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REVIEW ARTICLE

Diagnosis and Treatment of Iatrogenic Injuries of the Ureter in Patients Undergoing Pelvic Surgery in a Resource Limited Setting: A 10-Year Multi-Institutional Review

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Abstract

Background: Most ureteral injuries are iatrogenic, secondary to operative trauma. Iatrogenic ureteral injuries result from abdominopelvic surgery. The challenge is diagnosing these as early as possible so as to provide appropriate ureteral reconstruction early. The aim of this study was to summarize the etiologies, clinical features and general management of iatrogenic ureteral injury in a resource limited context of a low-income country.

Patients and methods: We carried out a multicentric study and reviewed all patients with iatrogenic ureteral injuries in three referral hospitals in Yaoundé, Cameroon, over a ten-year period.

Results: Overall, we recorded 38 cases of iatrogenic ureteral injuries out of 19053 pelvic surgeries performed during the study period. The average number of iatrogenic ureter injuries per year was 3.45 cases. The mean age was 46 ± 10.7 years; all were female. Hysterectomy accounted for 29 (76.3%) of the ureteral injuries. The majority, (34; 89.47%) of the cases, were diagnosed post-operatively. The most frequent symptoms were flank pain and vaginal urine leakage in 18 (47.4%) and 13 (34.2%) cases respectively. The most common imaging procedure was ultrasound showing dilation of the right ureter in 21 (55.2%) cases. Ureteral injuries were found to be located mostly at the right distal segment and the mid ureter with a frequency of 30 (78%) and 8 (22%) respectively. All the patients underwent surgical treatment including ureteroneocystostomy, uretero-ureterostomy, Boari flap reconstructions and nephrectomy. Seventy-four percent (n=28) of participants had a favorable outcome and 26.3% (n=10) developed postoperative complications.

Conclusion: In our setting, iatrogenic ureteral injuries are not uncommon in women undergoing pelvic surgery. In the absence of a high index of suspicion, diagnosis is delayed. Abdominal pelvic ultrasound usually shows the affected side. Ureteroneocystomy is commonly performed, with both minor and major complications.

Keywords: Iatrogenic Ureteral Injuries, Hysterectomy, Ureteroneocystostomy, Yaounde, Cameroon.

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1. Introduction

Despite their retroperitoneal anatomical location, the ureters are prone to both traumatic and iatrogenic injuries. Although not common, iatrogenic causes include mainly radical abdominal hysterectomy, colectomy and caesarean section with a high rate of lesions involving the distal segment of the ureter [1, 2]. In the last decade, with the development of minimally invasive surgery, several studies have reported an increase in the frequency of iatrogenic injuries of the ureter during laparoscopic procedures [1, 3]. Globally, iatrogenic ureteral injury has an incidence of less than 1%[4]. In contrast, previous studies in sub-Saharan Africa, where open surgery is still largely practiced, have found a high rate of iatrogenic ureteral injury (IUI) varying between 0.5 and 10% [5-7]. In Cameroon, the number of iatrogenic injuries to the ureter has dramatically increased, although the literature on the subject is limited. However, a recent study in a single center discovered that amongst other traumas to the genito-urinary tract, iatrogenic ureteral injury was found to be 2% [8]. A high index of suspicion and early diagnosis will limit intraabdominal or pelvic sepsis, urinary fistulae, renal damage or even death [1]. Unfortunately, most cases are still identified post-operatively from leakage of urine per vaginam, via surgical site and / or wound drainage site [5, 9, 10]. Successful management requires early and definitive intervention using endoscopic means, percutaneous drainage and stenting where possible. However, when these fail or are unavailable, a number of open surgical options are accessible [11].

Currently, there is no large-scale study of ureteral injury in Cameroon. Thus, we performed this multicenter study to describe the etiologies, clinical features and general management of IUIs.

