EXTRADURAL BLOCK IN MAJOR SURGERY OF THE HIP

BY

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At the inaugural meeting of the Faculty of Anaesthetists of the Royal College of Surgeons in Ireland, Gray modified the well-known “triad” of anaesthesia to “sleep, relaxation, and the depression of undesirable reflex responses to injury” (Gray, 1960). He emphasized that the modern anaesthetist should abandon the concept of “broad-spectrum” anaesthesia—that is, the use of one agent to produce all desired effects by progressive depression of the central nervous system—in favour of the selective production of various desiderata of anaesthesia.

Applying these principles to operations on and around the hip joint, the writers have come to the conclusion that the anaesthetic requirements are often best fulfilled by a combination of light hypnosis and extradural block. In support of this contention, a review is presented here of the records of thirty cases of major surgery of the hip performed under extradural block, together with some discussion of the theoretical aspects of the argument. The operations were performed under extradural block in the two years immediately preceding July 1960, at Dr. Steevens’ Hospital, Dublin. By excluding all cases following the address by Gray that originally stimulated this paper, it is hoped to avoid any subjective bias in the selection of cases for this type of anaesthesia.

THE TECHNIQUE

The technique, the rationale for its choice, and its advantages and disadvantages have been described in a previous paper (Delaney, 1960). For the sake of brevity, a detailed recapitulation is omitted here.

The patients were premedicated with papaveretum 10 mg and hyoscine 0.2 mg. Sleep was induced, in the majority of cases, by the intravenous injection of a mixture of promazine (Sparine) 40 mg and Pethilorfan (pethidine and levallorphan) 60 mg in the ward about half an hour before operation. A number of other regimes was employed.

The extradural injection was performed about 10 to 15 minutes before the start of the operation. The standard lumbar approach was used together with the loss of resistance sign as described by Bromage (1954). Lignocaine 1.5 per cent with adrenaline 1:240,000 was the local analgesic solution used throughout the series. It is emphasized that the same standards of asepsis applied to the performance of the block as to the performance of the operation.

Anatomical considerations.

The nerve supply to this region is summarized below (Gray, 1949).

The motor supply to the muscles of the hip is from (a) the femoral nerve (L2, 3, 4); (b) the obturator nerve (L2, 3, 4); (c) the accessory obturator nerve when present (L3, 4); (d) the sciatic nerve (L4, 5, S1, 2, 3); (e) the superior gluteal nerve (L4, 5, S1); (f) the inferior gluteal nerve (L5, S1, 2); (g) the nerve to quadratus femoris (L4, 5, S1); (h) the nerve to obturator internus (L5, S1, 2); (i) twigs directly from S1 and 2, supplying piriformis.

These nerves are unaffected by lignocaine in a dilution of 1.5 per cent. Relaxation of the muscles they supply is the result of interruption of the reflex arcs maintaining tone on the afferent side.

Articular branches to the hip joint are given off by (a) the femoral nerve (L2, 3, 4) via the nerve to rectus femoris; (b) the obturator nerve (L2, 3, 4); (c) the accessory obturator nerve (L3, 4) when present; (d) the sciatic nerve (L4, 5, S1, 2, 3); (e) the nerve to quadratus femoris (L4, 5, S1); (f) directly from the sacral plexus.

The sensory supply to the more superficial structures is derived from the femoral, obturator and sciatic nerves.

The sensory supply to the skin over this area is from (a) the ilio-inguinal nerve (L1); (b) the genitofemoral nerve (L1, 2); (c) the medial and intermediate cutaneous nerves of the thigh (L2, 3); (d) the lateral cutaneous nerve of the thigh (L2, 3); (e) the lateral cutaneous branch of the twelfth thoracic nerve; (f) the lateral cutaneous branch of the ilio-hypogastric nerve (L1); (g) the posterior primary rami of the first, second and third lumbar roots; (h) the posterior primary rami of the first, second and third sacral roots;
(i) the posterior cutaneous nerve of the thigh (S1, 2, 3).

The autonomic nerve supply of the hip. Autonomic efferent and afferent fibres may reach the hip directly from the sacral sympathetic trunks but more often are conveyed through perivascular filaments or through the numerous nerves derived from the sacro-coccygeal plexus. The autonomic fibres to the cutaneous structures travel through similar perivascular and mixed spinal pathways. The segments of the cord from which the autonomic supply of the hip is derived lie between the eleventh thoracic and second lumbar segments (Mitchell, 1953).

