

One hundred cases of anaesthesia for Extracorporeal Shock Wave Lithotripsy

MIRIAM FRANK FFARCS

Senior Lecturer and Honorary Consultant

EDWARD J McATEER FFARCS

Senior Lecturer and Honorary Consultant

DAVID G COHEN FFARCS

Lecturer and Honorary Senior Registrar

IAN J BLAIR FFARCS

Lecturer and Honorary Senior Registrar

Anaesthetics Unit,

The London Hospital

Key words: ANAESTHESIA; CALCULI, RENAL; SURGERY, EXTRACORPOREAL, SHOCKWAVE LITHOTRIPSY

Summary

One hundred cases of anaesthesia for Extracorporeal Shock Wave Lithotripsy (ESWL) are described. Epidural or general anaesthesia was used. Anaesthetic complications were mainly cardiovascular, namely hypotension and bradycardia. With increased experience, it was noted that the use of minimal concentrations of general anaesthetic agents, or epidural anaesthesia supplemented with ephedrine, decreased the incidence of these problems. There was a low incidence of nausea or vomiting or analgesic requirements postoperatively, and the average length of stay in hospital postoperatively was 3 days.

Introduction

The destruction of urinary calculi by shock waves was described by a Russian engineer in 1955 and until recently its clinical application has been confined to the destruction of bladder calculi and percutaneous lithotripsy. The Lithotripter (Dornier System GmbH) was developed to provide a totally noninvasive method of renal stone desintegration by shock waves. It was first introduced in the U.K. in 1984 (1).

The Lithotripter consists of three components; a shock wave generator, an x-ray imaging device and a computer-assisted patient positioning facility. The shock wave is generated by a spark discharge between two electrode tips situated in the first focus of an ellipsoidal reflector placed at the base of a water-filled stainless steel bath. The shock wave, which is a sharply peaked high energy pulse, is transmitted through the water and body tissues to reach the second focus of the reflector 20 cm above the first, where the full effect of the shock wave is concentrated. Paired x-ray image intensifiers, whose axes intersect at the second focus of the reflector, guide the positioning of the patient through a computerised hydraulic system to bring the kidney stone within this focus (Fig. 1). The shock waves are ECG r-wave triggered, this ensures their passage through the body during the heart's refractory period and minimises the arrhythmias otherwise associated with this procedure. The repeated shock

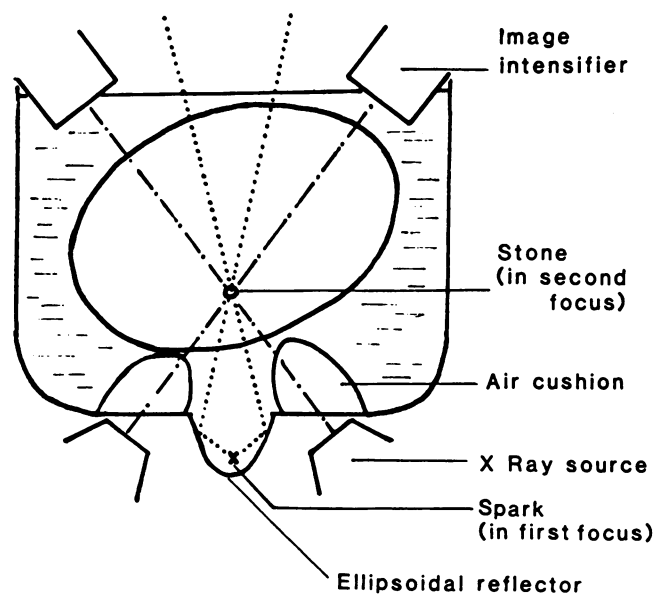


FIG. 1 Cross section of lithotripter.

waves cause the breakdown of the stone's structure, producing small fragments which are passed in the urine.

Initial experience in Germany has shown that Extracorporeal Shock Wave Lithotripsy (ESWL) produces a painful stimulus of sufficient severity to require general or regional anaesthesia. Problems to be considered in this special situation include:

- 1 The sitting position which cannot readily be altered.
- 2 The depth of immersion in the bath and its effect on the peripheral vascular system and consequently on cardiovascular dynamics. The mass of water above the chest and abdomen increases the work of respiration.

- 3 Immersion into water maintained at body temperature which may also contribute to the peripheral vascular changes.
- 4 The relative inaccessability of the patient's airway.

Patients

Height and weight of patients must fall within specified limits to allow positioning of the stone in the secondary focus of the shock wave. The exclusion limits are at present a height of less than 130 cm and a weight of over 135 kg. Other exclusion criteria include coagulopathies which cannot be corrected, uncontrolled dysrhythmias, severe scoliosis and pregnancy. The application of ESWL to patients with pacemakers is currently under investigation.

One hundred patients were anaesthetised for lithotripsy. Eleven patients received epidural anaesthesia and 89 general anaesthesia. The age and sex distribution is shown in Table I. Of the patients anaesthetised 71 were ASA I. The remainder had cardiovascular or endocrine disorders and a smaller number had respiratory or neurological disease (Table II).

