Extracorporeal shock wave lithotripsy: the first 50 patients treated in Britain

J E A WICKHAM, D R WEBB, S R PAYNE, M J KELLET, G WATKINSON, H N WHITFIELD

Abstract

Fifty patients have been treated for upper tract urinary calculi by extracorporeal shock wave lithotripsy (ESWL) at the Devonshire Hospital lithotripter centre since November 1984. The average stay for an inpatient was 3·7 days. All patients suffered minimal postoperative discomfort and nearly all resumed normal activity within one day after discharge. Complications requiring auxiliary procedures were few. The procedure was found to be safe, cost effective, extremely well received by patients, and superior to all other methods of removing renal stones.

This study confirms that treatment by ESWL is a specialised urological procedure that requires operators who are also trained in open, percutaneous, and ureteroscopic surgery and with a back up of a radiological team skilled in percutaneous renal puncture.

Introduction

Urolithiasis of the upper urinary tract is a fairly common condition in the United Kingdom,[1] causing considerable morbidity and requiring large and lengthy operations with an extensive convalescent period. Furthermore, patients who have one episode of calculi have up to a 60% chance of developing recurrent calculi.[2]

Percutaneous renal surgery has changed this picture but requires at least puncture of the kidney and possibly open nephrolithotomy for large branched calculi.[3] Extracorporeal shock wave lithotripsy (ESWL), which causes disintegration of the stone without contact, is therefore a far more attractive procedure for both patients and surgeons.

Since the first report of treatment of upper urinary tract urolithiasis by ESWL in 1980[4] over 8000 cases have been treated world wide. The procedure has been shown to be cost effective and indeed cost saving.[5] Before its introduction over six years of laboratory research had confirmed its safety.[6] This has been confirmed further by clinical follow up with renography, computed tomography, and ultrasound scanning.[7] As the indications for ESWL have widened to include infected, larger, and stag horn calculi so the necessity for combined treatment with skilled percutaneous renal surgery has become apparent. To treat large stone masses and obstructions at outlets ancillary endourological techniques are vitally important.[8]

The generation of shock waves as a form of treatment for urinary calculi was first described in 1955 by the Russian engineer Yutkin, who used an ultrashort high tension electrical discharge under water to vaporise a fluid medium.[9] The gas bubble produced by this discharge expands with tremendous speed and therefore acts as a shock wave at the gas-fluid interface. Such a shock wave generated in the first focus of a hemiellipsoid can be accurately focused to produce high tensile pressure at a small area of the secondary focus. Shock waves generated outside the body can be accurately focused with such an ellipsoidal reflector, the patient being suspended in water to facilitate transmission of the shock waves. These are focused precisely on to the calculus with biplanar radiography. The resultant fine fragments are passed spontaneously in the urine with minimal if any discomfort.

The lithotripter centre has incorporated all of the necessary auxiliary requirements for safe treatment by ESWL in a suite designed for the purpose. This enables ESWL, percutaneous lithotripsy, and ureteric stone manipulation to be carried out as a single or combined procedure under the same anaesthetic. This paper analyses critically the treatment and follow up of the first 50 patients treated with ESWL in Britain.

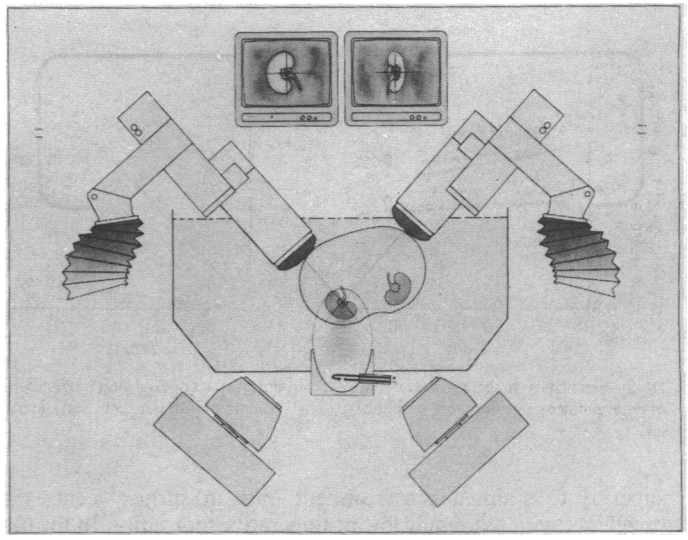

FIG 1—Schematic diagram showing three dimensional localisation of renal calculus in second focus of ellipse by biplanar fluoroscopy (by courtesy of Dornier).

Patients and methods

Of the 50 patients, 26 were National Health Service patients referred from elsewhere and the remainder were referred directly to the Devonshire Hospital lithotripter centre. The average age was 49 (range 22-83).

