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Comparative evaluation of general, epidural and spinal anaesthesia for extracorporeal shockwave lithotripsy

JEREMY K RICKFORD FFARCS
Senior Registrar
HUGH M SPEEDY FFARCS
*Locum Senior Registrar**
St Thomas's Hospital, London

JENNIFER A TYTLER FFARCS
Locum Senior Registrar†
MORTON LIM MD MRCP FFARCS
Consultant Anaesthetist

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Summary

The results of a prospective randomised evaluation of general anaesthesia (GA), epidural anaesthesia (EA) and spinal anaesthesia (SA) for extracorporeal shockwave lithotripsy are presented. GA provided speed and reliability but resulted in a high incidence of postoperative nausea, vomiting and sore throat. Both regional techniques conferred the advantages of an awake, cooperative patient, but EA required a longer preparation time than SA and more supplementary treatment with fentanyl or midazolam. A major drawback associated with the use of SA was a 42% incidence of postspinal headache. All three techniques were associated with hypotension on placement in the hoist; bath immersion resulted in significant rises in blood pressure in the EA and SA groups and a more variable (overall non-significant) response in the GA group.

Introduction

Since the introduction of extracorporeal shockwave lithotripsy (ESWL) into clinical practice in 1980 *(1)*, both general and regional anaesthesia have been used successfully to facilitate treatment. Although some complications involved with these techniques have been described *(2–5)*, no comparative evaluation has been made and the use of spinal anaesthesia has not been fully reported. We present here the results of a prospective randomised study to evaluate the use of general, epidural and spinal anaesthesia for ESWL.

Patients and methods

The study was confined to patients aged 17–70 years, ASA grades I and II, who were randomly allocated to receive one of the following anaesthetic regimens: Group I ($n=25$)—general anaesthesia (GA); Group II ($n=28$)—epidural anaesthesia (EA); Group III ($n=25$)—spinal anaesthesia (SA). Approximately 65% of patients treated were inpatients and the remainder were day case referrals from other centres. The patients were starved preoperatively and received atropine 0.6 mg i.m. approximately $\frac{3}{4}$h before treatment. All patients had a 14 or 16 gauge intravenous cannula inserted under local analgesia (1% lignocaine) and received a loading dose of 10 ml/kg Hartmann's solution before commencement of the anaesthetic procedure.

The standard GA technique involved induction with methohexitone (1.5 mg/kg), fentanyl (1 μg/kg), vecuronium (0.1 mg/kg), droperidol (0.05 mg/kg) and metoclopramide (10 mg). The latter two drugs were included because our initial (unpublished) experience with GA had indicated a relatively high (50–60%) incidence of postoperative nausea and vomiting. Tracheal intubation with a Portex® endotracheal tube was performed following onset of muscle relaxation and anaesthesia maintained with oxygen (33%), nitrous oxide (67%) and enflurane (1–2%). Intermittent positive pressure ventilation was performed using a Manley ventilator with minute and tidal volumes of approximately 85 ml/kg and 7 ml/kg respectively. Incremental doses of vecuronium (1–2 mg) were administered as necessary and residual neuromuscular blockade reversed at the conclusion of treatment with neostigmine and atropine in standard dosage.

Epidural anaesthesia was performed at T12/L1 or L1/L2 interspace with the patient lying in the lateral position. Analgesia to pinprick extending up to T4–T6 was achieved with bupivacaine hydrochloride 0.5% (15–25 ml) injected via the Tuohy needle following location of the epidural space using the loss of resistance to saline

*†Present appointments: *Senior Registrar, Leeds General Infirmary, Leeds, LS1 3EX; †Locum Senior Registrar, National Hospital for Nervous Diseases, Queen Square, London, WC1 3BG.

Correspondence to: M Lim, St Thomas's Hospital, London SE1 7EH.

technique. Following removal of the Tuohy needle, the puncture site was sealed with Nobecutane® spray and a waterproof adhesive dressing applied.

