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A comparison of spinal and epidural anaesthesia for hip arthroplasty

Spinal and epidural anaesthesia were compared in 65 patients undergoing hip arthroplasty, with regard to the degree of sensory and motor blockade, cardiovascular effects, operating conditions, the dose of propofol required to produce satisfactory hypnosis, and complications. Epidural anaesthesia was successful in 30 patients using an initial dose of 15 ml of 0.5% bupivacaine, and spinal anaesthesia in 32 patients, using 4 ml 0.5% isobaric bupivacaine. The two techniques were similar with regard to the level of sensory blockade (T_8), degree of hypotension and perioperative haemorrhage. Differences occurred in the degree of motor blockade (mean Bromage score of 1 in the spinal group vs 3.86 in the epidural group) ($P < 0.05$), time to achieve maximal cephalad spread (13 min in the spinal group vs 21 min in the epidural group) ($P < 0.05$) and the dose of propofol required to produce adequate hypnosis ($1.95 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ in the spinal group vs $2.89 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ in the epidural group) ($P < 0.05$). Only seven patients required urethral catheterization in this spinal group compared with 14 in the epidural group ($P < 0.05$). Spinal anaesthesia also proved advantageous by providing better operating conditions for the surgeon, with a lower incidence of patient movement.

Cette étude compare la rachi-anesthésie et l'anesthésie péridurale chez 65 patients subissant une arthroplastie de la hanche. Les paramètres évalués sont le niveau du bloc de conduction sensitif, la qualité du bloc moteur, les effets cardiovasculaires, la facilité d'accès chirurgical, les complications et

la quantité de propofol nécessaire pour maintenir une hypnose au cours de l'intervention. L'anesthésie péridurale est réalisée avec succès chez 30 patients en utilisant une dose initiale de 15 ml de bupivacaine 0,5%. La rachi-anesthésie est faite avec succès chez 32 patients en utilisant 4 ml de bupivacaine 0,5% isobare. Les deux techniques sont associées à un bloc de conduction sensitif de niveau T_8 . La chute de pression et les saignements périopératoires sont comparables avec une technique ou l'autre. Le bloc moteur moyen est de 1 à l'échelle de Bromage avec la rachi-anesthésie comparativement à 3,86 avec l'anesthésie péridurale ($P < 0,05$). La migration céphalade maximale de l'agent anesthésique est plus rapide avec la rachi-anesthésie (13 min versus 21 min; $P < 0,05$). La dose de propofol nécessaire pour maintenir l'hypnose est de $1,95 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ chez les patients du groupe rachi-anesthésie comparativement à $2,89 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ chez les patients du groupe péridurale ($P < 0,05$). Sept patients du groupe rachi-anesthésie versus 14 patients du groupe péridurale ont besoin de cathétérisme vésical ($P < 0,05$). La rachi-anesthésie est associée à moins de mouvements des patients durant la chirurgie, et de ce fait elle permet un meilleur accès chirurgical.

Key words

ANAESTHESIA: regional, epidural, spinal;
ANAESTHETICS, LOCAL: bupivacaine;
SURGERY: orthopaedic.

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The complications of spinal and epidural anaesthesia, as well as the relative advantages of the two techniques, have recently been comprehensively reviewed.^{1,2} The choice between techniques has also been the subject of recent editorial comment.³ Although both techniques are now widely used to provide anaesthesia for hip arthroplasty, there has been no controlled trial of the comparative merits of either technique for this particular procedure, which is often carried out in elderly patients and is associated with a considerable perioperative blood loss⁴ and with a high incidence of postoperative thromboembolism. Furthermore, iatrogenic bacteraemia must be avoided, as an infected prosthesis carries a severe morbidity. This prospective randomized study sets out to evaluate efficacy, cardiovascular effects, acceptability and complications of epidural vs spinal anaesthesia for hip arthroplasty.

Methods

The study was approved by the Ethics Committee of the University of Cape Town.

Sixty-five patients scheduled for primary hip arthroplasty were entered into the study after giving informed written consent. Patients with fixed cardiac output states, a bleeding disorder, skeletal abnormalities of the spine or neurological disease were excluded. All patients received premedication with oral diazepam $0.15 \text{ mg} \cdot \text{kg}^{-1}$, two hours preoperatively. In the induction suite a Plasmalyte B preload of $12 \text{ ml} \cdot \text{kg}^{-1}$ was given, a supine baseline blood pressure was recorded using a non-invasive, blood pressure monitor (Dinamap-Critikon), whereafter patients were prepared and draped in the sitting position. Using random numbers, patients were then allocated to either an epidural or spinal group.

In the epidural group the epidural space was located at L_{3-4} using an 18-gauge Tuohy needle and loss of resistance device (Portex). Bupivacaine 0.5%, 15 ml, was injected through the Tuohy needle as two increments – a 5-ml test dose, followed four minutes later by 10 ml injected over 60 sec. A catheter was then introduced into the epidural space for supplementary bupivacaine if required. In the spinal group lumbar puncture was performed in the L_{3-4} interspace using a 25-gauge spinal needle, and 4 ml of isobaric bupivacaine 0.5% was injected over ten seconds.

