BLOOD LOSS DURING MAJOR VAGINAL SURGERY
A Statistical Study of the Influence of General Anaesthesia and Epidural Analgesia

BY
DONALD D. MOIR

SUMMARY
Blood loss was measured using a haemoglobin extraction-dilution technique in 211 patients undergoing major vaginal surgery. Epidural analgesia combined with light general anaesthesia was used in 102 patients. In 56 instances nitrous oxide and halothane were used, ventilation being spontaneous, and in 53 patients nitrous oxide, oxygen and a muscle relaxant were used together with passive pulmonary ventilation. When epidural analgesia was employed the mean blood loss was about one-third of that associated with the other forms of general anaesthesia. It was not found necessary to induce profound hypotension with epidural analgesia in order to provide satisfactory operating conditions. There was no statistically significant difference in blood loss between the two general anaesthetic techniques. It was found that the operative blood loss was less in patients over 65 years than those under 65.

Bleeding during major vaginal surgery is too often troublesome and has seemed at times to be affected by factors outwith the knowledge and control of surgeon and anaesthetist.

Several American workers have estimated blood loss during gynaecological operations. Mean losses recorded at vaginal hysterectomies with pelvic floor repair were 716 ml (Buchman, 1953), 772 ml (Wexler, 1959) and 775 ml (Lazar and Krieger, 1959). Copenhaver (1964) observed a mean loss of 289 ml at vaginal hysterectomy without vaginal repair. During Manchester operations mean losses were 849 ml (Buchman, 1953) and 703 ml (Wexler, 1959). These writers do not give details of the anaesthetics used. All used swab-weighing as the method of blood loss estimation. This is accurate if performed before drying occurs but takes no account of blood on drapes and gowns. Buchman (1953) and Wexler (1959) avoided contamination of drapes and gowns by collecting blood in a plastic bag and later weighing, so that their results are accurate. Copenhaver (1964) made only a visual estimate of the blood on drapes and gowns and Lazar and Krieger (1959) make no mention of blood loss other than that on swabs. These series were all small, from 5 to 35 cases in all, the range of blood loss was always very wide and statistical analysis was not performed.

From Great Britain, Loudon and Scott (1960) reported on blood losses at 96 vaginal repair operations for which one of two anaesthetics was used. Under thiopentone, nitrous oxide and oxygen anaesthesia with a muscle relaxant and intermittent positive pressure ventilation the mean blood loss was 260 ml. Under epidural analgesia with a light covering anaesthetic the mean blood loss was only 98 ml. Blood losses were measured by swab-weighing and visual estimation of blood on drapes. Linacre (1961) described the results obtained in 1000 gynaecological operations performed under induced hypotension with a ganglion blocking drug and anaesthesia with thiopentone, nitrous oxide and oxygen, a muscle relaxant and controlled ventilation. Linacre did not measure blood losses but stated that in 87.9 per cent of cases the operating field was "dry", in 10.5 per cent it was "fair" and in 1.6 per cent it was "wet". This author stressed the safety and freedom from complications of hypotensive anaesthesia in association with a head-down tilt.

In 1966 McLaughlin wrote that "the capacity to ply his scalpel boldly (but often invisibly) at the bottom of a bloodsodden operative field is no longer the hallmark of the competent surgeon". Eckenhoff and Rich (1966) have commented on the scarcity of reports comparing the advantages
and safety of hypotensive with normotensive anaesthetic techniques. With these statements in mind and in the belief that excessive bleeding often hinders the performance of delicate vaginal surgery and occasionally endangers life, an accurate assessment of blood losses associated with four currently used anaesthetic techniques has been carried out.

**METHOD**

Two hundred and eleven patients were studied. Ages ranged from 37 years to 85 years. In 117 patients the Manchester operation was performed (anterior and posterior colpoperineorrhaphy with amputation of the cervix) and in 94 patients vaginal hysterectomy with anterior and posterior vaginal repair was carried out. Standardized surgical procedures were used by the several surgeons who performed the operations.

*Anaesthetic techniques.*

Premedication was papaveretum (Omnopon) 20 mg with hyoscine (Scopolamine) 0.45 mg. Patients over 65 years received atropine 0.6 mg with morphine 10 mg or 7.5 mg.

