Introduction

Haematuria is defined simply as “the presence of blood in urine either on voiding or in a catheterized specimen.”[1] There is currently no universal radiological protocol or imaging procedure for a patient presenting with Haematuria.[2] A shortage of strong data from randomised control trials makes the implementation of evidence-based guidelines difficult.[3] While there is no universal protocol there are guidelines implemented by the Royal College of Radiologists. These guidelines, combined with local trust expert knowledge demonstrate the practice that should be followed when imaging the patient with Haematuria.

It is well understood that Haematuria is a serious sign with up to a 2-5% prevalence in men[4] of which those over 40, up to 20% will have a major urinary tract lesion and 10% will have malignancy.[5] The Joint Consensus Statement on the initial assessment of Haematuria, a guideline created by the Renal Association and the British Association of Urological Surgeons uses the following standard terminology for classification of Haematuria:

(VH) Visible Haematuria: Previously known as macroscopic haematuria, is defined as: Urine that has a visible pink, red or colour reported by the patient or health care worker in the absence of other probable causes of urine discolouration, including myoglobinuria, haemaglobinuria, beeturia, and drug induced discolouration with Rifampicin or Doxorubicin.

(NVH) Non-Visible Haematuria: Previously known as microscopic haematuria is subdivided.

- (S-NVH) Symptomatic Non Visible Haematuria, when haematuria on microscopy or dipstick is discovered in the presence of Urinary symptoms such as Lower Urinary Tract Symptoms of frequency, dysuria, hesitancy and urgency.
- (A-NVH) Asymptomatic Non Visible Haematuria, when haematuria on microscopy or dipstick is discovered in the absence of Lower or Upper Urinary tract symptoms.
- Defining a positive Test on microscopy and Dipstick: On microscopy more than 3 RBC’s per High power field is considered positive. Dipstick is a sensitive measure (between 91%-100%)[6] and broadly 1+ is considered significant haematuria and trace is considered a negative result. Both non-haemolysed and haemolysed samples are considered a positive result given a 1+ result.[7]

The presence of Red blood cells in urine is a useful diagnostic indicator of pathology, but it may also be a normal finding. In one study, 70% of patients with microscopic or dipstick haematuria were found to have no abnormality following full urological investigation including urine cytology, cystology, renal ultrasound and IV Urogram.[8]
A Summary of common differentials diagnosis of Haematuria Table 1:

<table>
<thead>
<tr>
<th>Neoplasm</th>
<th>Bladder TCC, (Transition Cell Carcinoma) + SCC (squamous) cell carcinoma, Renal Adenocarcinoma, Renal pelvis a ureter TCC, Prostate Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stones</td>
<td>Renal, Ureteric, Bladder</td>
</tr>
<tr>
<td>Infection</td>
<td>Bacterial. TB, Schistosomiasis of upper or lower urinary tract</td>
</tr>
<tr>
<td>Inflammation</td>
<td>Cyclophosphamide cystitis, interstitial cystitis</td>
</tr>
<tr>
<td>Trauma</td>
<td>Pelvic fracture, catheterisation, post cystoscopy</td>
</tr>
<tr>
<td>Other</td>
<td>Benign Prostatic Hypertrophy, vascular malformations</td>
</tr>
<tr>
<td>Nephrological</td>
<td>IgA nephropathy, post infectious glomeronephritis, membrane proliferative glomeronephritis such as HSP, Alports, Goodpastures, Fabry’s etc.</td>
</tr>
<tr>
<td>Medical</td>
<td>Warfarin, Sickle cell disease, renal emboli</td>
</tr>
</tbody>
</table>

A summary of Radiological Investigations in the patient with Haematuria

KUB Radiograph
Kidney ureter bladder radiographs are a traditional imaging technique now of minimal use in the current investigation of patients presenting with Haematuria.[9]

Ultrasound KUB
Ultrasound uses high frequency (1-20Mhz) sound waves generated to image the soft tissues and organs.[10] Sound waves generated by piezoelectric crystals[11] travel through tissues and interact with tissues of different densities and acoustic impedances. The waves are reflected back are interpreted and used to create an image. This highly operator dependent investigation does not use ionising radiation. It is fast, safe and non-invasive.

