COMPARATIVE STUDY BETWEEN ULTRASOUND & KUB AND IVU IN RENAL COLIC PATIENTS IN KELANTAN

By

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**Dissertation Submitted In
Partial Fulfillment Of The
Requirements For Degree Of
Master Of Medicine
(Radiology)**

UNIVERSITI SAINS MALAYSIA
2001

To

My wife Dayang Ramlah Abang Ali, daughters
Nur Alya Hanani & Nur Hanis and my mother for their encouragement and support.

Acknowledgements

The author would like to thank the following individuals for their valuable comments, advice, guidance, help and support during the preparation of this dissertation.

- Assoc. Prof (Dr) Nurul Azman Ahmad Alias, my supervisor of this dissertation and lecturer/radiologist.
- Assoc. Prof (Dr). Ibrahim Lutfi Shuaib, Head Department of Radiology, lecturer/radiologist.
- All the lecturers/radiologist who directly or indirectly contribute their ideas and comments.
- Dr. Syed Hatim Noor @ Nyi Nyi Naing, lecturer, Unit of Biostatistic and Epidemiology, Department of Community Medicine.
- Dr. Md Ariff Abas, Head Department of Radiology, Hospital Kota Bharu.
- Puan Zaini Mohd Noor, Penolong Pengarah (Rekod Perubatan), Hospital USM.
- Staffs in the record office, Hospital USM.
- Colleagues and all the staffs in the Department of Radiology, HUSM.
- Colleagues and staffs in the Department of Radiology Hospital Kota Bharu.

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ABBREVIATIONS

CT	Computed Tomography
ESWL	Extracorporeal Shock Wave Lithotripsy
HKB	Hospital Kota Bharu
HUSM	Hospital Universiti Sains Malaysia
ICU	Idiopathic Calcium Urolithiasis
IVP	Intravenous Pyelogram
IVU	Intravenous Urography
KUB	Kidney Ureter Bladder
LT	Lower Urinary Tract
PAR	Plain Abdominal Roentgenogram
PTH	Parathyroid Hormone
RTA	Renal Tubular Acidosis
US	Ultrasound
UT	Upper Urinary Tract
UTI	Urinary Tract Infection

ABSTRAK

Tajuk: Kajian perbandingan antara US & KUB dan IVU pada pesakit 'renal colic' di Kelantan.

Latarbelakang: 'Intravenous urography' ialah satu penyiasatan radiologi di dalam pesakit batu karang. Penggunaannya telah melibatkan peningkatan masa pemeriksaan dan kos. Penyiasatan ini juga menggunakan radiasi dan kontras media yang mungkin memudaratkan pesakit. 'Ultrasound' boleh digunakan untuk mengenal pasti batu karang dan bengkak pada sistem ginjal. Gabungan antara 'ultrasound' dan 'KUB' boleh digunakan untuk mengenal pasti batu karang pada saluran ginjal. Kajian ini telah menunjukkan keberkesanan ultrasound dan KUB dalam siasatan pesakit buah pinggang.

Objektif dan Tatacara: Objektif kajian ini ialah untuk mengkaji keberkesanan US bersama atau tanpa KUB bagi pesakit yang mengalami 'renal colic. Kebengkakan dan komplikasi dari penyakit ini pada sistem ginjal turut dikaji. Umur, bangsa, jantina dan taburan geografi pesakit turut dilaksanakan. Satu penyelidikan prospektif ke atas 100 orang pesakit 'renal colic' telah dijalankan bermula pada 1hb Julai 1998 sehingga Julai 2000. Kajian ini telah dijalankan di Hospital Universiti Sains Malaysia (HUSM) dan Hospital Kota Bharu (HKB). Penyediaan pesakit sebelum pemeriksaan IVU telah dijalankan. Kesemua pesakit menggunakan kontras media yang bukan ionik dalam penyiasatan IVU. Pesakit yang mempunyai sejarah lelah dan alah kepada makanan laut diberi rawatan prednisolone sebelum penyiasatan IVU dijalankan. Tiada komplikasi

terhadap kontras media dikenalpasti. Radiografi biasa (KUB) merupakan filem kawalan dalam pemeriksaan IVU. Ultrasound dijalankan sebaik sahaja pemeriksaan IVU selesai atau selepas filem untuk pundi kencing diambil.