2. Methodology

2.1 Data Collection

We conducted a descriptive cross-sectional study with retrospective data collection covering a period of 10 years (February 2013-february 2023). This study was carried out in three reference hospitals in the capital city of Cameroon, Yaoundé; the Yaoundé Central Hospital (YCH), Yaoundé General Hospital (YGH) and at the Yaoundé Gynaecology-Obstetric and Paediatric Hospital (YGOPH). Ethical clearance was approved by their institutional ethics committees. We included all patients who had ureteral injury following pelvic surgeries which were either repaired immediately or later in the three study sites. Causes of IUI due to radiotherapy or malformations as well as incomplete files were excluded. Patient's files, operating room, surgical, gynecological, and urological ward registers from 2013 to 2023 were consulted. For each eligible patient we collected relevant sociodemographic, clinical and therapeutic variables of interest.

2.2 Clinical and Paraclinical Data

Iatrogenic was defined as illness (injury) caused by medical examination or treatment. A urinary fistula is considered to be an abnormal opening between organs in the urinary tract and another organ allowing urine to pass through. The methylene blue test consists of injecting methylene blue through an intravesical urinary catheter to look for communication between the bladder and vagina. The degree of hydronephrosis was classified according to radiology grading system [13, 12].

2.3 Surgical Procedures

When the injury was identified intraoperatively, either open or laparospically (Figure 1) different surgical options were applied depending on the site, length and gap between the distal and proximal ends. For injuries seen postoperatively within 14 days, the same principle was applied.

The Leadbetter and Politano [14, 13] technique has been mostly described in literature. In brief, following identification of the dilated ureter, a landmark suture is placed on its anterior surface. The bladder is then approached anteriorly and an opening is made high and medially. A fine forceps is passed through this opening to bring the ureter into the bladder without tension, traction or torsion. The ureter is then anchored to the bladder mucosa by interrupted stitches of 4/0 PDS monofilament with a JJ stent bypassing the anastomosis (Figure 2).

Post-operative treatment comprised of antibiotics, analgesics, pharmacological and mechanical prevention of thromboembolism, and wound care. The Foley catheter was removed after 7 days and JJ stent after 6 weeks.

2.4 Follow-up and complications

Post-operative follow-up was conducted at 6 weeks, 3 months, 6 months and then annually. At each post-operative visit, a physical examination was performed, blood serum urea and creatinine and an ultrasound of the urinary tract were requested. Most (27/38) of the patients were lost to follow-up after the second visit. Postoperative complications were assessed according to the Clavien Dindo classification. Surgical success

was considered satisfactory if the symptoms were resolved and if hydronephrosis was improved/ stabilized.

2.5 Statistical analysis

Data of completed and validated proforma were entered and analyzed using the Epi info 7.5.2.0 software. The results were presented as figures, tables, and diagrams and expressed in terms of means ± standard deviation with their range [Min; Max] or median with their interquartile range [25; 75] for quantitative variables as frequencies and percentages for categorical variables.

