Is Excretory Urography Still a Valuable Test in Diagnosing Ureteropelvic Junction Obstruction in Adults? A Prospective Comparison of Excretory Urography and Diuretic Renography

Abstract

Objectives. The aim of the study is to compare excretory urography (IVU) and diuretic renography (DR) in terms of their ability to provide objective data for discerning whether or not clinically significant ureteropelvic junction obstruction (UPJO) is present.

Material and Methods. IVU and DR were performed on 42 patients who had been diagnosed with UPJO on the basis of ultrasound examination (US). Clinically significant obstruction on IVU was defined as a ureteropelvic junction that was narrowed or not visible and dilatation of the pelvicalyceal system on the affected side. On DR a curve showing a plateau-like, gradually increasing or gradually decreasing third phase with no or little furosemide effect was assumed abnormal. The upper limit of the half-time to tracer clearance (T1/2) for nonobstructed systems was 12 minutes.

Results. IVU confirmed the diagnosis of UPJO based on US in 40 out of 42 patients (95.2%), whereas DR confirmed it in 35 out of 42 (83.3%). IVU and DR yielded unanimous results in 37 out of 42 cases (88%): Both tests indicated the presence of obstruction in 35 cases and excluded obstruction in two cases. False positive IVU results were observed in four patients (all of them asymptomatic). In one patient a false negative DR was noted.


Key words: excretory urography, diuretic renography, ureteropelvic junction obstruction.

Streszczenie

Cel pracy. Prospektywna analiza porównawcza przydatności urografii i renografii diuretycznej w diagnostyce przeszkody w połączeniu miedniczkowo-moczowodowym u dorosłych.

Materiał i metody. U 42 pacjentów, u których na podstawie badania USG rozpozano wstępnie przeszkodę w połączeniu miedniczkowo-moczowodowym wykonano urografię i renografię diuretyczną. Istotną klinicznie przeszkodę w urografii rozpoznano, jeśli w badaniu nie uwidoczniło się połączenia miedniczkowo-moczowodowego lub połączenie to było wyraźnie zwężone, a układ kielichowo-miedniczkowy nerki był wyraźnie poszerzony. W badaniu renograficznym przyjęto, że o przeszkodzie w połączeniu miedniczkowo-moczowodowym świadczy krzywe o typie plateau, stale wznoszące się lub tylko nieznacznie opadające w trzeciej fazie badania, z jednoczesnym brakiem istotnej reakcji na podanie furosemidu. Przyjęto, że prawidłowy czas połowicznej eliminacji znacznika po podaniu furosemidu nie powinien przekraczać 12 minut.

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Ureteropelvic junction obstruction (UPJO) is the most common congenital abnormality of the ureter [1]. Its incidence is five cases per 100,000 population annually. Although most cases are probably congenital, presentation in adults is not uncommon. The disease consists in significant impairment of urinary transport from the kidney to the ureter, which leads to overdistention of the renal pelvis and elevation of intrarenal pressure. High intrapelvic pressure results in interstitial fibrosis and inflammation of the renal parenchyma, hyalinization and reduction of glomeruli, and finally impairment of renal function. A diagnosis of UPJO is usually based on assessment of symptoms (pain scale), laboratory findings (which may reveal microhematuria, pyuria or frank urinary tract infection) and imaging studies (ultrasound [US], excretory urography [IVU], retrograde or antegrade pyelography, computed tomography [CT], diuretic renography [DR] or dynamic pressure perfusion studies) [2]. In most urological centers, anatomic and functional tests are used together, so as not to overdiagnose unobstructed hydronephrosis (pyelocaliectasis, megacalycosis) as UPJ obstruction [3].

Since its development in the late 1970s, diuretic renography has been a commonly used test for diagnosing UPJO; in some urological centers, however, excretory urography is still used, as it is considered an equally reliable test [4]. The authors decided to compare the ability of these two diagnostic procedures to provide objective data through which it can be discerned whether or not clinically significant obstruction is present.

