Regional Anesthesia in Obstetrics

Present Status

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CONTROL of pain in childbirth without ill effect to baby or mother is a challenge that today faces every physician who attends a delivery—as it has for centuries past. At the present time there are more than 70 standard technics which are used in obstetrics to relieve the pain of labor. There are even those who believe that parturition pain is no pain at all, but rather a combination of fear and tension engendered through centuries of misconception of "normal" body function.

RECENT TRENDS IN PAIN RELIEF FOR LABOR

The past decade has witnessed two major trends in pain relief for labor and delivery: "natural childbirth" technics and conduction (nerve block) anesthesia. The improvement wrought generally in the practice of obstetric analgesia as a result of the attention directed toward each of these popular movements has been outstanding, though neither has provided a completely adequate solution to the age-old problem.

Natural Childbirth

The advantages accruing to greater emphasis upon "natural childbirth" principles of education, relaxation and self-discipline were recognized by DeLee nearly fifty years ago, but the extreme lay publicity recently attendant upon Grantly Dick Read's[1] doctrines of "childbirth without fear" have served to push misnamed "drugless methods" into a place of prominence not deserved on the basis of actual experience in their use. Read, in his most recent publication, indicated that 50 per cent of 481 patients received some sedative, analgesic or anesthetic in the course of their labors.[2] Within the past few months, Javert and Hardy have clearly demonstrated with dolorimetric technics that pa-

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tients practicing "natural childbirth" experienced pain equal in intensity to that of parturients receiving *no analgesia.*[3] From the extensive investigation and practice of "training for (natural) childbirth" methods at Yale, Thoms states in his report of 1000 consecutive deliveries: "thus in 214, or *73.3 per cent* of *spontaneous** primiparous deliveries, *not over 125 mg.* of Demerol, or one dose of another agent, was used. *No analgesic* was received in *(only)** *19.9 per cent* (of spontaneous deliveries)".[4]

It becomes immediately obvious, therefore, even if one were to incorporate into what might be considered a balanced or "rational plan"[5] of obstetric analgesia the "natural childbirth" methods for the discomforts of premonitory labor and of the early dilating phase of labor, more definitive pain relief will be needed for the late first stage, for the second stage, and for delivery itself.

Regional Anesthesia

Continuous Caudal Analgesia. Regional anesthesia offered the most adequate answer yet to completely "painless childbirth" some ten years ago when Hingson combined his Lundy-Mayo background in extradural anesthesia with the revolutionary continuous spinal technic of Lemmon to create "continuous caudal analgesia." Up to 1949 there had been reported 600,000 deliveries under continuous caudal in 260 scientific papers in eight languages.[6] As one of the original members of the "Caudal 1000 Club," some 80 physicians who have managed 1000 or more deliveries under this technic, we can wholeheartedly substantiate Greenhill's statement in DeLee's "Obstetrics": "There is no doubt that when this procedure is properly performed without any misstep, there is no more satisfactory and pleasant type of analgesia in obstetrics."

And yet continuous caudal analgesia has failed of general usage because its complicated equipment, the need for increased nursing care, and the absolute requirements of skill, specialized obstetric judgment, and time-consuming watchfulness on the part of the physician. Those individual obstetricians, groups or clinics who have sufficiently desired the benefits possible have managed to overcome these obstacles and have kept continuous caudal analgesia alive. In our opinion the greatest deterrent to wider use of caudal analgesia has been the apparent tendency for the method to prolong both first and second stages of labor in many cases. As will be discussed later, this "slowing of labor" is inherent in any regional technic which extends its relief high enough to allay all uterine contraction pain, manifesting itself when anesthesia is induced too early in the first stage for the particular type of labor involved.

"Saddle Block" Anesthesia. The so-called "saddle block" technic of low spinal anesthesia provides an answer to many of the difficulties en-

* Italics and parentheses ours.

countered in the use of continuous caudal and is most applicable to general usage. Continuous peridural anesthesia is fraught with technical pitfalls for the occasional anesthetist; intradermal block for relief of dilatation pain has not proved consistent.

Six years have elapsed since Adriani reported in preliminary fashion his revival and simplification of Pitkin's "controllable" spinal anesthesia[7] of some twenty years before, and coined the misnomer "saddle block" anesthesia. Those of us who have been interested in regional anesthesia for obstetrics have followed closely the furor accompanying the advent of this technic, which, though slightly less spectacular than the rise and fall of continuous caudal anesthesia during the five years preceding, resulted in a nationwide trial of the method by qualified obstetricians and general practitioners alike.

In the years 1948 through 1950 we read scores of enthusiastic reports on the use of "saddle block" anesthesia in obstetrics, and, in the light of our own extensive and well-controlled experience, literally gasped in amazement and in dismay. The typical cycle of trial and appraisal was repeating itself in every particular. During the past two years we have observed fear and decreased use.

At present we are striving for sane appraisal of the method and recognition of its true merits. Two principal dangers have been described: neurologic injury to the mother and intrapartum death of the fetus. (Circulatory collapse and respiratory failure will not be problems in a block so limited in extent.) The importance of any neurologic complication in curbing the usefulness of "saddle block" can only be determined by the passage of the next few years and the proper compilation and analysis of scattered reports.

"SADDLE BLOCK" ANESTHESIA: TECHNIC

The technic we have used is an extremely simple one from the standpoint of the qualified anesthesiologist, and represents little, if any, deviation from the original procedure described by Adriani and Parmley[8] for obstetric use. The patient is anesthetized while in a sitting position over the side of her labor bed, under the mattress of which have been placed board supports to prevent sagging. The injection is made between contractions, in the fourth or third lumbar interspace, and through a short bevel 22 gauge Pitkin needle. Recently a 24 gauge needle (double-needle technic) has created a significantly smaller incidence of headaches. Anesthetic infiltration of the skin and deeper tissues is not carried out.

Exactly 30 seconds after injection the patient is placed flat on her back with a doubled pillow supporting the head. No change from this position is allowed for twenty minutes in the routine case, during which time the physician remains in constant attendance, making and recording

every few minutes observations of blood pressure, pulse, fetal heart rate, and level of anesthesia. Oxygen and emergency drugs are always at hand.

A variation of procedure may be carried out in cases requiring immediate delivery, the anesthesia being induced on the delivery table. In this instance the patient's head and trunk are elevated into 10 or 15 degrees reverse Trendelenburg position soon after injection and the legs immediately placed into stirrups. Anesthesia adequate for delivery is obtained in five minutes or less, with a skin level between the eighth and tenth thoracic segments. By this maneuver we can obtain safely for mother and fetus the advantages of regional anesthesia in cases where rapid delivery by operative means is indicated by pre-existing fetal distress or other extenuating circumstances. An example is one case requiring Duhrssen's incisions of the cervix and mid-forceps delivery for the rescue of a fetus having prolapse of the umbilical cord.

We have suggested repeatedly that no other alteration be made in this technic, on the basis that our results have been good clinically and that the method has proved safe as it stands. Simplicity and preciseness are important factors when an inexperienced physician is learning any procedure in medicine. More than 100 physicians, most of them assistant residents, have learned "saddle block" in our birthrooms.

Other nonvariables in our practice include the use of an anesthetic mixture of 1 cc. volume, and the carrying out of the actual injection as rapidly as is possible through a 22 gauge needle. These factors assist in creating clinically and pharmacologically safe levels which are constantly at or just above the umbilicus.

Solutions Employed

The great majority of the patients in our series have received 2.5 mg. of nupercaine in 5 per cent dextrose. We use 1 cc. of the premixed solution. This drug is a favorite because variations from the usual skin level of anesthesia with the above technic are exceedingly rare, and because duration of effect is longest. In the average case one injection by an experienced individual gives relief from uterine pain for approximately two hours and fifteen minutes, and perineal anesthesia of between three and four hours.[15]

Metycaine is preferred for operative deliveries because of its clinically profound effect, which invariably eliminates pressure discomfort during forceps traction and intrapelvic manipulations. Thirty mg. of this agent are used, in a premixed solution of 5 per cent dextrose. The incorporation of 0.4 gm. epinephrine into each cubic centimeter of the metycaine mixture has in our hands lengthened the duration of the effect of this agent 60 per cent to give a mean of two hours of uterine pain relief.[16] This phenomenon is due undoubtedly to the primary spinal anesthetic effect of epinephrine, previously reported by us.[10]

Pontocaine, 5 mg., and procaine, 40 mg., have also received clinical trials by us, and have been found satisfactory. Pontocaine should be used in dosage of not more than 3 mg. in light of more recent experience by us; a prepared ampule is available.