TABLE I. Age and sex distribution and anaesthetic technique

Age	Mean 49.25 (SD 14.11) yr	Range 13–80 yr
Sex	Male 82	Female 18
Technique	Epidural 11	General anaesthesia 89

TABLE II. ASA classification and intercurrent disease

ASA Grade	Number of patients
I	71
II	29
Cardiovascular disease	
Hypertension	10
Dysrhythmia	4
Myocardial ischaemia	2
History of infarction	1
Respiratory disease	
Asthma	2
Tuberculosis	1
Endocrine disease	
Diabetes mellitus	5
Gout	3
Neurological disease	
Transient ischaemic attacks	1
Multiple sclerosis	1
Familial tremor	1

Some patients enter into more than one category

Anaesthetic technique

All patients were unpremedicated, the majority (85%) received midazolam (1–5 mg) IV before the epidural or the anaesthetic induction. Each patient was preloaded with 500–1000 ml, 4.0% dextrose in 0.18% saline before bath immersion. A standard technique was used for epidural anaesthesia, the catheter being placed at L2–3 or L3–4. Five patients received bupivacaine 0.5% alone, the remaining 6 received a combination of lignocaine 1.5% and bupivacaine 0.5%. The upper level of block aimed for was T6 to allow analgesia in the region of the entry and exit of the shock wave. The standard technique for general anaesthesia was a barbiturate induction followed by a nondepolarising neuromuscular blocking agent to facilitate intubation and allow IPPV. Maintenance of anaesthesia was with a mixture of nitrous oxide and oxygen, with either enflurane or IV fentanyl (or alfentanil) or both. Bradycardia and hypotensive episodes were treated with atropine and sympathomimetics when necessary. Cardiovascular monitoring included continuous ECG, and the BP was recorded every 3–5

min using the Simonson and Weil combined monitoring system.

Anaesthetic data

The average anaesthetic time for patients requiring only ESWL was 57.26 min (SD 24.5, range 25–190 min). Five patients had ureteric stones and these required to be manipulated transurethrally into the renal pelvis prior to ESWL as a combined procedure. The average anaesthetic time for these patients was 90 min (SD 21.2, range 60–120 min). The average number of shock waves given was 1003 (SD 538, range 200–2000). At present, the maximum number of shock waves has been limited to 2000 at any one treatment.

Cardiovascular Changes

The IV fluid given prior to entering the bath was in order to compensate for possible postural hypotensive effects and also to maintain a high urinary output to flush out stone fragments.

HYPOTENSION

Over half the patients maintained their systolic arterial pressure (SAP) within 20% of the preinduction value. In 36 patients, SAP fell by 20–40% and in 9 by greater than 40%. In the epidural group 4 patients had hypotensive episodes where the systolic pressure dropped by 20–40%. The other patients remained normotensive (within 20% of initial value). In the group who received general anaesthesia 48 patients remained normotensive, 32 had a fall of 20–40% and 9 had a fall greater than 40% in their SAP (Table III).

TABLE III. Changes in systolic arterial pressure (SAP)

	SAP (% Decrease from baseline)		
	<20%	20–40%	>40%
General anaesthesia	48	32	9
Epidural	7	4	0
Total number of patients	55	36	9

When analysed according to anaesthetic agents used the following was found; 11 out of 38 patients who received vecuronium had hypotensive episodes, in the atracurium group 17 out of 49 had similar episodes. Of the patients who received enflurane 13 out of 39, and of those who received fentanyl or alfentanil 21 out of 43 had falls of systolic pressure greater than 20% of the original value.

Ten out of 100 patients were controlled hypertensives, 5 remained normotensive during anaesthesia, 4 had hypotensive episodes of 20–40% and 1 of more than 40%.

BRADYCARDIA

Patients were divided into 4 groups namely those with heart rates greater than 60, heart rate between 50 and 60, between 40 and 50 and below 40, as shown in Table IV. Eighty patients maintained their heart rate above 60. Fourteen had heart rates of between 50–60, 4 between 40–50 and 2 below 40. Of the patients who had epidural analgesia 6 of them developed a rate of less than 60, 2 between 40–50 and 2 reached values of below 40, (the lowest being 34). The lowest heart rates reached in 3 of these patients were associated with the administration of methoxamine. In the group of patients who received general anaesthesia 5 out of 38 patients who received vecuronium became bradycardic and 10 out of 52 who received atracurium had heart rates below 60. Of 40 patients who received enflurane, 8 had bradycardia. Ten bradycardias were recorded in the fentanyl/alfentanil group of 50 patients. The association between bradycardia and hypotension is shown in Table IV.