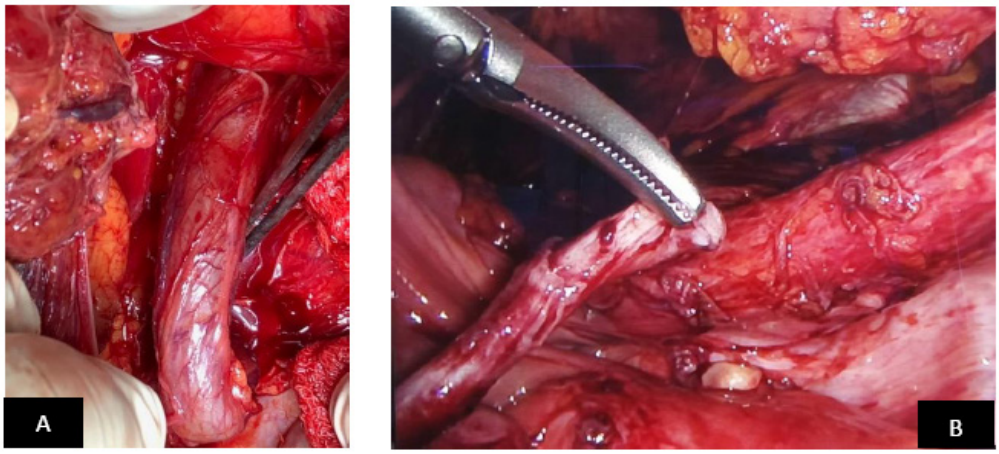

Figure 1. *Intraoperative view of iatrogenic ureter injuries. A. Dilated right pelvic ureter after ligation on the 5th post-operative day following a hysterectomy; B Pelvic left ureter sectioned in a woman undergoing laparoscopic surgery for infertility*

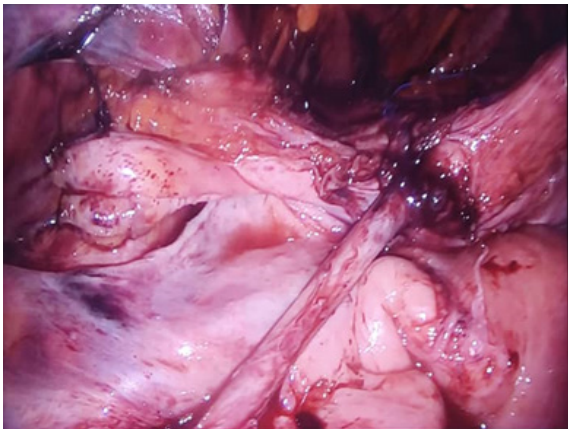

Figure 2. *Laparoscopic view of unilateral ureteral reimplantation*

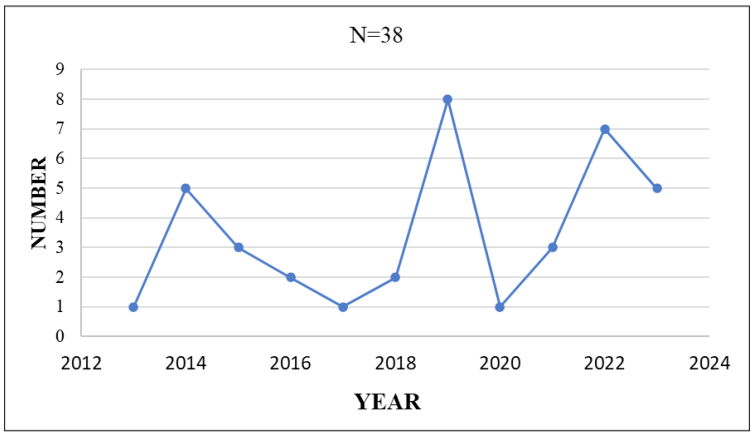

Figure 3. *Graphic representation of the number of cases received per year*

3. Results

In all, 52 cases of IUI were recorded during the study period out of 19053 pelvic surgeries performed during the study period in the three reference hospitals. Iatrogenic ureteral injuries were common at giving an incidence rate of 0.27%. After excluding incomplete files, we finally retained 38 files. Sixteen patients came from the YCH, 14 from the YGH and 22 cases were recruited from the YGOPH. Twenty-three (60.52%)

cases were referred from peripheral health centers. The average number of iatrogenic ureter injuries per year was 3.45 cases, with a bimodal peak in 2019 and 2022. (Figure 3)

The mean age was 46 ± 10.7 years, all female. The most frequent age range was 41-50 years (47%). Hysterectomy was the surgery responsible for most of the ureteral injuries with 29 (76.3%) cases, followed by caesarean section with 7 (18.4%) cases and annexectomy (surgical removal of ovary and fallopian tube unilaterally or bilaterally.) representing 2(5.2%) cases. Regarding injury mechanism, suture ligation accounted for 73.7% (n=28) of cases. Majority 34 (89.47%) of the cases of ureteral injuries were diagnosed post-operatively. Intraoperative diagnosis was made in only 4 (10.53%) patients. The time interval from injury to consultation ranged from 1 to 260 days with a median of 16 days, IQR [7; 28]. Table 1 summarizes the etiology and type of ureteric lesions encountered

