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Diagnostic Performance of Ultrasound for Macroscopic Hematuria in the Era of Multidetector Computed Tomography Urography

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Abstract

Purpose: The objective of this study was to evaluate the diagnostic performance of ultrasound for detecting urinary tract neoplasm in the setting of macroscopic hematuria by using multidetector computed tomography urography (MDCTU) and cystoscopy as the reference standard.
Methods: This retrospective study was approved by our institutional review board. Patients with macroscopic hematuria who were investigated with an abdominal or renal ultrasound, an MDCTU, and a cystoscopy between January 2007 and December 2009, were eligible (95 patients). Exclusion criteria were time interval >12 months between index and reference tests or the absence of histopathologic proof of malignancy. Ultrasound results of the remaining 86 patients were collected and compared with the reference standard test, which was the combination of MDCTU for the assessment of upper urinary tract and cystoscopy for assessment of the lower urinary tract. The final diagnosis of neoplasm was based on pathologic findings.
Results: Urinary tract neoplasm was diagnosed in 20% of the patients (17/86). Sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios of ultrasound for detecting urinary tract neoplasms were 35.3% (6/17), 89.9% (62/69), 46.2% (6/13), 84.9% (62/73), 3.48 (95% confidence interval, 1.34-9.02), and 0.72 (95% confidence interval, 0.5-1.3), respectively.
Conclusion: Sensitivity of ultrasound for the evaluation of macroscopic hematuria in the era of MDCTU is lower than expected. Results of our study suggest that patients with macroscopic hematuria should undergo MDCTU as first-line imaging modality, with little added benefit from ultrasound.

Résumé

Objet: Cette étude vise à évaluer l'efficacité diagnostique de l'échographie dans la détection de tumeurs urothéliales dans un contexte d'hématurie macroscopique en recourant à l'urographie par tomodensitométrie multibarrettes (uro-TDM multibarrettes) et à la cystoscopie à titre de standard de référence.
Méthodes: Cette étude rétrospective a été approuvée par le comité d'éthique de notre établissement. Les patients présentant une hématurie macroscopique et ayant subi une échographie abdominale ou rénale, une uro-TDM multibarrettes et une cystoscopie entre janvier 2007 et décembre 2009 ont été admissibles à l'étude (95 patients). Ils ont toutefois été exclus si les examens formant la norme de référence et l'examen échographique ont été réalisés dans un intervalle de plus de 12 mois ou si aucune preuve histopathologique de malignité n'était disponible. Les résultats échographiques des 86 patients restants ont été recueillis, puis comparés à ceux des examens utilisés comme norme de référence, c'est-à-dire à ceux de l'uro-TDM multibarrettes pour l'évaluation du tractus urinaire supérieur et à ceux de la cystoscopie pour l'évaluation du tractus urinaire inférieur. Le diagnostic définitif de néoplasie s'est appuyé sur un diagnostic histopathologique.
Résultats: Un diagnostic de néoplasie du tractus urinaire a été établi chez 20 % des patients (17 sur 86). La performance diagnostique de l'échographie dans la détection de tumeurs urothéliales révélait une : sensibilité de 35,3 % (6 patients sur 17), spécificité de 89,9 % (62 patients sur 69), valeur prédictive positive de 46,2 % (6 patients sur 13), valeur prédictive négative de 84,9 % (62 patients sur 73), rapport de vraisemblance positif de 3,48 (intervalle de confiance de 95 %, de 1,34 à 9,02) et rapport de vraisemblance négatif de 0,72 (intervalle de confiance de 95 %, de 0,5 à 1,3).
Conclusion: La sensibilité de l'échographie en matière d'évaluation de l'hématurie macroscopique à l'ère de l'uro-TDM multibarrettes est inférieure aux valeurs attendues. Les résultats de notre étude révèlent qu'une uro-TDM multibarrettes devrait être réalisée à titre de modalité

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d'imagerie de première ligne chez les patients présentant une hématurie macroscopique, le recours à l'échographie offrant peu d'avantages.

