EPIDURAL ANAESTHESIA FOR LUMBAR LAMINECTOMY AND SPINAL FUSION¹

D. MATHESON, F.F.A.R.C.S.²

THIS STUDY is limited to anaesthesia for operations on the lumbar and lumbosacral spine. It includes operations for correction of disorders of the intervertebral discs, of abnormal articular mobility and of other anomalies such as spondylolisthesis. It excludes new growths and infective processes.

These operations are, for the most part, conducted on otherwise healthy, and, usually muscular, individuals in the 30- to 50-year age group, the great majority being males.

The approach to the lumbar spine is rendered difficult by the size of the muscle mass, and the ultimate corrective part of the procedure is carried out in the depth of a narrow confined space, whose floor is readily obscured by oozing of blood.

POSITIONS USED

At this centre the majority of these operations are performed with the patient in the prone position with bolster supports, and with varying degrees of table flexion. Alternatively the lateral position with thighs and knees flexed is much less frequently used, and rarely the squatting position is employed.

ANAESTHETIC CHOICE

In order to provide good operating conditions, the anaesthesia should ensure a reasonably dry surgical field, with adequate muscle relaxation, and guarantee the safety of the patient. The procedures so frequently entail the use of electrical coagulating currents that the choice of a non-explosive anaesthetic technique is mandatory. Changes of posture in an anaesthetized patient, such as turning from the supine to the prone position or vice versa, can cause dramatic falls in blood pressure, and have been known to produce cardiac arrest. With this in mind, the choice of subarachnoid block offers a big advantage in that it can readily be induced with the patient already in the prone operating position, when a hypobaric solution is used. Epidural analgesia, on the other hand, is usually induced in the lateral position with flexion of thighs and knees, but because there is incomplete loss of motor power the patient himself can assist in his change to the prone position with a resultant lesser effect on haemodynamic stability, or alternatively he may position himself before the block becomes effective without any physiological upset whatsoever.

¹Presented at the Section of Anaesthesia, Conjoint Meeting British Medical Association and Canadian Medical Association, Edinburgh, July 22, 1959.

²Department of Anaesthesiology, Vancouver General Hospital, and the University of British Columbia.

General anaesthesia suffers greater disadvantages in this respect. Furthermore it is the impression of many of the surgeons and anaesthetists at this centre that more annoying bleeding occurs with this method, in the presence of adequate ventilation, than with regional methods, the end results of this being a prolongation of the operating time as well as increased demands on the blood bank.

MacMillan (1) claimed satisfactory operating conditions with minimal blood loss and few postoperative sequelae, using epidural block. Lucca Escobar, and Castillo (2) reported superior results in 34 cases using catheter epidural Xylocaine or Metycaine block. On the other hand, Bonica *et al.* (3) reported results inferior to subarachnoid block in 66 cases, in that analgesia was not always complete. They postulated that this might be due to interference with spread of the anaesthetic solution by the lesion. However, the paper of Lucca Escobar and Castillo (2) reported no difficulty in this respect. Bromage (4) states that epidural block with a stronger-than-usual addition of adrenalin (epinephrine) provides excellent operating conditions for laminectomies.

This paper attempts to analyse and compare the results of 211 lumbar laminectomies and/or spinal fusions performed at the Vancouver General Hospital in the past three years. Of these, 93 cases had epidural block, 29 had combined epidural block and general anaesthesia, 27 had subarachnoid block, 26 had general anaesthesia using N₂O and Pethidine (Demerol), and 29 cases had general anaesthesia with N₂O and Fluothane (halothane). During the past 12 months, a careful measurement of blood loss has been made in each case and the results are compared later in this paper.

SELECTION OF CASES

Choice of method was determined by acceptability to the patient, by the anticipated duration of the operative procedure, and by the anticipated technical facility or difficulty of producing regional block. Regional analgesia was avoided, first, when the patient had strong objections to the method and secondly when such severe pain and acute muscle spasm were present that suitable positioning would have been impossible. Regional and general anaesthesia involving endotracheal intubation was employed for anticipated very lengthy procedures, and general anaesthesia alone was used when the patient refused to consider regional methods. Previous laminectomy or spinal fusion was not necessarily considered a contraindication to either subarachnoid or epidural block.

