

# Analysis of Intravenous Urography Findings in a Tertiary Reference Center

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**Cite this article as:** Aklan HM, Mikhlafy A. Analysis of intravenous urography findings in a tertiary reference center. *Eurasian J Med* 2018; 50: 71-4.

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Received: December 17, 2017

Accepted: March 2, 2018

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DOI 10.5152/eurasianjmed.2018.170304

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## ABSTRACT

**Objective:** To analyze intravenous urography (IVU) findings in a tertiary reference center.

**Materials and Methods:** A retrospective, observational study was conducted in a tertiary reference center. The radiology reports of 1,470 patients subjected to IVU in the period from January 2008 to December 2012 were retrieved from the tertiary reference center databases. Patients' demographic characteristics, type of care (inpatient or outpatient), and IVU radiologic findings were reviewed and analyzed.

**Results:** Of 1470 patients, approximately two-thirds were males. The mean age of the patients was  $39.12 \pm 14.80$  years (range: 2-95). Most of them were inpatients (92.9%; 1365/1470). The IVU findings were abnormal in 68.8% (1012/1470) of patients. Urinary tract calculi were the most frequent type of calculi observed among patients (36.8%; 541/1470), and the kidney was the most frequently affected organ by calculi (66.5%; 541/814). Hydronephrosis was the second most frequent finding, being observed in 29.7% (436/1470) of patients.

**Conclusion:** The presence urinary tract calculi was the most frequent IVU finding, revealing that urolithiasis could be the main indication for IVU.

**Keywords:** Intravenous urography, radiology, uroradiology

## Introduction

Uroradiology emerged approximately a year after the discovery of X-rays in 1895, when it was first applied in the detection of urinary tract calculi. Following the discovery of various contrast materials that could be installed into the urinary tract, new applications were introduced, including cystography in 1903 and retrograde pyelography in 1906 [1].

Intravenous urography (IVU) was the most recommended radiologic examination for the diagnosis of urinary tract abnormalities until the end of the 20th century [2, 3]. In the late 1970s, ultrasonography started to be widely used in clinical practice. It was particularly useful to differentiate solid from cystic masses, thus avoiding direct cyst puncture [3]. Computed tomography (CT) scanning was introduced in the study and staging of renal masses in the 1980s [2]. Later, the diagnostic utility of CT imaging was improved by shortening the scanning time and radiation exposure as well as introducing multiplanar three-dimensional (3-D) reconstruction [4]. Nowadays, CT scanning is the "gold standard" of urologic imaging [4]. Multiphasic CT urography (CTU) has become the most suitable tool for the diagnosis of different urinary tract abnormalities, including congenital anomalies, infections, traumas, and tumors. In addition, its "one-stop-shop" use in the evaluation of vascular, parenchymal, and urothelial problems has a great impact on their management [5].

Reformatted 3-D CTU from thin-cut axial helical CT scans can create a coronal image similar to that of IVU. In addition to being easily interpreted by the clinicians unfamiliar with axial CT scan images, it improves the accuracy of diagnosing urinary tract abnormalities [6-8]. However, despite the recommendations by urology associations [9], IVU is still being requested by clinicians, particularly urologists, and is still being performed by radiologists, especially in the developing countries [9, 10]. Therefore, the aim of the present study was to retrospectively assess the trend of IVU use in the radiologic diagnosis of urinary tract abnormalities in patients attending a tertiary reference hospital in Sana'a city over a 5-year period.

## Materials and Methods

### Study Design and Data Collection

This retrospective, observational study was conducted at the Radiology Department of University of Science and Technology Hospital, a tertiary reference hospital in Sana'a, Yemen. Radiology reports of 1470 patients who were subjected to IVU in the period from January 2008 to December 2012 were retrieved from the hospital databases. Demographic characteristics of patients (e.g., age and gender), type of patient's care (inpatient or outpatient), and the IVU radiologic findings were collected and then analyzed.

### Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) software, version 18.0 (SPSS Inc., Chicago, IL, USA). Frequencies and percentages were used to present the data of categorical variables.

### Ethical Approval

This study was approved by the Research Ethics Committee of the School of Medicine, University of Science and Technology, Yemen. All data were dealt with confidentially and were used anonymously and for research purposes only.

