New methods for the treatment of renal calculi The St. Luke's Hospital Experience

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SUMMARY

The last decade has seen extraordinary advances in the management of urinary tract calculi. With the introduction of minimally invasive techniques, like percutaneus nephrolithotomy (PCN), and non-invasive ones, like extra-corporeal shock wave lithotripsy (ESWL), major surgery for urinary tract calculi is becoming obsolete. The indications, methodology and complications of these techniques are briefly discussed. The results of the first fifty PCNs carried out by the Department of Urology and Urological Endoscopy at St. Luke's Hospital, Malta are described. A 90% success rate with no mortality is claimed. During the same period open surgery for renal calculi was less than 5%.

HISTORICAL NOTE

Urinary stones are as old as Mankind itself. Urinary calculi have been identified in prehistoric graves and in Egyptian mummies. In his famous oath Hippocrates admonishes his students not to cut for the stone but to refer patients to specialists in this field. From the time of Hippocrates to the late nineteenth century stone surgery was usually carried out by deft surgeons cutting into the bladder in unaesthetised patients who were forcibly tied or held down. Not unexpectedly there was a high incidence of complications, morbidity and mortality — and very little could be done for kidney stones except ingestion of certain herbs reputed to dissolve stones (cf the local "scattapietra"). With the advent of general anaesthesia it was possible to tackle renal and ureteric stones so that the operation of pyelo-, nephro-, uretero-lithotomy became standard repertoire. However, cutting into the kidney was still frought with danger due to haemorrhage and there was a high incidence of nephrectomies. The 1960's and the 70's were marked by efforts to promote safe conservative renal surgery. Gil-Vernet (1965) demonstrated his dissection in the relatively bloodless plane between the renal sinus and parenchyma so that even large stones could be removed safely. Boyce (1969) preferred the "anatrophic nephrotomy" by incising the kidney in the relatively avascular posterior plane. Different methods of cooling the ischaemic kidney were described (Graves 1963, Wickham 1968, Marberger 1978).

THE NEW ERA (1980'S)

The 1980's have heralded a revolution in the surgical treatment of urolithiasis. Advances in imaging techniques and endoscopic technology made possible the development of two new techniques for the treatment of renal calculi: percutaneous nephrolithotomy (PCN) and extracorporeal shockwave lithotripsy (ESWL). The development of the ureteroscope also allowed the endoscopic treatment of ureteric calculi by uretero-renal endoscopy (URS). PCN and URS are at present available in Malta.

PERCUTANEOUS NEPHROLITHOTOMY

This technique, first described by Profesor Ingmar Fernström (1976), essentially involves the following steps:

a) location of the stone by fluoroscopy and the formation of a track from the skin down to the kidney preferably directly to the site of the stone;
b) Introduction of a nephroscope down the pre-formed track with visualisation of the stone inside the kidney;
c) Small stones are removed with specially designed forceps through the nephroscope. Larger stones are first disintegrated with shockwaves, either electro-hydraulic or ultrasonic (both of these modalities are available at St. Luke's Hospital).

PCN is a technique which can deal with most stones except for those up in an upper or middle calyx (which may not be accessible), multiple stones in different calyces (which may require several punctures) and very large stones e.g. staghorn calculi (which, however, can be removed by a combination of PCN and ESWL). The operation can be done either in two stages (with an interval of a few days between the formation of the track and removal of the stone) or as a one-stage procedure under general anaesthesia. The latter procedure is the one normally carried out at St. Luke's Hospital.

The only absolute *contraindication* to PCN is a blood clotting disorder and therefore coagulation screening is mandatory.

Establishing the Track:

The patient is first cystoscoped and and a ureteric catheter inserted up the ureter to the pelvis to allow retrograde injection of contrast medium and a dye. The patient is then turned into the prone oblique position on a radiological screen and suitably draped. The collecting system is opacified by injection on contrast (intravenously or retrogradely) and a translumbar aortogram (or other suitable) needle inserted percutaneously down to the appropriate calyx under screening. A guidewire is then introduced and the needle removed. Serial fascial dilators or telescopic bougies are then introduced over the wire to form a track 26 to 32 Ch in diameter. Once maximal dilatation has been achieved a rigid plastic tube (Amplatz tube) may be placed over the last dilator which is then withdrawn. The percutaneous track is thus kept open by the Amplatz tube through which a nephroscope can be inserted.