EPIDURAL BLOCK

Method

The agent used for all patients was 2 per cent Xylocaine (lidocaine, lignocaine) with 1:300,000 adrenalin (epinephrine). A standard dosage of 20 ml. was injected at L2-3 or L3-4 in all patients. Catheters were not employed in any case. There was considerable variation in the height of analgesia obtained with this standard dose, the average being to T6 or T7. In two patients, analgesia did not extend higher than the level of the site of injection, although it was adequate below this level. In one patient, analgesia was patchy below the L3 dermatome although

adequate above this level and extending as far as T4. In one case in which the myelogram showed a complete block there was a slight delay in the onset of analgesia below the level of the lesion, but analgesia became complete within 5 min. after the area above the lesion. In one patient there was considerable pain on injection of the analgesic solution no matter how slowly this was done. This patient had had a previous laminectomy, and at this present operation the ligamentum flavum was found to be extensively adherent to the dura mater at the site of laminectomy. However, there was no difficulty with diffusion of the solution which gave complete analgesia above and below the lesion. In this series, then, diffusion below the lesion was not a problem, failure having occurred in one case only.

Hypotension

Prophylactic vasopressor drugs were not used routinely pre-induction, and in no case was there any sudden severe hypotension. A more gradual lowering of the blood pressure was the rule with the lower limits becoming manifest very shortly after the establishment of the full extent of analgesia. Depression of systolic blood pressure below an arbitrary figure of 75 mm. Hg was controlled by fractional doses of a vasopressor drug such as Methedrine (methyl amphetamine). Recourse to these was not frequently required.

Duration of Analgesia

Duration ranged from 2½ to 4 hours, the average being about 3 hours. Most patients were given "sleeping" doses of Nembutal and/or Thiopentone (Pentothal), and in the longer procedures waning analgesia was supplemented with intravenous Pethidine (Demerol) either in fractional doses or in the form of a continuous drip.

Ventilation

No artificial airway was used in any case; Lucca Escobar and Castillo (2) reported airway difficulties associated with nasal congestion occurring in the prone position. This difficulty was not experienced in this series. Inefficiency of respiratory effort due to high block did not occur in any case. An increase in the amount of bleeding was usually noted about the 2-hour mark and occurred so regularly that it was attributed to the termination of the local action of adrenalin rather than to the accumulation of CO₂ resulting from possible inadequate ventilation.

Muscle Relaxation

In the majority of patients the muscle relaxation was satisfactory, although inferior to that obtained by subarachnoid block. In one or two cases the surgeon commented that the muscle was "a little tight."

Blood Loss

The general impression was that the operative field was drier with this type of block than with any other method, particularly deep down in the wound in the paravertebral tissues. Surgery was thereby facilitated and took less time. A

comparison of the actual amounts of blood loss are given in the following tables. It should be noted that in the patients given general anaesthesia breathing was either spontaneous or assisted manually. Positive-negative phase ventilators were not used.

Table I suggests that in the case of "laminectomy only" there is no appreciable difference in the blood loss with any of the methods, save perhaps in the cases done with N₂O/Pethidine. However, the number of cases done with the latter method is too small to be significant.

TABLE I
LAMINECTOMY ONLY

Agent	No. of cases	Percentage given blood or blood substitute	No. of cases	Average case measured blood loss (cc.)
Epidural	36	2.7	21	214
Subarachnoid block	5	0	5	209
Combined epidural and general	6	0	0	—
N ₂ O/Pethidine	2	0	2	337
N ₂ O/Fluothane	7	14	7	208

TABLE II
LAMINECTOMY AND SPINAL FUSION

Agent	Without iliac bone			With iliac bone		
	No. of cases	Percentage given blood or blood substitute	Case average blood loss	No. of cases	Percentage given blood or blood substitute	Case average blood loss
Epidural	9	22	322 cc.	48	35	298 cc.
	5			14		
Subarachnoid	4	50	—	18	56	615 cc.
Block	0			5		
Combined	8	25	297 cc.	15	67	494 cc.
Epidural & General	3			5		
N ₂ O/	11	82	691 cc.	13	77	644 cc.
Pethidine	3			3		
N ₂ O/	10	90	804 cc.	19	63	664 cc.
Fluothane	4			11		

Table II compares the blood loss occurring in "laminectomy and spinal fusion" first when fusion does not include the use of iliac bone and secondly when iliac bone is used. In this respect, cases of fusion, where a bone graft from the tibia is used, are included in the A columns of Table II, because the tibial graft is taken while using a tourniquet and entails no additional bleeding. Table II strongly suggests the superiority of epidural and combined epidural and general in all fusions.