## Results

### Characteristics of the Study Population

Table 1 shows that approximately two-thirds of patients subjected to IVU for the radiological diagnosing of urinary tract abnormalities were males and 94.8% (1394/1470) were older than 18 years (94.8%; 1394/1470). Moreover, the majority of patients referred for the radiological diagnosis using IVU were from the hospital admitted patients (92.2%; 1365/1470).

### Distribution of Abnormal IVU findings

#### According to Certain Population Characteristics

Table 2 shows an overall abnormal IVU finding rate of 68.8% (1012/1470) in the urinary tract of patients undergoing IVU. There was a statistically significant difference in the abnormal IVU radiologic findings according to the gender and type of patient's care, wherein males and outpatients showed higher abnormality rates of 72.7% and 86.7%, respectively.

### Distribution of Abnormal IVU Findings

#### According to the Types of Affected Organs

Table 3 shows that the presence of calculi (36.8%; 541/1470) was the most frequent kidney abnormality, followed by hydronephrosis (29.7%; 436/1470). However, other structural and functional abnormalities of the kidneys were observed among 6.3% or less of patients undergoing IVU.

Conversely, the presence of ureteral calculi was the most frequent abnormality in the ureters 17.6% (261/1470); however, the structural abnormalities of the ureter kinking and tortuous ureter were less frequently observed. Abnormalities in the urinary bladder were the least frequently observed IVU abnormalities of the urinary tract with diverticula being the most frequent finding among 1.0% (14/1470) of patients. According to the location of calculi in the urinary tract, most calculi were observed in the kidneys (66.5%; 542/814), followed by those in the ureters (31.9%; 260/814). However, bladder and pelvi-ureteric junction were the least frequently affected parts of the urinary tract with less than 1.0% of calculi being observed in each (Table 4).

### Trend of IVU Use in the Tertiary Reference Hospital

Figure 1 shows an increasing trend of IVU use over the period of the study in a tertiary reference hospital, where most procedures (397) were performed in 2012.

**Table 1.** Characteristics of patients undergoing IVU\*

Variable	n (%)
Gender	
Male	982 (66.8)
Female	488 (33.2)
Age (years)	
Mean±SD=39.12±14.80 (range: 2-95)	
<18	76 (5.2)
≥18	1394 (94.8)
Type of patient care	
Inpatients	1365 (92.9)
Outpatients	105 (7.1)

\*Total number of patients is 1470; SD, standard deviation  
IVU: Intravenous urography; n: number of patients

**Table 2.** Distribution of abnormal IVU radiologic findings among patients

Variable	N	Abnormal IVU Findings
		n (%)
Overall abnormal findings	1470	1012 (68.8)
Gender		
Male	982	714 (72.7)
Female	488	298 (61.1)
Type of patient care		
Inpatient	1365	921 (67.5)
Outpatient	105	91 (86.7)

IVU: Intravenous urography; N: total number of patients investigated; n: number of patients with abnormal IVU findings

## Discussion

The advent of technology has led to the loss of the importance and relevance of some older techniques and their replacement with newer ones that are more sensitive and specific, less invasive, and cheaper [11]. Although IVU was the "gold standard" imaging procedure for the urinary tract, this role has been shifted to CT scanning as a result of its advent and subsequent improvements over the last 2 decades [4]. In the present study, however, the trend of IVU

**Table 3.** Types of abnormal IVU radiologic findings among patients according to the type of affected organs\*

Organ	Type of Abnormality	n (%)
Kidney	Calculi	541 (36.8)
	Hydronephrosis	436 (29.7)
	Delayed secretion	92 (6.3)
	Small size	22 (1.5)
	Non-functioning kidney	15 (1.0)
	Poor secretion	13 (0.9)
	Large size	10 (0.7)
	Ectopic kidney	10 (0.7)
	Absence of kidney	10 (0.7)
	Agenesis	9 (0.6)
	Horseshoe kidney	8 (0.5)
Ureter	Sac-like kidney	2 (0.1)
	Calculi	260 (17.6)
	Ureteral kinking	6 (0.4)
	Tortuous ureter	2 (0.1)
Urinary bladder	Diverticula	14 (1.0)
	Irregular wall	12 (0.8)
	Neurogenic bladder	9 (0.6)
	Calculi	7 (0.5)
	Focal wall thickening	5 (0.3)