The anaesthetic techniques employed were:

1. General anaesthesia with thiopentone, suxamethonium, nitrous oxide, oxygen and halothane was used in 56 instances. The dose of thiopentone did not exceed 350 mg, the inspired halothane concentration did not exceed 1 per cent in most cases and the inspired oxygen concentration was at least 30 per cent. Spontaneous ventilation was permitted through an endotracheal tube connected to a Magill circuit with a fresh gas flow of at least 8 l./min.

2. General anaesthesia with thiopentone (not more than 350 mg), nitrous oxide, oxygen and tubocurarine was administered to 53 patients. Intermittent positive pressure ventilation was performed by a mechanical ventilator with a non-rebreathing circuit. A negative pressure was not employed during expiration. The expired minute volume was from 9 to 11 l./min and the inspired oxygen concentration was at least 30 per cent.

3. Epidural analgesia by a single-shot technique was given to 102 patients. From 10 ml to 24 ml of 1.5 per cent lignocaine solution with added 1:200,000 adrenaline was injected at the L2-3 or L3-4 interspace The dose of lignocaine was reduced as age increased and the dose was further reduced in the presence of degenerative arterial disease since the spread of local anaesthetic solutions in the epidural space is more extensive in the elderly and the arteriosclerotic (Bromage, 1962). A light general anaesthetic was also given using thiopentone, nitrous oxide, oxygen. If necessary, 0.5 per cent halothane vapour was added to the inspired gas mixture in the Magill circuit. The trachea was intubated. Arterial pressure was measured by an oscillometer at 10-minute intervals and more frequently than this during the initial phases of the epidural block. Patients in this group were classed, for the present purpose, as normotensive when the stable systolic blood pressure during surgery remained above 80 mm Hg and as hypotensive when the stable systolic blood pressure lay between 60 and 80 mm Hg. In all cases some fall in blood pressure occurred during anaesthesia; 48 patients were classed as hypotensive and 54 as normotensive. In all but two of the normotensive patients the systolic blood pressure fell to under 110 mm Hg. Hypotension was associated with a warm vasodilated skin and no vasopressor drugs were administered during surgery.

Patients with advanced arterial disease or a history of coronary insufficiency or cerebrovascular disease were not given hypotensive epidural analgesia. There was no other selection or exclusion of patients although random allocation was not practised.

*Blood loss estimations.*

Blood losses were measured by a haemoglobin extraction-dilution technique using a Rustad-Ohlin Perdometer apparatus (Wallace, 1967; Moir and Wallace, 1967) which is a development of the type of apparatus described by Roe, Gardiner and Dudley (1962) and Thornton and associates (1963). All swabs, gowns, gloves and drapes were put into the Perdometer. The accuracy of the apparatus was assessed against known volumes of blood on several occasions during the study and the recovery rate varied between 97 per cent and 100 per cent. Moore and his colleagues (1965) and Newton (1966) have found a comparable degree of accuracy with apparatus of the same general type.
RESULTS

Manchester operations.

Mean blood loss. Table I shows the mean blood losses associated with four anaesthetic techniques at 117 Manchester operations. Statistical analysis by the Student t test shows that the blood loss associated with all 54 epidural blocks was significantly less than that associated with either technique of general anaesthesia (P<0.001). The difference between the mean losses associated with hypotensive and normotensive epidural analgesia is not statistically significant (P>0.05). The mean loss associated with the general anaesthetic technique employing controlled ventilation is significantly greater than that occurring with nitrous oxide, halothane and spontaneous ventilation (P<0.05).

The influence of anaesthesia on mean blood loss at 117 Manchester operations.

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>No. of cases</th>
<th>Blood loss (ml) Mean and SD</th>
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<tr>
<td>Hypotensive epidural</td>
<td>24</td>
<td>81 64</td>
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<tr>
<td>Normotensive epidural</td>
<td>30</td>
<td>92 53</td>
</tr>
<tr>
<td>(\text{N}_2\text{O},) halothane</td>
<td>35</td>
<td>212 127</td>
</tr>
<tr>
<td>(\text{N}_2\text{O},) relaxant, IPPV</td>
<td>28</td>
<td>289 155</td>
</tr>
</tbody>
</table>

Light general anaesthesia was given also to the patients operated on under epidural analgesia.