The most frequent symptom in our study was flank pain, followed by vaginal urine leakage, oliguria and anuria with a total of 18 (47.4%), 13 (34.2%), 7 (18.4%) and 5 (13.2%) cases respectively. Upon physical examination, the most common sign found was vaginal urine leakage, with 13 (34.2%) patients, abdominal tenderness and urine leakage on wound site in 4 (10.5%) and 3 (7.8%) cases respectively .

Ureteral injuries were found to be located mostly at the distal segment of the ureter in 30 (79%) cases and the mid-ureter was involved in 8 (21%) patients. The most injured ureter was the right ureter, followed by the left ureter and both ureters in 21 (55.2%), 11 (28.9%) and 6 (15.7%) cases respectively. The most common imaging modality used was ultrasound in 28 (73.6%) patients showing dilation of ureter and renal pelvis. According to the uretrohydronephrosis classification, grade 2 was prevalent in 15 (53.57%) patients while grade 3 and grade 1 occurred in 12 (42.86%) and 1 (3.57%) cases respectively. The methylene blue test (dye test) was carried out in half of the patients to rule out a vesicovaginal fistula. CT urography was performed on 3 (7.8%) patients. Cystoscopy was carried out in 19 (50%) patients. Laboratory workup such as serum creatinine levels, urea levels, full blood count, coagulation profile, blood group and urine culture were done systematically for preoperative assessment. All patients underwent open surgical treatment including ureteroneocystostomy with and without non refluxing system and JJ stent insertion for six weeks in 86.8% (n=33) of cases, uretero-ureterostomy in 13.2% (n=5) of cases, Boari flap reconstruction and nephrectomy (for non-functioning kidney) in 5.2 % (n=2) of cases each. The median time between diagnosis and surgical treatment was 4.5 [2; 14] days.

In our study, we had a favorable outcome recorded in 74% (n=28) of participants. The remaining 10 (26.3%) participants presented with complications after surgery. A vesico-vaginal fistula (VVF) was the most frequent post-operative complication followed by wound infection, urinary infection and ureteral necrosis with a rate of 30% (n=3), 20% (n=2), 20% (n=2) and 10 %(n=1). All patients with vesicovaginal fistula underwent successful surgical repair within a minimum of 3 months. One case of ureteral necrosis of the reimplantation was revealed by the persistence of urine flow through the drain and surgical wound after ureteroneocystostomy using the Leadbetter Politano technique. She was successfully re-operated using the Lich Gregoir technique. We recorded two deaths; the first occurred in a 40-year-old patient whose ureteral injury was discovered intraoperatively during hysterectomy for cervical cancer. The ureter had been sectioned at its upper lumbar portion, and a trans-ureteroureterostomy was performed, but the patient died 2 days later from septic shock. Another HIV-positive patient who was not compliant with treatment underwent ureterovesical reimplantation and developed a high-flow enterocutaneous fistula 5 days after the surgery. During re-operation the re-implantation was unharmed, and an ileal perforation was repaired but the patient died in multi-visceral organ failure.