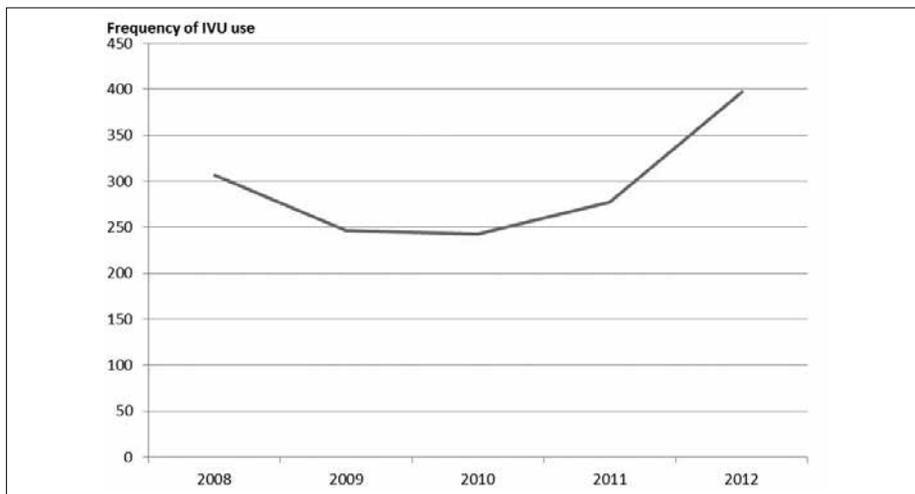
IVU: Intravenous urography; n: number of patients with abnormal IVU findings

\*Total number of patients investigated was 1470

**Table 4.** Frequency distribution of urinary tract calculi among patients

Location of Calculi	n (%)
Kidney	541 (66.5)
Ureter	260 (31.9)
Bladder	7 (0.9)
Pelvi-ureteric junction	6 (0.4)
Total	814 (100)

n: number of patients with calculi



**Figure 1.** Trend of the IVU use as a diagnostic procedure among patients

use in a tertiary reference hospital in Sana'a has increased over the years. It is noteworthy that the tertiary reference hospital is one of the largest private tertiary care hospitals in Yemen with a 200-bed capacity and equipped with modern medical equipment, including those for sonography, CT scan, and magnetic resonance imaging.

The present finding that about two-thirds of patients subjected to IVU were males is consistent with those reported from Jordan and Pakistan, being 60.0% and 63.0%, respectively [10, 12]. However, it is in contrast to a finding reported from the United States, where most cases (73.0%) were those of females [4]. It is noteworthy that the higher proportion of females undergoing IVU in the latter study could be attributed to the fact that most IVU requests (38.0%) were from the Department of Obstetrics and Gynecology.

Although IVU is an unsafe radiologic procedure with side effects such as radiation exposure, possible allergic reactions, and nephrotoxicity [13], most radiologic findings usually appear normal with varying percentages from one study to another. In the present study, the IVU findings were normal in 31.2% of patients. This is comparable to those reported from Pakistan and Brazil, being 26.0% and 23.1%, respectively [10, 11]. In contrast, a study conducted in Ireland reported higher proportion of IVU normal findings (77.0%) than our study [14].

The finding that 5.2% of IVU patient cases in the present study were younger than 18 years is consistent with that reported among Brazilian patients subjected to IVU, in which 3.6% of them were younger than 18 years [10]. The low proportion of children undergoing IVU in the present study reveals that Yemeni pediatric patients are exposed to the risk of

radiation during the IVU procedures despite the availability of low-dose and ultra-low-dose CT protocols.

In the present study, the presence of urinary tract calculi was the most frequent IVU finding, and this reveals that urolithiasis could be the main indication of IVU. In 2011, the European Association of Urology (EAU) recommended that non-contrast-enhanced CT (NCCT) should be used to confirm calculi in patients presenting with acute flank pain because of its superiority to IVU and that in patients with a body mass index (BMI) of <30, low-dose NCCT protocols should be used [9]. Moreover, in its updated guidelines in April 2014, EAU recommended NCCT for the evaluation of patients to be treated for renal stones because it enables the 3-D reconstruction of the collecting system in addition to the measurement of stone density and skin-to-stone distance [15].