Spinal anaesthesia was achieved using bupivacaine hydrochloride 0.5% in glucose 8%. Following location of the subarachnoid space with a 25 gauge needle (L2/3 or L3/4 interspace), 2.5–3.0 ml of the solution was injected with the patient positioned laterally with a slight head down tilt. Sensory blockade was then carefully monitored over the ensuing minutes and as soon as analgesia to pinprick was detected at the T6 dermatome, the patient was repositioned horizontally. The puncture site was sealed in the manner described for epidural analgesia. An ultimate level of sensory blockade extending to T3–T6 was achieved in all patients in this group.

Blood pressure was recorded with a Dinamap® automated blood pressure recorder. For all patients, falls in systolic pressure greater than 30% of pre-anaesthetic recorded pressures were treated with intravenous bolus injections of ephedrine (5–15 mg). Details of patient height, weight, age and resting blood pressure were recorded prior to anaesthesia. Further recordings were made of the time taken to induce anaesthesia (preparation time); time spent in the bath (treatment time); number of shock waves delivered; blood pressure changes on induction, positioning in the hoist, immersion in the bath (water maintained at 38°C) and after onset of treatment. For the regional anaesthesia groups, details of supplementary treatment with analgesic, sedative and anti-emetic drugs were recorded.

All patients were allowed to mobilise as soon as they felt capable of doing so. Postoperative morbidity was recorded by means of 2 questionnaires. The first, completed by the patient on the day following treatment enquired about nausea, vomiting, headache, abdominal pain, backache and urinary retention. Following reports of late onset (2–3 days postoperative) headaches in some patients who had received SA, and an apparent high incidence of sore throat in patients treated under GA, a second questionnaire was subsequently sent to the patients at home enquiring specifically about these problems in the first postoperative week and patient preference for an alternative anaesthetic technique in the event of a second treatment being necessary. The interval between the date of the procedure and receipt of the second questionnaire varied from 1 to 9 weeks for all the patients in the study.

For between-group comparisons, the significance of results was assessed by using χ^2 test (with Yate's correction) for binary outcome variables and analysis of variance for continuous outcome variables. Paired *t*-testing was used for changes within each group.

Results

At the outset it had been intended to include at least 100 patients in this study. During the course of the study however, it became apparent that a high proportion of patients receiving SA were experiencing postspinal headaches and the study was therefore curtailed after only 78 patients. In 17 cases, it proved impossible to collect complete data and these were, therefore, excluded from the analysis. The remaining 61 patients were divided amongst the 3 groups as follows: GA—20 patients; EA—22 patients; SA—19 patients. There were no signi-

TABLE I *Details of patients in the 3 groups. Values given are mean (s.d.)*

	(Group (n))		
	SA (19)	*EA (22)*	*GA (20)*
Age (yrs)	45 (17.9)	45 (12.3)	46 (12.4)
Weight (kg)	79 (9.1)	77 (10.5)	74 (7.5)
Height (cm)	172 (8.8)	173 (8.0)	173 (8.8)
Sex M/F	15/4	16/6	13/7

TABLE II *Intra-operative details for the 3 groups. Values given are mean (s.d.)*

	Group (n)		
	SA (19)	*EA (22)*	*GA (20)*
Preparation time (mins)	27.8 (6.8)	43.4 (14.5)	19.7 (6.0)*
No. of shocks	1326 (560)	1750 (600)	1122 (672)*
Bath time (mins)	36.0 (9.0)	35.0 (12.0)	36.1 (18.8)
Patients who received supplementary fentanyl/ midazolam	10.5%	36.4%	0%*
Patients who received anti-emetics	10.5%	18.2%	0%

*$P<0.05$

TABLE III *Changes in systolic and diastolic BP associated with various manoeuvres during treatment. All values mean (s.d.)*