Table III compares the case average measured blood loss in all types of operation. In operations lasting less than 2 hours, epidural block, subarachnoid block, and combined epidural and general gave better figures than general anaesthesia, while in operations lasting more than 2 hours and in all types and durations of operation, epidural gave decidedly lower blood loss figures.

TABLE III
CASE AVERAGE MEASURED BLOOD LOSS ALL OPERATIONS

Agent	No. of cases	A Less than 2 hours (cc.)	B More than 2 hours (cc.)	C All operations (cc.)	D Blood loss range (cc.)
Epidural	41	146	364	263	26-1,000
Subarachnoid block	10	143	821	414	34-1,664
Combined epidural and general	8	147	459	420	147- 880
N ₂ O/Pethidine	8	388	703	585	216- 998
N ₂ O/Fluothane	22	218	697	544	110-1,500

Table IV further subdivides the types and durations of operations. Here again there does not appear to be any significant difference in blood loss in "laminectomies only" taking less than 2 hours. In "laminectomies and spinal fusions" taking less than 2 hours, epidural block shows an appreciable advantage. In operations taking more than 2 hours and particularly when fusion is involved, epidural block is markedly superior.

Reference to Table V will show that the duration of operations taking longer than 2 hours was greatest in the N₂O/Fluothane series and consequently one would expect a greater case average blood loss in this group. However, Part 2 of Table V shows that the mean operating time for all types of procedures was highest in the combined epidural and general group, and this is only to be expected as already mentioned in the paragraph on case selection, because combined epidural and general anaesthesia was applied mainly to cases in which lengthy operative procedures were anticipated. The average blood loss per operating hour is again lower in the case of epidural and combined epidural and general, than in the other methods. Prolongation of the operating time in the N₂O/Fluothane group may well have been due to lack of an adequately dry surgical field.

Repeat Operations

In the more recent cases in which accurate blood loss measurements were made, twelve cases of "repeat" laminectomy or fusion occurred. The indications so far are that the blood loss is very much higher in these cases and that there is little to choose between one anaesthetic method and another where there is a lot of scar tissue.

Special Cases

Conjecture arose as to why there should be less bleeding with epidural block than with subarachnoid block. Bromage (4) states that the added adrenalin produces local vasoconstriction and cuts down local bleeding round about the epidural space. With this in mind, one patient in this series was given an epidural injection of 20 ml. of *saline* with 1:250,000 adrenalin, following which general anaesthesia was induced with Thiopentone followed by N₂O/O₂ and intravenous Pethidine. The patient remained normotensive throughout the procedure, and although there was brisk bleeding from the superficial tissues, the paravertebral

TABLE IV
ALL OPERATIONS

Agent	Operations lasting less than 2 hours						Operations longer than 2 hours					
	Laminectomy only			Laminectomy and spinal fusion			Laminectomy only			Laminectomy and spinal fusion		
	No. of cases	Percentage given blood or blood substitute	Average measured blood loss	No. of cases	Percentage given blood or blood substitute	Average measured blood loss	No. of cases	Percentage given blood or blood substitute	Average measured blood loss	No. of cases	Percentage given blood or blood substitute	Average measured blood loss
Epidural	28 13	0	152 cc.	26 7	13	138 cc.	9 8	11	315 cc.	30 13	46	394 cc.
Subarachnoid block	4 4	0	136 cc.	15 2	47	156 cc.	1 1	0	500 cc.	7 3	71	928 cc.
Combined epidural and general	5 0	0	—	7 1	43	147 cc.	1 0	0	—	16 7	50	459 cc.
N ₂ O/pethidine	1 1	0	216 cc.	8 2	62	474 cc.	1 1	0	458 cc.	16 4	88	764 cc.
N ₂ O/Fluothane	5 5	0	157 cc.	5 2	40	368 cc.	2 2	0	333 cc.	24 13	83	753 cc.

