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- Mendelson (1946) described 60 cases giving rise to two fatalities; these occurred among 44,016 cases.

The following authors have also described deaths due to aspiration of stomach contents. The incidence is higher than in prepared surgical cases, but often anaesthesia in obstetric practice is administered as an emergency, and it is well known that the emptying time of the stomach in women in labour is delayed. Eastman (1941) reported 51 deaths; an incidence of 1 in 40,000 anaesthetics. Dieckmann (1945) reported 45 cases in 46,000 deliveries (2 deaths; an incidence of 1 in 23,000 anaesthetics. Gilliat (1949), reviewing the causes of death among 55 patients, found that 3 were due to inhalation of vomit; an incidence of 1 in 11,382 anaesthetics. Merrill and Hingson (1951) reported 59 deaths; an incidence of 1 in 44,135 anaesthetics. Parker (1954) reported 5 deaths; an incidence of 1 in 3,708 anaesthetics. Hall (1940) and Willcox (1949) have also reported five and two deaths respectively.

The variation between the British and American figures is explained by the more frequent use of general anaesthesia during the second stage of labour in American hospitals.

Local analgesics rarely give rise to death, and when death does occur the following factors are usually involved: (1) large amounts of agent, (2) intravenous injection, and (3) idiosyncrasy. The first two factors are controllable and preventable; the third can be minimized by interrogation about previous idiosyncrasy, and the symptoms can be controlled by the administration of a rapidly acting barbiturate. Idiosyncrasy is very rare.

The toxic effects of lignocaine have been discussed in the correspondence columns of the *British Medical Journal* (1955). There is no doubt that lignocaine can be dangerous, but not if the maximum dosage is kept well below 1 g. in a single dose. Many of the cases mentioned as having had toxic reactions have one thing in common—namely, that 2% lignocaine had been used. Lock and Greiss (1955) report a death following the injection of 40 ml. of 2% lignocaine for pudendal nerve block in a secundipara with mitral stenosis. She died seven minutes after the injection. Dutton (1955) reports a case in which convulsions occurred after 80 ml. of 1% lignocaine had been used. Therefore safety lies in weak solutions of lignocaine, used in the minimum quantity necessary for effective analgesia.

The Pudendal Nerve and its Branches

The pudendal nerve arises from the second, third, and fourth anterior sacral trunks, which form a single trunk 0.5 to 1 cm. proximal to the ischial spine. The nerve trunk courses through the greater sciatic foramen inferior to the piriformis muscle, passing posterior to the ischial spine—between the sacrospinous ligament anteriorly and the sacrotuberous ligament posteriorly. As the nerve passes the inferior tip of the ischial spine it enters the pudendal canal. The nerve lies medial to the pudendal vessels. It divides into three main branches: the inferior haemorrhoidal nerve; the dorsal nerve of the clitoris, and the perineal nerve.

Inferior Haemorrhoidal Nerve.—Klink (1953) in a series of 85 dissections found that in 50% of cases this nerve did not arise from the pudendal nerve but as a separate branch from the fourth anterior sacral primary ramus. In these cases the nerve did not lie in the pudendal canal but passed through the sacrospinous ligament 0.5 to 1 cm. inferomedial to the pudendal nerve. This nerve supplies the mucosa of the lower part of the anal canal, the external anal sphincter, and the skin anterior and lateral to the anus.

The dorsal nerve of the clitoris runs between the layers of the urogenital diaphragm, terminating in the filaments supplying the clitoris.

The perineal nerve arises above the inferior border of the ischial tuberosity and divides into superficial and deep branches. The former constitutes the main nerve supply of the superficial structures of the vulva and perineum, and also anastomoses with the perineal branches of the posterior

OBSTETRIC INDICATIONS FOR THE USE OF PUDENDAL NERVE BLOCK ANALGESIA

BY

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The problem of anaesthesia during the second stage of labour is complicated by the fact that the safety of both mother and foetus has to be considered. Anaesthesia often has to be induced in an unprepared patient in whom the foetus is showing signs of distress.

The technique of pudendal nerve block is simple and safe, and it avoids many of the dangers and difficulties of inhalation, extradural, and spinal anaesthesia. It produces analgesia of the lower vagina, the vulva, a varying area of surrounding skin, and some relaxation of the pelvic floor. Excluding those patients who are mentally unsuited for local analgesic techniques, safe and reliable analgesia can be produced for a number of obstetric manoeuvres with a minimum risk to the mother and her yet unborn infant.