Of the 54 patients who received epidural analgesia, 70 per cent lost less than 100 ml of blood while only 14 per cent of 63 patients receiving general anaesthesia lost amounts as little as this. The mean blood loss associated with epidural analgesia is approximately one-third of the loss associated with general anaesthesia.

Rate of blood loss. Mean blood loss values take no account of variations in operating time. Calculation of the rate of blood loss (ml/min) eliminates the effect of different operating times (table II). The relationships between the anaesthetic techniques are now seen to be altered in some respects. Epidural analgesia remains superior to both general anaesthetic techniques (P<0.001) but it is now seen that hypotensive epidural analgesia was associated with a significantly lower rate of blood loss than was normotensive epidural analgesia (P<0.05). The difference between the mean rates of blood loss associated with two forms of general anaesthesia is not statistically significant (P<0.1).

The influence of age on blood loss. Table III shows that when patients receiving each anaesthetic were arbitrarily divided into two age groups, the mean losses in patients over 65 years of age were always lower than in patients under 65 years of age. The mean blood loss in the older patients was almost half that observed in the younger patients, in whom hypotensive epidural analgesia and nitrous oxide, halothane anaesthesia were employed, and in these two groups the reduction in mean blood loss with age is statistically significant (P<0.05 and P<0.01 respectively).

Within each age group the statistical relationships between the mean losses associated with the various anaesthetic techniques remain as already

<table>
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<td>Hypotensive epidural</td>
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<td>94 56</td>
</tr>
<tr>
<td>Normotensive epidural</td>
<td>18</td>
<td>106 83</td>
</tr>
<tr>
<td>(\text{N}_2\text{O},) halothane</td>
<td>23</td>
<td>255 126</td>
</tr>
<tr>
<td>(\text{N}_2\text{O},) relaxant, IPPV</td>
<td>18</td>
<td>306 125</td>
</tr>
</tbody>
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The influence of age on mean rate of bleeding at 117 Manchester operations.

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>No. of cases</th>
<th>Rate of bleeding (ml/min) Mean and SD</th>
</tr>
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<tbody>
<tr>
<td>Hypotensive epidural</td>
<td>24</td>
<td>1.5 0.9</td>
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<tr>
<td>Normotensive epidural</td>
<td>30</td>
<td>2.1 1.2</td>
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<tr>
<td>(\text{N}_2\text{O},) halothane</td>
<td>35</td>
<td>5.0 2.7</td>
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<tr>
<td>(\text{N}_2\text{O},) relaxant, IPPV</td>
<td>28</td>
<td>6.3 2.5</td>
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observed for patients of all ages, except that the difference between the losses associated with the two general anaesthetics ceases to be significant (P<0.2 for those under 65 years and P<0.1 for those over 65 years).

In table IV, the influences of age, operating time and anaesthesia were allowed for by calculating the rate of bleeding (ml/min) for each anaesthetic technique within each age group. Epidural analgesia is still superior to general anaesthesia (P<0.001) and neither technique of anaesthesia is statistically superior to the other (P<0.2). The apparent superiority of nitrous oxide, halothane anaesthesia over the techniques involving controlled pulmonary ventilation which is demonstrated by the mean blood loss values for all patients (table I) is thus not substantiated when the variables of age and operating time are excluded.

Hypotensive epidural analgesia was associated with a significantly lower rate of blood loss than normotensive epidural analgesia in patients under 65 years of age (P<0.05) but not in patients over 65 years of age (P<0.3).

**Vaginal hysterectomies.**

**Mean blood loss.** The mean blood losses in 94 patients in whom vaginal hysterectomy with colpoperineorrhaphy was performed under four anaesthetic techniques are shown in table V. The mean values are approximately twice those recorded at Manchester operations due to more extensive and prolonged surgery. Epidural analgesia was again associated with a highly significantly lower mean blood loss in comparison with either technique of general anaesthesia (P<0.001). The difference between the mean losses observed with the two general anaesthetic techniques is not significant (P<0.8); nor is the difference between the mean losses under hypotensive and normotensive epidural analgesia of significance (P<0.4).