		Group (n)		
		SA (19)	*EA (22)*	*GA (19)*
Pre-induction BP	Systolic	130.7 (17.6)	142.0 (18.1)	140.0 (17.4)
	Diastolic	74.1 (11.9)	83.5 (10.9)	83.7‡ (12.1)
Pre→post induction ΔBP	Systolic	−11.6† (15.3)	−17.9† (15.9)	−12.3† (14.2)
	Diastolic	−7.5* (13.0)	−11.2 (14.3)	−6.7* (12.4)
Pre→post placement in hoist ΔBP	Systolic	−18.5† (13.8)	−12.2† (12.7)	−24.0†‡ (16. 9)
	Diastolic	−10.7† (8.5)	−8.7† (9.6)	−18.5†‡ (15.5)
Pre→post immersion ΔBP	Systolic	+14.0† (18.3)	+13.7† (11.4)	+3.1‡ (16.1)
	Diastolic	+9.0† (11.9)	+7.1† (6.5)	+1.1 (12.6)
Pre-post 5 min of treatment ΔBP	Systolic	+7.4* (11.4)	+0.6 (10.7)	+6.7 (17.5)
	Diastolic	+1.2 (11.7)	+1.0 (8.4)	+8.0† (11.1)

*$P<0.05$ within group
†$P<0.01$ within group
‡$P<0.05$ between groups

ficant differences between the groups with regard to age, weight and height (Table I).

Intra-operative details are shown in Table II. It will be seen that the EA group required the longest preparation time and the greatest number of shocks during treatment, and was also associated with a high requirement for supplementary midazolam/fentanyl. Of the 8 patients (36%) in this group who required supplementary therapy, 6 complained of pain and in 4 of these, the pain was alleviated by fentanyl (50–200 μg) whilst the remaining 2 requested full general anaesthesia: 2 other patients in the EA group, whilst denying any pain, were unable to keep still, but responded well to intravenous midazolam (5–10 mg): 4 patients (18%) in the EA group required administration of anti-emetics because of nausea (unassociated with hypotension or bradycardia) during shockwave bombardment. SA was associated with a shorter preparation time and a lesser need for supplementary treatment compared with the EA group.

Changes in blood pressure during the procedure are shown in Table III and Fig. 1. In all 3 groups, induction of anaesthesia and positioning in the hoist were associated with falls in systolic and diastolic blood pressures.

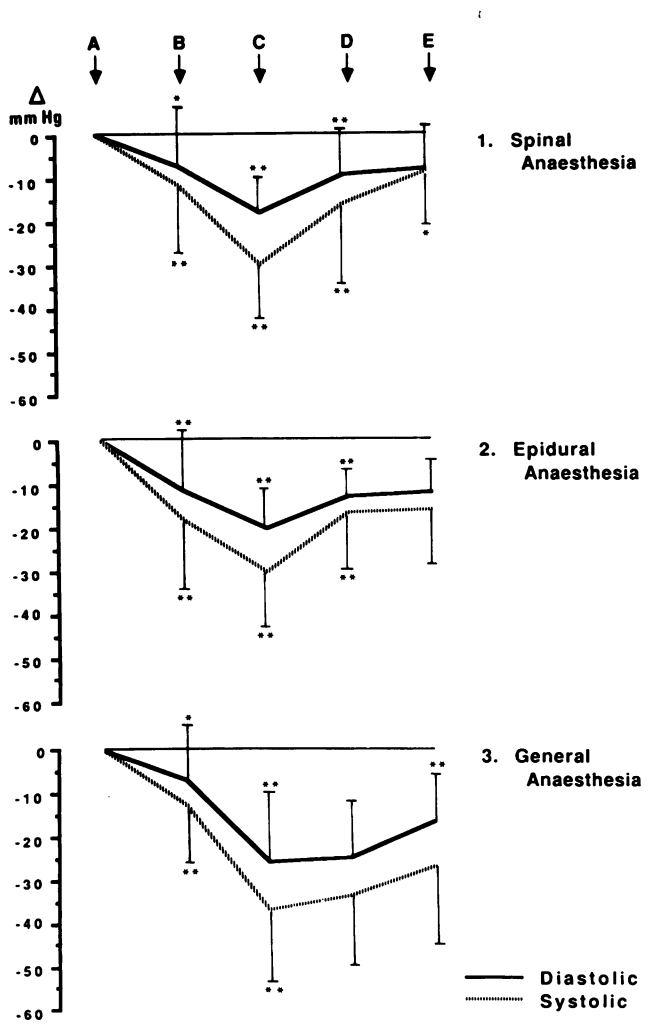

FIG. 1 Changes (mean±s.d.) in systolic (●– – – –●) and diastolic (●——●) blood pressure during stages of treatment. A=pre-induction; B=post-induction; C=post-hoist placement; D=post-bath immersion; E=5 min post-onset of ESWL. *$P<0.05$; **$P<0.01$ when compared with preceding stage