Anaesthetic Mortality and Morbidity

The present low maternal death rate due to anaesthesia should not lead to complacency, as there are fewer greater tragedies to a family than the loss of its mother. Inhalation anaesthesia is the most common form of anaesthesia used during the second stage of labour. Its complications are the inhalation of vomit or regurgitated stomach contents, depression of the foetal respiratory centre, and relaxation of the uterus leading to post-partum haemorrhage. Spinal and extradural techniques need even more specialized experience, and there is always the risk of infection and permanent spinal cord or nerve damage. Both of these techniques produce varying degrees of hypotension.

Inhalation of vomit has been reported as a cause of death by many workers, and consideration must be paid to the asthmatic type of aspiration pneumonitis caused by

femoral cutaneous nerve of the thigh. The latter are the source of supply to the deep muscles and fasciae of the perineum.

The ilio-inguinal nerve also send branches to the mons pubis and the labia majora.

Effect of Pudendal Nerve Block

Klink (1953) studied the effect of this nerve block on the sensation of touch, pin-prick, and haemostat pinch in the vagina. He found that whereas 10% of patients felt pin-prick and 50% felt haemostat pinch in the lower part of the vagina, a nerve block abolished response in this area and in the surrounding skin.

It is therefore possible by careful technique to obtain satisfactory skin anaesthesia and relaxation by blocking the main pudendal nerve and skin infiltration to exclude branches from the ilio-inguinal nerve and perineal branches from the posterior femoral cutaneous nerve. In those cases where the levator ani receives its main supply direct from S.4 relaxation may be poor.

Technique

The skin infiltration is begun at a point midway between the anus and the ischial tuberosity, using a fine needle. The nerve block and skin infiltration is then performed, using a 5-in. (12.5-cm.) needle, though a 3-in. (7.5-cm.) needle is often long enough to reach the ischial spine.

The main procedure is the pudendal nerve block, and aspiration must be performed before injection of the analgesic solution in order to make certain that the point of the needle is not in the lumen of a pudendal vessel.

Skin infiltration of the vulva is performed to produce a terminal block of any nerve filament arising from the ilio-inguinal nerve. A further injection into the deep tissues of the perineum and the levatores ani ensures analgesia in those cases where the inferior haemorrhoidal nerve arises as a separate branch from S. 4. An alternative is to inject 5 ml. of analgesic solution just medial to the ischial spine. The greatest technical difficulties arise in obese patients and when the presenting part is at the outlet, making palpation of the ischial spine less easy.

The purpose of the nerve block is explained to the patient and she is warned that only pain will be relieved, but that she will still be able to appreciate the sensation of pressure. Inhalation of gas and air or trichlorethylene is continued if necessary to relieve the discomfort of uterine contractions. As with all local analgesic techniques, patience and gentleness are required to achieve the patient's co-operation. Usually the interest of the mother to see the birth of her baby makes eye-shielding unnecessary.

The Investigation

The present series consists of 57 patients (38 primigravidae and 19 multigravidae) in whom pudendal block was carried out. An analysis of the group is given in the accompanying Table.

Analysis of Series

Total number of cases	57
Number of forceps deliveries	24
Stillbirths	2
Assisted breech delivery in multiple pregnancies	6
Forceps delivery in multiple pregnancies	5
Spontaneous vertex deliveries	7
Stillbirths	1
Number of infants delivered under pudendal block analgesia	51
Number of stillbirths	3

Of the three stillbirths one was a spontaneous delivery of the second twin, the second was a forceps delivery for foetal distress in a case of mitral stenosis, and the third was a forceps delivery of the leading twin because the foetal heart could suddenly not be heard.

Post-mortem examination in the last-mentioned case revealed no evidence of cerebral haemorrhage other than the petechial haemorrhages associated with foetal anoxia.

Drugs

A mixture containing 1% procaine or 1% lignocaine, 1 in 100,000 adrenaline, and 1,000 units of hyaluronidase was used. The first 19 cases had procaine blocks, and in the remainder lignocaine was employed. To 50 ml. of analgesic solution was added 0.5 ml. of 1 in 1,000 adrenaline. These volumes were chosen to eliminate the risk of a miscalculation of the adrenaline concentration. Then 1,000 units of hyaluronidase was added to the solution. It was found that by using freshly made solutions of procaine or lignocaine in saline which did not contain chlorocresol (usually added to maintain sterility) the sensation of stinging directly after the injection was relieved. A total of 30 to 40 ml. of solution was used. Many papers have been written on the use of hyaluronidase as an adjunct in nerve-block analgesia, and the use of adrenaline to prolong the duration of analgesia is well recognized.

