THE ROLE OF CONDUCTION ANESTHESIA IN THE
MANAGEMENT OF ECLAMPSIA *

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The pathologic and physiologic process of eclampsia are poorly understood. It is now commonly believed, however, that spasm of the terminal arterioles occurs throughout the entire body, especially marked in the kidneys (1, 2, 3, 4). If this premise is correct, the treatment of patients with eclampsia must be directed against the angiospastic mechanisms as the focus of the disease.

Conduction anesthesia is employed in the treatment of ischemia occurring in other pathologic conditions, and thus it appeared rational to utilize this form of anesthesia in the management of eclampsia.

A summary of the results of conduction anesthesia in an eclamptic patient is shown in table 1. Blocking efferent impulses from the

| TABLE 1 |
| How Therapeutic Nerve Block Acts on Toxaemia of Pregnancy |

Blocking efferent nerve impulses from sympathetic nerves.

<table>
<thead>
<tr>
<th>Blood Vessels</th>
<th>Kidney (T-8)</th>
<th>Suprarenals</th>
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<tbody>
<tr>
<td>(1) Vasodilatation below block (bloodless phlebotomy).</td>
<td>(1) Increase of blood flow.</td>
<td>Denervates suprarenal gland (T-8)</td>
</tr>
<tr>
<td>(2) Reflex vasodilatation above block.</td>
<td>(2) Parvex action of anesthetic.</td>
<td>(1) Decreased cortin.</td>
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<tr>
<td>(3) Relieves hypertension.</td>
<td>(3) Increased output.</td>
<td>(2) Decreased adrenalin.</td>
</tr>
</tbody>
</table>

Heart

| (1) Decreased venous return. |
| (2) Decreased peripheral resistance (decreases work of the heart). |
| (3) Increased stroke volume. |
| (4) Relieves pulmonary edema upon cardiac compensation. |

Brain

| (1) Increased oxygen. |
| (2) Decreased edema (secondary to improved circulation). |

Circulation

| (1) Decreases visceral and peripheral edema. |
| (Diminution of venous stasis and accelerated arteriolar blood flow.) |

Depresses motor nerves to skeletal muscle below block.

(Through courtesy of Robert A. Hingeman; teaching chart used at University of Tennessee College of Medicine.)


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sympathetic nerves results primarily in vasodilatation in that area and increased output of urine because of the relaxing effect upon the vascular bed of the kidney and upon the smooth muscles of the renal pelvis and ureters. The amount of epinephrine excreted by the adrenal gland also is decreased. The relief of hypertension which ensues eases the load carried by the heart, relieves pulmonary edema, increases the oxygenation of the brain, and decreases peripheral edema.

Blocking the motor nerves to the skeletal muscles decreases restlessness and venous return because of muscular relaxation and peripheral vasodilatation.

The relief of pain which follows conduction anesthesia lessens nervous irritability which in turn seems to relieve the little understood vasospastic angiotonic inactivated ischemia. In other words, conduction anesthesia not only blocks the pathways of pain but also the vasomotor fibers of the trunk and lower extremities (5).

The changes in blood produced by a general anesthetic agent such as ether are shown in table 2 (adapted from Stander [6]). It is

### TABLE 2

**ALL GENERAL ANESTHETICS IN 15 MINUTES PRODUCE CHANGES IN BLOOD SUGGESTIVE OF THOSE NOTED IN ECLAMPSIA**

<table>
<thead>
<tr>
<th>Stander (dogs)</th>
<th>Normal</th>
<th>Anesthesia</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. P. N.</td>
<td>40-55</td>
<td>40-55</td>
<td>None</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>0.0-0.9</td>
<td>0.9-2.5</td>
<td>Increase</td>
</tr>
<tr>
<td>Urea N₂</td>
<td>12-18</td>
<td>12-18</td>
<td>None</td>
</tr>
<tr>
<td>Sugar</td>
<td>70-100</td>
<td>150-300</td>
<td>Increase</td>
</tr>
<tr>
<td>Inorganic Phosphorus</td>
<td>1.5-3</td>
<td>2.0-4.0</td>
<td>Increase</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>12-20</td>
<td>18-35</td>
<td>Increase</td>
</tr>
<tr>
<td>CO₂</td>
<td>45-60</td>
<td>30-45</td>
<td>Decrease</td>
</tr>
</tbody>
</table>

readily apparent that they parallel those present in eclampsia. It may be noted that the general anesthetic agent causes an increase in the uric acid and blood sugar, inorganic phosphorus and lactic acid. Concurrently, the carbon dioxide combining power is decreased. Thus, it is the anesthetic agent rather than the operation that increases mortality in cases of eclampsia and preeclampsia. Therefore, conduction anesthesia is preferable to general anesthesia in these cases.

A series of 22 cases in which conduction anesthesia was employed was reviewed. A detailed description of the technics employed and the results obtained in each case of eclampsia managed with conduction anesthesia will not be given. The following case reports represent typical examples of each type of eclampsia. In addition, points of special interest or significance in other cases will be mentioned.
Eclampsia (Convulsive)

Case 1.—An 18-year-old negress, at term, was admitted August 17 at 8:00 a.m. Slight vaginal hemorrhage of one day's duration had occurred a week before admission. She had had edema of the ankles during the past month. On the morning of admission headache and blurring of vision developed.