Material and Methods

From February 2008 to March 2010, 42 patients with a preliminary diagnosis of UPJO were referred to the authors’ institution. UPJO was diagnosed in all cases by a primary urologist with ultrasound. There were 18 females and 24 males in the analyzed group. The average age was 29 years (range: 18–58 yrs). In 25 cases the right kidney was affected, in 17 it was the left kidney.

All patients suspected of UPJO had IVU and DR performed. The IVU was carried out in a standard manner: The patient was instructed to withhold fluids after midnight before the test. Bowel preparation was not performed. First a scout radiograph was taken in the supine position. Another radiograph was made five minutes after a contrast injection given as a bolus. In all cases Omnipaque 350 mg/ml (Amersham Health AS, Oslo, Norway) 1 ml/kg was used. Successive images were taken after 15 and 30 minutes. After 45 minutes a film was made in the upright position to exclude renal ptosis. If layering of the contrast medium in the hydronephrotic system was observed after this time period, a 60-minute film was made. Further imaging was individualized to the patient until the contrast was eliminated altogether. All urographic images were independently evaluated by two urologists from the authors’ institution (T.S., J.K). Clinically significant obstruction on IVU was defined as a ureteropelvic junction that was narrowed or not visible and dilatation of the pelvicalyceal system, with or without delayed excretion on the affected side.

All DR examinations were carried out in the Department of Endocrinology, Diabetology and Isotope Therapy of Wroclaw Medical University. A whole-body SPECT gamma camera (Nuclide 33, Mediso, Hungary) with a low-energy, general-purpose collimator with a peak of $^{99m}$Tc and a 20% window was used. Tc-99m-EC (Ethylenedicysteine) (CSK, Lodz, Poland) was applied as the radiopharmaceutical. The data were acquired using a $128 \times 128$ matrix; the frame time was 20 seconds. In accordance with the International Consensus Committee’s recommendation, a C-shaped, elliptical perirenal region of interest was adopted [6].

Thirty minutes prior to the tracer injection, the patient was given 500 ml of water to ensure appropriate hydration. During the procedure, the patient was placed in a supine position. The field of view always included the kidneys, ureters and bladder in their entirety.

An F+20 protocol was used in all cases [7]. After the completion of a 20-minute dynamic study,
furosemide (0.5 mg/kg) was injected slowly over a three-minute period.

The data analysis included differential renal function, half-times to tracer clearance after the furosemide injection and renogram curve patterns. The norm was defined as the situation when each kidney contributed 45% to 55% to total renal function. At the authors' institution the upper limit of the half-time to tracer clearance (T1/2) for nonobstructed systems is 12 minutes, while in obstructed systems T1/2 is over 20 minutes. Values between 12 minutes and 20 minutes are regarded as ambiguous. A normal renogram curve should show three phases – an initial rapid rise, a peak region and an abrupt decline in activity. A curve showing a plateau-like, gradually increasing or gradually decreasing third phase with little or no change following furosemide administration was considered abnormal.

The intensity of pain in all patients was evaluated on the basis of an analog pain scale. To assess overall renal function, we investigated serum creatinine concentration in every case. None of the patients in the study had a creatinine concentration beyond the normal range (0.4–1.4 mg/dl).

Results

Primary UPJO as we defined it was recognized on IVU by each urologist in 40 out of 42 cases (95.2%). In the remaining two patients IVU did not confirm the diagnosis based on US: One was diagnosed with mild dilatation of the pelvicaliceal system with no obstruction (patent UPJ); in the other case mild bilateral hydronephrosis with no obstruction (patent UPJ) in a horseshoe kidney was identified. Both of these patients were asymptomatic. In all 40 UPJO cases the degree of hydronephrosis was estimated using a four-grade scale [5]. Grade 1–2 hydronephrosis was recognized in 14 patients, and grade 3–4 hydronephrosis in the remaining 26 patients.

Diuretic renography confirmed the diagnosis of UPJO based on the previous US in 35/42 patients (83.3%). In all 35 cases the renogram curves revealed obstruction, and the half-times to tracer clearance (T1/2) were longer than 20 minutes. The mean function of the affected kidney was 37.8% of total renal function (range: 20% to 49.4%). All the patients in this group complained of pain; the intensity ranged from 2 to 10 and was 6.6 on average.