Keputusan: Batu karang telah dikenalpasti pada 61 orang pesakit yang menjalani pemeriksaan ultrasound dan IVU. Sembilan pesakit menunjukkan negatif palsu ultrasound dalam mengenalpasti batu karang. 'Intravenous urography' membuktikan bahawa batu karang dalam kes tersebut sebenarnya berada di dalam salur ginjal. Batu karang telah dikenalpasti melalui ultrasound pada 6 orang pesakit, apabila IVU gagal membuktikannya. Ini disebabkan batu karang tersebut terlalu kecil untuk dikenalpasti dalam IVU. Sensitiviti dan spesifisiti ultrasound dalam mengesan batu karang adalah 87.4% dan 80.0%. Seramai 65 orang pesakit telah menunjukkan positif batu karang dalam penyiasatan IVU dan KUB. Negatif palsu KUB dikenalpasti dalam 5 kes yang mana batu karang adalah 'radiolucent'. Tiada positif palsu dalam KUB. Sensitiviti dan spesifisiti KUB dalam mengesan batu karang adalah 92.9% dan 100.0%. Sensitiviti dan spesifisiti yang tinggi menggunakan KUB disebabkan ia merupakan sebahagian dari filem-filem IVU. Kecenderungan KUB dalam mengesan batu karang mungkin telah berlaku. Gabungan diantara US dan KUB telah meningkatkan sensitiviti ultrasound kepada 95.7% dalam mengesan batu karang. Spesifisitinya adalah sama. Ultrasound menunjukkan sensitiviti yang tinggi dalam mengenalpasti bengkak pada ginjal iaitu 98.1% dan specificiti 86.7%. Terdapat hubungan signifikan di antara KUB, US dan IVU dalam mengesan batu karang dan antara IVU dan US dalam mengesan bengkak pada ginjal.

Kesimpulan: Gunasama ultrasound dan KUB mengesan batu karang adalah lebih baik berbanding ultrasound sahaja. Penggunaan KUB membantu ultrasound mengesan batu karang pada salur ginjal. Tetapi pada masa yang sama, KUB tidak dapat mengenalpasti batu karang yang 'radiolucent'. Ultrasound dan KUB saling membantu dalam keadaan ini. 'Intravenous urography' masih merupakan penyiasatan yang utama untuk mengesan punca dan paras obstruksi. Penggunaanya harus dihadkan kepada pesakit yang menjalani rawatan ESWL dan pesakit apabila US dan KUB tidak diagnostik.

ABSTRACT

Topic: Comparative study between Ultrasound & KUB and IVU in renal colic patients in Kelantan.

Overview: Intravenous urography has been a standard investigative method in patients with nephrolithiasis. Routine use of intravenous urography has shown to increase examination time and cost. Besides, it requires ionizing radiation and contrast media that carries a risk to the patient. Ultrasound can detect calculi and dilatation of the pelvicalyceal system. Combination of KUB and US can significantly improve the detection of calculi especially at the ureter. The study illustrates the effectiveness of ultrasound and KUB in evaluating renal colic patients compared to IVU.

Objectives and Methodology: The specific objectives in this study are to assess the usefulness of ultrasound with or without KUB in the evaluation of renal colic. Pelvicalyceal system dilatations or any other lesions noted in IVU and US were also evaluated. The age, sex, race and geographical distribution of patients were noted. A two-year prospective study was performed from 1st July 1998 till July 2000 in 100 patients who presented with renal colic. The study was conducted in Hospital USM and Hospital Kota Bharu. Intravenous urography was performed with bowel preparation. Non-ionic contrast media were used in all of the patients. Patients with history of asthma or allergic to seafood were properly covered with prednisolone. No complication noted in all of the patients. A plain film (KUB) was done as part of IVU films. Ultrasound was performed immediately after IVU or just after full bladder view film was taken.

Results: Calculi were noted in 61 patients both IVU and US. Nine patients showed false negative of ultrasound in detecting calculi. Intravenous Urography showed that these calculi were actually in the ureters. Six patients showed false positive for calculi in US. The sensitivity and specificity of US in detecting calculi were 87.4% and 80.0% respectively. Both KUB and IVU detected calculi in 65 patients. Five false negative noted in KUB, which were actually radiolucent stones. No false positive noted in KUB. The sensitivity and specificity of KUB in detecting calculi were 92.9% and 100% respectively. The high sensitivity and specificity of KUB were due to the fact that it was done the control film for the IVU examination. A detection bias probably occurred. Combinations of US & KUB in detecting calculi were significantly increased the effectiveness of US in detecting calculi. The sensitivity was 95.7% and specificity remains 80.0%. Ultrasound also showed high sensitivity in detecting hydronephrosis. The sensitivity and specificity were 98.1% and 86.7% respectively. There were significant correlations between KUB, US and IVU in detecting calculi and between IVU and US in detecting hydronephrosis.

Conclusion: Ultrasound and KUB X-ray have significantly improved the detection of calculi compared to ultrasound alone. Kidney, Ureter and Bladder X-ray (KUB) helps US in the detection of calculi in the ureter. However, the drawback of KUB was it is unable to detect radiolucent calculi. Ultrasound played a complementary role in this situation.

Intravenous urography still remains the gold standard method in evaluating the cause and level of obstruction. Routine use of IVU should be reserved for patients undergoing ESWL and for patients with persistent colic in whom US & KUB were not diagnostic.