Table 1. *Characteristics, etiology, type of iatrogenic ureteral injury*

Variable	Frequency	Percentage
Age (years)		
• <40	10	26.3
• ≥40	28	73.7
Nature of the primary surgery		
• Hysterectomy	29	76.3
• Cesarian section	7	18.4
• Annexectomy	2	5.3

Origin of cases		
• Referred	23	60.5
• Non referred	15	39.5
Laterality		
• Right	21	55.2
• Left	11	29
• bilateral	6	15.8
Location		
• Upper ureter	0	0
• Middle ureter	8	21
• Lower ureter	30	79
Type of injury		
• Suture ligation	28	73.7
• Ureteric transection	6	15.8
• Electrocoagulation	4	10.5

4. Discussion

In this study, the diagnosis of iatrogenic ureteral injury was based on a combination of clinical examination, methylene blue test and ultrasound. These findings are in line with those of other authors in Africa and elsewhere [1, 14, 15]. The relatively low incidence (0.27%) observed during the study period is probably underestimated. Indeed, that two-thirds of the cases originating from peripheral centers, suggests that there are many others that do not reach the hospital. Ouattara [10] in Burkina Faso made a similar observation with the same ratio of peripheral referrals. This could explain the increase or reduction in the number of cases, depending on the number of patients referred by peripheral centers.

Over the last few decades, these accidents were often attributed to inexperienced general practitioners [9]. Though this is probably still the case, some cases are the result of emergency surgery sometimes performed by specialists. Although the increasing use of ureteral endoscopy and laparoscopy could influence this trend in the future [1, 3]. Abdominal hysterectomy was the leading cause of ureteral injuries as previously reported byTijani [9] and Mteta [16] with a frequency of 75% in Nigeria and 47.4% in Tanzania respectively. On the contrary, Williams et al [17] in Ethiopia found caesarean section to be the leading cause with a frequency of 72%. This could be explained in part considering that the most frequent age range in our study was 41-50 years (47%). At this age, many women have gynecological problems such as uterine fibroids and cervical cancer, most of which are treated surgically [18].

Ligation injury was the most common form of iatrogenic ureteric injuries reported in the operation notes, most likely during uterine artery ligation. This is consistent with the findings of Tijani, Chianakwana, and Brandes [9,19, 20] but contrasts with the findings of Oboro et al [21] who reported transection injury as the most common cause.

The pre-eminence of postoperative diagnosis in our series is in agreement with the literature [15, 22]. Over the years, the time taken to diagnose iatrogenic ureteral injury is variable. For instance, according to Kpatcha in Senegal [6], the average time to diagnosis was 68 ± 12.6 days. Bouya [5] in Congo and Ouattara in Burkina Faso [10] similarly found an average time to diagnosis of 15 days, with ranges oscillating from 0 to 350 days and 1 to 180 days respectively. Delay in identifying ureteral injuries was noted in our study in keeping with reports from earlier authors [5, 14]. This highlights how iatrogenic ureteral injury is difficult to diagnose as it has no pathognomonic or classic signs nor symptoms [23]. The delay in diagnosis usually results from a poor understanding of the mechanism of injury. When there is no evidence of ligature or section of the ureter, other mechanisms such as crushing from a clamp, thermal injury, or ischemia from devascularization are difficult to assess [24]. Ureteric injuries are identified after surgery through imaging which includes ultrasound scan, Intravenous urography (IVU), Computed tomography (CT) scan, dye test (methylene blue) and cystoscopy as in our study. This is in agreement with studies carried out by Chalya and Tijani [9,14].The recommended imaging method in cases of ureteral trauma is CT urography [23, 24]. Unfortunately, the cost of CT urography in our country is still out of reach for many families, even though it is available in a number of health facilities. In the current study, most of these cases were diagnosed using ultrasound in combination with clinical signs. Therefore, any dilation of the ureter, renal pelvis or calyces in the presence of vaginal urine leakage, flank