Percutaneous Endoscopic Removal of Calculi

A nephroscope, irrigated by normal saline at body temperature, is introduced down the Amplatz tube. If the track has been correctly sited the stone should be quickly ▶

seen but occasionally repuncture may be necessary. Stones less than 1.5 cms diameter can usually be extracted intact with specially designed forceps. Larger stones will have to be disintegrated into smaller pieces using either electrohydraulic or ultrasonic shock waves and removed piecemeal. At the end of the procedure a nephrostomy tube is inserted and left for 24 to 48 hours. Post-operatively patients receive antibiotics and analgesics. Most patients can return home within 5 days with only a tiny residual scar in the flank.

Complications of PCN

1. *Bleeding*, usually due to damage of the vascular plexus at the calyceal neck. Some patients will require blood transfusion pre- and post-operatively. Particular attention should be directed to identifying patients with clotting disorders.
2. *Perforation* of the collecting system either by the rigid operating instruments or the shock waves.
3. *Post-operative ileus* due to extravasation of irrigating fluid.
4. *Damage to bowel* (uncommon).
5. *Migration of stone fragments* down the ureter causing obstruction.

EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY

This is a completely non-invasive method of disintegrating urinary calculi which was developed in Germany due to combined research by the University of Munich (Chuassy, 1984) and the AeroSpace Company, DORNIER. Essentially, the technique involves the creation of a spark or electrical explosion by discharge of potential across a large electrode. The shock waves thus created are focussed by means of an eliptical metal bowl and are directed at the calculus with the help of two dimensional X-Ray screening or ultrasound scanning and a computer.

Approximately 300-1600 shock waves are required to break the average stone which is rendered to dust and is passed down the ureter. Occasionally, the grit becomes impacted in the ureter forming a *stein strasse* (or stone street) which may require removing endoscopically. The first generation machines cost about LM 650,000 and involved the immersion of the patient bodily in a water bath under general anaesthesia. In the more recent models (which are cheaper) the patient is simply placed on a flat surface and the procedure can be done without anaesthesia or exposure to X-Rays by using ultrasound imaging.

Virtually all renal stones are amenable to treatment with ESWL, with a success rate of 90%. The large staghorn calculi are first debulked by PCN and the remnant fragments treated by ESWL. Even ureteric stones are amenable to treatment by ESWL.

THE POLICY IN THE UROLOGY DEPT. OF ST. LUKE'S HOSPITAL REGARDING REMOVAL OF RENAL CALCULI

An ESWL machine is not available in Malta as at present it is not considered cost-effective due to the smallness of the population. However, it is hoped that, with reduction in initial and running costs, such a machine will become available in the not too distant future, particularly if the indications of lithotripsy are extended to other spheres e.g. gall stone disintegration.

The present policy in the Urology Dept. at St. Luke's Hospital is as follows:

a. most kidney stones are treated locally with PCN;
b. the larger (e.g. staghorn) stones are referred to lithotripter centres in the U.K. for combined treatment with PCN and ESWL.
With this procedure the need for surgery for renal stones has been reduced to less than 5%

PCN AT ST. LUKE'S HOSPITAL

This procedure was started as a combined effort between the Departments of Urology and Radiology in October 1986. The first ten cases were done by a team from the Institute of Urology and the London Lithotripter Centre comprising Mr. J. Wickham FRCS (Urologist) and Dr. M. Kellett FRCR (Radiologist) two leading exponents of the technique. The following forty procedures were carried out by a local team. The results obtained in these first fifty patients will be discussed.

Table 1 shows the site of the stones. The majority were in the renal pelvis with the remainder in the calyces. In 3 cases the stone was lodged in the upper end of the ureter — in these cases we prefer to flush the stone back into the pelvis whence it is pulled out by PCN. Three cases were staghorn calculi — in these cases PCN was used to debulk the stone as a first stage procedure prior to referral to UK for completion of the process by shockwave lithotripsy to the remaining fragments.