Suitability for treatment was decided by a panel of urologists and radiologists. Suitable stones were those in the renal collecting system that could be localised radiologically and were able to pass spontaneously after fragmentation via an unobstructed urinary system. Patients who were unfit for anaesthetic or had an incorrectable clotting disorder or a cardiac pacemaker were rejected. Due to the limitation in size of the supportive cradle and the short distance (20 cm) between the two foci patients under 130 cm in height or over 135 kg in weight could not be treated.

Fifteen patients were women and 35 men. Fourteen had had previous

Devonshire Hospital Lithotripter Centre, and Academic Unit, Institute of Urology, London W1M 7PG

J E A WICKHAM, MS, FRCS, director
D R WEBB, FRACS, DOBSTRCOG, research fellow and urologist
S R PAYNE, MB, FRCS, fellow in percutaneous renal surgery
M J KELLET, MB, FRCR, consultant radiologist
G WATKINSON, superintendent radiographer

St Bartholomew's Hospital, London EC1

H N WHITFIELD, MCH, FRCS, consultant urologist

Correspondence to: Mr J E A Wickham.

surgery for renal stones on the affected side. Nine had multiple ipsilateral calculi, 11 had solitary symptomatic caliceal calculi over 1 cm in diameter, and three had partial or complete stag horn calculi. Two had large upper ureteric stones, which were manipulated transurethrally under image intensifier control back into the renal pelvis and then treated by ESWL under the same anaesthetic. The remainder had pelvic renal stones. Three patients had stones in solitary kidneys.

All patients underwent plain abdominal radiography (kidney, ureter, and bladder), renal ultrasonography, routine biochemical testing, analysis of urine, and a full clotting profile before treatment. One third of the patients underwent epidural anaesthesia and the remaining two thirds intubated general anaesthesia. After anaesthesia a urethral catheter was inserted. Treatment was performed by a urologist using the Dornier systems extracorporeal shock wave lithotripter (fig 1). Shock waves were triggered by the R wave of the electrocardiogram. The position of the calculus and progress of disintegration were checked radiologically every 100 shock waves and the electrode replaced after every 700 shock waves. All patients received co-trimoxazole orally before and after the procedure. A plain *x* ray film of the kidney, ureter, and bladder was taken immediately after treatment to confirm adequate disintegration, and the passage of stones was monitored by a further *x* ray film and renal ultrasonography two days later. The patients were discharged when they were comfortable and mobile and showed radiological evidence of progression of the stones without severe ureteric obstruction. All patients were reviewed 10 days after treatment with a further *x* ray film and ultrasound scanning, and follow up was arranged for three months. The urine was strained and the fragments sent for biochemical analysis. All symptoms and intake of analgesics were recorded.

Results

Localisation of stones was satisfactory in all patients. One fairly lucent pelvic stone (urate) required intravenous contrast for positive identification. The position of the patient on the frame was found to be critical, and three patients had to be removed from the bath and repositioned (fig 2). Patients who had received epidural anaesthesia were able to cooperate with positioning and transfer on to and off the frame and were not at all alarmed by the procedure. Both forms of anaesthesia seemed equally effective for treatment. One patient developed ventricular extrasystoles during treatment. In this case the shock waves were hand triggered owing to a technical problem with the electrocardiogram. The arrhythmia settled spontaneously. Another patient developed a sinus bradycardia with a rate of 40 beats/minute. This resolved after the patient was removed from the bath and given intravenous atropine. The treatments were then completed without further incident.

Almost all patients developed macroscopic haematuria during treatment, which settled spontaneously within a few hours. Five developed mild bruising at the entry or exit sites of the shock waves on the body. These were not tender or painful and rapidly resolved. All calculi disintegrated satisfactorily.

The average operative time (excluding anaesthetic) was 23·5 minutes (range 10-60 minutes), which is roughly half the average time for percutaneous extractions. The average number of applications of shock waves was 779 (range 300-2000). The diameter of the stones averaged 31 mm and ranged from 8 mm to 8 cm in two patients with large stag horn calculi.

Patients spent an average of 3·7 days (range 2-10 days) in hospital, but this depended on whether further procedures were required; 28 patients required no postoperative analgesia, and only four required parenteral narcotic analgesia. The remainder were comfortable with oral non-narcotic analgesics. Three patients were readmitted for a maximum of 48 hours for ureteric colic after discharge. Fevers of over 37·5°C in three patients resolved with oral antibiotics alone and lasted less than two days.

At discharge 34 patients showed radiological evidence of progression of fragments and seven had a "steinstrasse" (a radiological description of fragments in the ureter making a long fine cast of the lumen). Seven were completely free of stones. On ultrasound scanning six had mild dilatation and one had moderate and one complete obstruction. At follow up nearly all patients had resumed normal activity in less than one day, the maximum being five days.