Kiaer (1950) reported that pain afferents from the head and neck of the femur, in man, probably run through sympathetic nerves and the first and second lumbar ganglia.

From this summary, it will be apparent that in order to be successful the extradural block must extend as high as at least the twelfth or possibly the eleventh thoracic segment.

ANALYSIS OF THE SERIES

The results of all calculations throughout are given to the nearest whole number.

Age distribution.

Figure 1 shows a breakdown of the series according to age. The percentage of cases in the higher age groups is related to the incidence of osteoarthritis in these groups.

Operations.

Table I shows the series broken down according to sex and type of operation. The high percentage of central dislocation arthrodeses reflects the relative frequency of this operation in the practice of this hospital.

**Sleep.**

Hypnosis was achieved and satisfactorily maintained in thirteen cases with Pethilorfan and promazine alone; two of these cases were a little restless during the application of the spica. In addition, four patients given this combination of drugs required supplemental narcosis, three being given a 50 per cent nitrous oxide and oxygen mixture to breathe and one receiving 100 mg of thiopenone. Eight cases had a light general anaesthetic (thiopenone 100 to 200 mg, nitrous oxide and oxygen sequence). Four cases were given hydroxydione (Presuren) 0.5 g. with satisfactory results and one case was given sodium amylobarbitone 0.5 g. intravenously. This was unsatisfactory as a hypnotic, the patient being restless and confused and requiring additional small doses of thiopenone to a total of 250 mg. This is not unexpected in view of the experience of James (1943) and the recent work of Clutton-Brock (1959) and Dundee (1960). Table II illustrates these results in more detail.

It may also be of interest to note that patients who received Pethilorfan and promazine, though usually merely drowsy on arrival in the theatre, fell asleep with remarkable regularity following completion of the epidural injection. Possibly this is due to the absorption and central effect of the injected lignocaine. Dawkins and Steel (1957) and De Clive Lowe, Desmond and North (1958) have drawn attention to the properties of this drug when used as an intravenous or intramuscular analgesic. This has led to the suggestion (Editorial, 1958) that there may yet be a return to a technique
EXTRADURAL BLOCK IN MAJOR SURGERY OF THE HIP

TABLE II
Analysis of hypnotherapy

<table>
<thead>
<tr>
<th>Type of operation</th>
<th>Sex</th>
<th>Hypnotics</th>
<th>No. of cases</th>
<th>No. of cases</th>
<th>No. of cases</th>
<th>No. of cases</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pethilorfan + promazine</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Central dislocation arthrodesis</td>
<td>Male</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>5</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Moore's arthroplasty</td>
<td>Male</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Male</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>13</td>
<td>13</td>
<td>27</td>
<td>13</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Percentage of series

involving the use of only one drug, with the replacement of ether by lignocaine.

The extradural block.

The success rate, by chance, was 100 per cent for this series. However, with a little skill, a 98 to 99 per cent success rate can confidently be expected for any unselected series (Bromage, 1954).

The dose of lignocaine required ranged from 15 to 30 ml of the 1.5 per cent solution, with a mean value for the series of 24.3 ml (table III). Adrenaline was omitted from the solution in one case only. Women required less than men.

TABLE III
Average dose of lignocaine 1.5 per cent

<table>
<thead>
<tr>
<th>Type of operation</th>
<th>Dose of lignocaine in ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Central dislocation arthrodesis</td>
<td>26</td>
</tr>
<tr>
<td>Moore's arthroplasty</td>
<td>25</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>25</td>
</tr>
</tbody>
</table>

Analgesia was complete in all thirty cases. Two cases became restless during the application of the spica plaster; the patient who had sodium amylodarbarbitone was restless throughout. In all three instances, it was evident that the principal cause of the restlessness was a lightening of sedation rather than a fading of the block.

Patients required no postoperative analgesics for periods varying from 3 to 6 hours.

Relaxation was excellent in all cases.

Changes in blood pressure.

An initial fall in blood pressure following the induction of sleep was succeeded by a further fall following the extradural block. These are the usual concomitants of the loss of consciousness and extradural analgesia (Bromage, 1954; Swerdlow and Nabi, 1959; Wylie and Churchill-Davidson, 1960).