Factors Affecting Safety

It may appear presumptuous to dwell at such length and so emphatically upon technical points which seem almost ridiculously simple. But there are reasons for this—particularly when one realizes that the great majority of physicians who are and will be using "saddle block" over the country are neither trained anesthesiologists nor qualified obstetricians. We have proved this method a safe one when simple precautions are kept in mind. We have learned repeatedly, from the early experiences of men who rotate through our birthroom service, that seemingly minor deviations from the technic result in inadequate anesthesia, while without alteration we have used the procedure successfully in women ranging in weight from 110 to 285 pounds.

Perhaps the most important lesson that we have learned during the past three years is that over-all success and satisfaction in the use of "saddle block" depend much more upon obstetric factors than upon anesthesiologic technic. Aside from the usual organic and psychologic contraindications to spinal anesthesia, obstetric judgment must decide which labors and what types of deliveries may be managed with the method.

When to Give "Saddle Block"

The question most commonly asked of us is: "When, in the course of a patient's labor, do you give the 'saddle block'?" It has been the policy of our staff to restrict the use of spinal on clinic cases to one injection. This rule automatically limits the procedure to semi-terminal use. In our original "experimental" series repeat blocks were used in about 10 per cent of patients, primarily in selected cases of toxemia, diabetes, heart and pulmonary disease and premature labor.

It is advisable for the average physician, without previous obstetric experience with continuous caudal or other regional methods, to limit his early efforts with "saddle block" to anesthesia for terminal labor and delivery itself. This implies induction on primiparas when cervical dilation is complete or practically so, and when the presenting head is well engaged. In multiparas the cervix should be 6 to 7 cm. dilated with the head at least fixed in the pelvis. The qualified obstetrician with experience in the mechanism of labor under regional anesthesia may select cases to anesthetize earlier. Regardless of when anesthesia is induced, we prefer to use *minimal* dosage. We disagree with those who would *double* the

dose for instance, and then attempt to *individualize* the period of time through which the patient sits upright after injection in order to obtain the proper level of anesthesia.[9]

One must emphasize that the time for inducing the anesthesia cannot be generalized in terms of so many centimeters of cervical dilatation. Some multiparas may be anesthetized as early as 3 cm., while in an occasional primipara one must wait until the presenting part has reached the perineal floor. Careful analysis must be made of the uterine contractions, position of the fetus, and cephalopelvic relationship. For example, a deflexed, posteriorly positioned head should indicate need for delaying the block until the situation had improved and all suggestion of dystocia eliminated. A vaginal examination profitably could precede the block, particularly if intact membranes were present (best ruptured in advance of the anesthetic in such situations).

Premedication

It is obvious that adequate premedication must be given when "saddle block" is used late in labor. On the Lying-in staff service it is routine to use morphine sulfate 10 mg. (1/6 grain) and hyoscine 0.5 mg. (1/130 grain), with repetition of the hyoscine in smaller dosage as indicated. Methadone (10 mg.) recently has been used in place of morphine.[37] It has been our experience that administration of 0.2 gm. (3 grains) of a short-acting barbiturate, such as Seconal or Amytal Sodium, early in labor serves to alleviate apprehension and restlessness on the delivery table.

"SADDLE BLOCK" ANESTHESIA: BENEFITS TO THE FETUS

Much has been said about the absence of respiratory depression and systemic narcosis in babies delivered under regional anesthesia. Scientific backing has been given these impressions by the studies of Taylor,[12] and of Henderson and Watts,[13] on the oxygen content of the blood in newborn infants. The survival figures in the well-controlled study of Masters[14] have demonstrated beyond honest doubt the protection afforded the premature infant (Table 1). The corrected fetal mortality in 932 carefully analyzed per vaginal births under saddle block on our service was 0.42 per cent. If we were to remove from the "preventable" column three neonatal deaths in prematures who were born after less than thirty weeks of actual gestation, only one infant with any respectable chance of survival can be considered lost (0.11 per cent).

This group of patients may be described as significantly unselected in so far as types of delivery are concerned, with the single exception of a lower than usual incidence of breech delivery in viable single pregnancies, i.e. 2.5 per cent as compared with approximately 4.3 per cent (Table 2). Maternal diseases and complications, omitting severe degrees of placenta

previa and abruptio placentae, were well distributed in our series, and the incidence of premature births was well above normal.[15, 16]

While it may be true that our series was not perfectly controlled, it does offer additional evidence that properly regulated "saddle block"—undoubtedly the form of regional anesthesia best suited for use in the average practice of obstetrics—can be of definite benefit to the fetus in the face of prematurity as well as in labor at term.

Table 1

PREMATURE MORTALITY RATES—CONDUCTION VS. NONCONDUCTION ANESTHESIA

WEIGHT GROUP (gm.)	CONDUCTION (244 cases) Per cent	NONCONDUCTION (347 cases) Per cent
2500 to 2001	3.6	7.8
2000 to 1501	6.2	22.7
1500 to 1001	25.0	52.9
1000 to 500	76.9	100.0

Table 2

DELIVERY IN CEPHALIC PRESENTATIONS

TYPE OF DELIVERY	CONTROL (2907 cases) Per cent	SADDLE BLOCK	
		Late (a) (407 cases) Per cent	Early (b) (436 cases) Per cent
Spontaneous	36.2	4.8	1.4
Outlet forceps	37.6	62.2	56.6
Low forceps	14.1	20.4	15.3
Manual rotation + low forceps	7.0	9.0	7.3
Low forceps rotation	4.1	2.8	4.5
Mid-forceps	2.0	0.8	1.9

(a) Cervical dilatation 9 to 10 cm.
(b) Cervical dilatation 8 cm. or less.

In this presentation we have thought it timely to analyze various situations in which death of the fetus has occurred, or may occur, during the course of the anesthetic. We have used the word "attributed" in the course of our presentation, because it is obvious to us that most of the fetal deaths are not directly "attributable" to the method, but are rather due to misapplication of the method or to errors in obstetric judgment. Whether the anesthetic method in itself predisposes to more frequent errors in judgment is a point which merits serious consideration.

"SADDLE BLOCK" ANESTHESIA: DANGERS TO THE FETUS

If "saddle block" literally can save the lives of some babies, how may it play a part in killing others? The answer to this question has many

facets, incriminating spinal anesthesia directly as well as indirectly, and depending to a considerable degree upon the judgment and care with which the physician fits the method into his practice.

The so-called "specific dangers" to the fetus during labor and delivery under spinal anesthesia stem, for the most part, from three abnormal situations attributed to the method per se: (1) an increased incidence of major operative deliveries, (2) a tendency for delay in the normal progress of labor, and (3) an apparent marked increase in frequency of fetal distress during the terminal phases of labor.

1. An Increased Incidence of Major Operative Deliveries

An abnormally high percentage of major operative deliveries invariably results over a period of time in an increased incidence of fetal death or irrevocable damage in infants who survive. This is axiomatic in obstetrics, irrespective of the dexterity of the physician or the method of anesthesia.

When "saddle block" anesthesia is used recklessly as a routine procedure and without careful individualization of each labor, the opportunity for otherwise unnecessary major operative procedures for delivery is definitely greater than with the use of general anesthesia.

Softening and relaxation of muscular tissues in the maternal pelvis and perineum are mentioned repeatedly as a major advantage of regional anesthesia, in minimizing trauma to the fetal head during terminal labor. Yet ipso facto this beneficial factor becomes nonfunctioning if the presenting part fails to descend to the pelvic outlet in normal fashion.

Operative Deliveries in Presence of Fetopelvic Disproportion

Previously Unrecognized Disproportion. Previously unrecognized, *relative* cephalopelvic disproportion at the mid-pelvis and below is an important etiologic factor in cessation of descent under regional anesthesia —and a potential cause of fetal death through subsequent traumatic delivery. A case in point is typical of the difficulties the physician may bring upon himself by failure to appreciate such a situation.

Case I. Primigravida, 34 years, Rh incompatibility, normal gynecoid pelvis, prenatal course uneventful, weight gain 12 kg. Admitted at term with membranes ruptured, not in labor. Blood pressure 126/98. Vaginal examination 24 hours after rupture of membranes and following 10 hours of regular mild contractions revealed "adequate pelvis with no obvious disproportion." Position ODT, station −2, cervix 2 cm. and thin. Penicillin started. Progressive elevation of blood pressure to 166/130 developed with labor; 4 cc. of 50 per cent magnesium sulfate given intramuscularly. Normal pressure persisted thereafter, proteinuria absent. After 27 hours of labor cervix was dilated 7 to 8 cm., position ODA, station +1. Morphine 10 mg. ($\frac{1}{6}$ grain) and scopolamine 0.4 mg. ($\frac{1}{150}$ grain) given intramuscularly.

