PROBLEMS ASSOCIATED WITH THE USE OF THE KNEE-CHEST POSITION FOR OPERATIONS ON LUMBAR INTERVERTEBRAL DISCS

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A number of authors have described the advantages of the knee-chest position for operations on lumbar intervertebral discs (Lipton 1950; Taylor, Gleadhill, Bilsland and Murray 1956; Wayne 1967). Wayne listed the advantages as simplicity of positioning, ease of maintenance of good ventilation, avoidance of epidural venous engorgement, excellent exposure of the interlaminar space and decreased risk of injury to major prevertebral vessels and organs. He showed that vena cava pressure was minimal in this as compared with other positions even in obese patients, and assumed that this low venous pressure existed in the epidural and vertebral veins. Similar studies by Pearce (1957) demonstrated low venous pressure with the patient in the prone supported posture.

This paper describes experience in anaesthetising 151 patients consecutively for operations on the lumbar discs in the knee-chest position. A number of patients had lumbar discography immediately before operation, and a further six patients had lumbar discography only. The extent and frequency of hypotension in these patients at the termination of the operation or investigation prompted this communication. Some biochemical estimations were undertaken in an effort to discover the cause for the hypotension.

POSITIONING

Once the patient is anaesthetised and intubated he is positioned as described by Wayne (1967). The arms are abducted to 90 degrees and supported by the pillows under the chest or by armboards on either side. Another pillow under the thighs prevents too acute flexion of the knees and hips (Fig. 1).

Three methods of anaesthesia were employed, each of which was known to produce a useful degree of hypotension (Table 1).
### TABLE 1

<table>
<thead>
<tr>
<th>Anesthetic technique</th>
<th>Blood pressure fall of 50 per cent or more ( percentage of patients)</th>
<th>Average blood loss (millilitres)</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent positive pressure ventilation, hyperventilation nitrous oxide-oxygen-halothane (0.5 to 1 per cent, curare, halothane)</td>
<td>30 (Range 20 to 100)</td>
<td>78 (Range 13 to 200)</td>
<td>40</td>
</tr>
<tr>
<td>Intermittent positive pressure ventilation, oxygen-halothane (1.5 to 2 per cent, curare)</td>
<td>10 (Range 40 to 130)</td>
<td>6 (Range 40 to 130)</td>
<td>6</td>
</tr>
<tr>
<td>Closed circuit oxygen-halothane, spontaneous ventilation</td>
<td>100 (Range 29 to 1,000)</td>
<td>115 (Range +10 to –90)</td>
<td>81</td>
</tr>
<tr>
<td>Discography</td>
<td>45 (Range +20 to –80)</td>
<td>25 (Range +20 to –80)</td>
<td>3</td>
</tr>
</tbody>
</table>

Range of values is shown in brackets. The last column gives the percentage of patients in whom blood pressure fell to 50 per cent or less of pre-straightening value. Six patients who had lumbar discography performed under oxygen-halothane anaesthesia are included. The groups were similar as regards average age, weight and duration of operation.
MEASUREMENTS

Systolic blood pressure was recorded frequently with a sphygmomanometer cuff and radial pulse palpation. Mean systolic pressure was calculated in each patient as the average systolic pressure during operation.

Blood loss was measured by weighing the surgical swabs as soon as they were discarded, and adding the contents of suction bottles.

In view of the known changes in blood pressure which occur when the legs are straightened at the end of the operation, investigations were undertaken in an attempt to demonstrate inadequate perfusion of the lower limbs in the knee-chest position. Particular emphasis was placed on obtaining blood samples within minutes before and after the patient was straightened.

In thirty-two patients estimations of pH, pCO₂ and standard bicarbonate were carried out on radial artery samples by the Astrup interpolation technique. The pH was measured with a Radiometer 4 meter, and the pCO₂ and standard bicarbonate were calculated from the Siggaard Andersen nomogram. Samples were taken before induction of anaesthesia, and within ten minutes before and after the patient was straightened. In some patients additional samples were taken approximately twenty minutes after straightening.