**TABLE V**

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>No. of cases</th>
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</tr>
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<tbody>
<tr>
<td>Hypotensive epidural</td>
<td>24</td>
<td>144</td>
<td>112</td>
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<tr>
<td>Normotensive epidural</td>
<td>24</td>
<td>188</td>
<td>184</td>
</tr>
<tr>
<td>N₂O, halothane</td>
<td>21</td>
<td>441</td>
<td>181</td>
</tr>
<tr>
<td>N₂O, relaxant, IPPV</td>
<td>25</td>
<td>460</td>
<td>184</td>
</tr>
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</table>

None of the 46 patients who received general anaesthesia lost less than 100 ml of blood, yet 22 of the 48 patients operated on under epidural block lost under 100 ml of blood. The mean blood loss at vaginal hysterectomy under epidural analgesia was approximately one-third of that lost under general anaesthesia, a relationship already observed during Manchester operations.

**Rate of blood loss.** When the mean rate of blood loss is calculated for each anaesthetic technique (table VI) the statistical relationships between the four techniques are the same as those demonstrated by calculation of the mean blood losses.

**TABLE VI**

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>No. of cases</th>
<th>Rate of bleeding (ml/min)</th>
</tr>
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<tbody>
<tr>
<td>Hypotensive epidural</td>
<td>24</td>
<td>2.0 1.4</td>
</tr>
<tr>
<td>Normotensive epidural</td>
<td>24</td>
<td>2.9 2.6</td>
</tr>
<tr>
<td>N₂O, halothane</td>
<td>21</td>
<td>5.5 1.4</td>
</tr>
<tr>
<td>N₂O, relaxant, IPPV</td>
<td>25</td>
<td>5.6 2.1</td>
</tr>
</tbody>
</table>
The influence of age on blood loss. Division of patients into those over 65 years of age and under 65 years of age shows that there was a consistently smaller mean blood loss in the older group with each anaesthetic technique (table VII). This reduction in the elderly is statistically significant in patients receiving nitrous oxide, halothane anaesthesia (P<0.01), anaesthesia with intermittent positive pressure ventilation (P<0.01) and hypotensive epidural analgesia (P<0.05).

When the rate of blood loss is calculated for each type of anaesthesia within each age group, the relationships between the four anaesthetic techniques remain the same as those demonstrated by calculating the mean losses (table VIII).

DISCUSSION
It has been shown in this series that blood loss at major vaginal surgery was reduced by two factors, namely, the use of epidural analgesia and increasing age of the patients. When the technique of general anaesthesia employing nitrous oxide, halothane, and spontaneous ventilation was compared with the technique employing nitrous oxide, a muscle relaxant and intermittent positive pressure ventilation, there was no statistically significant difference in blood loss.

When during epidural analgesia there was a stable systolic blood pressure below 80 mm Hg a slight further decrease in bleeding was noted in comparison with that measured when the systolic pressure was between 80 and 110 mm Hg. This reduction with hypotension was not always statistically significant and indeed was of small clinical importance since, whatever the blood pressure, epidural analgesia combined with light general anaesthesia produced operating conditions which were much superior to those usually associated with general anaesthesia alone.

There will always be a number of patients in whom troublesome bleeding occurs no matter what anaesthetic is used. Some of this bleeding may be attributed to patient factors such as obesity, arterial hypertension, a gynaecological lesion of unusual severity, or to errors in surgical technique. Nevertheless, anaesthesia may be an important cause of excessive bleeding. In the present series of 211 operations, blood loss in excess of 500 ml occurred in 22 of 109 patients who received general anaesthesia alone and in only 2 of 102 patients who received epidural anaesthesia with a light general anaesthetic.