Figure 2 is an attempt to illustrate the rough correlation that exists between the maximum fall in systolic pressure (expressed here as a percentage of the pre-operative level) and the level of the pre-operative systolic pressure.

Changes in blood pressure.
These results are in line with those reported by Pugh and Wyndham (1950) in spinal anaesthesia, and are probably explicable in the light of the findings of Neumann, Foster and Rovenstine (1945) and Milwidsky and de Vries (1948). Plethysmographic and other studies by these workers revealed a compensatory vasoconstriction above the level of the block. In the presence of atherosclerosis, this is probably relatively ineffective and consequently the fall in blood pressure more profound.

The mean value of the maximum falls in systolic pressure expressed as percentages of the pre-operative levels, are compared for five categories of hypnotic in table IV.

The categories are too small to draw valid conclusions but there does not seem to be any significant variation.

There was no demonstrable direct relationship between the dose of lignocaine and the degree of hypotension. In six cases of central dislocation arthrodesis, each given 25 ml of 1.5 per cent lignocaine, the maximum fall in pressure varied between 20 and 50 per cent. The lowest dose employed for this operation was 15 ml, the highest 30 ml; the respective maximum falls were 59 and 30 per cent.

In the one case in which adrenaline was not used, there was a catastrophic fall to an unrecordable level which has been given the arbitrary value of 10 mm Hg. In view of the absence of gross haemorrhage, the cause was uncertain. Possibly, the lack of a local vasoconstrictor effect permitted the extension of the block to a level higher than that intended. It seems unlikely that adrenaline injected into the extradural space in a dilution of 1:240,000 and a total dose of about 0.125 mg would have any significant systemic effect.

Methylamphetamine and noradrenaline were the only pressor substances used in the series. The majority of cases (77 per cent) received methyamphetamine 15 to 30 mg intramuscularly as a routine before returning to the ward. During the operation, falls in pressure below 80 mm Hg systolic were corrected by intermittent intravenous injections of methyamphetamine or drip infusion of noradrenaline.

Table V compares the types of hypnotic used with the pressor requirements. It is apparent from this that methyamphetamine alone, was relatively ineffective in patients receiving promazine. The most profound hypotension of the series (already mentioned) occurred in a patient who had had none of the phenothiazine derivatives. The administration of methyamphetamine here produced an immediate and dramatic response.

Dundee (1958) and Swerdlow and Nabi (1959) have commented on similar findings. Dundee (1958) recommends phenylephrine as the most effective single-dose vasopressor in hypotension associated with the use of phenothiazine derivatives. Swerdlow and Nabi (1959) quote Armstrong-Davison as noting the efficacy of atropine.

Burn and Rand (1958) have postulated that there is a release of pockets of noradrenaline in the vessel wall by the action of ephedrine. Methylamphetamine may act in a similar manner. The known antagonism of the phenothiazine derivatives to adrenaline and, to a lesser extent, noradrenaline may be, therefore, a possible explanation of the lack of response to methyamphetamine following their use.

Methylamphetamine also failed to raise the blood pressure in the four patients who were given hydroxydione.

Blood loss and replacement.

It is generally accepted (Bromage, 1954; Dawkins, 1956) that bleeding is reduced under extradural analgesia. In order, therefore, to minimize an admitted subjective bias, the rough, clinical estimates made at operation of the amount

<table>
<thead>
<tr>
<th>Table IV</th>
<th>Correlation of hypotension and type of hypnotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pethilorfan + promazine alone</td>
<td>Pethilorfan, promazine and other agents</td>
</tr>
<tr>
<td>No. of cases</td>
<td>13</td>
</tr>
<tr>
<td>Mean per cent fall in systolic B.P</td>
<td>50</td>
</tr>
</tbody>
</table>
### Table V
Comparison of hypnotics and pressor requirements