In thirty patients arterial or arterialised venous lactate was measured (following immediate deproteinisation in 0·6 per cent perchloric acid) by the lactate dehydrogenase method of the Boehringer Corporation.

RESULTS

Blood pressure fall—The last two columns of Table I show the average fall in systolic blood pressure in the three anaesthetic groups when the patient was straightened and indicate the frequency with which the pressure fell to at least 50 per cent of its pre-straightening value. Greatest and most frequent falls were seen in patients in whom the lowest blood pressure levels were recorded during operation. Severe falls also seemed to be related to prolonged recumbency before operation, obesity, increased operation time, blood loss and age. Severe falls in blood pressure were also noted in patients having lumbar discography performed in the knee-chest position.

Blood loss varied from 13 to 1,000 millilitres. Only one patient required blood transfusion. This was a man weighing 83 kilograms who underwent a prolonged, difficult and extensive dissection. The pillows supporting his chest became displaced to lie under the epigastrium and this probably led to an increase in epidural venous pressure.

Acid-base changes—In nine out of fourteen patients who had intermittent positive pressure ventilation and who were monitored, a decrease of at least 0·1 pH unit was noted when the patients were returned to the prone position at the end of operation (Fig. 2). In patients breathing spontaneously, variable changes were noted which were not considered significant.

Lactic acid—In six out of nineteen patients having intermittent positive pressure ventilation blood lactic acid increased 50 per cent or more over control values once the legs were straightened (Fig. 3). Similar changes were found in three out of the eleven spontaneously breathing patients who were studied.

Complications—The following complications were encountered.

Insecure endotracheal tube—In two patients the endotracheal tube became dislodged, fortunately before operation had begun. The patients had to be turned into the supine position to allow re-intubation.

Post-operative deep vein thrombosis—This occurred on a few occasions.

Femoral vein thrombosis—This occurred in a fit young man aged twenty-five weighing 89 kilograms. The vein was explored on the seventeenth day after operation and a large amount of clot removed with a Fogarty catheter. Thereafter he made excellent progress on long-term anticoagulant therapy.
Treatment of hypotension—As a rule, hypotension after straightening was of short duration often lasting a few minutes or less, and responding to head-down tilt, rapid infusion of fluid or methyl-amphetamine 5–30 milligrams intravenously. Occasionally the degree and extent of the hypotension led to anxiety. Patients who were lightly anaesthetised at the end of the operation as demonstrated by movement or bucking on the endotracheal tube tended to have lesser and shorter falls in blood pressure.

Fig. 2
Arterial blood pH changes in five patients having intermittent positive pressure ventilation. The second sample was taken shortly before straightening, the third soon after. The vertical line indicates the moment of straightening and the time scale is related to this. Small figures refer to the time the patient was in the knee-chest position.

Fig. 3
Changes in blood lactate in six patients. The horizontal broken line is the upper limit of normal values (16 milligrams per cent). Small figures refer to time in the knee-chest position.
DISCUSSION

This communication has been prompted by the observation that many patients having operations or investigations in the knee-chest position have a marked fall in blood pressure when the legs are straightened at the end of the procedure. A search of the literature has revealed only one brief reference to post-operative hypotension after surgery in this position (Hastings 1969). As one would expect, an anaesthetic technique which provides the lowest systolic blood pressure readings during operation (hyperventilation with nitrous oxide-oxygen-halothane with increments of hexamethonium) is associated with less bleeding, but also with more severe falls in blood pressure after operation (Table I). This may be due in part to the more frequent use of hexamethonium in these patients, although many in whom hexamethonium was not used had hypotensive episodes of equal severity.