SECTION ONE

INTRODUCTION

in lesser-developed parts of the world tend to have bladder stones. Epidemiological data (Benedict et al, 1997) suggests that both climate and diet may play significant roles in the pathogenesis of urolithiasis and these factors may help to explain the geographic disparity. Several regional trends have been identified within the United States. The prevalence of kidney stones increases as one travels from the West coast to the East coast, as well from the North to the South. (Seftel et al, 1990, Soucie et al, 1996). These findings suggest that the Southeast have the highest prevalence of stone disease.

Urinary calculus disease is a common problem encountered in clinical practice in Kelantan, the northernmost state on the east coast of Peninsular Malaysia. A study by Lim et al (1986) in Hospital Universiti Sains Malaysia (HUSM) showed it accounted for 12.4% of general surgical admissions. The ratio of males to females in that study was 1.2:1. Two hundred and sixteen patients had surgery for urinary calculi in Kelantan, 136 in Hospital Kota Bharu and 80 in Hospital USM. The admission/operation ratio in HUSM was 7.4:1 for patients with UT stones, but 1:1 for those with LT stones. Multiple admissions were common amongst patients with UT as opposed to LT stones.

In previously published study of extent and distribution of calculus disease in the Peninsula Malaysia, Screenevason et al (1981) used the five yearly hospital returns to examine the admission rate. In the last period of the study, between 1972-1976, he found an incidence of 33.3 per 100,000 for upper urinary tract (UT) calculi and 3.6 per 100,000 for lower urinary tract (LT) calculi in Kelantan.

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The latest statistics obtained also showed that calculi of the upper urinary tract are more common than the lower urinary tract. From 1997 to 2000, there were 203 patients admitted in HUSM for the upper urinary tract calculi and 95 for the lower urinary tract calculi. In HUSM, patients with renal colic are commonly seen at emergency department and urology clinics. Pain relief is the initial treatment to these patients and evaluation of the underlying cause is the ultimate aim. Kidney, ureter and bladder (KUB) x-ray is commonly requested; later proceed with US and/or IVU. From 1998 to 2000, 439 IVUs had been performed. They were requested for various reasons such as to assess the ureters in pelvic tumours and the investigation for the cause of back pain and haematuria. The most common request was to evaluate the renal tract for renal calculi.

Intravenous urography is an important and reliable method of evaluating the urinary tract. However, it is associated with complications and limitations. (Haddad et al, 1992). It can cause death and mortality rate of 1.3:100,000 had been reported. (Hartman et al, 1982). Ultrasound has been shown to be a sensitive method of evaluating patients with chronic obstructions, bladder outlet obstruction, urinary tract infection, renal failure, renal and bladder neoplasm and renal transplants. It is now method of choice for preliminary assessment and follow-up of several of these disorders. A major limitation of US in the urinary system is the inability to depict the entire length of the ureter. Several reports have assessed the value of US in evaluation of renal colic. The results were controversial. In many centers, IVU is the primary radiological study for patients with renal colic. To date, there are not many local studies to evaluate the usefulness of plain X-ray of kidney, ureter and bladder (KUB), ultrasound and IVU in renal colic patients. Therefore, it is felt that the study will be useful to improve the cost effectiveness in the investigation of renal colic patients.

SECTION TWO

LITERATURE REVIEW

2.1 LITERATURE REVIEW

The radiologist is involved intimately in the diagnosis and treatment renal colic and urinary tract obstruction. Developments in diagnostic imaging have elevated the importance of the radiologist as a participant in the clinical evaluation of such disease. A basic understanding of stones formation and the physiology of obstruction are critical if the radiologist is to maximize the information available from the many imaging techniques used in the assessment. The radiologist should exercise treatment options only after assessing imaging studies and properly evaluating the physiologic characteristics of obstruction.

2.1.1 HOW DO STONES FORM?

About 75% of stones are calcium-based, consisting of calcium oxalate, calcium phosphate or a mixture of oxalate and phosphate. Mixed stones have more than one component, such as a uric acid nidus with aggregation of calcium. Another 10% of renal stones are uric acid, 1% cystine-based and the remainder primarily struvite. In susceptible patients, stone formation begins when urine is supersaturated with calcium, cystine, uric acid, struvite or oxalate.

Two fundamental processes are involved in the pathogenesis of nephrolithiasis, namely, supersaturation and nucleation. (Coe et al. 1992, Kupin et al. 1995, Trivedi et al. 1996).

Supersaturation occurs when the substances that make up the stone are found in large volumes in the urine, when urine volume decreases and when the chemicals in urine that inhibit stone formation decrease. In normal urine the concentration of calcium oxalate salt is four times higher than its solubility. High rates of calcium and oxalate excretion and low urinary volumes increase calcium oxalate supersaturation. Because citrate forms a soluble complex with calcium, low urinary citrate excretion increases calcium oxalate supersaturation. A urinary pH above 6.5 increases the proportion of divalent and trivalent phosphate ions and therefore increases calcium phosphate supersaturation. Inhibitors of crystallization include citrate, magnesium, pyrophosphate, nephrocalcin, uropontin and Tamm-Horsfall mucoprotein, the latter three being protein synthesized in the kidney. Nephrocalcin, an acidic glycoprotein that contains unusual amino acid γ-carboxyglutamic acid, inhibits calcium oxalate nucleation, growth and aggregation. Tamm-Horsfall mucoprotein inhibits aggregation alone. Uropontin inhibits the growth of calcium crystals. (Coe et al, 1992, Trivedi et al, 1996). Urine citrate forms a soluble salt with calcium that normally reduces free calcium ion levels appreciably; low urine citrate levels from bowel, renal tubular acidosis, dietary and hereditary causes, can raise the level of calcium oxalate supersaturation and promote the formation of stones.