Key Words: Multidetector computed tomography urography; Ultrasound; Macroscopic hematuria; Urinary tract neoplasm; Transitional cell carcinoma

In large cross-sectional [1] and cohort studies [2], the prevalence of urologic malignancies among patients who present with macroscopic hematuria was 22%-24.2%. The majority of these cancers were transitional cell carcinoma or renal carcinoma, and, infrequently, prostate cancer [3,4]. Although experts agree that further investigation is prompted to evaluate the cause of macroscopic hematuria, the lack of data has hampered the construction of a widely accepted evidence-based algorithm for the radiologic investigation of macroscopic hematuria [5,6]. Both the Canadian Association of Radiologists and American Urological Association state thatintravenous urography (IVU), abdominal ultrasound, and multidetector computed tomography urography (MDCTU) are all indicated but that there is wide variation in local policy and that imaging strategies should be discussed with local nephrologists and urologists [6,7]. The American College of Radiology in its *ACR Appropriateness Criteria: Hematuria* states that both abdominal ultrasound and IVU may be appropriate and that MDCTU is usually appropriate [8]. In a recent algorithm based on consultations with clinical experts, IVU was no longer recommended for radiologic investigation of macroscopic hematuria [3].

The main objective of imaging studies in the setting of macroscopic hematuria is to rule out lesions of the upper urinary tract, although they also are able to detect lesions of the lower urinary tract in some cases [9]. Recent studies evaluated the diagnostic performance of ultrasound for investigation of the underlying cause of hematuria, but those studies used either IVU or the final diagnosis as the reference standard. The reported sensitivities varied from 11.1%-97.7% [10−16]. This large variability may be explained by different definitions of a positive test. None of these studies used MDCTU and cystoscopy as the reference standard. The aim of this study was to evaluate the diagnostic performance of ultrasound in macroscopic hematuria by using MDCTU and cystoscopy as the reference standard.

Methods

Patients

This retrospective study was approved by our institutional ethics committee. We reviewed the records of all the patients investigated or admitted for evaluation of macroscopic hematuria from January 2007 to December 2009 in our tertiary-care university-affiliated hospital. This time interval correlates with the beginning of the systematic use of MDCTU. Patients were included in the study if they were investigated for macroscopic hematuria with (a) an abdominal or renal ultrasound, (b) an MDCTU, and (c) a cystoscopy within a 12-month period. Patients were included regardless of the order in which the imaging studies were performed; however, cystoscopy was always performed after both imaging studies. Patients were excluded if histologic diagnosis was not available in the event of a positive imaging investigation.

A total of 95 patients met our inclusion criteria. However, 8 were excluded because the overall evaluation was not performed within a 12-month period, and one was excluded because histologic proof was not available after a positive MDCTU for suspicion of renal cancer (biopsy and surgery were declined by a 90-year-old patient). Data on bladder cancer risk factors were collected from the patients' medical records. These included the following: smoking history, occupational exposure to chemicals or dyes, previous urologic history, history of irritative voiding symptoms, history of urinary tract infection, analgesic abuse, history of pelvic irradiation, and history of cyclophosphamide use.

All ultrasound examinations were performed by using a 3−5-MHz curvilinear probe (Sequoia [Accuson, Mountain View, CA]; iU22 or ATL HDI 5000 [Philips Medical Systems, Best, the Netherlands]). All ultrasound examinations included a complete grey-scale assessment of both kidneys (when both were present). When achievable, assessment of the bladder and ureters was recorded. Full bladder distension was not mandatory. ultrasound examinations were initially performed by a technologist or a resident, and complete real-time scanning was repeated by a board-certified radiologist according to a systematic double-reading protocol that is standard at our institution.

Imaging Reference Standard

All MDCTU examinations were performed on MDCT scanners (16 detector rows: Lightspeed Plus [GE Medical Systems, Milwaukee, WI]; 64 detector rows: Brilliance [Philips Medical Systems, Cleveland, OH]) by using a modification of a previously described split-dose 2-phase protocol [17,18]. The first phase consisted of images of the abdomen and pelvis by using a maximum collimation of 2.5 mm, 85 seconds after intravenous injection of 70 mL iohexol contrast medium (Omnipaque 300; GE Healthcare Inc, Princeton, NJ) via a power injector at a rate of 3.0 mL/s. Then, after a 3-minute delay, 50 mL contrast medium (Omnipaque 300) was injected, followed by 200 mL of NaCl 0.9 at a rate of 3.0 mL/s. The second phase consisted of scanning the kidneys and urinary tract 7 minutes after the second contrast injection, with a maximum collimation of 1.0 mm. Coronal images (3-mm thickness, 3-mm reconstruction interval) were reconstructed from pyelographic phase axial images. All MDCTU examinations were interpreted unblinded by 1 of 6 fellowship trained body imaging radiologists (experience ranging from 2-25