The blood pressure was 160 mm. systolic and 120 mm. diastolic. At 8:50 a.m. a convulsion developed which lasted approximately four minutes. At 9:10 a.m. she had a second convulsion, lasting approximately three minutes. The pulse rate was 144. She was given calomel, 1/4 grain, every half hour for four doses, followed by magnesium sulfate, 4 cc., two hours later. At 9:15 a.m. she had a third convulsion. Magnesium sulfate, 4 cc. of a 50 per cent solution, and glucose, 500 cc. of a 20 per cent solution, were given. The blood pressure was 150 mm. systolic and 110 mm. diastolic. At 7:45 p.m., a fourth convulsion occurred. After each convulsion she appeared more comatose, restless and confused. The blood pressure was 190 mm. systolic and 110 mm. diastolic.

At 9:30 p.m. on the day of admission the patient was seen in consultation with an obstetrician. Continuous lumbar analgesia was instituted. At this time labor pains were weak and ineffective. The cervix was dilated one fingerbreadth. Continuous spinal anesthesia, by the catheter technic, was induced. The patient was placed in the lateral Trendelenburg position (approximately 5 degrees with the horizontal); a Tuohy spinal needle was introduced into the subarachnoid space by the sublaminar approach. The bevel of the Tuohy needle was turned caudad and a continuous caudal catheter (3½ French) was inserted approximately 5 cm. beyond the tip of the needle, almost to the end of the subarachnoid space. The patient was turned supine and 12 cc. of a hypobaric pontocaine solution (0.1 per cent) was introduced slowly. The level of anesthesia extended to the eighth dorsal segment. Every four hours thereafter during the next two and a half days an additional 10 cc. of pontocaine of the same dilution was introduced through the catheter.

Figure 1 illustrates graphically the effect of continuous spinal anesthesia on the patient's blood pressure and pulse as well as on the fetal heart. Some of the significant results obtained were as follows: the initial blood pressure of 180 mm. systolic and 110 mm. diastolic dropped quickly to 140 mm. systolic and 90 mm. diastolic. During the next two days it varied between 150 to 130 mm. systolic and 100 to 90 mm. diastolic. The fetal heart rate was 140 to 144 but decreased to approximately 124 and remained at this rate until delivery.

Other effects produced by the lumbar analgesia were: (1) convulsions ceased, the patient's headache and restlessness disappeared and the blurring of vision improved. (2) The edema gradually disappeared. (3) The output of urine increased markedly. (4) Labor apparently progressed favorably without the patient being aware of it. At 4:30 a.m. the nurse noticed that the membranes were protuding and the cervix was found to be fully dilated. At 4:47 a.m. a healthy boy, lying in the right occipito posterior position, was delivered by midforceps extraction.

At 10:00 o'clock the next morning, August 18, the patient was hungry and alert, vision was clear and the headache had disappeared. By 3:00 p.m. the urine output totaled 1100 cc. for the day, with an intake of 500 cc. Urinalysis demonstrated the following: albumin 4+ and specific gravity 1.013. The urine contained many erythrocytes.
On August 19 at 8:45 p.m. following an injection of 10 cc. of hypobaric pontocaine solution, the sensory analgesia extended to the seventh dorsal segment; vision was clear and the patient was bright and alert. The blood pressure was 120 mm. systolic and 80 mm. diastolic.

On August 20 the urinary output for the day was 4400 cc. The postpartum course was entirely uneventful and the patient was discharged August 24. At that time the blood pressure was 124 mm. systolic and 80 mm. diastolic. The urine contained a trace of albumin. The specific gravity was 1.008. The non-protein nitrogen value of the blood was 27 mg. per 100 cc. On August 25 a phenolsulfonphthalein test gave negative results.

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Fig. 1A. Anesthesia record of case 1.
This case is typical of eclampsia. In consultation with the obstetrician, we thought that with the usual treatment of eclampsia the mother's chance of survival was poor and the baby's almost nil. We believed that the induction of spinal analgesia, even though it would stop labor completely, would have no ill effects on the fetus.

**Case 2.**—This patient was in the sixth month of gestation, with a dead fetus. Abruptio placentae developed during severe convulsions; therefore, cesarean section was performed. Spinal anesthesia, by the single dose method was induced, utilizing 10 mg. of a hypobaric pontocaine solution to which had been

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**Fig. 1B.** Anesthesia record of case 1 (continued).
added 10 mg. of neosynephrin. It was necessary to administer 5 cc. of 2.5 per cent solution of pentothal sodium to stop a convulsion before inducing spinal anesthesia. On the sixth postoperative day the patient left the hospital. One year later the blood pressure was 140 mm. systolic and 90 mm. diastolic.