TABLE IV Number of patients and respective heart rate (HR) reached during procedure

		HR (bpm)			
		>60	50-60	40-50	<40
Epidural		5	2	2	2
General anaesthesia		75	12	2	0
Total		80	14	4	2
SAP%	<20%	45	5	4	1
Decrease	20-40%	26	9	0	1
From Baseline	>40%	9	0	0	0

DYSRHYTHMIAS

Eight patients developed dysrhythmias while ESWL was in progress. Three were supraventricular in nature, the other 5 had ventricular ectopics. Normal rhythm was restored when the ESWL was temporarily discontinued. Two patients who were in long standing controlled atrial fibrillation and one patient with right bundle branch block were treated uneventfully. One patient with left bundle branch block had brief episodes of ventricular ectopics which reverted to normal rhythm.

Other anaesthetic related problems which arose with these 100 patients undergoing ESWL included three cases of difficult intubation. Two patients who received atracurium developed erythema, no further sequelae occurred. In six patients where the renal calculus was sited near the diaphragm, hiccups occurred during ESWL. One patient who had an epidural anaesthetic experienced pain when the water level dropped below the point of exit of the shock wave.

Postoperative Period

In the immediate postoperative period, 8 patients required parenteral anti-emetics and 9 required parenteral analgesia. In the first 24 hrs postoperatively, 62% patients required no analgesia, 25% required oral paracetamol, and 13% required parenteral pethidine.

Discussion

ESWL is a new noninvasive method of renal stone disintegration. Since its introduction in 1980 over 15,000 cases have been treated outside the UK, and the first lithotripter in this country became operational in November 1984.

General anaesthesia was used predominantly in this series of 100 patients. Epidural anaesthesia was found to have the advantage that patients were able to cooperate in their transfer to and from the adjustable chair used for their positioning, and the reduction of anaesthetic equipment attached to the patient in the bath. The disadvantage was the delay between treatments when there is only one anaesthetist.

Anaesthetic problems anticipated were mainly cardiovascular postural effects and possible interference with heart rhythm by the shock waves. Weber *et al.* (2) presented cardiovascular data showing increases in right atrial pressure, pulmonary capillary wedge pressure and pulmonary

artery pressure proportional to depth of immersion. Compression of the peripheral vessels by the hydrostatic pressure in the bath and a shift of the circulation to the central compartment was considered to underlie these changes. Dilatation of peripheral veins in the isothermic bath was noted in our patients and this is consistent with the hypotensive episodes already described. Further studies to investigate these changes are planned. Differential analysis of anaesthetic drugs used did not demonstrate any potentiation of hypotension by any one agent compared with the others. There was a clinical impression in the group of patients who received general anaesthesia that minimal anaesthesia was associated with normotension in contrast to the use of higher doses or concentrations of anaesthetic agents. Those patients who received epidural analgesia were maintained normotensive when IM ephedrine was administered before bath immersion. In a number of patients during our early experience, bradycardia was encountered in association with the use of methoxamine as the vasopressor agent. This is known to have beta receptor inhibiting effects (3), and has since been replaced by ephedrine without further incidences of severe bradycardia. Arrhythmias appeared in 9% of patients, these were brief in duration and reverted to normal rhythm.

Other complications encountered have been described. Four percent of patients who received atracurium had evidence of histamine release, this lies between figures previously published (4, 5). Six percent of patients with high renal calculi developed hiccups during treatment. It is likely that this was associated with diaphragmatic irritation by the proximity of the path of the shock wave. In one patient, pain was experienced at the exit site of the shock wave only when the water level fell below it. This may have resulted from the refraction and possible reflection of the shock wave at the tissue-air interface.

The immediate postoperative period was noted by a low incidence of nausea or vomiting and of analgesic requirements. The latter, particularly, is in marked contrast to the course following invasive nephrolithotomy. This applies also to the postoperative time to hospital discharge, an average of 3 days in contrast to open surgery (12-17 days) and percutaneous lithotripsy (5 days).

We would like to thank the medical and nursing staff of the London Lithotripter Centre and Mrs Amanda Plumer for her secretarial assistance.

References

- 1 Wickham, JEA, Webb DR, Payne SR, Kellet MJ, Watkinson G, Whitfield HN. Extracorporeal shock wave lithotripsy: the first 50 patients treated in Britain. *Br Med J* 1985;290:1188-9.
- 2 Weber W, Madler CH, Schmucker D, Peter K, Chaussy CH. Aspects of shock wave treatment in patients with cardiac risk. In: Abstracts of the Second World Congress on Percutaneous Renal Surgery. Mainz; University of Mainz 1984:55.
- 3 Karim SMM. Sympathetic B-receptor blocking action of methoxamine. *Br J Pharmacol* 1965;24:365-74.
- 4 Sokoll MD, Gergis SD, Mehta M, Kemmotsu O, Rudd D. Haemodynamic effects of atracurium in surgical patients under nitrous oxide, oxygen and isoflurane anaesthesia. *Br J of Anaesth* 1983;55:77-9S.
- 5 Collins KM, Plantevin OM, Docherty PW. Comparison of atracurium and alcuronium in day case gynaecological surgery. *Anaesthesia* 1984;38:1134-5.