TABLE V

Agent	Operations lasting longer than 2 hours		All operations	
	Average duration of operation (hrs.)	Average blood per hour (cc.)	Average duration of operation (hrs.)	Average blood loss per hour (cc.)
Epidural	2.5	158	2.1	125
Subarachnoid block	2.75	337	1.6	259
Combined epidural and general	2.9	158	2.75	153
N ₂ O/Pethidine	2.75	278	2.3	254
N ₂ O/Fluothane	3.1	243	2.6	209

tissues were relatively dry. This would support the adrenalin local vasoconstriction theory. However, a second case undergoing laminectomy only, a procedure which was not anticipated to take longer than one hour, was given an epidural block using 20 ml. of Xylocaine *without adrenalin* and here the lowest blood loss figure of the whole series was recorded—26 ml. It is hoped to do further work along these lines.

Comparison of Blood Pressure Charts

The blood pressure charts of the cases done with epidural block, with subarachnoid block, with combined epidural and general, and with general anaesthesia alone using N₂O/Fluothane were fairly comparable. There was a mean drop in systolic blood pressure in these cases of 30 mm. mercury. The average case was maintained at a systolic pressure of 75 to 100 mm. mercury. In the cases done with N₂O/Pethidine, however, there was considerable variation from one case to the next. Some patients remained normotensive, some were maintained with small falls of systolic pressure, while others showed elevated pressures throughout the procedures. In this series, no constant relationship could be shown between degree of hypotension and amount of blood loss.

Complications

Table VI shows no significant complication difference among the methods. There were five recorded cases of postoperative urinary retention requiring catheterization in the epidural cases—almost a 5 per cent incidence—but this was transient only. Apart from this, the postoperative course was mainly uneventful and most patients experienced a minimum of upset from the operation. Respiratory and gastrointestinal disturbance incidence was low in the epidural cases. There was no significant difference in the amount of analgesic drugs required postoperatively, between one method and another.

NOTE. General anaesthesia combined with controlled hypotension using ganglionic blocking agents such as thiophanium camphorsulphonate (Arfonad) are now seldom used at this centre, because results with their use had been extremely variable, were often disappointing in the matter of providing a "dry" field, and also because with this method one case of cardiac arrest during spinal fusion had occurred in a healthy adult male.

TABLE VI
POSTOPERATIVE COMPLICATIONS

Agent	No. of cases	Minor respiratory	Major respiratory	Gastro-intestinal upset	Head-ache	Transient urinary retention	Wound haematomata	Other delayed healing	Deaths
Epidural	93	Nil	Nil	1	1	5	1	1†	Nil
Subarachnoid block	27	1‡	Nil	3	1	1	2	1†	Nil
Combined epidural and general	29	1‡	1§	2	Nil	Nil	1	Nil	Nil
N ₂ O/Pethidine	26	3‡	Nil	2	Nil	Nil	1	Nil	Nil
N ₂ O/Fluothane	36	4‡	Nil	3	Nil	1	3	Nil	Nil

*Dura opened during surgery.

†Sero-sanguinous discharge lasting several days.

‡Mild sore throat or tracheal catarrh.

§Atelectasis and bronchopneumonia occurring in a bronchiectatic patient.

SUMMARY AND CONCLUSIONS

In a study of 211 cases of lumbar laminectomy and/or spinal fusion for correction of non-infective and non-malignant conditions, a comparison is made among various methods of anaesthesia and particularly with regard to blood loss and "dryness" of the surgical field. Epidural analgesia is considered a very satisfactory method for these operations, because of the relatively good operating conditions which it provides, together with minimal perioperative and postoperative upset to the patient. Its particular value lies in the fact that the depth of the surgical field remains relatively dry, thus ensuring an unobscured view of the more vital structures, and facilitating the approach to the diseased disk, as well as reducing the oozing of blood during spinal fusion. Its disadvantages lie mainly in the limited duration of its action and in the occasional technical difficulty in performing the block. It has not been shown in this series to possess any superiority to other methods, in providing a dry surgical field in repeat operations on the lumbar spine.

RÉSUMÉ

Cette étude se limite à l'anesthésie pour les opérations sur la colonne lombaire ou lombo-sacrée. Elle comprend les opérations visant à corriger les désordres des disques intervertébraux, de la mobilité articulaire anormale et des déformités comme le spondylolisthésis, sont exclues les excroissances et les infections.

Nous faisons une comparaison des résultats obtenus chez 200 malades avec l'épidurale, la rachianesthésie et l'anesthésie générale. En faisant cette comparaison, nous portons une attention spéciale au saignement dans le champ opératoire et à la quantité de sang perdu.