<table>
<thead>
<tr>
<th>Type of hypnotic</th>
<th>Methylamphetamine</th>
<th>Noradrenaline</th>
<th>Methylamphetamine and noradrenaline</th>
<th>No vasopressors</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cases</td>
<td>Per cent</td>
<td>No. of cases</td>
<td>Per cent</td>
<td>No. of cases</td>
</tr>
<tr>
<td>Cases receiving promazine</td>
<td>5</td>
<td>29</td>
<td>3</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Cases receiving light general anaesthesia</td>
<td>4</td>
<td>50</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cases receiving Presuren</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Case which received amylobarbitone sodium</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>9</td>
<td>30</td>
<td>3</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>

### Table VI
Replacement of blood loss

<table>
<thead>
<tr>
<th>Amount of blood loss (ml)</th>
<th>Percentage of total number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>Central dislocation arthrodesis</td>
<td>6</td>
</tr>
<tr>
<td>Moore's arthroplasty</td>
<td>14</td>
</tr>
<tr>
<td>Miscellaneous operations</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
</tr>
</tbody>
</table>
of blood lost have been ignored for the purpose of analysis. Instead, as accurate records of blood replacement were kept, these have been analyzed and are set out in table VI as a guide to the severity of the bleeding. To the writers the amounts do not appear excessive for admittedly sanguinary procedures and it is fair to point out that in nearly every case, the estimates of actual blood loss are lower than the actual amount transfused.

Postoperative complications.
There were no fatalities and no major complications attributable to the anaesthetic. Persistent hypotension was not a problem; ensuring that all patients left the theatre with a satisfactory blood pressure, the routine administration of intramuscular methylamphetamine and the blocking of the foot of the bed on return to the ward as routine measures did much, it is thought, to prevent this complication of the technique. The return to normal of the blood pressure was accompanied in three cases by troublesome oozing from the wound. Postoperative vomiting was remarkable by its absence.

DISCUSSION
As stated earlier, the object of this study was to try to find a regime which did not use “broad-spectrum” anaesthesia, but one which specifically dealt with the problems involved in hip operations. These problems are the induction of sleep, the production of muscular relaxation, and the relief of painful stimuli or at least the depression of undesirable reflex responses brought about by noxious stimuli.

These points will be dealt with separately.

Sleep. Sleep was induced to prevent possible psychic trauma or embarrassment to the patient from the sounds of operative procedures or the unconsidered remarks of the surgeon.

Given a state of analgesia, the lightest possible degree of narcosis is desirable. Artusio (1955) suggests that a state of amnesia and analgesia, without gross impairment of the special senses or the ability to respond to the spoken word, is the optimal condition for major surgery. The writers have found that intravenous Pethilorfan and promazine is the simplest method of producing an approximation of this state.

It is free from the disadvantages of electroencephalographic control and intubation in the lightly anaesthetized patient as described by Artusio (1955) for his technique with ether. It does not produce the restlessness associated with the barbiturates; it is very much cheaper than the steroid basal narcotics and does not carry the same risk of venous thrombosis. In addition it has a supplemental analgesic action, is a fairly powerful anti-emetic and the risk of respiratory depression is negligible. The main disadvantages are the possibility of promazine-induced hypotension, the ineffectiveness of some vasopressors in its presence, the slow onset and long duration of its action, and the extra care these factors make necessary.

Its site of action, in common with chlorpromazine and other phenothiazines is probably the mesodiencephalic alerting system (Himwich, 1955; Rinaldi and Himwich, 1955; Hopkin, Buxton and Brown, 1958) and, in fact, it has been suggested (Wyke, 1960) that all general anaesthetic agents act at this same level.

Relaxation. As the approach to the hip is through some of the most powerful muscles in the body, and as operations such as that for central dislocation arthrodesis require considerable manipulation of the limb, it is obvious that adequate relaxation is an advantage. The alternatives are deep anaesthesia, the use of one of the muscle relaxants or a local block. The disadvantages of deep anaesthesia in poor-risk patients do not require reiteration. The use of relaxants is associated with a varying degree of respiratory paralysis and the attendant dangers of either inadequate ventilation or of assisted or fully controlled respiration in patients who are frequently emphysematous and whose cardiac reserves are often poor. These problems are not insuperable but with local analgesia they do not arise. Indeed, Bromage (1954) has pointed out that ventilation is frequently improved in the emphysematous patient undergoing extradural analgesia. Further, the interruption of the reflex arc on the afferent side produces perfect relaxation localized to the required area and does not interfere with voluntary movement.