In all 35 patients in whom both urography and diuretic renography indicated UPJO, laparoscopic pyeloplasty was performed. In all these cases an obvious ureteropelvic junction obstruction (extrinsic or intrinsic) was found.

In 7/42 patients the T1/2 was shorter than 12 minutes and renogram curves showed a prompt washout of pelvicaliceal activity after the administration of intravenous furosemide. For two patients from that group – both asymptomatic – urography did not confirm UPJO either. For four of the remaining five cases – also asymptomatic – urography and diuretic renography yielded disparate results, so these cases were carefully monitored. Control DR was planned for them first after six months and then once a year if the results of the examination revealed no obstruction. In two of these patients, diuretic renography six and 18 months after the initial examination indicated appropriate half-time to tracer clearance and no deterioration of renal function. The other two had each had one DR performed so far, and the results likewise did not indicate obstruction or deterioration of renal function. As the patients have reported no pain and successive DRS have revealed no obstruction and no deterioration of renal function, the authors concluded that the IVU results must have been false positives.

The fifth patient with disparate results from

| Table 1. Results of excretory urography and diuretic renography in 42 analyzed patients |
|-----------------------------------------|----------------------------------------|
|                                        | Excretory urography (Urografia) | Diuretic renography (Renografia diuretyczna) |
| True positive (Prawdziwe pozytywne)    | 36 | 35 |
| True negative (Prawdziwe negatywne)    | 2  | 6  |
| False positive (Falszywie pozytywne)   | 4  | 0  |
| False negative (Falszywie negatywne)   | 0  | 1  |
urography and diuretic renography (grade 2 HN) complained of pain, the intensity of which she assessed as 6 on the analog pain scale. Since urography in this case indicated UPJO, while diuretic renography did not reveal obstruction and the patient reported pain, a Whittaker test was additionally performed. It indicated renal pelvic pressure as high as 21 cm H2O. The upper limit for nonobstructed systems at the authors’ institution is 15 cm H2O, and therefore we proceeded with laparoscopic pyeloplasty. A Hynes-Anderson pyeloplasty with transposition of the crossing vessel was performed eight months ago, and since then the patient has remained asymptomatic. The urography and Whitaker test results, our intraoperative observations combined with the patient reporting no pain after laparoscopic pyeloplasty seem to indicate that in this case the DR had been a false negative.

Table 1 presents the results of IVU and DR in the 42 patients analyzed. IVU and DR yielded unanimous results in 37/42 cases (88%). Both studies indicated the presence of obstruction in 35 cases and excluded obstruction in 2 cases. The specificity of IVU and DR were 33.3% and 100% respectively; sensitivity: 100% and 97.2%.

Discussion

Although in a number of urological centers DR is commonly used to diagnose UPJO, in others IVU is used, as it is considered an equally reliable test [4, 8]. Each of the methods has its limitations and each may yield false positive or false negative results. When performing DR special attention should be paid to proper patient preparation, radiopharmaceutical selection, furosemide dosage and administration, and image interpretation to ensure accurate diagnosis. During the current study, the authors followed the recommendations of the International Consensus Committee [6]. Tc99m-EC (CSK, Lodz, Poland) was used instead of Tc99m-MAG3 because – according to research comparing the two agents – the former had better properties than Tc99m-MAG3: simplicity of preparation, better stability, better renal uptake, more rapid transit time, and less hepatobiliary activity [9, 10]. Evaluating the results of DR, it has been noted that even in technically satisfactory studies, false positive results can result from poor renal function (single kidney glomerular filtration rate < 15 ml/min) and/or huge-capacity systems [6]. In the current study no false positive results were observed, but in one patient a false negative result was noted. False negative findings are less common than false positives [6], but they have been observed in both animal experimental models and in clinical practice [11, 12]. O’Reilly et al. noted that such results “can occur in highly compliant (small volume, ‘tight’) renal pelves, or when there is powerful high-pressure diuresis through partially obstructed systems” [6].