Saddle block anesthesia was administered 30 minutes after medication without change in blood pressure or in fetal heart rate. The patient was prepared for

delivery 40 minutes after block; cervix completely dilated, station +1. Mid-forceps rotation from ODA to OA carried out after L.M.L. episiotomy. Fetal heart tones remained normal. Extraction of head was difficult and prolonged, requiring a second obstetrician. Shoulders delivered with moderate fundal pressure and No. 2 "tight-ring" manuever. Ergotrate 0.2 mg. was given intravenously with posterior shoulder; placenta followed almost immediately. Minimal extension of the episiotomy resulted, but no cervical or other vaginal lacerations.

The baby made no attempts to breathe, and the heart beat was but questionably detected for a short time immediately after delivery. The infant weighed 4150 gm., was 55.5 cm. in length. Autopsy revealed marked evidence of asphyxia neonatorum and abrasions of the face.

The maternal postpartum course was afrebrile and blood pressure did not rise above 120/80.

The decision of the senior resident in attendance to administer "saddle block" at the particular time was based upon the belief that delivery would become imminent in a short time, together with the opinion that regional block for the delivery would be beneficial to both mother and baby in the face of prolonged labor and intrapartum hypertension. These complications also were operative in the election of forceps extraction within a very short time after complete dilatation of the cervix had occurred.

The primary error in judgment was the failure to appreciate the relative fetopelvic disproportion and to anticipate the prolonged and difficult extraction which resulted in death of the fetus. Were the spinal anesthetic to have been omitted (or delayed) in this case, it is quite conceivable that the barrier of relative disproportion would have been overcome by the patient's own reflex and voluntary "bearing-down" efforts, here completely inhibited by the regional block.

It is true that prolonged or forceful "pushing" in the second stage is not desirable from the standpoint of increased damage to the supporting structures of the pelvis, yet there are instances where this "price" must be paid if simple delivery from below is to be accomplished. This statement is made in full realization that in present day obstetrics cesarean section is often preferable to mid-forceps extraction.

This case and its outcome is surely not an isolated instance in practice with regional anesthesia, though the only one to occur on our service. In the face of recognized clinical and roentgenologic difficulties in correctly evaluating in advance of very late labor relative degrees of mid-pelvic disproportion, one may expect to meet this situation not infrequently —and usually without the fairly tenable indications for cutting short the second stage which existed here. A recent treatise designed to teach anesthesiologists the management of labor included the advice: "The accoucher who is not capable of performing expertly any of the *simple* maneuvers should not be provided with caudal or spinal analgesia."[18] To this masterful understatement we add emphatically Dyer's[22] admonition that anyone setting out to use saddle block must be adept in the use

of forceps at the *midplane*, which—as noted here—is often far from a *simple* maneuver.

"Saddle block" anesthesia should not be used in any case where the physician is aware of some disproportion in the mid-pelvis and *plans* to have the patient use her voluntary forces to considerable extent if necessary. At least the block should be delayed until the head has descended. When the fetopelvic disproportion is recognized unexpectedly after the block has been administered, one is faced with the serious difficulties discussed in our case presentation above. The choice then lies between a traumatic forceps extraction, cesarean section after trial of forceps, podalic version and breech extraction, or simply allowing the anesthesia within the pelvis to wear off.

The last alternative means a wait of three to six hours from the original time of the block if the anesthetic agent is the commonly-used nupercaine. Such delay exposes the fetus and mother to the added dangers of an extremely prolonged second stage, with no positive assurance that subsequent "pushing" efforts by the patient will be successful in accomplishing descent.

Internal Podalic Version and Extraction. This procedure, as a method for management of disproportion at *any* level of the pelvis, has been largely discredited in the enlightened obstetric practice of the present age. Under unsupplemented regional anesthesia the irritability of the unparalyzed upper uterine segment usually renders this operation impossible of performance in single pregnancies, particularly in the absence of an intact bag of waters. The likelihood of uterine rupture and/or major trauma to the fetus is self-evident. Superimposition of deep ether anesthesia may be the mortal blow for a fetus already (most likely) subjected to trial of mid-forceps and now facing version and extraction through a disproportionate pelvis.

Cesarean Section. Cesarean section following brief but carefully executed trial of forceps remains a possibility for the skilled obstetrician. Its application by the average physician in a predicament originating from poor judgment would be difficult to justify to both family and colleagues. Trial of forceps and subsequent section under the same low spinal anesthetic may be good practice and an advantage of the regional method in certain planned situations—where mid-pelvic disproportion has been recognized, descent has not taken place in an appropriate interval, and delivery without further delay is deemed advisable. This procedure has been used successfully twice in the last four years on our service.

True Outlet Forceps Deliveries

Delivery by so-called "prophylactic" or true outlet forceps with liberal episiotomy, made as soon as the presenting fetal head firmly presses

upon the perineal floor but before extreme "bulging" or "crowning," is considered good practice by the bulk of present-day obstetricians, regardless of the type of anesthesia used. With the use of regional anesthesia, outlet forceps extraction has all but eliminated spontaneous delivery in normal labors (Table 3).

Where "saddle block" anesthesia has been given late in the first stage, and the fetal head rotates fully and descends promptly and completely to a relaxed perineal floor under the force of uterine contractions alone and without violent and traumatic "bearing-down" efforts, it would appear that the true culmination of DeLee's motto, "non vi, sed arte," had been reached. Fetus and mother are free of narcosis in the absence of injudicious preliminary sedation, and both benefit from relaxation of muscular tissues. The perineum may be reconstructed following episiotomy without need for haste.

Table 3

EFFECT OF "SADDLE BLOCK" UPON NORMAL TYPE DELIVERIES

DELIVERY	CONTROL (2907 cases) Per cent	EARLY SADDLE BLOCK (407 cases) Per cent	LATE SADDLE BLOCK (436 cases) Per cent
Spontaneous	36.2	4.8	1.4
Outlet forceps	37.6	62.2	56.6

Low or Low-Midforceps Deliveries

Even the semi-terminal use of "saddle block" at times exposes both the baby and its mother's tissues to undue and unnecessary trauma. This danger is part and parcel of the increased incidence in so-called low or low-midforceps deliveries noted in the majority of reported series. Along with many other clinics, we always have distinguished between outlet and low forceps. In the first group, the presenting head is visible at the introitus or has established firm contact against the perineum before forceps are applied. In the low forceps category, the presenting head has not achieved so complete a descent, but is 2 cm. or more below the ischial spines.

In many instances there is little if any greater traction force needed for the low extraction under regional block than for the true outlet delivery. Frequently delivery may be achieved by means of Kristeller pressure from above, or by the directed pushing efforts of the mother herself working with uterine contractions. Parenthetically it might be added that, as in the case of the true outlet forceps deliveries, we prefer to avoid Kristeller pressure, as it is occasionally traumatic to the baby and to the mother's uterus. To cause further dilemma is some evidence that strong pushing efforts on the part of the parturient may predispose

to higher incidence of severe postpartum headaches—coming in those patients in whom the spinal tap has been the cause of a sizable rent in the dura. Likewise in many of these low or low-midforceps cases rotation of the fetal head from the frequently-seen transverse or posterior positions may be almost ridiculously easy to accomplish, often by a single finger as the rotating vectus. Yet two situations commonly and insidiously arise in deliveries lumped into the low forceps classification which become a potential source of fetal death or fetal brain damage as well as injury to maternal tissue.

The first instance is the tendency for obstetricians to reach progressively higher and higher above the perineum to perform elective forceps deliveries. The basic etiology may be carelessness or exaggerated self-confidence. Occasionally there may be inertia to the point of standstill in the second stage. This may be the result of an abnormally high level of spinal anesthesia which deteriorates uterine motility, or may arise from a combination of general body relaxation after pain has been relieved with a cumulative effect of previous sedative medication. In other instances, in spite of strong uterine contractions, the obstetrician may neglect to wait long enough for the fetal head to "drop" to the perineal floor following artificial rupture of the bag of waters found intact when the patient was prepared for delivery.

Though actual cephalopelvic disproportion may not exist, the process of carrying out elective forceps delivery from a level in the pelvis almost as high as the mid-plane itself often requires extreme force and considerable downward traction toward the hollow of the sacrum in order to stem the occiput under the symphysis. To anyone who has terminated a number of otherwise normal labors in such a manner it becomes obvious that usually this is "non arte, sed vi." In the absence of fetal or maternal indication for immediate termination of labor, we do not feel that such deliveries are to be recommended as "prophylactic" obstetrics by any substantial criterion.[17, 19]

Even more likely to involve physical trauma to the fetus and vigorous exercise plus psychic trauma to obstetrician, is the second type of unindicated low or low-midforceps operation too frequently seen with "saddle-block" anesthesia. In this situation there has been caput formation and molding of the fetal head to the point of creating an impression that the presenting occiput has descended *almost* to the perineal floor, while actually there is a degree of true obstruction from relative cephalopelvic disproportion in the low-midpelvis. Usually there is accompanying failure of anterior rotation of the head (often unrecognized by rectal examination), and quite occasionally a significant degree of deflexion.