Table 2 shows the otucome of stone removal by PCN in the first 50 patients. If all stones are included complete clearance was achieved in 84% of cases while if the staghorns are excluded the figure reads 90%. Considering that this early series included the "learning curve" of the procedure the results are remarkable and compare well with what is being achieved world-wide with PCN.

In less than half of the cases the stone could be pulled out whole by means of grasping forceps through the track. Stones larger than 1.5 cms were first disintegrated by electrohydraulic or ultrasonic shockwaves before being pulled or sucked out piece meal. In 5 cases, including the 3 staghorn calculi, fragments were left in the kidney. The technique failed in 3 cases (Table 3): in one case the radiologist could not reach the relevant calyx in an obese lady; in one other case the stone was accurately localised but could not be broken despite bombardment with the strongest electrohydraulic shock waves; one stone was stuck in the upper end of the ureter and could not be dislodged into the pelvis or reached by the ureteroscope thus necessitating open ureterolithotomy.

The commonest complications were bleeding and post-operative pain (Table 4). Bleeding during the operation may be due to damage to the renal parenchyma during the formation of the access track or to damage to the kidney or the calyceal blood vessels by the rigid nephroscope or lithotrite during endoscopic extraction of the stone. Fifteen of our patients required blood transfusion. One patient, who had mild bleeding during the procedure, had severe post-operative haemorrhage through the nephrostomy tube which required exploration of the kidney: there was no gross superficial damage to the kidney or a peri-renal haematoma and the bleeding appeared to be due to the nephrostomy tube impinging on the blood vessels in the neck of a tight calyx. The patient kept his kidney which was seen to be functioning normally on subsequent IVU.

Post-operative pain was usually mild. In only two cases was there severe pain requiring analgesia for more than twenty-four hours.

Paralytic ileus is not uncommon and is usually due to extravasation of irrigation fluid into the peritoneal cavity.

Damage to bowel (usually colon) has been reported but fortunately never happened in our series.

Urinary tract infection is often a sequel to pre-operative infection. It is our custom to perform the procedure under antibiotic cover to minimise infection and septicaemia. Nevertheless, septicaemia did occur in two patients who fortunately responded well to treatment.

In one case a stone was lost outside the renal parenchyma as it was being delivered through the nephrostomy track. Post-operative X-Rays showed it lying harmlessly in the perirenal tissues.

There was no mortality in this series. ▶

CONCLUSION

The 90% success obtained in this study is very encouraging particularly as the present series represented the "learning phase" of the PCN technique. Logistical problems undoubtedly exist. Personnel trained in renal access and endoscopic retrieval are not readily available at St.Luke's Hospital. Moreover, PCN procedures demand team-work and therefore put a strain on various specialities. However, the procedure is cost-effective and, more important, the patient is saved the trauma of a major operation with consequent reduction in morbidity, avoidance of large scars and early discharge from hospital.

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TABLE 1: SITE OF STONES (50 patients)

Renal pelvis	33
Upper calyx	4
Middle calyx	3
Lower calyx	10
Upper end ureter	3

TABLE 2: OUTCOME OF STONE REMOVAL BY PCN IN 50 PATIENTS

Forceps removal (in toto)	20 (40%)
Lithotripsy breakdown	25 (50%)
Complete clearance of stones	42 (84%)
Incomplete removal of stones	5(10%)
Failed PCN	3(6%)

TABLE 3:
CAUSES OF INCOMPLETE/FAILED REMOVAL OF STONES BY PCN

Incomplete: (5 patients)
— staghorn calculi (3)
— calyceal stones (2)

Failed: (3 patients)
— failed access (1)
— unbreakable stone (1)
— stone stuck in ureter (1)

TABLE 4: COMPLICATIONS OF PCN

Bleeding: requiring transfusion	15
requiring exploration	1
Paralytic ileus	3
Pain (requiring analgesia >24hr)	2
U.T.I.	5
Septicaemia	2
Stone "lost" outside kidney	1
Mortality	0