pain or anuria in a patient who had undergone pelvic surgery should raise the suspicion of an iatrogenic ureteral lesion. This is in contrast to Rahoui et al [2] in Tunisia who combined CT scan and intravenous urography to confirm the diagnosis and establish the level of the lesion in all cases. With regard to the topography of ureteral injuries, several authors have highlighted the predominance of the distal segment of the ureter. The right and left ureters are affected to varying degrees from one study to another. On the one hand, similar to our findings, the right ureter was predominantly injured in 64% and 58% of cases in the studies of Li and Oboro [1, 21] respectively. On the other hand, the left ureter was more affected by 48.5%, 59.8% and 72.2% in the reports of Ouattara, Chalya and Ding [10, 14, 25]. According to Odegard et al [26] the left ureter courses 2 to 4 mm more lateral and anterior than does the right ureter. The cervix is also positioned 2 to 4 mm to the left side, and as a result, the ureters are actually symmetric to the cervix. Although seemingly small, 2 to 4 mm is the width range of a Heaney clamp. These anatomic differences may be a contributing factor to the increase in ureteral injuries on the left side compared with the right. More reviews may need to be done to confirm if hysterectomy increases injury risk to right ureter. Furthermore, the surgeon's position may also be a contributing factor in injury to the left ureter [22].

Ureteral reconstruction remains a challenge in the field of reconstructive urology but the basic principles of good vascular supply, complete excision of scar tissue, spatulation and tension free anastomoses should be respected [11, 25]. This can be achieved by minimally invasive surgery (stenting or percutaneous drainage) or open and laparoscopic surgical approaches [11]. In our study, ureteral stenting failed in most patients as the origin of the lesion was mostly surgical ligation. Our patients benefited from ureteral reimplantation using Leadbetter-Politano and Lich-Gregoir techniques. Despite the consensus favoring a non-refluxing reimplantation [27], there is no detrimental effect or increased risk of stenosis compared to the refluxing repair. The British Association of Urological Surgeons (BAUS) recommends that the choice between a refluxing or non-refluxing anastomosis will depend on the clinical scenario and the surgeon's expertise/preference [28].

Previous studies have shown that early or immediate (injuries diagnosed intraoperatively) surgery has better results than delayed surgery particularly for open surgery [11, 22]. In most cases, injuries found intraoperatively benefit from definitive curative surgery. However, cases diagnosed postoperatively can sometimes require transitional treatment, such as insertion of a JJ catheter or nephrostomy. According to BAUS and others studies, it is recommended that in case of postoperative iatrogenic ureteral injuries, surgery should be performed within 14 days following the injury, or postponed for a minimum of three to six months [11,15, 28]. This time interval was observed in all of our cases. The complications noted in this study were comparable to the outcomes from a series in Tanzania where complications included surgical site infection and two cases of death [14].On the one hand, the infection may be due to contamination of the wound during surgery. With regards to the cases of death, the poor general condition of the patients could be most detrimental. Cases of urinary incontinence persisting after ureteronecystostomy were all diagnosed as vesico-vaginal fistula. These were probably iatrogenic or missed lesions difficult to diagnose with the coexisting ureteral lesion. Dissection of the ureter requires careful ureteric mobilization with preservation of blood supply within the adventitia [11, 28] which was unlikely to be the case in the lone case of ureteral necrosis observed in our study. Most of our patients with favorable outcomes did not return after the second postoperative visit three months later. This has also been reported [14], illustrating the difficulties of long-term follow-up in our environment. A limitation in our study as in most retrospective series is the unavailability of data in 14 patient records, as well as the potential loss of patients with asymptomatic unilateral ureteral pathogenic injury. The predominance of women is a recruitment bias.

5. Conclusion

In our setting, pelvic surgeries, including hysterectomy and caesarean section, are the most common causes of iatrogenic ureteral injuries.Most women present late with nonspecific symptoms. In the absence of CT urography, ultrasound is a useful diagnostic imaging modality for identifying the injured ureter. Injuries located mainly on the distal ureter were managed by ureteroneocystostomy or uretero-ureterostomy. The importance of prevention, high index of suspicion and early diagnosis cannot be overemphasised particularly in our environment where most patient would present late for medical care and may be lost to follow-up. We recommend that all units undertaking complex pelvic surgery need to have access to CT urography, be it on site or nearby.

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