The obstetrician may knowingly undertake delivery because of lack of progress though a prolonged second stage under spinal anesthesia. More commonly he completely misinterprets the factors involved and assumes

that he is dealing with a routine "almost outlet" forceps situation, which, when "saddle-block" anesthesia is induced, he will be able to terminate by simply "lifting" the fetal head over the incised perineum with a gentle, one-handed sweep of the finger-held forceps. Very often this misinterpretation is abetted by a desire to "finish up the case" as soon as possible. The actual state of affairs in these cases is a maternal pelvis filled to its utmost capacity by this particular infant's head. The result is a traumatic, often long and drawn-out manipulative delivery which finds the infant's head and face marked by bruises and forceps cuts and the maternal vagina and cervix multiply lacerated. Good judgment in this type of case would dictate postponement of regional anesthesia until the parturient's urine and voluntary powers create complete flexion and anterior rotation of the occiput with almost complete descent to the true perineal outlet.

So long as babies are assisted in their birth per vaginam, always will there remain indications for "high-low" or "low-mid" forceps—regardless of the type of analgesia and/or anesthesia employed. In addition to the occasional labor requiring "emergency" interference on the basis of maternal or fetal indications, we shall continue to see inertias and relative degrees of disproportion wherein delivery from below is deemed the procedure of choice.

In dealing with "saddle block" our concern with this type of delivery is its elective use at will, together with its employment from necessity in situations created primarily by the regional anesthetic (since these arise less often in its absence). Particularly apt to occur is the obligatory, nonelective instrumentation when induction of the block has been premature in so far as the individual labor is concerned, and/or there has been injected an amount of anesthetic drug from 50 to 100 per cent greater than the minimal effective dose.

Incidence of Major Operatives Procedures, and Their Level, under Saddle Block

In a significant percentage of published reports on series of deliveries managed under "saddle block," it is difficult, or even impossible, to calculate or estimate the incidence of major operative deliveries and to discover the level within the pelvis at which listed manipulative procedures for delivery were carried out. Some reports, usually those appearing in local journals and particularly apt to influence the general practitioner, evade completely or pass over lightly the problem of complications in labor and delivery.

A comparison of several of the more or less completely analyzed (or analyzable) series reveals a wide variance in the percentage of major operative deliveries. Examples of reports with relatively high operative rates are those of (a) Ziegler,[20] (b) Jorgensen,[21] and (c) King and Dyer[22];

encies. Its use routinely, or by any except experienced obstetricians, is not advised.

Twin Pregnancies

In our review of the records of 53 cases of twin pregnancy managed under regional block, only once was there recorded any difficulty attributable to the anesthesia. The obstetrician in this case ruptured the membranes of the second bag of waters and then delayed seven to ten minutes before setting out to perform a version and extraction on the aftercoming twin. The fundus had contracted firmly around a "jack-knifed" infant; delivery was not possible until relaxation of the uterine musculature through deep ether anesthesia had been achieved. In 21 cases, version and extraction of the second twin was accomplished under conduction block alone. Care should be taken to avoid rupture of the second bag until version is underway and, if possible, until the feet of the second infant have been brought down in the hand below the level of the head. All manipulations should be carried out gently and between contractions.

Face Presentations

We have not hesitated to use conduction block in face presentations when delivery is imminent. In two instances of true brow presentation at term we have utilized "saddle-block" to carry out with remarkable facility the operative procedure of bimanual conversion. In one case the cervix was dilated 8 cm. when the brow presentation was confirmed by vaginal examination after a "suspicious" rectal examination. With the presenting part at mid-pelvis, the labor was allowed to proceed after the conversion until dilatation was completed and an outlet forceps delivery was possible. The inability of the method to bring about systemic narcosis with concomitant deterioration of uterine contractions makes conduction anesthesia an invaluable adjunct to the operation of conversion, and should serve to make this procedure one of choice whenever a brow or posterior face presentation is discovered in a patient who is well along in labor. In our second case complete cervical dilatation was present at conversion, and low forceps delivery was possible soon after.

2. A Tendency to Delay in the Normal Progress of Labor

Second, in the three principal characteristics of "saddle block" anesthesia which are said to contribute to unwarranted fetal deaths, is an alleged common tendency of the method to cause a significant deterioration in the efficiency of uterine contractions and concomitant delay in the progress of labor.[48, 49] The latter is said to result in an elevation of the infant death rate from such assorted secondary effects as simple increase in the incidence of prolonged labor and its accompanying dangers, pro-

traction of the second stage with anoxia and/or cerebral damage of the fetus, greater tendency for the performance of traumatic operative procedures, etc.

In the past four years we have studied the effect of spinal anesthesia upon uterine motility during labor in approximately 100 patients, employing both the Fenning single-point tokometer[50] and the Reynolds' three-channel tokodynamometer.[51]

The results of our studies are being reported in detail elsewhere, but summary of a few apropos findings may be in order.

"Saddle block" anesthesia causes a significant deterioration of the uterine contraction pattern in less than 10 per cent of patients, *provided*, first, the block is not instituted until labor is progressive in the face of normally strong, frequent and regular contractions, plus fixation of the presenting part in the pelvis; and second, the level of anesthesia is maintained at the level of thoracic skin segments 9 and 10. Cervical dilatation (beyond 4 cm.) is of lesser importance if other criteria are met perfectly.

There may, on occasion, be some delay in descent of the presenting part and (rarely) in terminal cervical dilatation. These effects are seen most commonly when an intact (bulging) bag-of-waters exists. Artificial rupture of the membranes almost invariably results in completion of cervical dilatation and quite prompt spontaneous descent to a perineal station. In some instances the not-uncommon simple delay in descent of the head may be corrected by properly directing the parturient to "push" with each painless contraction. Some prefer to use manual pressure on the fundus through the abdomen for a similar result. Both methods assume completion of cervical dilatation.

It is possible to illustrate some of the definitive procedures used in management of induced lack-of-progress situations by means of an abstract of an actual case. Seen not infrequently in our early experience with continuous caudal, this patient's course after anesthesia is typical of the delay which can be expected when saddle-block is induced without meticulous attention to all conditions existant in the fetopelvic relationship. Particularly significant were the presence of a posteriorly-positioned occiput with deflexion to slightly beyond a "military attitude," the lack of complete engagement of the head, and the persistence of an intact bag-of-waters. The development of reversal in the physiologic uterine gradient with lack of fundal dominance was clinically determined without difficulty by palpation of the entire uterus during a contraction, although palpation of the fundus alone and simple timing of contractions would not have revealed this cause of the functional dystocia. More frequently the etiology of delay in progress following regional block (particularly when the labor beforehand is not so well advanced, nor as progressive) has been the development of the "classic" inertia pattern of uterine activity with weakened and/or irregular contractions.

CASE II. Para 0; EDC 5/30/50. Pelvis gynecoid, adequate. Labor began 1:30 A.M., 6/10/50.

TIME	POSITION	DILATATION	STATION	CONTRACTIONS
3:15 A.M.	OLA	1–2 cm.	−0	Every 5 min., "fair"
6:00 A.M.	OLA	5–6 cm.	−0	Every 3 to 5 min., "fair" to "good"
6:30 A.M.	Caudal anesthesia started. "No change" in labor and no progress in next 8 hours. Level of anesthesia T9-10-11.			
2:30 P.M. (Vaginal)	ORP Deflexion Membranes ruptured artificially, Caudal discontinued, Demerol-scopolamine administered.	6+	0	Every 3 min., hard, no fundal dominance
5:00 P.M.	ORT	9	+1	Every 2 min., hard, good fundal dominance
6:00 P.M.	ORA "Saddle block" administered	Comp.	+2	Every 2 min., hard
6:52 P.M.	Outlet forceps delivery with episiotomy. Female infant; 7 pounds, 9 ounces; respirations immediate.			

It is at times possible to achieve success in overcoming such instances of induced delay in progress without terminating the conduction anesthesia. Rupture of the membranes with or without rotation of the head, and correction of the deflexion, frequently suffices, particularly where the "classic" inertia syndrome has developed. In some cases of "reversal" the simultaneous administration of a barbiturate or narcotic with scopolamine to create systemic relaxation has in itself accomplished the task. In the particular case abstracted we felt the failure of progress had been allowed to go on unchallenged over such a long period of time as to require truly vigorous treatment, without preliminary trial of any portion of the therapy.