TABLE IV *Results from first[1] and second[2] postoperative questionnaires*

	Group (n)		
	SA (19) %	*EA (22)* %	*GA (20)* %
Nausea and vomiting[1]	21.1	27.3	50
Abdominal pain[1]	36.8	45.5	25
Backache[1]	36.8	45.5	20
Headache[1]	10.5	18.2	15
Urinary retention[1]	0	27.3	0*
Headache[2]	52.6	18.2	11.1*
Sore throat[2]	15.8	4.6	44.4*
Preference for[2] alternative technique	31.6	31.8	27.8

*$P<0.01$

Immersion in the bath resulted in rises in systolic and diastolic blood pressures in the EA and SA groups, but not the GA group. Onset of treatment was associated with a rise in systolic pressure in the SA group and diastolic pressure in the GA group. Six (30%) patients in the GA group, 5 (23%) in the EA group, and 5 (26%) in the SA group received ephedrine (5–15 mg) during the period incorporating hoist placement and immersion in the bath.

The results from the 2 postoperative questionnaires are shown in Table IV. GA was associated with the highest incidence of nausea, vomiting and sore throat, whilst EA was associated with the highest incidence of backache and urinary retention. Although the initial responses indicated a relatively low incidence of postoperative headache in the SA group, the results from the second questionnaire indicate that this was a major problem subsequently. The overall incidence of headache in the SA group was 53% as compared with 18% and 11% in the EA and GA groups respectively. Eight of the 10 patients in the SA group (42%) who complained of headaches identified a clear relationship to posture and coughing and were therefore classified as suffering from postspinal headaches.

There was no difference in the proportion of patients in each group who expressed a preference for an alternative anaesthetic technique.

Discussion

From a logistic point of view, regional anaesthesia is obviously advantageous for ESWL in that awake patients who retain motor power in their arms can assist in placement in the hoist and the risk of accidental extubaton or ventilator tube disconnection during treatment in the bath is eliminated. However, in our study, preparation time was prolonged when the regional techniques were used and although SA was quicker to perform than EA, preparation time for the former was still approximately 8 min longer when compared with GA. The time factor can be obviated by assigning 2 anaesthetists for each treatment session so that one looks after a patient in the bath while the other performs the regional block on the next patient, but unavoidable delays may be incurred if there is only one anaesthetist per list, especially if supplementary sedation is found to be

necessary in some patients with inadequate sensory blockade (see below).

In spite of achieving somatic sensory blocks extending to T3–T6 (SA) and T4–T6 (EA) before the start of shockwave therapy, both regional techniques were associated with a significant need for supplementary drug therapy during the procedure. This was most marked in the EA group—2 patients in this group eventually requiring full general anaesthesia. This finding is at variance with an early claim that sensory blockade to T7 would provide sufficient cover for the procedure *(2)*, but it is perhaps not surprising in view of the fact that the region around the focus in which half the peak pressure is exerted has been shown to be cigar-shaped, about 12 cm long, orientated along the major axis of the ellipsoidal reflecting dish, with a maximum diameter of 2 cm centred on the focus *(6)*—a region which can clearly encompass abdominal organs other than the kidney.

With regard to the changes in blood pressure, it is interesting to note that the falls in both systolic and diastolic pressures following placement in the semi-upright position in the hoist were most marked in the GA group. Furthermore, whereas the majority of the patients receiving either SA or EA responded to immersion with a rise in systolic and diastolic pressures (mean changes showing a significant rise at the $P<0.01$ level), patients undergoing GA showed a marked variation in their response to immersion, with several patients exhibiting further falls in systolic blood pressure ranging from 1–30% of their pre-immersion values (mean change NS) (Table III and Fig. 1). This latter phenomenon is in accord with the observation of Weber *et al. (7)* who postulated that the occasional hypotension seen in some anaesthetised patients following immersion in a warm bath could be the result of temperature induced vasodilation. A further possibility to consider is that myocardial depression induced by enflurane *(8)* may well have compromised the ability of some of the patients to respond to the increase in preload associated with immersion in the bath.