Douglas and Vosburgh (1951) tested concentrations of 1% and 2% procaine with and without the addition of hyaluronidase and adrenaline. They got the best effect from using 60 ml. of 1% procaine with hyaluronidase and adrenaline. With procaine and hyaluronidase, the delay before the onset of analgesia was only one to two minutes, but the duration of analgesia averaged only 32 minutes. With the addition of adrenaline (1 in 240,000) the delay averaged five minutes and analgesia lasted about 80 minutes.

In the present series of cases the following points were observed: (1) A five-minute delay occurred before the onset of analgesia, using 1% procaine plus adrenaline. (2) With the use of lignocaine and adrenaline the average delay was only one to two minutes, and an episiotomy could be performed without distress to the patient within that time. (3) The duration of analgesia was not timed, but was at least an hour. On several occasions a few millilitres of solution had to be injected before the superficial skin sutures were inserted. (4) Supplementary inhalation anaesthesia was used in three cases.

Indications

Normal Labour

This group comprised five cases of spontaneous delivery, all in primigravidae. Pudendal nerve block was performed because the duration of the second stage had exceeded one hour and only slow progress was being made. This effectively abolished the discomfort caused by stretching of the soft parts, and spontaneous delivery was accomplished with the aid of an episiotomy. Abolition of the perineal reflex meant that the expulsive efforts of the mother had to be directed for about a quarter of an hour, after which time expulsive effort recurred spontaneously.

Foetal Distress

In this group there were 11 cases of forceps delivery (seven primigravidae) and one stillbirth. The advantages of this form of analgesia are mainly that it allows the administration of pure oxygen to the mother while delivery is in progress, and the foetal respiratory centre is not depressed.

A block can be performed in two minutes and the forceps applied within five minutes of beginning the injection. This is equally as quick as induction and stabilization of anaesthesia with nitrous oxide, oxygen, and ether. Another merit is that there is no delay until the arrival of an anaesthetist.

The one stillbirth was in a patient with mitral stenosis. Oxygen was given by a B.L.B. mask during delivery.

In one case a transverse position of the head was easily corrected.

Delay in the Second Stage of Labour

The 13 patients, including 10 primigravidae, in this group had low forceps extractions because of failure to make steady progress. They comprised two cases of previous caesarean section (one patient also had heart disease); two cases of pulmonary tuberculosis (one bilateral artificial pneumothorax, and one tuberculous pleural effusion in early

pregnancy); eight cases in which the main indication was a second stage of labour prolonged for two hours—there were five primigravidae over the age of 30 among them; and one case of deep transverse arrest: the position of the vertex in this case was thought to be anterior until more adequate examination, after the nerve block had been performed, showed the true position. Kielland's forceps were applied and a forceps rotation and extraction was performed without distress to the mother. Unless rotation can be done without difficulty pudendal nerve block analgesia is not suitable for manoeuvres such as forceps rotation and extraction. Traction was performed at the time of uterine contractions.

Previous Caesarean Section.—Routine forceps delivery is advocated only when there has been no previous vaginal delivery. In this type of patient the second stage of labour may be prolonged, and it is felt that once the cervix is fully dilated no further prolonged strain should be placed on the uterine scar. In the case of patients who have had previous vaginal deliveries forceps delivery is indicated if the second stage of labour has lasted over half an hour.

Maternal Disease.—In cases of chest disease, heart disease, protruded intervertebral disk, etc., especially in primigravidae, forceps extraction under pudendal nerve block analgesia is a safe method of reducing the strain of the second stage of labour.

Assisted Breech Delivery

The nine patients in this group included six primigravidae. In an assisted breech delivery anaesthesia or analgesia is required during delivery of the arms and the head. Induction of anaesthesia with thiopentone, nitrous oxide, oxygen, and divinyl ether (Law and Ransom, 1954) or "neothyl" (methyl-*n*-propyl ether) combines the dangers of general anaesthesia with delay before anaesthesia is stabilized. Pudendal nerve block can be performed when the breech is on the perineum, and analgesia is sufficient to allow the performance of an episiotomy, Løvset's manoeuvre, and controlled extraction of the foetal head.

In four cases forceps were applied for delivery of the after-coming head.