We have seen in a very few instances a poor pattern of uterine contractions improve remarkably under spinal, but we do not recommend use of conduction block in uterine inertia except as an excellent means of providing an interim of rest for the patient without narcosis—and, most emphatically, as anesthesia for delivery after a protracted labor.

Danger to the fetus from interference with labor will rarely be seen in our opinion, unless one misjudges cephalopelvic disproportion, uses the block prematurely, or fails to follow a technic which will limit the height or level of anesthesia. We have seen in consultation one patient who was given a block to the skin level of the eighth thoracic at 9 cm. of cervical dilatation—head at station spines plus 2, who thereupon ceased having *any* uterine contractions through twenty-six hours when seen by us. She was then delivered by forceps, aided by a small laceration of the cervix, which we had recommended be incised. One other proven

similar case has been brought to our attention. We do not condone the indiscriminate use of pituitrin to augment labor which has been deteriorated by conduction anesthesia.[52, 53]

3. Increase in Frequency of Fetal Distress During Terminal Phases of Labor

Of all fetal deaths attributed to spinal anesthesia, those occurring very near the termination of labor are the most difficult to analyze from the standpoint of exact etiology and, by the same token, the most difficult in which to rationalize away the anesthetic method as principal causative factor. This latter fact is, at the same time, illogical and readily understood. It is illogical because the great majority of second stage intrapartum stillbirths fall into various classifiable situations, regardless of the presence or absence of any specific method of pain relief. From the standpoint of the person who does not possess a complete understanding of the physiopharmacologic effects of spinal anesthesia upon the woman in labor, various results which are capable of producing or threatening fetal anoxia are ready-made culprits upon which to hang the onus of stillbirths. Actually, these fetal deaths are most commonly attributable to errors in judgment, or careless management on the part of the attending physician.

As a background for better understanding of some 4 to 5 intrapartum fatalities which have occurred during terminal labor in the course of nearly 8000 deliveries under "saddle block" spinal anesthesia on our service over the past sixty-nine months, and as a basis for preventative measures in the future, we have thought it apropos to analyze a number of circumstances under which fetal distress may occur or threaten to develop. For this purpose we are utilizing various data collected during the course of studies on the influence of "saddle block" upon uterine motility and upon maternal blood pressure.

Recognition of Fetal Anoxia

The single adequately dependable and clinically appropriate means of recognizing intrauterine fetal anoxia during labor is auscultation of the fetal heart tones. Subject to the normal variation of a mild sinus arrhythmia and to individual resistance of the organism to oxygen lack, fetal anoxia in utero is first indicated by a slowing of the fetal heart rate. Significant bradycardia implies a drop of the rate from the usual 120 to 140 beats per minute to a figure below 100. Prognosis for survival of the fetus without permanent brain damage deteriorates progressively after the bradycardia has become constant throughout the interval between contractions, after first being noted only during and immediately after a contraction. Irregularity of the rate along with bradycardia likewise is a manifestation of extremely poor prognosis.

The transient and apparently "compensatory" nature of the tachycardia in cases of threatening fetal asphyxia, as suggested by Freed[54] in 1927, was confirmed by Lund[55] in 1940—using a method of continuously recording the fetal heart rate while producing progressive anoxia in the mother host through nitrous oxide anesthesia. Lund noted that the first sign of fetal asphyxia is not, as in adult life, tachycardia—but rather a decrease of the heart rate. A rapid fetal heart rate was seen during the "recovery period," i.e., as the mother was given oxygen rather than nitrous oxide and was removed from the state of relative anoxia. Lund[56] also has served to put on a sound basis the fact that constant or intermittent tachycardia (160 plus beats per minute) is in itself an innocuous —and not rare—finding during labor. We have noted tachycardia quite frequently following manipulation of the fetal head incident to artificial rupture of the membranes.

The physiologic mechanism for the fetal bradycardia and compensatory tachycardia of anoxia is as yet poorly understood. Some consider it based upon blood chemistry variations acting directly on the heart's pacemaker. The role of the vagus nerve here, likewise, is an incomplete mystery, abetted by an ignorance concerning the functional maturity of the cardiodepressor reflex endings in the human fetus of thirty to forty weeks' gestation.

Passage of Fresh Meconium. The passage of fresh meconium is another sign which has been considered indicative of fetal asphyxia. Schulze[57] reported that the passage of meconium during labor occurred in 3 per cent of 5534 deliveries; it was of negligible significance unless accompanied by changes in the fetal heartbeat, when it would signal profound asphyxia. Meconium may appear in combination with fetal heart rate changes, but its absence certainly does not preclude intrauterine distress. This is important, for some obstetricians feel that its absence is a favorable sign. Its presence occasionally precedes fetal heart rate changes.

Mechanisms Contributing to Maternal Respiratory Paralysis and Acute Hypotension

It is a well established fact that the pregnant woman at or near term is extremely susceptible to the two major "immediate" complications of spinal anesthesia, namely: (a) respiratory paralysis, and (2) acute hypotension with complete "vasomotor collapse" and subsequent cardiac failure. Factors contributing to the development of this potentially dangerous situation are:

1. The exaggerated vasomotor instability inherent in most pregnancies.
2. The tendency for venous pooling in the lower extremities.[58]
3. Three phenomena of pregnancy tending to create an abnormally

high level of anesthesia for a given amount of anesthetic agent:

a. Increased intra-abdominal pressure from the "physiologic tumor" of pregnancy.
b. Elevated spinal fluid pressure and turbulence of the fluid accompanying voluntary or reflex straining at the instant of uterine contraction.
c. Increased lumbar lordosis which tends to create "overflow" and pooling of the anesthetic solution into the upper thoracic segments.

It should be emphasized that these mechanisms act relatively infrequently when the "saddle block" procedure is carried out correctly. Anesthesia is instituted with the patient in a sitting position, and the minimal dose of the agent is rendered hyperbaric, or greater than spinal fluid in specific gravity, by the addition of 5 per cent dextrose. Volume of the dose is constant at 1 cc. The actual injection of drug is made rapidly, and with "no" preliminary aspiration during an interval between contractions; the patient remains in a sitting position after injection for 30 seconds. This is adequate time to allow greatest concentration of the drug in the sacral and lower lumbar segments.

Fetal Bradycardia in Presence of Maternal Hypotension

In greater than 95 per cent of unselected cases, properly managed with the precise and unvaried technic we have emphasized, only enough drug drifts upward when the patient is placed in a supine position to create skin hypesthesia to the thoracic skin segment 10 or 9, a level adequate for complete relief from uterine contraction pain. Relatively little hypotension *of significance* results with such levels of hypesthesia, particularly if a vasopressor drug is administered prophylactically to patients whose resting systolic blood pressure before labor is below 120 mm. Hg—or even 110 mm. Hg.

Hingson[11] states that whenever the maternal blood pressure drops below 80 mm. Hg systolic during labor, the contracting uterine tone is conceivably greater than the arterial pressure. He finds that fetal anoxia frequently is demonstrable where this condition is allowed to exist for five minutes or longer. In our first series of 709 cases,[9] *the vasopressor was withheld deliberately* to allow a more complete evaluation of the technic, and there was noted a systolic blood pressure fall below 80 mm. Hg for a recordable period of time in 97 cases (13.7 per cent). (Hingson reported such a hypotension in 10 per cent of some 2500 patients receiving continuous caudal analgesia.) In our 97 patients the drop below 80 mm. Hg was less than five minutes in duration in 51 per cent and ten minutes or less in 75 per cent. Fetal bradycardia below 100 beats per minute occurred in 11 instances, and all responded promptly to maternal administration of oxygen and/or the intravenous injection of a vasopressor drug.

In accordance with Hingson's early observations, in approximately 48 of our 97 patients—rather than in only 11—should we have noted the fetal bradycardia of anoxia. In our initial study group each patient was under constant observation of one of three physician anesthetists; blood pressure and fetal heart rate determinations were made and recorded *at least* as often as once every five minutes for the first hour of anesthesia —*and more frequently when hypotension supervened.* The possibility of failing to observe fetal bradycardia is not then tenable, although continuous recording of the heart beat, as with a phonocardiograph, would have been preferred.

