SPINAL ANÆSTHESIA, HEAVY SOLUTION OR LIGHT?

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Kelly, writing in the Journal of the Michigan State Medical Society, says: "With the very great increase in the literature on spinal anaesthesia it seems regrettable that many articles appearing in the current literature are written either by the proponents or opponents of the method, and their analysis of the subject is reflected by opinions already formed as to its value or lack of value."

Anyone who has had sufficient experience of spinal anaesthesia to justify them in putting other people to the trouble of reading what they write is almost certain to have formed a fairly definite opinion as to its value, and therefore may be said to be either a proponent or an opponent of the method. There is nothing regrettable in that. What is unfortunate is that prejudice should be allowed to form the basis of remarks which should only be made on the basis of experience and, if possible, extensive experience. I heard not very long ago a professorial criticism of the views of a well-known writer on international affairs. As the critic ended with the remark that he "loathed the Germans" it was impossible to attach any importance to his views, distorted as they were by his strong emotional bias. A passionless judgment, impossible as it may be to achieve in national affairs, ought surely not to be beyond the compass of anaesthetists anxious alike for the welfare of their patients and their own reputation.

Life is not long enough for all of us to have sufficient experience in every method of anaesthetizing patients to be able to make our own comparisons, and therefore we compare our methods with those of others and naturally are very apt to prefer our own, merely because they are our own. The personal bias tends to creep in. As far as possible the personal bias in the present series of cases has been
eliminated because the person is the same in them both, and the comparison is not between spinal anaesthesia and general anaesthesia or between one drug and another, or even between a simple novocain solution and a novocain gliadin mixture, but between two novocain gliadin mixtures, one of which is lighter than cerebro spinal fluid and the other of which is heavier than cerebro spinal fluid. The two solutions are compared under the following heads: I—Composition; 2—Quickness of Action; 3—Power; 4—Duration; 5—Safety; 6—Effect on Blood-pressure; 7—Effect on Respiration; 8—Reliability; 9—Mortality; 10—Morbidity.

**Composition.**—Each solution is a 10 per cent novocain solution containing sufficient gliadin to increase the viscosity of the solution. One is made lighter than the cerebro spinal fluid by means of alcohol, and the other is made heavier than the cerebro spinal fluid, usually by the addition of glycerine.

**Quickness of Action.**—The heavy solution is much quicker in action than the light. Operations have occasionally been begun within two minutes of the injection. It is probable that the glycerine acts as a link between the nervous elements and the novocain, because if the solution is made heavy in some other way than by the addition of glycerine this extremely rapid action is not noticed.

**Power.**—I have been unable to detect any difference in the power of the two solutions, but one surgeon tells me that light duracain relaxes the sphincter ani more completely than the heavy. Both solutions give complete muscular relaxation of the abdominal wall.

**Duration.**—In equivalent doses I am inclined to think that the light solution gives a somewhat longer anaesthesia than the heavy, but as there is considerable variation between one individual and another, between one theca and another, and probably between the reaction of novocain to different nervous tissue, it is not a point on which I am prepared to be dogmatic. The longest time (two hours and six minutes) for a high abdominal was obtained with heavy duracain, though other anesthetists using the light solution record still more prolonged anaesthesia.

**Safety.**—It is necessary to think of this in connection with
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reliability. Both are absolutely safe in low anaesthetics because the only way in which novocain by its own action kills is by paralysing respiration. In endeavouring to get a high anaesthesia one is always between the Scylla of too low and the Charybdis of too high, and actually in practice I was unable to obtain a satisfactory high anaesthesia in more than 84 per cent of upper abdominal operations, when using the light solution. On the other hand, using heavy duracain the successes are in the neighbourhood of 100 per cent. The failures have so far in these 500 cases been due either to the fact that the operation took longer than expected, was a different operation to the one contemplated, or was an operation that outlasted the capability of the anaesthetic. There has not been a failure to get the anaesthesia high enough, nor has there been any high enough to interfere with respiration. On the score of safety and reliability combined the difference is enormously in favour of the heavy solution.