The time for induction of the nerve block is when delivery of the buttocks is anticipated. Otherwise loss of the perineal reflex produces a time-lag of about 15 minutes before spontaneous expulsive efforts become re-established.

This technique allows a gentle unhurried and controlled delivery of the head without any danger of maternal anoxia. Oxygen can also be administered to the mother, so allowing good oxygenation of the infant during delivery.

Multiple Pregnancy

This group comprised five cases of twins and one case of triplets. Four of the mothers were primigravidae. There were two stillbirths.

The indications for pudendal nerve block fall into two categories: (a) when the breech is presenting; and (b) when forceps delivery of the leading presenting vertex is indicated: in these cases the urgency for extraction of the second twin because of general anaesthesia is removed. One is always loath to have to reintroduce anaesthesia.

Among the 13 infants in this group there were six assisted breech deliveries; two spontaneous vertex deliveries (one stillborn) and five forceps deliveries—the indication in four cases was foetal distress.

Repair of Severe Lacerations

Pudendal nerve block was carried out for third-degree tears in four cases; repair of recto-vaginal fistula in three cases, and secondary suture of perineum in three cases.

The advantage of this form of analgesia is that immediate repair of third-degree tears is possible, and the same applies to the repair of the recto-vaginal fistulae of small dimensions immediately after delivery.

Secondary suture can also be satisfactorily performed, but gross perineal infection is an absolute contraindication.

Failures

There were three failures in this series. Case 1: twin pregnancy; foetal distress. After nerve block the vertex was found to be in the occipito-posterior position and general anaesthesia was induced. Forceps rotation and extraction was carried out. Case 2: Bronchiectasis; cyanosis in labour relieved by oxygen therapy. Re-examination revealed an occipito-posterior position and posterior lip of cervix. Continuous caudal analgesia given, and manual rotation and forceps delivery performed at full dilatation of the cervix. Case 3: Breech presentation with extended legs. Breech extraction performed under deep ether anaesthesia because of delay in delivery of the buttocks.

Complications

Bruising.—In six patients vulval bruising occurred after infiltration with analgesic solution. Severe varicose veins of the vulva are a contraindication to the use of this type of analgesia.

Haematoma Formation.—In two patients an ischio-rectal haematoma was formed. This was found on vaginal examination because the patient complained of unilateral perineal pain. In neither case was there any rise in the temperature, and no special treatment was required.

Oedema of the Vulva and Perineum.—Three patients had severe oedema, arising about six hours after delivery. By raising the foot of the bed the oedema resolved in about 12 to 24 hours. An injection of hyaluronidase might be a useful adjunct to this treatment.

Perineal Sepsis.—There were no cases of infection of the perineum, and all the episiotomies performed under pudendal nerve block analgesia healed by first intention.

Advantages

(1) The fatality described is the only one I have found reported in the literature associated with pudendal nerve block. (2) There are no pulmonary complications directly attributable to the procedure. (3) The technique is relatively simple and may be used in a home as well as in a hospital. (4) There are no ill effects on such vital sites as the liver, lungs, cardiovascular system, or kidneys. (5) There is no interference with the action of the uterus, the anterior abdominal wall, or the respiratory system. (6) The risk of asphyxia of the child, such as may occur after the use of inhalation anaesthesia, is absent. (7) The tissues must be handled gently, and there is seldom need for brutal hurry. (8) There is a reduction of bleeding from the episiotomy.

Disadvantages

(1) A needle may break during an injection, but since a needle nearly always breaks near the hub a long needle is advised. (2) Intravenous injection. Aspiration should always be performed before injection, and injection should be carried out slowly. (3) Idiosyncrasy to procaine or lignocaine. Fortunately this is rare. (4) Local complications such as bruising and oedema.

Contraindications

(1) When intrauterine manipulations are required. (2) Vulval sepsis, oedema, or varicose veins. (3) For correction of malposition of the presenting part unless this is very easy to perform. (4) In highly strung nervous patients.

Summary

A series of 57 patients (38 primigravidae and 19 multigravidae) in whom pudendal nerve block was performed is reported.

Pudendal nerve block was found to give safe and effective analgesia for the performance of low forceps delivery, for assistance in breech delivery, for the repair of severe lacerations, for the management of certain types of multiple pregnancy, and as a method of anaesthesia

for cases of lung and heart disease. It is also a useful technique in the management of the second stage of labour in primigravidae.