Supersaturation creates stone crystals by causing ions in solution to combine with one another into a solid phase, a process called nucleation. Calcium and oxalate ions can orient themselves on the surfaces of another crystal, such as uric acid and such heterogeneous nuclei may promote the formation of calcium oxalate stones. Disorders that raise the level of supersaturation and promote heterogeneous nucleation are presently accepted causes of nephrolithiasis. Small (1 to 4mm) calculi often have one smooth convex face and one concave face that may have been attached to a renal papilla. The composition of these stones is usually calcium oxalate monohydrate but stereo microscopic and scanning electron microscope studies of these stones often demonstrate a whitish Randall's plaque, composed of calcium phosphate, in the concave depression. Calcified renal tubules have even been found. Renal calculi may originate with the intra-tubular precipitation of calcium phosphate, which becomes overgrown with calcium oxalate monohydrate. A papillary tip calculus can detach and pass spontaneously as a common ureteral stone or grow into a larger renal pelvic or calyceal stone. (Jenkins et al, 1992).

Epidemiological studies have been performed in an attempt to explain the regional differences in the prevalence of kidney stones. It has been found that both ambient temperature and sunlight index are independently associated with stone prevalence. The higher the annual ambient temperature and sunlight index, the higher the prevalence of stone disease. One proposed theory (Soucie et al, 1996) suggested that warmer climates are associated with an increased frequency of dehydration; this, in turn, can cause both the concentration and the acidity of urine to increase and subsequently promote stone formation. Another theory (Soucie et al, 1996) suggests that sunlight exposure influences the occurrence of calcium stones secondary to an increased level of 1,25-dihydroxy vitamin D. Elevated levels of 1,25-dihydroxy vitamin D can enhance intestinal calcium absorption, which can lead to hypercalciuria and stone formation. Hypercalciuria has been found to be the most common risk factor for nephrolithiasis and elevated levels of

1,25-dihydroxy vitamin D have been found in some patients with hypercalciuria. (Benedict et al, 1997).

2.1.1.1 DIETARY RISK FACTORS

The role of diet in the formation of stone disease has been and is being examined closely. There is speculation that a high dietary protein intake may be associated with increased risk of stone formation. (Seftel et al, 1990, Benedict et al, 1997). This was proposed based on the historical observation that during the World War II, the incidence of stone disease declined as meat products became scarce and dietary animal protein consumption declined. It has also been observed that vegetarians have a significantly reduced incidence of stones. (Benedict et al, 1997). Studies have shown that urinary calcium, oxalate and uric acid levels are increased after ingestion of a protein load, conditions that favour stone growth. However, it has yet to be shown that restriction of dietary protein can produce a long lasting remission from stone disease. (Kupin et al, 1995, Benedict et al, 1997).

The role of dietary sodium is evaluated. Increased urinary sodium is directly correlated with increased urinary calcium excretion. There is no definitive evidence that patients with recurrent calcium stones ingest a greater amount of dietary sodium than do controls. It has been suggested that patients with recurrent nephrolithiasis might be more sensitive to the calciuric effects of urinary sodium excretion than non-stone formers. (Benedict et al, 1997).

Restriction of dietary calcium has long been a component of maintenance therapy for recurrent calcium stone formers. However, Curhan et al (1993) actually showed an apparent protective effect of high dietary effect of high dietary calcium intake. Thus, the mechanism by which hypercalciuria occurs is presumed to influence by more factors than simple excess calcium ingestion and gastrointestinal absorption.

Normal urinary oxalate levels are much lower than normal urinary calcium levels. Some studies suggested that a mildly elevated urinary oxalate level has greater risk factor for stone formation than mildly elevated urinary calcium. Sources of dietary oxalate include tea, chocolate, spinach, peanuts, rhubarb, strawberries and pepper. (Seftel et al, 1990, Kupin et al, 1995, Trivedi et al, 1996, Benedict et al, 1997). It is proposed that a small increase in urinary oxalate has a more profound effect on crystal precipitation than a comparable increase in urinary calcium. Historically, recurrent calcium oxalate stone formers have been instructed to avoid oxalate-rich foods, as it has been shown that urinary oxalate excretion does indeed increase after ingestion of these items. (Kupin et al, 1995).