The Dinamap was set to measure and record at one-minute intervals, then the patients were placed in the supine position and after 15 min the Dinamap was reset to record at five-minute intervals, which was continued for the duration of the procedure.

The cephalad spread of sensory blockade was measured by determining the upper level of analgesia to pinprick at five-minute intervals until a maximum height was reached. The degree of motor blockade of the lower limbs was measured at five-minute intervals using a Bromage score⁵ (1 = complete paralysis; 2 = movement of feet only; 3 = slight flexion of knees; 4 = full flexion of knees) for 30 min or until complete paralysis occurred. In the epidural group injection of the test dose was taken as time zero.

Hypnosis was provided with an infusion of propofol, initiated at a dose of $2 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ and adjusted according to individual response, to abolish verbal communication and movement. Intraoperative fluid therapy consisted of crystalloid (Plasmalyte B), colloid (Haemaccel) for intraoperative hypotension, defined as systolic blood pressure $<66\%$ of baseline, and whole blood or packed red cells if blood loss was predicted to result in a haemoglobin concentration of $<8.5 \text{ g} \cdot \text{dl}^{-1}$. Blood loss was assessed by weighing swabs and measuring the volume suctioned from the operation site.

TABLE I Demographic data – spinal vs epidural anaesthesia

		Spinal	Epidural
Age yr	Mean	59.4 ± 14.8	59.7 ± 16.3
	Range	18–82	18–83
Weight kg	Mean	67.8 ± 14.3	67.4 ± 8.8
	Range	47–90	40–93
Sex	Male:Female	13:19	13:17

Oxygen saturation, measured throughout, using pulse oximetry (Oxyshuttle-Critikon), was maintained $>90\%$ using oxygen-enriched air via a ventimask.

Sensory and motor blockade were monitored at 15 min intervals after surgery until there was a two-segment regression of sensory block and the minimum Bromage score had increased by one point.

Any unacceptable patient movement reported by the surgeon, who had no knowledge of the anaesthetic technique used, was noted and the anaesthetic was deemed unacceptable. Further assessment included the measurement of postoperative blood loss via a portovac drain during the first 24 hr and the need for urinary catheterization.

Results were analysed using Student's *t*, Fischer's exact or Wilcoxon rank sum tests where appropriate. $P < 0.05$ was considered statistically significant.

Results

Thirty-two patients were randomized to the epidural and 33 to the spinal group. The groups were similar with regard to age, sex and weight (Table I). One patient in the spinal group (sensory level L_2) and two in the epidural group (unilateral left-sided block for right-sided surgery and no sensory deficit after 40 min) had an unsatisfactory level of sensory blockade and, following the institution of general anaesthesia, were not subjected to further investigation.

While the degree and duration of sensory blockade were similar (Table II), there was a marked difference in the degree of motor blockade, as indicated by the Bromage score. All patients in the spinal group had a Bromage score of 1 and all but one patient in the epidural group had a score of 4, with the one exception having a score of 3. Two patients in the spinal and nine in the epidural group ($P < 0.05$) exhibited an unacceptable degree of lower limb movement intraoperatively. There was no difference in the degree of hypotension, intraoperative or postoperative blood loss (Table III). The propofol required by the epidural group $2.89 \pm 1.5 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ was greater than in the spinal group $1.95 \pm 0.8 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ ($P < 0.05$).

Seven patients in the spinal and 14 in the epidural

TABLE II Sensory blockade – spinal vs epidural anaesthesia

		Spinal	Epidural
Mean height of sensory block	Mean	T ₈ ± 2.2	T ₈ ± 2.15
	Range	T ₄ –T ₁₂	T ₄ –T ₁₂
Time to maximum height (min)		13 ± 7	21 ± 4*
Time to 2 segment regression (hr)		3.74 ± 0.85	3.46 ± 1.03

**P* = 0.05.

TABLE III Degree of hypotension, intraoperative blood loss and postoperative drainage: spinal vs epidural anaesthesia

	Spinal	Epidural
% decrease of systolic blood pressure	18.5 ± 11.1	20.3 ± 9.3
Intraoperative blood loss (ml)	850 ± 497.8	961 ± 696.6
Postoperative blood loss (ml)	774.4 ± 302.3	819.3 ± 371.6

group required catheterization for urinary retention after surgery (*P* < 0.05). In the spinal group catheterization occurred 4.2 ± 1.7 hr after transfer to the postoperative high care unit compared with 4.7 ± 2.3 hr in the epidural group (*P* > 0.05).

Discussion

The study has shown a number of advantages of spinal anaesthesia over the epidural technique, viz: more rapid cephalad spread, increased motor blockade, decreased dose of propofol to produce hypnosis, less patient movement and urinary retention requiring catheterization. Furthermore, this study has not demonstrated decreased haemodynamic stability with the spinal route.