The explanation for the low incidence of anoxemic bradycardia in the face of marked maternal hypotension lies in a study of intrauterine pressures during and between contractions. Woodbury, Hamilton and Torpin,[26] using as pickups small balloons over a stiffened catheter inserted between fetal membranes and uterine wall, recorded and calculated the pure intrauterine pressure as 5 to 10 mm. Hg in the resting interval between contractions, and up to 30 or 50 mm. Hg at the height of a contraction. Alvarez and Caldeyro[27] measured the intrauterine pressure directly through transabdominal needle trocars and arrived at almost identical results (though slightly higher contraction peaks). Recently Williams and Stallworthy at Oxford[28] have recorded comparable pressures as transmitted through a narrow plastic tubing which has been introduced high into the amniotic cavity via the cervix by means of an extraovular Drew-Smythe catheter.

If the patient does not introduce the added component of increased intra-abdominal pressure by deliberately straining, it follows that any maternal hypotension in association with spinal anesthesia must be of extreme degree (below 40 to 60 mm. Hg systolic) before the majority of fetuses will suffer through the mechanism of an intrauterine contraction pressure that is greater than the maternal arterial pressure, creating in turn a physiologic "obstruction" to passage of maternal oxygenated blood into the placental circulation. On the other hand, any degree of hypotension sufficient to cause (usually *with* other factors) definite oxygen deficiency in the mother's blood primarily, will similarly affect the fetus secondarily, even though the relative pressure gradient remains adequate for "physical" replenishment of the fetal circulation. This may be expected to occur when there is pre-existing maternal marked hypoxemia from severe anemia, pharmacologic narcosis, etc. Herein possibly lies the explanation of at least some of our 11 unexpected fetal bradycardias, as well as a share of the occasional slowed fetal heart rates in the presence of a relatively minor maternal hypotension—such as 85 to 95 mm. Hg systolic.

Fetal bradycardia in the presence of maternal hypotension may make an appearance as late as thirty minutes or more after the blood pressure

has dropped. The need for close observation of blood pressure and fetal heart tones longer than the usually advised "ten" or "twenty" minutes becomes obvious. This is particularly true when actual or borderline hypotension is present for a brief period soon after induction of anesthesia, and *especially* when bradycardia (though transient) has been present, and/or an abnormally high or a "climbing" level of anesthesia exists.

Our own clinical observations that relatively marked maternal hypotension need not result in anoxic bradycardia in the fetus correlate well with the study of Latterell and Lundy[29] comparing the oxygen and carbon dioxide content of arterial blood before and during spinal analgesia. Using both the Van Slyke method and continuous observation with the Millikan oximeter, these workers have shown clearly in a series of 25 surgical patients that oxygen saturation was decreased on the average only 1 per cent, with a range of −9 to +4 per cent. There was no correlation between either the level of analgesia or the changes in systolic pressure and the oxygen saturation of arterial blood until respiratory exchange was seriously compromised. The carbon dioxide content of arterial blood was found to be normal.

At the clinical level we make it a rule to treat all maternal hypotensions which are characterized by one or more of the following: fetal bradycardia below 100, maternal systolic pressure below 80 mm. Hg or marked maternal symptoms (vomiting, syncope, manifestations of anoxic anoxia, etc.). Elevation of the feet to put the legs at a right angle to the trunk and so cause an autotransfusion, with or without concomitant oxygen inhalation, usually suffices.

In some cases, particularly where heavy sedation has been used and hypotension with fetal bradycardia occurs during periods of "dozing," merely keeping the patient awake with conversation and encouraging periodic deep breathing are enough to prevent this phenomenon. Delayed hypotension may occur under such circumstances. The patient is left alone for long periods of time, falls into deep sleep, and pressure and respiration gradually decrease.

Neurogenic Shock with Marked Maternal Hypotension. Uncommonly in our experience maternal hypotension of extreme degree associated with apparent vasomotor collapse of syncopal type has been a cause of fetal bradycardia. The condition has been transient in each of 5 cases followed throughout the episode—but in the absence of treatment it is conceivable that fetal death or fetal brain damage from anoxia could result in the rare case.

In each case the circumstances point to psychogenic or neurogenic and/or postural etiology. One of the patients, quite well sedated, was sitting up awaiting "saddle block" induction for cesarean section. A second collapsed during the thirty-second waiting period in the sitting-up

position following injection of the drug. The third and fourth patients became "pulseless and pressureless" immediately upon—and a few minutes after—being placed upon their backs. The fifth case occurred under identical circumstances but the episode was not as strikingly severe.

The first 2 patients responded to positioning in the supine position, plus intravenous administration of 25 mg. of ephedrine. (In the first instance, successful "saddle block" without incident was carried out within a few minutes and the section proceeded without incident.) The third patient was rushed to the birthroom and responded to oxygen and outlet forceps delivery of an active and normal baby, the fetal heart rate being normal just before delivery. In the fourth case a "brave" and experienced physician anesthetist did nothing; response to normal was spontaneous. The patient in this instance later stated that she "always fainted" upon being injected with any medication. The third and fifth patients described inability to lie on their backs in late pregnancy "without fainting." (This particular type of postural reaction has been described in detail recently by McRoberts.[30])

These observations indicate that at least three varieties of "neurogenic shock," with marked hypotension in the laboring woman, may contribute to the development of temporary fetal anoxia in association with "saddle block" anesthesia. These include two with postural etiology (orthostatic and dorsal recumbent) and a third of psychic origin (here needle injections). It is obvious how the physician may be "stampeded" into an unnecessary operative (and perhaps traumatic) delivery. Testing of patients for postural reactions frequently during the last trimester may pick out individuals to be bolstered by a vasopressor before induction of block anesthesia during labor. In addition, the specifically inciting posture could be avoided.

Fetal Bradycardia without Maternal Hypotension

It had been noted by us in our first two years of working with "saddle block" that quite regularly—though not often—fetal bradycardia of short duration, i.e., several minutes, was found without any evidence of maternal hypotension.[9] This transient bradycardia has been detected by Hingson[31] and others independently.

In the course of recording uterine contractions before and after "saddle block" spinal anesthesia with our modified Fenning Tokograph, we noted in 8 patients out of 57 a period of incomplete relaxation of the uterus, accompanied by fetal bradycardia, without any significant change in maternal blood pressure. The onset of this phenomenon after administration of the anesthetic ranged from four to twelve minutes, and the duration of the phenomenon was again from four to twelve minutes. Recovery of normal motility and normal fetal heart rate was spontaneous and

complete. No treatment was carried out, though oxygen, emergency drugs, and facilities for immediate delivery were kept in readiness.

In duplicating this work with the Reynolds' three-channel tokodynamometer we have noted the same phenomenon. "Upper" or "middle" uterine segments, or both of these in about equal frequency, have been involved in a majority of some 50 patients who were studied. The true incidence of temporary failure of muscular relaxation following the induction of "saddle block" appears to be much greater than we originally found it to be with a relatively crude pick-up and recording apparatus; on the other hand, the relative number of cases where this increase in tonus has been so marked as to interfere with fetal oxygenation (if such is the explanation) is no greater.

This disturbance of normal uterine activity is most likely a manifestation of increased reactivity of the myometrium resulting from the removal of certain inhibitory nervous impulses by the spinal anesthetic—as first observed at the time of section laporotomy upon pregnant women by Malpas.[32] Compensation apparently takes place within a short time. A somewhat similar phenomenon has been noted by us[33] following the administration of 25 mg. of ephedrine intravenously to patients in labor under spinal anesthesia. (Woodbury[34] and others have found that ephedrine diminishes activity in the nonpregnant woman.) In this instance, however, there is no bradycardia—perhaps due to the central nervous system stimulatory action of the ephedrine. (We have noted violent fetal activity and a fetal heart rate above 180 as a result of the administration of 25 or 50 mg. of the drug intravenously.)

This sustained contraction or failure of relaxation after induction of spinal—with occasional fetal bradycardia—is similar to that seen with excessive reaction from oxytocics, in abruptio placentae of a severe degree,[39] in the occasional case of true tumultuous labor, and rarely when the parturient manifests hysteria or psychotic reaction. Stallworthy[41] has seen a case of uterine tetany from psychic reaction wherein section was deemed necessary in the interest of the fetus.

The etiology of such bradycardias is in dispute,[35] and a review of various theories would be of no avail here. The entire matter is complicated by a distinct paucity of definitive data concerning utero-placental physiology in the human during labor, and a lack of knowledge as to the functional development of the vagal reflex mechanism in the human fetus at or near term.

Reynolds[42] suggests that the mechanism in fetal bradycardia during uterine "tetany" is no different from that induced by compression of the umbilical cord, both depending on the fact that the main venous return to the heart has been interfered with. Since two-thirds of the fetal cardiac output goes to the placenta,[42] the effect of interference at this point upon the fetal blood pressure must be considerable. The mechanism whereby

this change (fall) in blood pressure is manifested by bradycardia represents the major unknown factor. It is our personal opinion that the answer will be found in the form of a functioning vagal reflex phenomenon.

