severity of the injury [1]. In cases of perforated distal ureters, the optimal treatment involves the placement of a ureteral stent, which is generally removed after a period of 4 to 6 weeks. A urethral Foley catheter may be used temporarily to prevent urine from the bladder refluxing into the ureter, thus promoting maximum healing. Complete avulsions of the ureter necessitate surgical exploration and subsequent repair. The assessment of a potential ureteral injury usually takes place during the operation; therefore, the visibility of the pelvic ureter is restricted by the initial exposure obtained for the main procedure. When a urological surgeon examines a potential pelvic ureteral injury, they may utilize a cystoscope in conjunction with a retrograde pyelogram if direct access to the pelvic ureter is not feasible due to surgical exposure limitations. The intravenous use of methylene blue can assist in identifying subtle injuries effectively. Likewise, methylene blue can be administered via cystoscopy through retrograde methods by using ureteral catheterization. If intraoperative imaging indicates a potential injury, or if fluoroscopy is unavailable, the surgical incision is either enlarged or an additional incision is made to allow for sufficient mobilization and direct observation of the ureter. The segment of ureter under examination should be assessed for tissue viability, which can be determined by the appearance of the ureteral tissue, any urine leakage, and the extent of the disruption or injury. It is essential to inquire about the cause of the injury, as thermal injuries may necessitate debridement beyond the visible area of damage. Other frequent causes of injury include sharp trauma or transection, crush injuries, sutural ligation, and the use of stapling or clipping devices on the ureter. Prior to surgery, careful evaluation of the patient's imaging is crucial to recognize anatomical variations such as solitary kidneys or duplicated ureters.

Conclusion

The ureter comprises two tubular structures responsible for transporting urine from the kidneys to the bladder. Similar to most components of the urinary system, the ureter serves solely a conducting function. This indicates that its sole purpose is to channel urine, without affecting the urine's volume or its composition. The ureter begins within the renal pelvis, descends through the retroperitoneal area situated in the abdominal cavity, and reaches the small pelvis. The terminus of the ureter, which empties into the urinary bladder, is found in the small pelvis.

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