IV Urography
Urography is rarely used presently and has largely been superseded by CT Urography. The imaging technique combines a series of plain film X-rays with intravenous contrast to visualise the kidneys, collecting ducts, ureters and bladder. It is a cheap and easy test to perform that easily detects parenchymal lesions and lesions in the ureters and bladder. IVU allowed rough calculation of the site of a calculus, the size of the obstruction, whether it was complete or partial and allowed accurate demonstration of anatomy ahead of surgical procedures.[12] However, it cannot distinguish solid from cystic masses.

CT Urography
CT Urography provides a single examination of the kidneys, ureters and bladder in one scan. Using a CT urographic protocol and administration of IV contrast, arterial phase and
excretory phase imaging is used to demonstrate the renal arterial system, renal collecting ducts and rest of urinary tract. [13] CT has been proven to be more effective at detecting pathology than both ultrasound and IVU and is subsequently the first line imaging modality in patients with painless haematuria.

**MR Urography**
Secondary investigation used for patients with contraindications to CT urography, including pregnancy, children and patients with recorded allergy to Technetium/Iodine based contrast used in CT. Electromagnetic radiation is used instead of ionising radiation to produce high resolution images of the kidneys urethers and bladder.

**Aims**

Haematuria is defined simply as “the presence of blood in urine either on voiding or in a catheterized specimen. There is currently no universal radiological protocol or imaging procedure for a patient presenting with Haematuria. The aim of this study is to evaluate the current guidelines for radiological imaging following a patient presenting with Haematuria in use at Whiston Hospital. I did this by comparing the Royal College of Radiologist Guidelines (in use at Whiston) with published literature. Each investigation will be evaluated, justified, and compared with published imaging practices used in other settings.
Current RCR guidelines for Microscopic Haematuria

Table 2:

<table>
<thead>
<tr>
<th>Imaging Modality</th>
<th>Dose</th>
<th>Indication</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>US + AXR Cystoscopy</td>
<td>Low-Medium</td>
<td>Indicated</td>
<td>For low-risk patients, US and AXR together with cystoscopy are the initial investigations, enabling detection of renal masses while keeping radiation dose low. Although US may detect bladder tumours, it is not sufficiently sensitive to obviate cystoscopy. When haematuria persists but initial investigations are negative, CT urography is required.</td>
</tr>
<tr>
<td>CT Urography</td>
<td>High</td>
<td>Indicated</td>
<td>CT urography is the best test for detecting renal calculi, renal masses and upper tract urothelial tumour. However, this is at the expense of a significant radiation dose. CT urography, together with cystoscopy, should be used for high-risk patients and in low-risk patients when initial investigations (US, AXR, cystoscopy) are abnormal.</td>
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</tr>
<tr>
<td><strong>IVU</strong></td>
<td>Medium</td>
<td>Indicated only in specific circumstances</td>
<td>When CT urography is not available, IVU is an alternative but is less sensitive for detecting upper tract urothelial tumours.</td>
</tr>
<tr>
<td><strong>MRU</strong></td>
<td>None</td>
<td>Indicated only in specific circumstances</td>
<td>MR urography may be considered as a problem-solving tool particularly in pregnancy or when patients present with hydronephrosis but have iodine contrast allergy or renal failure. It is not reliable when upper tracts are not dilated.</td>
</tr>
</tbody>
</table>
Current RCR guidelines for Macroscopic Haematuria

Table 3:

<table>
<thead>
<tr>
<th>Imaging Modality</th>
<th>Dose</th>
<th>Indication</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>US + AXR Cystoscopy</td>
<td>Low-Medium</td>
<td>Indicated</td>
<td>For low-risk patients with microscopic haematuria, US and AXR may be used to image the upper tracts (with cystoscopy when required). This strategy misses some upper tract lesions, including some calculi. Low-dose CT without iodinated contrast will detect calculi suspected but not shown on AXR. For higher risk patients, US and AXR are the initial investigations (with cystoscopy when required).</td>
</tr>
<tr>
<td>CT Urography</td>
<td>High</td>
<td>Indicated</td>
<td>Contrast-enhanced CT (CT urography) is helpful in patients with recurrent symptoms, abnormal urine cytology or a history of previous urothelial malignancy. IVU should only be considered when CTU is unavailable.</td>
</tr>
<tr>
<td>IVU</td>
<td>Medium</td>
<td>Not Indicated</td>
<td>When CT urography is not available, IVU is an alternative but is less sensitive for detecting upper tract urothelial tumours.</td>
</tr>
<tr>
<td>MRU</td>
<td>None</td>
<td>Not Indicated</td>
<td>MR urography may be considered as a problem-solving tool particularly in pregnancy or when patients present with hydronephrosis but have iodine contrast allergy or renal failure. It is not reliable when upper tracts are not dilated.</td>
</tr>
</tbody>
</table>
Discussion