Assessment of Dangers to Fetus in "Saddle Block" Anesthesia

From the foregoing it would appear at first thought that considerable basis exists for the impression that the pharmacologic effects of "saddle block" anesthesia, in combination with the cardiovascular lability of the pregnant woman at term, constitute in themselves a significant hazard to the well-being of the fetus. In actual practice such need not be the case. It is necessary only that the physician in attendance evaluate the cardiovascular status of each patient in advance while remaining alert to the recognition of, and therapy for, each type of reaction. In particular has the occasional bradycardia due to uterine hyperreactivity constituted a needless source of anxiety to the inexperienced individual who does not pay attention to the character of the uterine contractions while busy making frequent checks on the maternal pulse and blood pressure and the fetal heart rate.

Since in the great majority of cases the average obstetrician will anesthetize his laboring patient near the end of labor—and most commonly during the second stage—the truly significant risks to the fetus *attributed* to the anesthetic are in reality *attributable* to the effects of labor process upon the particular fetal situation. In other words, the problem is actually little different here than it was over thirty years ago, when DeLee emphatically warned that in the second stage of labor the fetal heart rate must be determined no less frequently than every ten minutes. The common risks to the fetus during terminal labor (perineal stage) have been discussed by Harrar and Buchman[36] in a recent survey of infant deaths occurring at this time. Those appropriate here may be listed as follows:

Cord complications:
  a. Cord around the neck or shoulder
  b. Prolapse
  c. Intrauterine rupture of cord
  d. Compression of vessels (vasa previa)
Premature separation of the placenta
Excessive sedation
Prolonged second stage
Prolonged perineal stage

The addition of "prolonged perineal stage" has been made by us since pressure of the fetal head against the perineum, over a long period of time, constitutes a hazard whose incidence has multiplied manyfold by

the great increase in the use of regional anesthesia. Physicians have held the erroneous impression that under regional anesthesia the actual delivery may be postponed almost indefinitely without undue risk to the fetus and/or probability of spontaneous (unprepared) delivery from the force of uterine contractions alone. Actually, both impressions are completely in error. In the author's cumulative experience with deliveries under spinal and caudal anesthesia, we have seen unexpected "precipitate" deliveries occur on the average of perhaps once every 200 or 300 labors.

There have been on our service (since the first 1000 deliveries tabulated earlier in this presentation) 2 fetal deaths in association with abnormal delay in carrying out delivery while the head rested against the perineum and the uterus continued to contract vigorously. In these cases the delay was 60 minutes in one case and over 120 minutes in the other. At autopsy only signs of asphyxia were present in the case with the least delay, but the clinical diagnosis of cause of death must be modified by the statement of the attending physician, that a loop of cord was felt between a shoulder and the pelvic wall. The second autopsy revealed intracranial hemorrhage.

We have reviewed approximately 10 cases ending in delivery of a live infant wherein the second stage was longer than two hours, and in 1 instance as long as three and one-half hours. These do not modify our firm belief that the "softened and relaxed perineum" is no absolute protection against the dangers to the fetus from abnormal delay once the patient is ready for spontaneous or outlet forceps delivery. Furthermore, it should be remembered that McKhann[38] has shown that the second principal etiologic factor in a large series of children surviving with cerebral damage from birth was undue delay in delivery.

In 2 other cases among the last 2000 "saddle blocks" on our service, the fetus died while the fetal head remained at a level of about 2 cm. below the ischial spine for 45 to 60 minutes after the cervix was completely dilated. It has been our feeling that in 1 case (a 2200 gm. premature infant) death was due to placental separation; in the second a cord constriction was the cause. Our 2 other "saddle block" deaths have been alluded to earlier.

In spite of the fact that in some cases the fetal head does not descend to the perineal floor for a relatively long period of time following complete cervical dilatation, it is still entirely possible for shortening of the uterus to occur (in the attempt by continuing contractions to empty itself) sufficient in degree to bring about a separation of the placenta of such magnitude as to cause fetal death—or permanent brain damage. The lack of a progressive descent on the part of the fetus may be compensated for in some cases by the aforementioned tendency for the uterus to be overactive (hyperirritable) under spinal anesthesia. More commonly,

however, we have seen uterine activity practically cease once the dilatation is complete and the head has descended to a level at or near the perineum.

The dangers to the fetus during terminal labor, and in the course of the perineal stage specifically, were impressed upon us recently when we analyzed the data collected in 1000 cases wherein methadone and scopolamine were employed for analgesia.[37] In 560 deliveries under "saddle block" there were 26 babies (4.6 per cent) who did not breathe spontaneously within five minutes after birth.

Fourteen of these 26 infants went through a perineal stage of longer than 60 minutes, and two endured the second stage of labor for more than 150 minutes. Apropos our discussion earlier in this report, 7 deliveries were classified as significantly traumatic.

The contribution of pharmacologic narcosis to the difficulties of this group of infants likewise appears prominent in the compilation of etiologic factors. As has been pointed out in countless discussions on the use (and abuse) of analgesics in obstetric labor, our data confirm the dangers inherent in (1) the cumulative effect of a narcotic with a barbiturate, (2) the use of two therapeutic doses of a narcotic within a relatively short time, and (3) the administration of a presumably nondangerous dose of a narcotic at a time when delivery is from 60 to 150 minutes ahead and where there are present factors rendering the fetus more susceptible to asphyxia or contributing to its development.

Though there were no stillbirths in this group of 26 cases (2 died neonatally), it is not difficult to visualize similar situations ending in fetal death at delivery. By the same token it is by no means far-fetched to picture a good share of such infant fatalities being attributed to the use of "saddle block," particularly if a fetal bradycardia were to develop within 30 to 40 minutes after induction of anesthesia. (Transient fetal heart rate below 110 was recorded in 9 of the 26 cases here.)

Of immense significance in the data from which these 26 cases came is the finding that in the 440 deliveries under inhalation anesthesia 15.2 per cent of the infants did not breathe spontaneously in the first five minutes. From the percentage standpoint, therefore, severe apnea was over three times more common with inhalation anesthesia then when "saddle block" was used for delivery.

Management in Cases of Fetal Bradycardia

In all previous reports and discussions on technic and management in obstetric "saddle block" we have emphasized the absolute necessity of closely observing the vital functions of parturient and fetus following administration of the anesthetic. On the other hand, it is not enough merely to record every five minutes the level of anesthesia, blood pressure, and pulse in the mother, plus the rate of heart beat in the fetus;

ten minutes; persistent uterine hypertonicity with bradycardia may be a harbinger of *abruptio placentae*, whose serious prognosis for the fetus requires active treatment. The patient in such a case should be transported to the delivery room for oxygen administration and vaginal examination. Concomitant bleeding may thus become evident. Rupture of the membranes may reveal "port wine" amniotic fluid as an added point in diagnosis, as well as serving as a stimulus toward more rapid progress in labor.

Attention to uterine activity may rule out hypertonicity but reveal an *intermittent bradycardia* occurring primarily *with contractions*. This finding, usually indicative of umbilical cord compression, should, of course, be followed by trial of Trendelenburg position, oxygen administration, and vaginal examination in search of a prolapsed or impinged cord.

5. If the cause of the slowing of the fetal heart rate has not been revealed by procedures 1 to 4 above—and bradycardia persists, one must consider a variety of relatively uncommon situations. Among these are "silent" abruptio, continuous umbilical cord compression between pelvic wall and fetus, cord entanglement, cord "knotting," abnormally increased intracranial pressure (brain hemorrhage or direct vagal center stimulation), congenital fetal anomaly, oversedation, and others even more rare.

Definitive treatment for such a variety of "unknown" situations is not possible, but at times one may use profitably the "*test of oxygen*." If the fetal heart rate returns to, and remains at, normal levels during the administration of oxygen, one may assume an integrity of utero-placental exchange as well as of umbilical cord transport. Delivery of a live fetus without gross interference may then be possible.

CESAREAN SECTION ANESTHESIA

Basis of Early Objections to Regional Methods

Over the past twenty-five years no procedure in obstetric therapeusis has provoked such bitter discussion as the use of spinal anesthesia for cesarean section. When compared to inhalation anesthesia the benefits of spinal to the fetus in preventing narcosis, and to the mother in minimizing uterine hemorrhage, postoperative ileus and other complications were recognized early in this period and appreciated by all who ventured; the high incidence (and utter finality) of circulatory failure and respiratory paralysis discouraged all but a meager few. A large bibliography of fatalities accumulated, and the Germans coined the term "rachi-sensitive" to characterize the pregnant woman in her relatively poor ability to tolerate spinal anesthesia.