En comparant les quantités de sang perdu, nous en venons à la conclusion que, dans les cas où la laminectomie était la seule opération pratiquée, il n'y a pas de différence importante dans les pertes de sang avec les diverses méthodes, quoique, chez plusieurs cas d'épidurale, les chiffres fussent particulièrement bas.

Toutefois, chez les malades où la laminectomie a été suivie de fusion vertébrale,

les quantités les plus faibles de sang perdu ont été obtenus avec l'épidurale. Ce fait était particulièrement marqué, lorsque l'opération durait moins de deux heures. Lorsque l'opération se prolongeait de beaucoup au-delà de deux heures, chez les cas soumis à l'anesthésie épidurale, on observait une augmentation disproportionnée du saignement. L'induction de l'anesthésie générale, suivie de l'intubation endotrachéale, à la suite de l'anesthésie épidurale, a augmenté la perte sanguine de quantités dépassant celles des cas à l'épidurale seule.

La moyenne des pertes sanguines par cas a été moindre dans la série de cas faits à l'épidurale, plus considérable dans la série de cas faits avec N_2O , O_2 et Fluothane et intermédiaire dans la série de cas faits à l'épidurale et générale, à la rachianesthésie et au N_2O et O_2 et pethedine (Demerol). Mentionnons, toutefois, que, dans la série de cas faits au Fluothane, un petit nombre de cas seulement ont duré moins de deux heures et, dans les cas plus courts au Fluothane, les pertes sanguines étaient bien inférieures.

Nous n'avons pas noté de différences considérables dans les chiffres obtenus selon la position du malade: ventrale avec support ou autrement en position latérale.

L'épidurale: dans tous les cas, nous avons employé de la Xylocaine 2 pour cent avec adrénaline 1:300,000. Nous avons injecté une quantité standard de 20 ml. à L2-3 ou L3-4. Avec cette quantité, nous avons observé une variation considérable dans la hauteur de l'analgésie obtenue. Chez deux malades, l'analgésie ne s'est pas étendue au-dessus du site de l'injection, bien que, au-dessous, elle fût adéquate. Dans un cas, l'analgésie était inégale au-dessous du dermatome L3 bien qu'elle fut adéquate au-dessus de ce niveau. Chez tous les autres malades, l'analgésie s'est étendue de façon satisfaisante. Avant l'induction, nous n'avons pas injecté de routine d'hypertenseurs et rarement nous y avons eu recours après l'installation de l'analgésie même chez les malades où elle a atteint le niveau de T3. Nous n'avons pas observé de cas d'hypotension marquée. La durée de l'analgésie a varié entre 2½ heures et 4 heures, la moyenne étant de 3 heures. La plupart des malades ont reçu des quantités anesthésiques de Nembutal et/ou de thiopentone (Pentothal) et, dans les cas qui se prolongeaient et où l'analgésie disparaissait, l'on complétait par de la pethedine (Demerol) intraveineuse soit en doses fractionnées, soit en goutte-à-goutte. Chez aucun malade, l'on a dû installer un tube. L'évolution post-opératoire a été sans incident chez la plupart des cas.

S'il n'y a pas présence d'infection ou de malignité, l'épidurale s'est avérée une méthode d'anesthésie satisfaisante pour les opérations sur la colonne lombaire. Elle procure, dans la grande majorité des cas, de bonnes conditions opératoires.

REFERENCES

1. MACMILLAN, A. A. Department of Anaesthesia, Vancouver General Hospital; Personal communication.
2. LUCCA ESCOBAR, ROBERTO J., & CASTILLO, RAFAEL. Continuous Epidural Anaesthesia for Laminectomy. *Anesth. & Analg.* 37: 328 (Nov.-Dec., 1958).
3. BONICA, JOHN J.; BACKUP, PHILLIP H.; ANDERSON, CHARLES E.; HADFIELD, DALE; CREPPS, WILLIAM F.; & MONK, BENJAMIN F. Peridural Block: Analysis of 3,637 Cases, and a Review. *Anesthesiology* 18: 723 (Sept.-Oct., 1957).
4. BROMAGE, P. R. Spinal Epidural Analgesia. Edinburgh: E. & S. Livingstone Ltd. (1954).