Operating conditions may be regarded as good when the total operative blood loss is less than 100 ml. It amounted to less than this in 59 per cent of all operations carried out under epidural block and in only 8 per cent of those performed under general anaesthetics. Blood transfusion is

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<th>Anaesthetic</th>
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<td></td>
<td></td>
<td>Mean and SD</td>
<td></td>
<td>Mean and SD</td>
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<tr>
<td>Hypotensive epidural</td>
<td>12</td>
<td>164 121</td>
<td>12</td>
<td>121 101</td>
</tr>
<tr>
<td>Normotensive epidural</td>
<td>13</td>
<td>267 226</td>
<td>11</td>
<td>101 59</td>
</tr>
<tr>
<td>N₂O, halothane</td>
<td>11</td>
<td>580 185</td>
<td>10</td>
<td>330 68</td>
</tr>
<tr>
<td>N₂O, relaxant, IPPV</td>
<td>13</td>
<td>541 182</td>
<td>12</td>
<td>356 118</td>
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</tbody>
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<tr>
<td></td>
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<td>Mean and SD</td>
<td></td>
<td>Mean and SD</td>
</tr>
<tr>
<td>Hypotensive epidural</td>
<td>12</td>
<td>2.2 1.5</td>
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<tr>
<td>Normotensive epidural</td>
<td>13</td>
<td>3.7 3.2</td>
<td>11</td>
<td>1.9 1.2</td>
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<td>N₂O, halothane</td>
<td>11</td>
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<td>4.8 1.3</td>
</tr>
<tr>
<td>N₂O, relaxant, IPPV</td>
<td>13</td>
<td>6.6 2.3</td>
<td>12</td>
<td>4.3 1.1</td>
</tr>
</tbody>
</table>

TABLE VII
The influence of anaesthesia and age on mean blood loss at 94 vaginal hysterectomies.

TABLE VIII
The influence of anaesthesia and age on mean rate of bleeding at 94 vaginal hysterectomies.
not without serious risks (Brit. med. J., 1967) and is rarely required during surgery under epidural analgesia.

There were no serious complications attributable to any anaesthetic technique in the present series and there was no instance of secondary haemorrhage.

Among the many factors which may influence operative blood loss are the arterial blood pressure, the venous pressure, the arterial carbon dioxide and oxygen tension, the effect of anaesthetic technique on regional blood flow, the level of the operation site in relation to the right atrium, obesity, age, the severity of the lesion and the skill of anaesthetist or surgeon.

In vaginal surgery bleeding commonly takes the form of a venous or capillary ooze. The venous pressure is raised by coughing and straining (Hamilton, Woodbury and Harper, 1944) and by intermittent positive pressure ventilation (Hubay et al., 1954; Pierce and Vandam, 1962), so that faulty anaesthesia or the use of controlled ventilation may increase venous bleeding. Raising the intrathoracic pressure may slow venous blood flow. Hodgson (1964) found that controlled ventilation trebled the venous emptying time of the deep veins of the leg. In the present series, controlled ventilation, with a minute volume likely to produce a mild respiratory alkalosis, and an inspired oxygen tension likely to avoid arterial hypoxaemia, was associated with a greater blood loss than was anaesthesia with spontaneous ventilation. This difference is not statistically significant when the effect of age and operating time are allowed for (P<0.2). It seems probable that any beneficial effect of the presumed respiratory alkalosis was offset by elevation of the venous pressure and by venous stasis. It is stressed that extreme hyperventilation was not used in this series. Loudon and Scott (1960) also believe that a raised venous pressure is an important cause of bleeding in vaginal surgery.

The efficacy of epidural analgesia is doubtless in part due to arterial hypotension. It has been shown that, even with only moderate hypotension, the blood loss under epidural analgesia is very much less than that associated with general anaesthesia, so that hypotension is probably not the sole cause of reduced bleeding. Sympathetic nerve block dilates the veins (Beaconsfield, 1954). The distensibility of the now hypotonic veins lowers the venous pressure so that small gravitational forces may produce emptying of the veins (Lurie, 1963). Under epidural block, slight elevation of the operative site will empty the veins and minimize venous oozing.

Capillary bleeding is related to the arteriolar blood pressure at the point just distal to the precapillary sphincters. If the pressure at this point falls below the critical closing pressure of the precapillary sphincter then the capillaries will be emptied of blood (Burton, 1954). In general the critical closing pressure falls synchronously with the arterial blood pressure where the anaesthetic technique is associated with vasodilatation (Jennings, 1964). Epidural block is associated with a greatly increased cutaneous blood flow and a slightly increased muscle blood flow (Russell et al., 1962; Thomson and Moir, 1967, unpublished).