In the UK, the first line investigation for a patient presenting with haematuria is US KUB and AXR according to the RCR guidelines. The evidence from multiple papers supports the case for US KUB as a first line investigation with the ACR guidelines supporting this. They state that US is important as the initial investigation of choice to search for bleeding along the urinary tracts. Sensitivity of ultrasound is dependent on mass size. It is able to detect 26% of masses less than 1cm, 60% of masses 1-2cm and 82% of masses 2-3cm and 85% of masses 3cm+. The characterising ability of US is relatively superior demonstrated by an accuracy when differentiating solid lesions from cysts of 82% with those between 1.0 and 3.5 cm and 100% accuracy in lesions over 35mm. The use of non-ionising radiation is a major advantage of US, making the procedure relatively safe in pregnant women and children. No contrast is required making US a cost effective, minimally invasive approach and an appropriate first line investigation of haematuria. The disadvantage is that as with all US, the investigation is highly dependent on the skill of the operator. This evidence is in line with the RCR Guidelines and supports the position of US as a first line investigation.

IVU has been show to have a low sensitivity in detecting renal masses less than 2-3cm and was shown to have a sensitivity of 60.5% and specificity of 97.4% in ability to correctly recognise the cause of Haematuria. While this may show IVU to be an efficient investigation, if a mass is found, further differentiation of the mass would be required. Secondary imaging most likely comprising of CT urography or MRI would be indicated, therefore making the initial IVU investigation superfluous. This rationale has lead to the modern practice of performing CT Urogram in place of IVU, making IVU almost redundant and only reserved for special situations. This agrees with the RCR Guidelines.

CT Urography in the same study demonstrated 100% sensitivity and 97.4% specificity with the overall accuracy for differentiating the cause of the haematuria at 98.3%. MDCTU or Multi-Detector CT Urography has been established as the most sensitive and specific investigation for confirming urolithiasis and for both detecting and characterising renal masses. CT Urography has the advantage over IVU of being able to image extra-luminal structures including the retroperitoneum over the simple luminal imaging of IVU supporting the previous claims in this discussion that IVU is almost redundant. CT Urography therefore offers the best diagnostic performance at detecting Malignancy and is accessible, leading many authors to declare this the ‘first-line” imaging technique of choice in patients with Haematuria. While RCR guidelines show CTU as an indicated study, they do not suggest that it should be first-line.

MR Urography is used less often, but is a rapidly developing technique. It has a proven lower rate of detection of calculi relative to CT Urography but in another study has been shown to be comparable with CT when detecting renal masses. The RCR Guidelines recommend that MR Urography is therefore only used when CT Urography is contraindicated.
or when exposure to ionising radiation is not an option which is inline with some evidence.[23]
This is not to say that it is not an invaluable investigation, it has specific uses and is often the last imaging option available for some patients.

Conclusions

The Current U.K RCR Guidelines for imaging in patients with Haematuria as represented in the tables 2 and 3, do not fully comply with current evidence based knowledge. The evidence would suggest that CT Urogram should be made a more obvious first line imaging choice. It is possible to defend the use of Ultrasound in this case due to its advantage of using non-ionising radiation. The relative lack of sensitivity of US compared to CT Urography forms the basis of a reasonable argument that CT urography should be first-line in the majority of patients presenting with Haematuria.
MR Urography according to the RCR guidelines is maintained as a second line investigation in those where exposure to ionising radiation is undesirable, this is supported by the Evidence base[21] and no change should be made here. It is likely this may change in the future as MR imaging advances.
There would be no reason for significant change from the current RCR guidelines however, a review and update in light of any new evidence should be considered. The RCR Guidelines are less specific than the ACR guidelines represented in the appendix but are broadly similar. In practical situations the choice of individual imaging technique is influenced by the clinical circumstances of the patients and the experience of the Radiologist authorising the investigation. This means that it may be appropriate to not adhere to the RCR guidelines in some situations; this is part of the nature of Medicine.

Further work:

A multi author systematic review should be conducted, quality assessing all of the most up to date research and summarising the findings. This would allow the current guidelines to be assessed in greater detail. Then a national level Audit measuring individual trust adherence to guidelines should be conducted assessing areas where the guidelines are not followed and establishing a reason why.
References