From the practical point of view, it is clear that the period incorporating transfer into the hoist and immersion in the bath is one where the patient who is receiving a GA is susceptible to significant hypotension and appropriate care should therefore be taken to ensure early detection and treatment. Patients undergoing regional anaesthesia are similarly susceptible to hypotension during the hoist placement, but the tendency is for systemic pressures to normalise on immersion. In all cases, although the hypotension associated with hoist placement may to a certain extent be minimised by prior administration of fluid, the subsequent increase in preload resulting from immersion *(7)* dictates that any fluid 'preloading' should be performed judiciously and that it may be preferable to counteract any hypotensive tendency prior to immersion with a vasoconstrictor such as ephedrine.

Although we did not assess the degree of stone movement associated with spontaneous and controlled ventilation in our patients, all the lithotripter operators commented on the convenience of the regular and controlled stone movement resulting from IPPV for stone placement in the focal zone, as opposed to the often irregular and jerky movements occurring during regional blockade. In this context, it should be noted that patients undergoing GA with IPPV required the least number of shocks for stone fragmentation. However, no formal attempt was made to match either stone size or type, or lithotripter operators in this series and no definitive conclusion can therefore be drawn regarding the effects of these 3 anaesthetic regimens on stone fragmentation.

The main postoperative complaints in patients undergoing GA were nausea and vomiting, in spite of the administration of prophylactic anti-emetics at induction of anaesthesia, and sore throat. Surprisingly, several patients in the EA and SA groups also complained of postoperative nausea and vomiting, and this together with the observed incidence of nausea during treatment lead us to question the assertion of Abbot *et al. (2)* that the shockwaves are free of any effect on the gastrointestinal tract.

There was no significant difference between the groups in the incidence of postoperative abdominal pain and backache, but it is clear that the major problem associated with the use of SA is the high incidence of postspinal headache (42%) which led us to curtail the study. The incidence recorded is surprising in view of the fact that previous studies have reported that it can be minimised with use of a 25 gauge needle *(9)*, and that early ambulation does not predispose towards its occurrence *(10, 11)*. It does however, approximate the 37% incidence of postspinal headache quoted for a group of outpatients who underwent spinal anaesthesia with a 25 gauge needle in a recent publication *(12)*. There are two factors which may have contributed towards the high incidence of headaches observed. Firstly, it is possible that placement of the patient in the hoist, in a position which may result in a certain degree of flexion of the lumbar spine, so soon after performance of the dural puncture, may cause an accentuation of CSF leakage. Secondly, we actively enquired specifically about the occurrence of headaches over a one week period, and it will be noted that whereas the incidence in the first postoperative day was 11%, extension of the period covered to a full postoperative week resulted in the high incidence observed. One encouraging feature which did emerge from the survey was that the headaches were all confined to patients under the age of 60 years. This finding is in agreement with the general observation that the incidence of postspinal headache appears to decrease with age *(13)*.

Although postoperative headaches were not a particular problem in the EA group, there was a significant number of patients in the group who developed urinary retention which required catheterisation. This may be an important consideration in those units such as ours where catheterisation is not routinely performed during treatment.

In conclusion, our results indicate that in the main, both GA and EA are suitable techniques for ESWL. The main advantages of the former are its speed and reliability, whereas the latter confers the logistic advantages of an awake patient who can cooperate in hoist transfer and avoids the dangers associated with maintaining general anaesthesia in a relatively inaccessible milieu. SA was quicker to perform than EA and appeared to provide better analgesia, but was associated with a 42% incidence of postspinal headache. All 3 techniques were associated with significant falls in systemic blood pressure on placement in the hoist; bath immersion resulted in significant rises in blood pressure in the EA and SA

groups, and a more variable (overall non-significant) response in the GA group.

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ERRATUM

Fine needle aspiration cytology, with immediate reporting, in the outpatient diagnosis of breast disease Thomas C B Dehn MS FRCS *et al. Annals*, November 1987, vol 69, p280.

Summary—The penultimate sentence should read:

There were no false positive diagnoses and only one false negative cytological diagnosis of breast cancer.