The risk of aspiration pneumonia is obviated, and for this reason the technique can help to reduce mortality and morbidity.

There were no foetal deaths that could be attributed to the anaesthetic used.

It is suggested that this is a simpler form of analgesia than caudal and spinal analgesia, and one which allows for full oxygenation of the mother and the foetus.

The maternal complications were comparatively slight and the length of stay in hospital was not increased, though 9 out of the 57 patients had oedema, bruising, or haematoma formation.

In three cases another form of anaesthesia was given in order to accomplish a technically more difficult delivery.

My thanks are due to Miss Janet Bottomley and Mr. Oswald Lloyd for their permission to perform the pudendal nerve blocks and to report the results.

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FLUID CONTENT OF THE NUCLEUS PULPOSUS AS A FACTOR IN THE DISK SYNDROME

FURTHER OBSERVATIONS

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The possibility that the hydrophilic property of the nucleus pulposus of the intervertebral disk has some bearing upon the development and symptomatology of low back pain, sciatica, brachial neuritis, and disk prolapse was suggested by Charnley (1952) and by us (Naylor, 1951; Naylor and Smare, 1953). The swelling of the nucleus due to an increased fluid content is thought to cause increased internal pressure within the disk, thus stretching the annulus fibrosus and stimulating the nerve-endings contained therein. Whilst the adult intervertebral disk has a poor blood supply, a considerable fluid interchange can occur, as shown by the rapid absorption of 35% diodrast when used in disk nucleography (Cloward and Buzaid, 1952). Charnley further showed that the absorption of fluid by the isolated nucleus could result in considerable pressure being developed when the nucleus was contained in a plethysmograph.

These results were obtained with nuclear material which was (a) removed from the disk, the annulus being disregarded; and (b) was not maintained at constant volume.

A preliminary investigation was carried out by two of us (Naylor and Smare, 1953) to discover whether the nucleus contained within a lumbar disk could absorb enough fluid to develop a high intra-disk pressure that might account for the symptoms associated with disk lesions. Isolated cadaveric disks, from subjects of varying ages, were immersed in water or isotonic saline solution and the pressure developed within the disk was recorded by means of a mercury manometer. Pressures of between 8 and 300 cm. mercury (1.5–58.1 lb. per square inch) were obtained from young subjects, but no pressures were recorded in disks from aged subjects in whom advanced degeneration was found to be present. A more comprehensive survey has now been made on disks from subjects in the age range 19–87 years, using the apparatus described below.

Apparatus

A diagram of the apparatus is shown in Fig. 1. A standard Bourdon gauge type pressure indicator A, reading up to a maximum of 60 lb. per square inch (4.2 kg. per square cm.), was connected to a copper tube, B, of $\frac{1}{2}$ in. (1.3 cm.) internal diameter. Tube E, a glass capillary about 8 in. (20 cm.) long and 1 mm. internal bore, was attached by pressure-tight joints to B and to a 20-gauge serum needle F. A metallic bellows, C, closed at one end, was connected to tube B and could be compressed by means of screw D. The whole apparatus above point X was filled with water, while below this point there was an unbroken column of mercury as far as the tip of the serum needle. The mercury-water interface was arranged to be about halfway along the glass capillary, and consequently was always visible.

When used the needle was inserted through the annulus fibrosus of the disk into the nucleus pulposus. On absorption of fluid by the nucleus, expansion of the latter forced mercury up the serum needle. The bellows, C, was compressed until the mercury meniscus returned to its original position. The pressure recorded by the gauge was thus the pressure developed in the nucleus. An indicator (not shown in Fig. 1) was used to enable the mercury meniscus to be adjusted with precision.

Experimental Procedure

Fresh lumbar disks, usually in sets of five (L 1–2, L 2–3, L 3–4, L 4–5, L 5–S 1), were obtained from necropsy subjects with a plate of bone on each side (about $\frac{1}{4}$ in. (6 mm.) thick, this being essential for maintaining the nucleus under conditions corresponding as far as possible with those *in vivo*). Forces generated by the increase in volume of the nucleus will consequently result in a slight increase in the circumference of the annulus fibrosus and not in a bulging of the bone end-plates. The annulus of the disk under test was pierced by a hollow needle of the same gauge as that used in the apparatus, and the needle attached to the apparatus inserted along the track made. This minimized the risk of blockage of the needle by tissue. Each disk was then totally immersed in distilled water contained in a Petri dish.

FIG. 1.—Diagram of apparatus (see text).