Marked congestion and cyanosis of the lower limbs has been observed on many occasions while patients are in the knee-chest position. This was particularly obvious in a very obese (89 kilograms) female undergoing discography whose systolic blood pressure fell from 100 to 40 millimetres mercury on straightening. Gordon and Newman (1953) recorded similar congestion in the lower extremities of a 109-kilogram male undergoing a three-hour laminectomy who developed fatal lower nephron nephrosis after operation, secondary to bilateral calf muscle ischaemia.

The biochemical evidence supports the suggestion that tissue perfusion is poor in the lower limbs. Figure 2 shows an initial rise in pH from control values, which is to be expected in patients having intermittent positive pressure ventilation, particularly with hyperventilation (Payne 1962), with an immediate fall in pH when the legs are straightened and blood is returned to the general circulation from poorly perfused tissues.

Changes in blood lactate also point to poor tissue perfusion. Figure 3 shows a slow rise in lactate from control values during intermittent positive pressure ventilation, with a much steeper rise as soon as the patient is straightened. In one patient (top trace) blood lactate continued to rise. This has been reported by Chamberlain and Lis (1968) during recovery from hyperventilation anaesthesia. Weil and Afifi (1970) consider that measurement of lactate serves as a reliable indicator of cumulative oxygen debt and that the measurement of pyruvate, lactate pyruvate ratios or excess lactate is unnecessary.

The pH and lactate changes found in patients breathing spontaneously were more variable. It is not certain whether the type of anaesthesia was a factor here, or whether the higher blood pressure levels associated with oxygen-halothane anaesthesia permitted better perfusion of the lower limbs and therefore less consistent biochemical changes. These cases occurred later in the series and greater care was taken in the positioning of patients.

Post-operative hyperaemia in those parts of the lower limbs subject to pressure has been seen frequently: it occasionally involves the entire lower extremities. This supports the suggestion that perfusion is curtailed in the knee-chest position, and that the hypotension may be due in part at least to release of a tourniquet effect similar to the “declamping phenomenon” seen after aorto-iliac occlusion. Johnstone, Lawson and Mucklow (1965) found a two- to three-fold increase in blood lactate with a rise in hydrogen-ion concentration after release of aortic clamps but considered that this rise due to release of anoxic metabolites was not responsible for the systemic hypotension observed. The hyperaemia seen in our patients indicates vasodilation, which could well account for the hypotension which occurs when the patient is straightened. Central venous pressure was monitored in a few patients and consistently fell to low levels (0-2 centimetres water) at this time.

The undesirable effects of the knee-chest position can be limited by preventing acute flexion of the lower limbs. In our patients a pillow was tucked under the thighs. More elaborate buttock supports have been described by various authors (Tarlov 1967; Hastings 1969; Laurin, Migneault, Brunet and Roy 1969; Macnab and Dall 1971). Other workers (Taylor et al. 1956; Pearce 1957; Smith, Gramling and Volpitto 1961) prefer variations in the
supported prone position which may not flex the lumbar spine to the same extent. Smith and colleagues (1961) keep the arms "above the head". This may lead to excessive strain on the brachial plexus which can be appreciated if one adopts the position for a short time. Brachial neuritis has been reported in two patients after laminectomy (Hewitt 1971). One other patient was noted to have developed an ulnar nerve paresis, presumably due to careless positioning of arms.

The use of hypotensive anaesthetic techniques on patients in the knee-chest position does not appear to be justified in view of the increased frequency and severity of hypotension when the prone position is resumed. This agrees with the conclusions of Taylor and colleagues (1956), who were able to produce almost cadaveric operating conditions with high spinal anaesthesia, but eventually gave up the refinement of controlled hypotension in view of the increased risk to the patient.

SUMMARY

1. The knee-chest position offers the surgeon excellent conditions for operations on lumbar intervertebral discs.
2. Hypotension on resumption of the prone or supine position is common: it is influenced by the anaesthetic technique, the physical state of the patient, the operation time and the extent of surgical bleeding.
3. The hypotension is thought to be due to poor perfusion of the lower limbs while the patient is in the knee-chest position.

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REFERENCES