The role of fluid consumption play in the prevention of stone formation has been given significant importance. Dietary fluid intakes need to be high enough to adequately dilute salts that are prone to precipitate in the urinary tract. (Kupin et al, 1995). Ideally, the fluid ingested to prevent supersaturation of salts should be water. Pak et al (1980) showed that urinary dilution by ingestion of water reduced the urinary saturation of calcium phosphate, calcium oxalate and monosodium urate. Increased fluid intake increases the urinary output, lowering the concentration of the substances involved in stone formation. While strict guidelines are not available, doubling the urinary output or a 24-hour urinary output greater than 2 L is generally recommended to reduce new stone formation. In actual practice, however, the beneficial effects of hydration may be seen with a much smaller increase in urinary volume. (Coe et al, 1988).

Certain medications can significantly alter the composition of the urine and may predispose to stone formation. High doses of aspirin or probenecid are associated with increased excretion of uric acid. Carbonic anhydrase inhibitors, such as Diamox (acetazolamide) can cause a chronically alkaline urine and decreased urinary citrate, predisposing to calcium calculus formation. Triamterene preparations (e.g. Dyazide) and its metabolites have been identified in some urinary stones. Loop diuretics are well known to promote hypercalciuria. (Benedict et al. 1997).

2.1.1.2 TYPES OF STONE

Understanding how to prevent and treat stone disease requiring basic knowledge of the metabolic conditions that predispose to nephrolithiasis. There are many different types of stones, the most common are calcium stones (calcium oxalate and calcium phosphate), struvite (i.e. infection) stones, uric acid stones and cystine stones. It is important to identify both the metabolic and environmental risk factors present in each patient. Calcium containing stones the most common and 20-40% (Benedict et al. 1997) of patients with recurrent calcium stones will have hypercalciuria. Approximately 20% will have an identifiable underlying systemic disease as the cause. (Coe et al, 1992, Curhan et al. 1993). The remainder of calcium stone patient's will be diagnosed with idiopathic calcium urolithiasis (ICU).

2.1.1.2.1 CALCIUM STONES

Idiopathic calcium urolithiasis (ICU) is a diagnosis by exclusion. Thus, conditions that are known to cause hypercalcaemia and/or hypercalciuria, such as primary hyperparathyroidism, sarcoidosis, Cushing's syndrome, hyperthyroidism and immobilization must be ruled out. Of all the aforementioned conditions, primary hyperparathyroidism is the most common hypercalcemic condition associated with urolithiasis and accounts for stone formation in 5% of patients. (Benedict et al, 1997). Elevated levels of parathyroid hormone (PTH) cause increased bone resorption, renal reabsorption and intestinal absorption of calcium, thus increasing serum calcium levels and supersaturating the urine with calcium salts. (Seftel et al, 1990. Coe et al, 1992). Patients are diagnosed with the finding of an elevated serum calcium level in conjunction with an inappropriate elevated PTH level. Eighty percent of these patients were found to have a single adenoma.

Many patients will have hypercalciuria without hypercalcaemia. Many of these patients will have idiopathic hypercalciuria secondary to excessive gastrointestinal absorption.

However, hypercalciuria can also be secondary to administration of loop diuretics, excessive sodium ingestion, and familial hypercalciuria or type 1 distal renal tubular acidosis (RTA).

Seventy percent of patients with distal RTA will develop nephrolithiasis. The diagnosis of a Type 1 RTA is made when there is a systemic acidosis and urine pH>6. These patients are unable to lower their urine pH despite being systemically acidotic and have a normal ability to reabsorb bicarbonate. Excessive serum acid is buffered by calcium from bone, which is then excreted in the urine. This hypercalciuria, particularly in the setting of alkaline urine (which favours calcium phosphate precipitation) and hypocitraturia (citrate inhibits calcium phosphate crystal formation) favours the formation of stones.

Calcium can also complex with oxalate to form stones. Primary hyperoxaluria is an extremely rare disorder with approximately 50% of patients dying of renal failure by the age 20. (Benedict et al, 1997) This disease diagnosis should be considered in the very young patient who has evidence of large calculi on plain abdominal films, a positive family history for stone disease and elevated urinary oxalate level upon laboratory testing. A somewhat more common oxalate disorder is enteric hyperoxaluria. Enteric hyperoxaluria is most commonly associated with patients who have small bowel disorders. Patients with inflammatory bowel disease or chronic pancreatitis or patients post small bowel resection or jejunoileal bypass can have problems with fat malaborption. The increased intestinal fat binds calcium, thus less calcium is available to bind oxalate present in the gut predisposing to hyperoxaluria and stone formation.

Patients with inflammatory bowel disease have been found to have 2-3% incidences of nephrolithiasis, post ileal resection have a 10% incidence of stone disease.