Eckenhoff and Rich (1966) believe that the aim of the anaesthetist using hypotensive anaesthesia should be to obtain the least degree of hypotension which will minimize bleeding and to avoid hypoxia and respiratory acidosis. Epidural analgesia satisfies these desiderata. Profound hypotension is not necessary and ventilation is unimpaired. Even high epidural block is associated with negligible changes in maximal and resting ventilatory function (Moir, 1963) and the arterial carbon dioxide and oxygen tensions are normal (Moir and Mone, 1964; Ward et al., 1965).

Pelvic floor surgery is particularly suitable for epidural analgesia. The position of the patient is conducive to the maintenance of blood flow to vital organs, and the cutaneous vasodilatation of the head and neck with rapid arteriolar-capillary refilling and constricted pupils are characteristic.

The diminished bleeding in elderly patients is probably due to the low oestrogen levels of such patients. Oestrogenic substances are vasodilators and Nickerson and Lee (1965) showed that administration of these to premenopausal patients led to increased operative bleeding. There is no correlation between the day of the menstrual cycle on which the operation is performed and operative blood loss (Copenhaver, 1964; Johnson and Roddick, 1956).

Several workers have shown that locally infiltrated vasoconstrictor solutions can reduce bleeding at vaginal surgery. Adrenaline is effective
BLOOD LOSS DURING MAJOR VAGINAL SURGERY

(Lazar and Krieger, 1959; Copenhaver, 1954) but was considered by Lazar and Krieger to be unsuitable for use in older patients in whom it frequently caused hypotension and cardiac arrhythmias. Cardiac arrest has been reported following the local infiltration of adrenaline during halothane anaesthesia (Varejes, 1963; DeLange, 1963; Rosen and Roe, 1963). Posterior pituitary extracts are as effective as adrenaline (Pratt et al., 1960; Dillon, 1962). Octopressin is also as effective as adrenaline and is claimed to have fewer side effects (Lazar and Snider, 1966).

ACKNOWLEDGEMENTS
I wish to thank Dr. J. Crawford, Dr. H. Y. Wishart and the other anaesthetists who co-operated in this study. I am also indebted to Sister H. Abernethy and her staff for their willing help.

REFERENCES


PERTE DE SANG AU COURS D'OPERATIONS VAGINALES MAJEURES: UNE ETUDE STATISTIQUE DE L'INFLUENCE DE L'ANESTHESIE GENERALE ET DE L'ANALGESIE EPIDURALE

SOMMAIRE
A l'aide d'une technique d'extraction-dilution d'hémoglobine, la perte de sang a été mesurée chez 211 patientes, subissant une intervention chirurgicale majeure par voie vaginale. Chez 102 patientes, il y eut une analgésie épiderale, associée à une légère anesthésie générale. Dans 56 cas on employa protoxyde d'azote et halothane avec ventilation spontanée, et dans 53 cas protoxyde d'azote, oxygène et un relâchant musculaire avec ventilation pulmonaire passive. Lors de l'emploi de l'analgésie épiderale, la perte de sang n'atteigna qu'environ le tiers de celle associée aux autres formes d'anesthésie générale. On ne jugea pas nécessaire de provoquer une profonde hypotension sous l'analgésie épiderale, afin de rendre les conditions opératoires satisfaisantes. Il n'y eut de différence statistiquement significative en perte de sang entre les deux techniques d'anesthésie générale. On a observé que la perte de sang peropératoire était moins grande chez les patientes audessus de 65 ans que chez celles endessous de 65 ans.

THE SURGICAL SECTION OF THE CZECHOSLOVAK MEDICAL SOCIETY (J. E. PURKYNĚ)

XVTH CZECHOSLOVAK SURGICAL CONGRESS
PRAGUE, SEPTEMBER 3-6, 1968

Principal subjects:
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(2) Portal hypertension.

Apart from the joint General Section, the scientific programme includes sections on traumatology, paediatric surgery, neuro-surgery, cardiovascular surgery, plastic surgery and urology.

Languages: Czech or Slovak, Russian, German, English and French are the official congress languages. A simultaneous translation system will be provided.

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