There was virtually no opposition to this impression of an "inherent

drug hypersusceptibility" until after 1940. Tardy though it was, there came to a few astute workers in the field the realization that the cause of death in most fatalities was a tendency for the pregnant woman to develop, unusually soon after injection, an abnormally high level of anesthesia per given dose of any drug—in comparison to the nonpregnant individual. Some of the anatomic and physiologic factors involved have been mentioned earlier in this paper in the discussion of the effects of hypotension in "saddle-block"; there are many more complicated and little-understood details in related circulatory phenomena which remain to be clarified.

Table 4

MATERNAL DEATHS FROM OVERWHELMING DOSAGE IN SPINAL ANESTHESIA*

SOURCE	DOSAGE	NO. OF DEATHS
North Carolina, 1946–1948	Pontocaine 14–16 mg.	3
	Procaine 150 mg.	3
Jefferson, Philadelphia	Procaine 200 mg.	2
Charity Hospital, New Orleans	Pontocaine 15 mg.	2
	Procaine 150 mg.	1
Grace Hospital, Detroit	Procaine 200 mg.	1
Massachusetts Report, 1941	—	1
Hospitals of Brooklyn	—	8
Loretto Hospital, Chicago (1950)	Nupercaine 7.5 mg. with 1 mg. epinephrine	1
Franklin Square Hospital, Baltimore	Pontocaine 12 mg.	1
		Total 24

* Modified from Hingson and Hellman.[45]

In the early forties there was brilliant progress in the struggle for safe spinal anesthesia in pregnancy, but this was limited to a few isolated instances—Rufus Thomas in England,[43] the Margaret Hague group, Hingson at the Philadelphia Lying-in, and a paucity of others. The bulk of the interested medical profession on both sides of the Atlantic was not prepared to accept—or was not aware of—the "new philosophy" of minimal dosage, fractional administration, and regulation of anesthetic level by use of weighted solutions. This typical (though here exaggerated) delay in utilization of new technics was detrimental to the well-being of pregnant womankind in at least two paradoxically divergent directions.

Outmoded Methods. First, a few widely read obstetric commentators continued to condemn spinal anesthesia on the basis of outmoded methods. Bourne and Williams,[44] in the 1946 edition of the English *Recent Advances in Obstetrics and Gynecology*, felt certain that "there is a mortality risk associated with spinal anesthesia which appears to be unavoidable"; they agreed "with DeLee and Greenhill" that Thomas

had been "lucky" in his announced series of 121 spinal anesthetics without a maternal mortality. Greenhill continued to warn the profession with statistics ten to fifteen years old until at least 1948.

The Sin of Massive Dosages. Secondly, the continued widespread use—almost to the present—of what should have been recognized as massive dosage, served to perpetuate the occurrence of needless maternal deaths. A compilation by Hingson and Hellman[45] of some of the more recent known deaths (Table 4) vividly illustrates the extent of some of the dangerous single doses being used. The amounts of drug in individual cases were sufficient for from 3 to 13 different patients when used properly. For example: Hingson has used a total of 15 mg. of procaine in scores of cases under the fractional technic, while we frequently administer but 2.5 mg. of nupercaine for section with a simple modification of the "saddle-block" technic. We have seen the administration of 5 mg. of nupercaine to a 200 plus pound laboring white woman result promptly in anesthesia to the clavicles. (The technic used was identically that advised by an eminent authority in a manual still widely circulated.)

Safety in Modern Methods and Minimum Dosages

Continuous Spinal Anesthesia. The "weapon" which sent all statistic-quoting critics figuratively scurrying for cover and served to dispel all doubts as to the *potential* safety of spinal anesthesia in cesarean section was the paper in 1948 by Lull and Ullery[59] reporting 1000 consecutive sections performed under continuous spinal at the Philadelphia Lying-in without a single fatality remotely attributable to the anesthetic. (The single death in the entire series was from overwhelming leukemia.) Since this report other comparable series have been compiled under the same method, and the Philadelphia cases are approaching 2000 in number.

It would appear, therefore, that continuous spinal is the anesthetic method of choice for cesarean section, provided there is available the special apparatus necessary and a physician qualified as anesthetist. The introduction of the Lemmon malleable steel needle or the Tuohy catheter via needle trocar does require some manual dexterity; proper instruction is advisable.

Though 5 per cent procaine in spinal fluid is the solution most commonly used in surgery and by many for section, a more dilute solution will allow less opportunity for nerve damage. The Philadelphia group prefers 1.5 per cent procaine in Ringer's solution; 1.5 per cent metycaine in Ringer's is the favorite of Hingson, while many other workers employ 2.5 per cent procaine in spinal fluid. In Table 5 are presented the average doses of the various drugs used in the Philadelphia Lying-in series of sections under continuous spinal anesthesia.

Some anesthesiologists believe that the special needle or the trocar and catheter set expose the patient to too great a risk of nerve damage,

and therefore prefer alternative procedures involving a single injection through a fine gauge needle—chiefly with a hyperbaric solution of a long-lasting anesthetic agent.

"Saddle Block" Anesthesia. Though the continuous spinal technic with malleable needle and with procaine as agent is now used as method of choice in over 90 per cent of sections performed at the Chicago Lying-in Hospital, we have found it feasible to utilize also the "saddle block" procedure described early in this presentation, with two minor variations.[60] The first consists of the use of 3.75 mg. of nupercaine (1.5 cc.) instead of 2.5 mg. whenever the patient is of average size or larger. The second involves testing the level of skin hypesthesia at once after the patient is placed on her back 30 seconds after injection, with subsequent tilting into a temporary 5 degree Trendelenburg position just long enough to allow hypesthesia (and subsequent anesthesia) to dermatome level T8. This height of anesthesia is ideal for low segment section.

Table 5

DRUG DOSAGE IN 1000 SECTIONS UNDER CONTINUOUS SPINAL ANESTHESIA*

DRUG	AVERAGE DOSE
All drugs	65.9 mg.
1.5% metycaine in Ringer's solution	58.0 mg.
1.5% procaine in Ringer's solution	71.4 mg.
2.5% procaine in spinal fluid	108.9 mg.
Usual initial dose, 15 to 25 mg. (71 sections were done with 15 to 30 mg. total dosage)	

*Modified from Lull and Ullery.[59]

In addition to nupercaine in 5 per cent dextrose, we have used in similar ("saddle block") fashion a 3 per cent metycaine solution in 5 per cent dextrose, with 0.4 mg. of epinephrine per cubic centimeter added to achieve prolongation of action. An adequate dose of this agent has been 35 or 40 mg. Where extreme duration of effect is desired, nupercaine with 0.4 to 0.5 gm. of epinephrine per cubic centimeter may be used.

Since it has been found possible to reduce dosage by 67 to 75 per cent, 4 mg. or 6 mg. of pontocaine in 5 or 10 per cent dextrose has found many backers as preferred agent in single injection spinal anesthesia for section. Anesthesia is induced with the patient on her side, and appropriate tilting is carried out until the desired level is achieved.

SUMMARY

Some fifty years after the introduction of their predecessors into medical practice, regional anesthesia procedures have come into their own as valuable adjuncts in obstetric therapeusis.

The so-called "saddle block" technic of low spinal anesthesia offers to any physician capable of a high degree of care and a moderate degree

of judgment in obstetric management the opportunity of carrying out the variety of delivery procedures commonly encountered with conscious comfort to the mother and without narcosis to the baby.

Obstetric pitfalls generally encountered in the use of low spinal anesthesia have been described in detail and their management described.

The contraindications and specific indications for regional (especialy low spinal) anesthesia in vaginal procedures may be listed as follows:

Contraindications: Disease of the central nervous system, skin infection over the lower back, previous spinal anesthetic complication, fear of spinal or desire to be asleep, persistent hypotension, difficult breech extraction or version, lack of experience. Spinal anesthesia must not be used to retard delivery.

Indications: Respiratory conditions (acute infection, pulmonary tuberculosis, asthma), full stomach if gastric lavage is not feasible, vomiting during labor, operative delivery if prolonged anesthesia is necessary, pulmonary edema, hypertension, rheumatic heart disease (selected cases), prematurity, patient's fear of general anesthesia.

In the field of cesarean section, conduction block now makes it possible to achieve safely all the benefits of local anesthesia for the baby with a minimum of postoperative complications, plus comfort for the mother, as well as operative ease for the obstetrician. Preferred procedure is continuous spinal anesthesia, but good results with little technical difficulty may be obtained with single-injection spinal block utilizing hyperbaric solutions.

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