Calcium oxalate and calcium phosphate stones are black, gray or white; on x-ray films they are small (<1cm in diameter), dense, opaque and sharply circumscribed. (Coe et al, 1992)

2.1.1.2.2 URIC ACID STONES

Uric acid stones account for up to 5 to 10% of stones in the United States and most of these patients do not have gout. (Pollack et al, 1978, Motola et al, 1990, Benedict et al, 1997). There are three factors felt to be associated with uric acid stone formation: 1) hyperuricosuria, 2) persistently acid urine and 3) low urinary volume. Approximately 25% (Benedict et al, 1997) of patients with primary gout will develop uric acid stones and those patients treated with uricosuric agents are at increased risk. Other disorders that predispose to uric acid stone formation include myeloproliferative disorders (secondary to increased cell turnover), particularly when undergoing chemotherapy. Patients with atypically acid urine, e.g. patients with ileostomies or chronic diarrhea (in which fluids and bicarbonate losses can be excessive), can also develop uric acid stones.

The average pH uric acid stones is often less than 5.5, making uric acid available to promote crystal and stone formation. Indeed, the renal collecting tubules may become plugged by uric acid crystals, causing acute renal failure. Uric acid stones are white or orange. Uric acid gravel is orange but nearly transparent radiographically unless mixed with calcium crystals or struvite. Uric acids stones are typically seen as filling defects on intravenous pyelogram. (Coe et al, 1992)

2.1.1.2.3 STRUVITE STONES

Struvite stones, also called infection stones, are composed of magnesium ammonium phosphate. Infection stones account for 15-20% (Ohkawa et al, 1992, Benedict et al, 1997) of all urinary stones. These stones are the consequence of infection of the urinary tract with urease-producing bacteria, such as Proteus species. Ohkawa et al,(1992) studied the composition of urinary calculi related to urinary tract infection. Their study revealed that the highest frequency of urinary tract infection was found in patients with struvite stones and lowest in patients with calcium oxalate stones. Thirty five percent were urease-producing organisms, consisting of 10 strains of *Proteus. Mirabilis* and 7 other proteus species, Klebsiella, Pseudomonas and Staphylococci. (Seftel et al, 1990). These organisms hydrolyze urea to produce ammonia, which then causes alkalinization of the urine. Alkaline urine then promotes the precipitation of magnesium, ammonium and phosphate. Struvite stones are found in the setting of other disease whereby urinary tract infection has been superimposed. If the infection is silent and the stones allowed growing, large staghorn calculi formed; these stones form a cast of the calyceal system and cause complete obstruction requiring surgical intervention.

Struvite stones occur mainly in women. They can grow to very large size, filling the renal pelvis as typical staghorn calculi. The stones seldom pass spontaneously; 25% are discovered incidentally. If untreated, they result in loss of the affected kidney in 50% (Kupin et al, 1995) of cases. Struvite stones demand urgent intervention. The stones are amenable to lithotripsy, with percutaneous nephrolithotomy to extract stone particles. Occasionally, open surgery is required. Struvite stones seemed gnarled and laminated on radiographs, resembling ginger root. (Coe et al, 1992).

2.1.1.2.4 CYSTINE STONES

Cystine stones are extremely rare. Its occurrence is due to the inherited disorder cystinuria. It is an autosomal recessive disorder in which proximal tubular and jejunal transport is impaired for dibasic amino acids such as cystine, lysine, ornithine and arginine. Hence, excessive amounts of all of these are excreted. However, clinical disease is due solely to the poor urinary solubility of cystine. (Kupin et al, 1995). Because of the heritable nature of the disease, cystine nephrolithiasis is usually diagnosed in children and is an uncommon cause for first time stones in adults. Cystine stones are greenish yellow and flecked with shiny crystallites, like mica. On X-ray films, they look like homogeneous pieces of sculpted wax or soap. (Coe et al, 1992).

2.1.2 DIAGNOSTIC APPROACH

2.1.2.1 HISTORY AND PHYSICAL EXAMINATION

The initial step to diagnose nephrolithiasis is clinical suspicion. The diagnosis of nephrolithiasis is not difficult in most patients. Classically, most patients initially present with excruciating episodic pain. It begins suddenly and intensifies over a period of 15 to 30 minutes into a steady, unbearable pain that causes nausea and vomiting. (Coe et al, 1992). The pain, like the stone, often passes downward from the flank along a path that curves anteriorly toward the groin. Urinary frequency and dysuria can occur as the stone reaches the ureterovesical junction. When the stone passes into the bladder or moves in the ureter to decompress the urinary system, the pain vanishes so abruptly.

Stones cause obstructive uropathy, especially if they are painless and therefore remain undetected for long periods. Though common and disturbing for patients, bleeding has little importance of its own. The most helpful piece of history is history of a previous kidney stone. Stones also present "silently" as persistent or recurrent urinary tract infections (UTI). A family history, dietary history and medication history should also be taken.

In the absence of colic, the physical examination is usually unremarkable. When colic is present, patient is usually restless and uncomfortable. Costo-vertebral angle tenderness or diffuse abdominal tenderness may be present, however, there should be no signs of peritoneal irritation. The physical examination is the initial screen for underlying occult systemic disease, such as evidence of gouty arthritis or findings of malignancy. (Benedict et al. 1997, Coe et al, 1992).