Effect on Blood-pressure.—The usual statement made as regards the effect of spinal anaesthesia on blood-pressure is to the effect that the fall is proportional to the height of the anaesthesia. Thus Pitkin: "If the anaesthesia fluid is confined to the lumbar spine there is no change in the blood-pressure; if it reaches the first thoracic the pressure becomes nil."

How it is possible for any clinician to make such a statement it is difficult to imagine. Perhaps it is not as a clinician that he makes it but as an experimenter. As regards clinical work, I have records of not one but dozens of cases in which the anaesthesia was in the neighbourhood of the first thoracic and the fall of blood-pressure was either slight or non-existent. The most striking recent instance of that sort occurred on December 3, 1932. The patient, a man, aged 46, in excellent condition, with a good heart and strong abdominal muscle, had had a gastro enterostomy performed two or three years before. A considerable improvement followed, but latterly symptoms had reappeared and it was thought that he might be the victim of a jejunal ulcer or possibly a commencing gastroduodenal fistula. I was asked to arrange for a two-hour session. The anaesthesia lasted two
hours and was up to the fourth cervical, as evidenced by the fact that it was possible to close towel forceps in the skin covering both shoulder joints without the patient being able to feel them. The operation was much shorter than anticipated, nothing being found of a pathological nature except numerous adhesions. It lasted 45 minutes. Before the operation the blood-pressure was 120, during the operation it rose to 160 and returned to 120, at the end of the operation being 125. There was never at any time the slightest embarrassment of respiration and the patient could move his arms. Such a case demonstrates a good many things, but it definitely contradicts generalizations such as Pitkin's. Nor is the second part of his statement true either, viz., that if the anaesthetic be confined to the lumbar spine there is no fall of blood-pressure. We have all seen cases where the anaesthesia reached only to the umbilicus. True that is slightly above the lumbar spine, but it does not materially affect the argument, in which the radial pulse was so feeble that it was not possible to measure the blood-pressure; in two recent cases in which the anaesthesia did not go above this level the radial pulse was for a time so feeble as to make it impossible to take the blood-pressure; in the second case, in fact, the radial could not be felt. This means at least that even if the anaesthetic be confined to the lumbar spine the blood-pressure may fall to a point at which it is no longer measurable. There are, in fact, other causes of a fall of blood-pressure besides a spinal anaesthetic. The second of the two cases mentioned above was put into the steep Trendelenburg position, and he said afterwards that he thought that it was this turning upside down that had upset him. A sound sleep the night before the operation plus a sedative one hour before are the best preventatives of these alarming but usually quite harmless 'faints'. Though it is thus easy to contradict the too facile generalizations of Dr. Pitkin it is impossible to substitute any other to take their place. The reason for this is obvious when we consider the nature of blood-pressure.