The depression of undesirable reflex responses. The affective component of pain sensation is abolished by prefrontal leucotomy and suppression of the thalamus leads to the loss of all consciousness of pain as such. It is also “probably significant that
the concentration of ether required to block the reticular alerting system is of the same order as that required to produce analgesia; and it may be that the perception of pain or the reaction to it is served by projection fibres from this system” (Woolmer, 1957).

However, even in the decerebrate state, nociceptive impulses continue to produce widespread, prepotent reflex effects (Wright, 1956). The uninhibited interaction of these reflexes, together with other results of what has been called “the physiological trespass” of the surgeon, will eventually produce the complex clinical entity of “shock”. It is this end-product which the anaesthetist is concerned to abolish by the “depression of undesirable reflex responses to injury”.

Johnstone (1958) has laid the main responsibility for the initiation of the physiological train of events whose end result is the shocked patient, on the vasomotor section of the sympathetic system. He favours the control and limitation of shock by the paralysis of the efferent side of this system through the readily reversible action of halothane. The same results have been sought by the use of total spinal analgesia, ganglionic blockade, chlorpromazine, and by lowering the blood \( P_{\text{CO}_2} \) by hyperventilation (Gray, 1960). In both the latter, their effects are mediated probably, at least in part, through the reticular system.

Theoretically, however, it seems more logical to employ a technique which seeks to prevent the passage of all impulses from the site of injury, rather than to depend on the uncertain control of the effects of these impulses once initiated. Thus, local analgesia not only prevents the conscious appreciation of pain but blocks nociceptive impulses at their source. The action of the vasomotor centre in the floor of the fourth ventricle is modified by afferents from baroceptors, chemoreceptors, the sensory system and the cerebral cortex. Psychic factors are eliminated by the induction of sleep, the sensory afferents are blocked and the quiet respirations and low metabolic requirements of patients sedated by promazine undergoing extradural analgesia prevent marked changes in the pH value of the blood. Alterations in vasomotor activity in these cases, therefore, are dependent mainly on alterations in blood pressure.

In fact, provided care is taken to ensure adequate replacement of blood loss, there is noticeably less traumatic shock in cases receiving some form of nerve block (Evans, 1949; Dawkins, 1956; Gardner, 1958). Bromage (1954) has also shown that blockade of the operation site prevents the fall in circulating eosinophils reported by Roche, Thorn and Hills (1950) to occur in patients undergoing surgery under general anaesthesia.

Finally, while bleeding is scarcely a reflex it is certainly undesirable. The controlled hypotension of an extradural block produces a marked reduction in blood loss (Dawkins, 1956) and is the nearest approach to the ideal of the tourniquet that can be achieved for operations on the hip. It has led, in fact, to the statement by one of our surgeons that “It transforms the operation of central dislocation arthrodesis”. However, at the risk of seeming ungrateful, it is pointed out that the responsibility for postoperative bleeding rests with the surgeon and that the occurrence of such bleeding is not a valid criticism of the technique.

**CONCLUSION**

Lumbar extradural block is a comparatively safe and simple technique. With a little practice and good organisation, it can be performed in about 10 minutes. As compensation for the extra time involved, the patient is protected from the stress of the operation, there is analgesia lasting into the postoperative period, and the pre-operative state of his respiratory physiology and fluid balance is not significantly disturbed. For the surgeon there is perfect relaxation and a dry field.

Severe hypotension and inadvertent total spinal block are the main complications of the technique and both are eminently treatable. Permanent neurological sequelae are extremely rare, but paraplegia (the signs being those of the anterior spinal artery syndrome) has been reported (Davies, Solomon and Levene, 1958). Spasm of the artery following a fall in blood pressure is one suggested explanation.

A mixture of Pethilorfan and promazine given intravenously provides a reasonably safe and satisfactory hypnotic.

**SUMMARY**

The records of thirty cases of major surgery on the hip under lumbar extradural block are reviewed and presented, together with a discussion
of the theory, as evidence in favour of the contention that this type of anaesthesia affords marked advantages to these cases.

ACKNOWLEDGMENTS

We wish to thank Messrs. Chance, Cherry and Dunlop and the Ward Sisters for their patience and cooperation during the period covered by this series, and Mr. W. Parry of John Wyeth and Brother Ltd., who supplied the Sparine.

REFERENCES