2.1.2.2 RADIOGRAPHIC IMAGING

2.1.2.2.1 INTRAVENOUS UROGRAPHY

Intravenous urography (IVU) has an unrivalled position in imaging of acute renal colic for over 50 years. This position is further strengthened by the progressive refinement of contrast media, nephrotomographic techniques and film screen combinations. Nevertheless, the inherent risks in the use of iodinated contrast media, especially the ionic ones and the use of ionizing radiation. It remains the gold standard with 95% sensitivity and specificity in detecting the cause and level of obstruction. (Mutazindwa et al, 1996).

Intravenous urogram can delineate the exact location of a calculus within the pyelocaliceal system or ureter. Renal calculi may be proven to be within the pyelocaliceal system by at least two projections or by being outlined by the contrast material, resulting in the appearance of a 'filling defect'. Even opaque renal calculi that are evident on a plain abdominal radiograph may produce the picture of a filling defect if they are relatively less dense than the excreted contrast material. Once the location within the kidney is defined, they do not necessarily require any further investigation. Similarly, after the administration of contrast material, it may become evident that the calcification is within the kidney but not within the collecting system. This will be accompanied by demonstration that the density is not obscured by the contrast material or by oblique films that the density is clearly outside the area defined by the contrast material.

The degree of obstruction associated with a ureteral calculus affects the findings on the intravenous urogram and often the clinical management. In acute ureteral obstruction, an obstructive nephrogram is often produced that is characterized by the presence of an enlarged kidney that is increasingly dense opacified.

Renal function and anatomy may be ascertained after the injection of contrast material. Although the study is not a test of renal blood flow and differential function, enough information can be gained in most instances to make a decision regarding management of a calculus or calculi. The intravenous urogram may suggest segmental problems associated with obstruction from a calculus or other abnormalities related to anomalies of position and development. A few examples are incompletely rotated kidneys, ectopic kidneys, horseshoe kidneys and duplex systems. Renal cysts and other renal masses may also be noted. All these factors will influence the surgical, endourologic or extracorporeal approach to the management of a stone within the afflicted kidney or ureter.

Recently, IVU as a first line modality in this clinical set up has been challenged, and US + plain abdominal film (KUB) proposed as a replacement. Haddad et al (1992) noted in his study that, US when combined with KUB, ROC curves yielded sensitivities of 94% and 97% for two reviewers at a specificity of 90%. He concluded that US combined with KUB radiography could replace IVU in initial evaluation. Middleton et al (1988) noted that US has overall sensitivity of 96%. The ability of US to detect stone was independent to location or patient size. His study concluded that US is an effective means for detecting kidney stones in patients with suspected nephrolithiasis.

Dalla Palma et al (1993) in their prospective study suggested that in the hydrated patient the combination of KUB plus US is a sensitive but not very specific screening test. (sensitivity 95%, specificity 67%).

Mutazindwa et al (1996) showed that although intravenous urography is relatively more expensive than US, it still remains the gold standard in investigation of renal colic. In their experience, they suggested that an IVU should be conducted, whenever possible, in acute renal colic and should be extended until the cause and site of obstruction are established. This important strategy allowed prompt definitive clinical decisions on management to be made. If the results are negative, the other differential diagnoses that might explain the pain can be considered.

2.1.2.2.2 Kidney, Ureter and Bladder Radiograph.

A common practice for evaluating renal colic includes a plain abdominal roentgenogram (PAR) or precisely a radiograph of Kidney, Ureter and Bladder (KUB). The use of KUB in detecting renal stones dates back to 1897, when Swain published a case in which the diagnosis of renal stone was made by abdominal roentgenogram. Subsequently, Swain, Chappel and Chauvel (1932) studied the radiopacity of renal stone after they were passed or extracted. Based on the results of their studies, they reported that 90% of the urinary stones cast radiologic shadows. Their results were supported by two other studies that were limited to patients from urology clinics. This became the basis for the assumption that more than 90% of renal stones are radiopaque and are visible on KUB. (Mutgi et al, 1991)

The KUB has become a routine preliminary test to evaluate renal colic and great reliance has been placed on it. Major textbooks recommend using KUB routinely in diagnosing or excluding renal stones and this has been incorporated into clinical teaching. Unfortunately, the studies did not take into consideration referral bias, selection bias and detection bias. They also did not consider the influence of prevalence of renal stones and the predictive value of KUB in detecting or excluding renal stones. In emergency department and primary care practice, a KUB is often used to exclude the presence of kidney stones in patients with suspected renal colic; this test is often followed by an intravenous pyelogram (IVP).

Roth et al (1985) challenged the validity of routine use of KUB in renal colic. Their study suggested a relatively low sensitivity for KUB and poor predictive value in diagnosing renal stones. Another study by Mutgi et al (1991) highlighted the low sensitivity and specificity of KUB, which had 58% and 69% respectively. The positive predictive value of KUB did not significantly improve the pretest probability at any given prevalence rates of stone occurrence.