The study was performed at a peripheral orthopaedic hospital, where anaesthetic staffing is such that the use of blind assessors to the quality of anaesthesia, could not be considered. We believe that measurement of both sensory and motor blockade is objective enough so as not to detract from the merit of this unblinded study.

Patients in the epidural group were given an initial dose of 15 ml 0.5% bupivacaine with the facility to increase the dose via the epidural catheter. This volume has previously proved to be adequate for hip arthroplasty.⁴ In this study an acceptable sensory level was obtained in all but two patients. One patient developed a unilateral block and the other had no appreciable loss of sensation after 40 min, casting doubt on the site of injection. Given this, and the tendency to compartmentalization of the epidural space,⁶ it appeared both futile and dangerous to increase the volume of bupivacaine via the catheter, and general anaesthesia was instituted.

A major reason advanced for the preference of the extradural route is the threat of hypotension caused by the sudden and very extensive vasomotor block associated with the intrathecal route.⁷ Numerous studies have demonstrated this phenomenon, but these have all been in obstetrical patients.^{8,9} Furthermore, comparison of the haemodynamic stability of the epidural route is purely historical.⁷ This study has demonstrated an equal degree of haemodynamic stability in patients undergoing total hip replacement.

An important finding was the decreased incidence of urinary retention resulting in catheterization. The sympathetic outflow to the lower urinary tract promotes urine storage. When intravesical pressure reaches a critical level, stretch receptors in the bladder wall initiate efferent impulses that reach the spinal cord via pelvic nerves. Such activation elicits parasympathetic efferent release of acetylcholine, with detrusor contraction and internal sphincter relaxation. Urinary retention is due to complex effects on peripheral and central neurogenic mechanisms controlling the micturition reflex. These would include autonomic blockade, estimated to be three times longer than two segment regression time.¹⁰ Catheterization occurred well within this period in both groups. Epidural anaesthesia produces only partial motor blockade as opposed to the more intense block affected by the spinal technique. It is possible that this variability produced by epidural anaesthesia also applies to autonomic blockade, with a relatively intact sympathetic supply. This is the first description of this difference between the extradural and intrathecal route in the induction of central neural blockade. The implications are important in the context of hip arthroplasty. Sepsis following hip arthroplasty usually results in the rejection of the prosthesis. Bacteraemia and metastatic infection may follow urethral instrumentation¹¹ and the need for catheterization increases the incidence of deep sepsis following hip replacement to 6.2%¹¹ – compared with an infection rate of 0.5% when operations are performed in clean air.¹² Therefore, spinal anaesthesia, with an incidence of catheterization similar to general anaesthesia,¹³ appears to offer an advantage over the epidural technique in this respect.

The shorter time taken to achieve maximal cephalad spread in the spinal group is inconsequential when seen in the total context of the rigorous preparation and draping routine required for hip arthroplasty in a clean air enclosure.

The Bromage score has been criticized as a qualitative indicator of motor blockade and does not evaluate the block quantitatively.¹⁴ In this study, however, there was good correlation between the different degree of motor blockade, as measured by the Bromage score, and the

difference in the number of patients exhibiting an unacceptable degree of movement. Two patients in the spinal group, with an initial Bromage score of 1, exhibited unacceptable lower limb movement intraoperatively in spite of adequate sensory block, indicating relatively brief motor blockade. The remainder of the spinal group of patients had complete relaxation throughout the procedure.

While the improved motor function produced by epidural anaesthesia may be advantageous in terms of venous stasis, the absence of motor function produced by spinal anaesthesia produces better operating conditions for the surgeon. Furthermore, excessive patient movement is not merely of nuisance value, but could have deleterious consequences were the patient to move during the seating of a cemented prosthesis. Fortunately this did not occur in this study.

A further difference between the groups was the higher dose of propofol required by patients in the epidural group. Similar results have been reported previously. Valli and Rosenberg provided additional analgesia to 11 of 15 patients who received epidural anaesthesia, whereas only one of 15 patients who received spinals had these requirements.¹⁵ In a large retrospective study comparing continuous spinal to continuous epidural anaesthesia in elderly patients, there was no difference in the requirement for intraoperative sedative or analgesic drugs. However, the epidural group in that study had received more premedication.¹⁶ This is the first prospective study demonstrating less sedative requirements in patients undergoing hip surgery. The higher rate of propofol infusion required by the epidural group probably reflects the need for deeper hypnosis in an attempt to provide similar operating conditions, and abolish the excess movement resulting from retained motor function.

In summary, spinal anaesthesia provided better operating conditions, and required less supplemental hypnosis to produce satisfactory conditions. A further, important advantage was that it resulted in less urethral instrumentation. Whether the increased degree of motor function provided by the epidural technique imparts protection against DVT requires further investigation.

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