Although the IVU use shows a downward trend worldwide, the present study reveals its upward use in tertiary care hospitals in Yemen. Contrary to the findings of the present study, a study conducted in a single medical center in the United States showed a threefold decrease in the use of IVU over the period from July 1995 to February 2006 [16]. Similarly, the use of IVU substantially decreased from 323 cases in 1999 to 17 cases in 2006 in the Montefiore Medical Center, Bronx, USA, and IVU has not been performed in the Brigham and Women's Hospital, Boston, Massachusetts since 2000 [3]. The upward trend of IVU use in the present study could be attributed to the fact that clinicians do not fully appreciate that a more accurate delineation of the urinary tract can be performed using other alternative techniques such as CT scanning. In fact, CT is more sensitive and specific for the majority of urinary tract

pathological conditions not just for flank pain and urolithiasis but also for hematuria and renal masses as well as the assessment of regional lymph nodes, where it has been found to be superior to all other imaging modalities [4, 17]. Recently, Hale et al. [4] found that 48.0% of patients who had undergone IVU went through additional radiologic studies within 30 days for a further evaluation of unresolved issues related to their initial complaint (i.e., persistent symptoms and/or no clear diagnosis with IVU). In addition, 36.0% of patients had either differing or additional diagnostic information that could lead to a change in medical decision making. Therefore, the need for these additional studies and their added information further demonstrates the diagnostic limitations of IVU and superiority of CT scanning [4].

Despite the higher radiation dose in conventional helical CT compared with IVU, this problem can be overcome by the use of new low-dose and ultra-low-dose helical CT protocols [18]. Therefore, exposure to radiation can be reduced to levels below those associated with IVU (0.97–1.9 millisievert "mSv" for low-dose NCCT compared with 1.3–3.5 mSv for IVU), while still remaining highly sensitive and specific for urinary abnormalities [18]. Low-dose CT has been shown to have a sensitivity level of 86.0% for detecting ureteric calculi smaller than 3 mm and 100% for calculi larger than 3 mm in patients with BMI <30 [18]. In addition, low-dose CT shows a pooled sensitivity of 96.6% and specificity of 94.9% for the diagnosis of urolithiasis in a meta-analysis of prospective studies concerning its diagnostic performance [19]. Conversely, cost could be supposed as another drawback of CT, where some clinicians still believe that IVU is more cost-effective. However, taking into consideration other factors such as the longer IVU procedure, cost of the room, and the personnel and follow-up tests required, IVU becomes more expensive than CT. This was confirmed by Pfister et al. [20], who found that NCCT can be a better alternative to IVU because of its higher diagnostic accuracy and better economic impact as a result of its higher effectiveness, faster performance, lower cost, and less risk compared with IVU. In addition, it also enables the detection of various additional renal and extra-renal pathological conditions [20].

Although the present retrospective study is limited by the fact that it was conducted in one hospital, the large sample size and length of the study duration can give clinicians and radiologists clear-cut prospects about the uroradiologic practice in the country for the sake of shifting to better radiodiagnostic alternatives.

In conclusion, IVU is still used excessively in Yemen. The presence of urinary tract calculi was the most frequent IVU finding, which reveals that urolithiasis could be the main indication for IVU.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of School of Medicine, University of Science and Technology, Yemen.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - H.M.A., A.M.; Design - H.M.A., A.M.; Supervision - H.M.A., A.M.; Resources - H.M.A.; Materials - H.M.A., A.M.; Data Collection and/or Processing - H.M.A.; Analysis and/or Interpretation - H.M.A., A.M.; Literature Search - H.M.A., A.M.; Writing Manuscript - H.M.A., A.M.; Critical Review - H.M.A., A.M.; Other - H.M.A., A.M.

**Acknowledgements:** The authors thank the management of University of Science and Technology Hospital, Yemen for their cooperation and giving the permission to use the records.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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