Chia et al (1995) showed that the sensitivity and specificity of KUB for picking up urinary calculi were 82% and 72% respectively. This study gave slightly higher yield than Mutgi et al, (1991). However, it reflected the inconsistence of results of KUB in detecting stones. It was known that KUB would merely show opacifications along the urinary tract and occasionally the renal outline in the better-prepared bowel. Although 90% of urinary calculi are radio-opaque, they may not be seen on the KUB. This may be due to the fact that the stone is too small or obscured by adjacent structures. KUB has limited value as the initial investigations of renal colic and cannot be regarded as the sole investigation to determine the subsequent evaluation. Other explanations for poor performance of KUB, which were well recognized include, (1) intestinal gas, (2) overlapping bone shadows, (3) obesity, (4) other calcified structures, such as pelvic phleboliths.

Ghali et al. (1998) noted that KUB had a sensitivity of 79%, a specificity of 77%, positive predictive value of 87% and negative predictive value of 66%. These results indicated that KUB was neither an excellent test in screening for stones, nor a poor one as reported by some workers. It was a test of moderate value that cannot be relied upon since one third of the patients who had no stones on KUB in their study turned out to have stones in the final diagnosis.

2.1.2.2.3 ULTRASOUND

It has been suggested that ultrasound examination used as the first line of investigation of patients with colic, thereby avoiding invasive, expensive and labour-intensive techniques. Renal ultrasound can be readily performed in patients who are sensitive to contrast agents. The examination is obviously independent of renal function, which is uniquely helpful in severe renal failure where calculus disease maybe the cause of the obstructive uropathy. (Edell et al, 1978) At our institution, HUSM, ultrasonography has been used often as the preferred supplemental method for diagnosing and differentiating nonopaque renal calculi from other filling defects within the collecting system. All calculi, regardless of their chemical composition, has a characteristic appearance that consist of bright echoes representing the stone and a relatively echo-free zone or acoustic shadow beyond the stone that results from reflection of most of the sound wave by the stone. (Pollack et al, 1978, Van Arsdalen et al, 1990). Sonographic evaluation of patients with urolithiasis has progressively improved with technological advances. Many publications reflected the considerable clinical observations of stones variable appearance with differing technique factors. Sonography has been shown to be accurate in the evaluation of calyceal stones larger than 5mm. (LeRoy et al, 1994). Unfortunately, most clinicians believed stones in this position rarely caused signs or symptoms. It is less clear that sonographic detection was reliable for stones in the usual locations associated with symptoms or surgical impact, such as within a nondilated renal pelvis, at the ureteropelvic junction or in the upper or midureter. Stones in the lower ureter and at the ureterovesical junction are well seen with sonography. A confident diagnosis of stone disease can be made in patients with findings such as dilated collecting systems, definable calculi, elevated intrarenal vascular resistance with spectral Doppler and a lack of urine flow from the affected ureter into the bladder. (LeRoy et al, 1994).

The ultrasound evaluation may also be beneficial to determine the degree of hydronephrosis and to measure the thickness of the renal parenchyma, especially in cases of chronic obstruction. (Van Arsdalen et al, 1990). The sensitivity of ultrasound for detecting hydronephrosis is between 98 and 100%; (Laing et al, 1985, Scola et al, 1989) it was considered a reliable screening technique for excluding obstruction. Its high sensitivity, the rapidity and ease with which it can be performed and the avoidance of ionizing radiation and contrast material make it an attractive screening modality for patients with suspected renal obstruction.

Ellenbogen et al (1978) demonstrated that the sensitivity of ultrasound detecting hydronephrosis was 98% and specificity of ultrasound detecting hydronephrosis was 78%. Hence, ultrasonography was highly sensitive in detecting dilated kidneys but led to a great number of false-positive diagnoses. The large number of false-positive diagnoses ultimately led to a great deal of confusion. It was recognized that many causes of false-positive ultrasonographic examinations exist both for hydronephrosis and obstruction. (Table 2.1). (Cronan et al, 1991).

Table 2.1: Causes of ultrasonic False-positive results for renal obstruction

Normal variants	Distensible collecting system Extra renal pelvis Full bladder Blood vessels in renal sinus
Increased urine flow	Overhydration Medications Osmotic diuresis Diabetes inspisidus
Renal cystic disease	Simple cysts Renal sinus cysts Adult polycyctic
Other	Postobstructive dilatation Vesicoureteric reflux Papillary necrosis Congenital megacalices

It must be recognized that ultrasonography has specific limitations. First, the technique is both operator and equipment-dependent, particularly with regard to the demonstration of acoustic shadowing. Second, it may not be possible to detect stones that are smaller than 5 mm. Third, other structures in the renal hilum, such as calcified arteries, may appear as echogenic foci with acoustic shadowing. Fourth, the ultrasound examination is not a functional study and a significant degree of obstruction, manifested by alterations in the excretion of contrast material on intravenous urography, may be associated with little evidence of dilatation of the collecting system. Fifth, ultrasonography does a relatively