According to Campbell-Walsh Urology: “Excretory urography remains a reasonable first-line option for radiographic diagnosis” of UPJO [2]. Urologists using this test to diagnose UPJO report that in most cases IVU allows the anatomic and qualitative functional assessment necessary for the diagnosis and makes it possible to avoid costly imaging studies like a CT angiogram or DR [4]. It seems that diuretic urography in particular is a most valuable test for preoperative and postoperative evaluation of patients with UPJO because the combination of contrast and furosemide creates maximal diuresis, and such “supranormal” conditions are highly conducive to unmasking and documenting diuresis. Excretory urography makes it possible to evaluate the degree of hydronephrosis; to identify anatomical abnormalities such as a duplicated collecting system or high ureteral insertion; to detect the crossing vessel in many cases (there are usually distinctive radiographic features); and to plan appropriate treatment. However, although IVU helps in the qualitative evaluation of the obstruction, quantitative assessment of it can be difficult [13]. It can also be difficult to differentiate between hydronephrosis in the course of UPJO and pyelocaliectasis without obstruction.

Research data comparing IVU and DR side by side are scarce. The authors have come across a study according to which there was a 32% correspondence between the results of urography and those of diuretic renography in the analyzed material [14]. It is noteworthy, however, that the research concerned children aged from 6.8 months to 10.4 months. In that age group the kidney is immature and the renal pelvis is prone to distension, which makes it difficult to evaluate the degree of obstruction of the UPJ. In the current body of literature we have not found reports comparing the two diagnostic procedures in adults.

In our prospective comparison, correspondence between IVU and DR was found in 88% of the cases. It seems noteworthy that all the patients in that group complained of pain. In five cases IVU indicated UPJO but DR revealed no obstruction. Four of them were asymptomatic; in all these cases hydronephrosis was diagnosed on ultrasound carried out for some other reason. None of those four patients had a Whittaker test done, as it was considered too invasive an examination for asymptomatic patients with no sign of obstruction on DR. The
results of the control DR performed in all these patients seem to justify this decision: T1/2 was within the normal range in all of them and in none did the test reveal deterioration of renal function. It appears that in these four cases IVU contributed to overdiagnosis of unobstructed hydronephrosis as UPJ obstruction. One patient with disparate IVU and DR results who complained of flank pain (6 on the analog pain scale) had a Whitaker test performed; because it indicated UPJO, the patient underwent laparoscopic pyeloplasty. Intraoperative findings confirmed hydronephrosis caused by the crossing vessel at the UPJ. Disparate results from DR and Whitaker tests have been reported [15]. The correspondence between these two tests, each of which is considered by many urologists as more objective than IVU, has been reported as 53–85% [16]. Cases of symptomatic patients with no sign of obstruction on DR have also been reported [17].

The cohort of patients in the current study was not particularly large. However, the authors believe that it is possible to compare both IVU and DR in terms of their ability to provide objective data through which it can be discerned whether or not clinically significant obstruction is present. We hope the study has shown that diagnosing UPJO on the basis of US and IVU may result in overdiagnosis; on the other hand, US and DR may give false negative results. It therefore seems very important to take note of pain reports and to assess pain intensity. In all the symptomatic patients in the study, the IVU and DR results were unanimous except in one case. In this patient DR did not indicate obstruction but a pressure-perfusion study demonstrated high intrapelvic pressure; and the intraoperative findings as well as the result of the operation confirmed the validity of IVU. It seems then that excretory urography combined with the assessment of pain is still a reliable method of diagnosing UPJO in adults with a normal serum creatinine concentration. Asymptomatic patients, as well as cases in which there is doubt as to the functional viability of the affected kidney, should have DR performed in addition.

The authors concluded that excretory urography still remains a valuable test in diagnosing UPJO in symptomatic patients. In asymptomatic patients a diagnosis of UPJO on IVU should be confirmed by DR.

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Conflict of interest: None declared

Received: 10.08.2010
Revised: 12.11.2010
Accepted: 1.12.2010