As the physiological connection between different parts and systems of the body is continuously in existence it
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follows that any modification of one part will be immediately met by necessary adaptations in other parts, and so a balance will be kept. The normal blood-pressure of any individual is such a physiological or dynamic balance. Although we know a number of proceedings which will disturb the blood-pressure and some of the mechanisms which operate immediately to limit or annul such disturbance, it is probable that we do not know them all. Moreover, in any given case it is impossible to assess accurately the part played by the various restorative mechanisms. Thus if we ascend a mountain or in any other way breathe an atmosphere in which the oxygen pressure is lowered this would immediately give rise to a lowered oxygen pressure in alveoli blood and tissues, were it not for compensatory measures such as increased breathing oxygen secretion and a rise in the percentage of HbO₂. But increased breathing makes the system more alkaline; it diminishes the hydrogen concentration of the blood were it not that the kidney decreases the amount of available alkali. The original decreased oxygen pressure is not compensated for then by some massive change as, for example, great increase in the breathing, because that would need other massive compensations, but by slight readjustments all round so that the normal relations of the tissues are maintained but at a different level. Similar adjustments are made when there is initiated a big change in one of the normal mechanisms maintaining blood-pressure. Thus Samson Wright and Kremer have shown that section of the splanchnics consecutively or even simultaneously is followed in half their cases by a slight fall of blood-pressure, and in the other half there is actually no fall at all. Though the blood-vessel area supplied by the splanchnics is in a state of dilation those above and below the splanchnic outflow are in a state of compensatory constriction, and therefore there is no fall of blood-pressure. It is unlikely that a heavy solution of duracain would affect the anterior roots of the dorsal nerves at a higher level than the fifth or sixth, and therefore would be even less likely than the section of the splanchnics to cause a fall of blood-pressure, and this is borne out in practice. The rule is that
the blood-pressure remains at its pre-anæsthetic level or even rises between the time of giving the ephedrin and anaesthetic and the commencement of the operation. The blood pressure falls as a rule only after the surgeon has explored the abdominal cavity or made traction on the stomach or duodenum. Not always then. The fall of blood pressure which takes place under these circumstances is in all probability not a simple phenomenon. It is partly physical and partly psychic. Afferent impulses passing up the vagus, which is beyond the reach of the spinal anaesthetic, reflexly affect the heart and lower the blood-pressure. There is no doubt that psychic influences also play a part and, indeed, often a large part; possibly at times are solely responsible for even a complete loss of measurable pressure. The two cases to which reference has been made above may be examples of a fall of blood-pressure due entirely to psychic influences, seeing that the anaesthesia did not extend above the umbilicus. As the fall of blood-pressure, which more often than not takes place immediately following the exploration of the abdomen, is as a rule only of a temporary nature, it is possible that it is due to the absorption of histamine in part at any rate. Howard Jones has suggested that it is due to the absorption of the anaesthetic itself into the blood. The normal blood-pressure curve which follows the intrathecal injection of percaïne lends colour to this suggestion. As far as novocain is concerned there is neither clinical nor experimental evidence for this; the latter, indeed, very definitely contradicts it. There is a certain type of case which is an exception to the general rule that the blood-pressure does not fall until the abdomen is explored, and that is the acute perforation. In such a case the blood-pressure comes down with a run immediately the anaesthetic is given. It is probable that pressor impulses by way of the splanchnics are suddenly shut down by the S.A., and the recently overstimulated V.M.C. reacts to a quiescent period. Provided the coronary circulation is not dependent on the maintenance of a normal or nearly normal blood-pressure no harm results from such a fall which is gradually recovered from during the operation.

Confusion is apt to arise in the discussion of the fall of
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blood-pressure unless it is made clear whether or we are dealing with man or animals.

Prof. Pannett, in an address to the Association of Surgeons of Great Britain and Ireland, suggests that the fall of blood-pressure which follows the injection of 0.4 c.c. of a 5 per cent solution of novocain into the theca of a cat is due to the dilatation of the vessels of the muscles of the legs; it may well be so. It will not, however, explain why the fall of blood-pressure in man only takes place as a rule after the abdomen is opened. If we compare the two cases we shall see that 0.4 c.c. of a five per cent solution of novocain is relatively a much larger dose of novocain given in a much larger bulk of solution. 0.4 c.c. in a cat is about equal to 12 c.c. in a man, and 20 mm. is about equivalent to 600 mm. I never use more than 300 mm. in 3 c.c., and that is perhaps why I seldom see a fall of blood-pressure before the abdomen is opened. There is not sufficient bulk of fluid to soak the anterior roots; particularly is this likely to be the case as the patient is immediately turned on to his back, whereas the cat is probably kept on its side. It is certain that the technique that I adopt paralyses the abnormal muscles for a longer period than the leg muscles, because it generally happens that the patient can move his feet while the abdominal muscles are still completely relaxed. It is almost certain that under some conditions the vessels and capillaries of the muscles are so relaxed as to be a big factor in the causation of a marked fall of blood pressure, e.g. in shock. The fact that intramuscular injection of pitressin together with intravenous glucose saline will improve the condition of the moribund and save those who are only just short of it, tends, I think, to corroborate this view.