Auxiliary procedures were required in four patients. An 83 year old patient with a 3 cm stone in a solitary kidney developed pain and obstruction four days after ESWL; this rapidly resolved after temporary fine needle nephrostomy. A 22 year old woman with hyperoxaluria, large bilateral stag horn calculi, and a nephrostomy required percutaneous clearance of the renal fragments. One patient developed a severe urethritis because of the catheter and required cystoscopy and stone basket extraction of the lower ureteric and bladder fragments. The fourth patient, a 65 year old man with a solitary kidney, developed obstructive anuria and acute renal failure. He required open ureterostomy in situ to treat his severe renal failure, which resolved rapidly after this drainage.

Discussion

With no deaths and minimal morbidity the procedure has been shown to be safe and effective and is universally accepted by patients. It is clearly a specialised urological procedure. A patient undergoing ESWL must be managed by a "stone centre" capable of supplying this skill. The number of days spent in hospital is similar to that for percutaneous renal surgery[10] (3·7 compared with 4·9) and considerably less than that for open surgery (12-17 days).

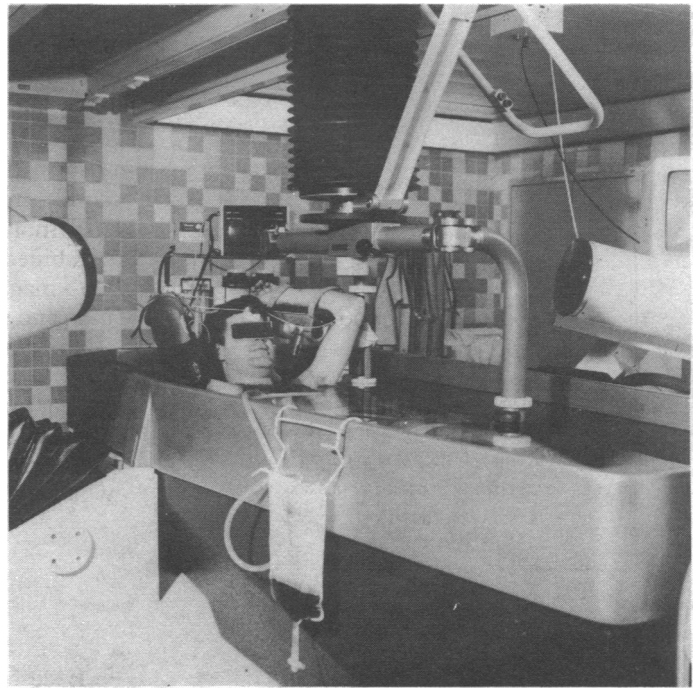

FIG 2—Patient suspended in bath before positioning of image intensifiers.

There is an extremely brief convalescence period after discharge, which effects large savings to the hospital, patient, and community. The incidence of auxiliary procedures and intervention (8%) compares well with other series (18%).[7] This must be expected to rise as more difficult stones are treated.

A larger stone mass and a solitary or compromised drainage system obviously require extremely close postoperative monitoring to avoid serious complications. If anticipated these can be avoided by minimal or non-invasive techniques.

References

1 Scott R, Freeland R, Mowat W, *et al.* The prevalence of calcified upper urinary tract stone disease in a random population—Cumbernauld health survey. *Br J Urol* 1977;**49**:589-95.
2 Ljunghall S, Hedstrand H. Epidemiology of renal stone disease in a middle-aged male population. *Acta Med Scand* 1975;**197**:439-45.
3 Wickham JEA, Kellett MJ. Percutaneous nephrolithotomy. *Br Med J* 1981;**283**:1559-629.
4 Chaussy C, Brendel W, Schmeidt E. Extra corporeally induced destruction of kidney stones by shock waves. *Lancet* 1980;ii:1265-8.
5 Miller K, Fuchs G, Rassweler J, Eisenberger F. Financial analysis, personnel planning and organisational requirements for the installation of a kidney lithotripter in a urological department. *Eur Urol* 1984;**10**:217-21.
6 Chaussy C, ed. *Extra corporeal shock wave lithotripsy*. Basle: Karger, 1982.
7 Wilbert DM, Muller SC, Alken P, Hohenfellner R. Extra corporeal shock wave lithotripsy—Mainz experience. In: *Abstracts of the second world congress on percutaneous renal surgery*. Mainz: University of Mainz, 1984:55.
8 Fuchs G, Miller K, Bub P, Eisenberger F. Extra corporeal shock wave lithotripsy: critical experience and results. In: *Abstracts of the second world congress on percutaneous renal surgery*. Mainz: University of Mainz, 1984:53.
9 Yutkin LA. *Electro hydraulic effect*. (Document 62—15184MCL1207/1-2.) New York: US Department of Commerce Offers of Technical Services, 1955.
10 Wickham JEA, Miller RA, Kellett MJ. Percutaneous nephrolithotomy: results and cost effectiveness. *Br J Urol* 1983;Suppl:103-6.

(Accepted 4 March 1985)