Pannett quotes Seevers and Waters as holding the opinion that the fall of blood-pressure is due to the “loss of inspiratory suction into the heart.” On turning to their paper in the Journal of the American Medical Association, September 17, 1932, they say: “The fall in systolic pressure is directly proportional to the height of the block” (in dogs). This they attribute partly to V.C. paralysis and partly to intercostal nerve paralysis. Owing to the low blood pressure thus
induced the oxygenation of the blood begins to be deficient, and anoxæmic blood supplied to the heart causes first a weakening and subsequently a failure of that organ.

They say further: "A.R. alone with the Drinker respirator will maintain the blood pressure near its original level after a block paralysing all respiratory activity" Diaphragmatic and costal? So that V.M. paralysis doesn't matter. Also "Passive distension of the lungs with 100 per cent oxygen will maintain an adequate blood-pressure in the absence of any respiratory movement for at least fifteen minutes." So complete paralysis of the thoracic wall doesn't matter.

The essence of the matter, the sine qua non, then, is efficient oxygenation of the tissues, which can be achieved even in the presence of complete V.M. and respiratory paralysis.

Effect on Respiration.—Either solution will paralyse respiration if introduced into the cisterna magna or if introduced into the lumbar region and subsequently pushed up by the injection of saline it will paralyse the phrenics and intercostals. With the correct technique neither of these contingencies occur in clinical practice. With the light solution tingling of the fingers and some slight distress, some feeling of inability to breathe even though the actual ability be preserved occurs occasionally. With the heavy solution these slight inconveniences seldom occur, and it is quite possible to get analgesia ten segments higher than paralysis. The case quoted earlier in this paper is a remarkable example.

Reliability.—Little remains to be said on this head. In cases of operation on the upper abdomen the severest test of spinal anaesthesia, the light solution in my hands failed to reach the desired height in 16 per cent, whereas the heavy solution never fails to reach the correct height, but does not always last long enough to complete a very long abdominal operation.

Mortality.—This, of course, depends on how one selects cases. If the patient is strong, and has a sound heart, there should be no mortality with either solution; but this is not the case in practice. Confronted with a grave risk, advanced
peritonitis causing a high grade toxæmia, gall bladders with
fat toxic "cholecystitic" hearts simulating or possibly actu-
ally being angina, a grave risk has to be taken, and in such a
case if a spinal anaesthetic is decided on I am quite definitely
of the opinion that the heavy solution is the one to choose.
In the present series of 1,000 cases upon which these opinions
are based I have seen three deaths in which the anaesthetic
was a factor the solution in each case being the light. I
have only seen one death on the table whilst using the
heavy solution, and the anaesthetic had nothing to do with
that fatality.

Morbidity and Sequelaæ.—As far as I am aware there has
been no morbidity or any undesirable sequel in this series
with the exception of very occasional slight headache. One
patient who had a very severe and prolonged (a fort-
night) headache after percan given for a colostomy,
had no headache following the exhibition of heavy dur-
cain for the much more extensive operation of removal of
the growth. Occasionally a patient has died within one to
two hours of the operation. There has on all occasions but
one been something definite to account for the death, such
as the known presence of anginal attacks or the severity of
the operation. In the one instance referred to the operation
had been a double herniotomy on a man between 60 and
70. He died quite suddenly and unexpectedly three hours
after receiving the anaesthetic (light duracain). The anaes-
thesia had been away for at least one and a half hours. He
had felt a little breathless shortly after the beginning of the
operation but that had all passed off, and towards the end
of the operation he was joking with his doctor and after
being carried back to bed moved his legs freely and had
been talking in a perfectly normal way to his nurse for
about one and a half hours when he suddenly appeared in
distress, became deeply cyanosed, and died within three
minutes. Save for a sudden drop and an equally sudden
recovery of blood-pressure almost immediately the anaes-
thetic had been given, which must be put down to
nervous apprehension, it ranged throughout the operation
between 150 and 170 mm.Hg. It is difficult to see what
part, if any, the anaesthetic played in this death.