Case 3.—This patient, an 18-year-old primipara, underwent numerous convulsions. The antepartum blood pressure was 205 mm. systolic and 100 mm. diastolic. Spinal anesthesia was induced with a single dose of 12 mg. of hypobaric pontocaine solution (0.1 per cent) to which had been added 10 mg. of neosynephrin. Delivery was uneventful. The blood pressure on the following
day was 130 mm. systolic and 80 mm. diastolic. By the fourth day urinalysis gave negative results.

**Case 16.**—Convulsions and hypertension in this case were controlled during a two and a half day period by continuous spinal anesthesia, using the catheter technic and a hypobaric pontocaine solution. Because of severe vaginal bleeding resulting from placenta praevia, pregnancy was terminated by cesarean section. The postoperative course was uneventful.
POSTPARTUM ECLAMPSIA

Case 4.—The patient, aged 37 years, was admitted February 12. The blood pressure was 170 mm. systolic and 105 mm. diastolic. She complained of slight headache, swelling of the feet during the last month, occasional attacks of dizziness and occasional nausea and vomiting.

Urinalysis on admission demonstrated the following: albumin was graded 4+ and the specific gravity was 1.025. The urine was cloudy and loaded with bacteria, it contained many casts and the reaction was acid.

During the afternoon and evening nausea increased and blurring of vision developed. These symptoms increased in severity during the next day and the blood pressure level rose to 180 mm. systolic and 110 mm. diastolic. At 11:34 p.m. a living baby was delivered under nitrous oxide anesthesia. The blood pressure following delivery varied from 150 to 200 mm. systolic and 90 to 150 mm. diastolic. The usual treatment for eclampsia was instituted but, despite this, the symptoms increased in severity. These symptoms were: (1) increasing nausea, epigastric pain, headache and blurring of vision; (2) convulsions gradually increasing in severity, followed by stupor; (3) a blood pressure rise to 220 mm. systolic and 120 mm. diastolic and (4) oliguria. Spinal anesthesia, utilizing a single dose of 12 mg. of a hypobaric pontocaine solution (0.1 per cent) to which 10 mg. of neosynephrin had been added, was induced at 1:00 p.m. The results obtained are shown in figure 2. The systolic and diastolic blood pressure levels improved after conduction anesthesia even though convulsive seizures, heart failure, oliguria and anuria and albuminuria presented evidence of severe vasomotor crisis. Headache disappeared immediately and vision improved. The patient became more alert, recognized her husband and began to take an interest in her surroundings. The blood pressure decreased to 140 or 150 mm. systolic and 90 or 100 mm. diastolic, and the pulse rate decreased.

In three hours the blood pressure level gradually rose to from 160 to 180 mm. systolic. Spinal anesthetics were given repeatedly, each one producing a result similar to that shown in figure 2. Ordinarily it would have been preferable in such a case to have employed continuous caudal or spinal block with the catheter technic; technically, however, it would have been very difficult owing to obesity, convulsions and lack of cooperation of the patient.

A systolic blood pressure reading of 160 to 170 mm. apparently was the critical level at which headache appeared. When this occurred, anesthesia was induced. During this regimen the convulsive seizures stopped and all other symptoms disappeared; urine output was increased, albuminuria gradually disappeared and the blood pressure returned to normal levels.

On February 16 erythrocytes numbered 2,440,000 and the hemoglobin was 12 gm. (80 per cent). On February 19 the specific gravity of the urine was 1.011; it contained albumin 2+, no casts and a few bacteria; the reaction was alkaline. On February 21 the urea nitrogen was 17.7 gm. On February 23 a phenolsulfonphthalein test was carried out; at the end of the first hour 20 per cent, and at the end of the second hour 2.0 per cent of the dye was excreted. A Mosenthal test was performed on February 25; the specific gravity was 1.008 and there was a trace of albumin.

The patient was discharged February 24, at which time the blood pressure was 135 mm. systolic and 75 mm. diastolic. At the last examination the obstetrician found her to be normal in every respect.
Fig. 2. Anesthesia record of case 4.

Postpartum eclampsia, which may occur at any time during the first week of the puerperium, is the severest form of all the toxemias of pregnancy, and carries the highest mortality rate.

Case 7.—A 19-year-old primipara was admitted with typical convulsive eclampsia. Routine therapy did not bring about lowering of the blood pressure. On the fifth hospital day, under spinal anesthesia, utilizing 7 mg. of a hypobaric pontocaine solution, 0.1 per cent, she was delivered of an apparently normal girl. Two hours after delivery marked hypertension, headache and visual dis-
CONEMAUGH VALLEY MEMORIAL HOSPITAL
ANAESTHESIA RECORD

Room No. ... WARD ...
Date. 4-9-49

PATIENT'S NAME A. L. ...
SEX F ...
AGE 25 ...
WEIGHT 185...

PREOPERATIVE TEMPERATURE ...
PULSE ...
RESPIRATIONS ...
BLOOD PRESSURE ...
RISK GRADE ...

SPECIAL FINDINGS: Hypertension, edema, urine albumin +

DIAGNOSIS: Pre-eclampsia; labor—4 days duration

EFFECT OF PREMEDICATION ...

PRELIMINARY MEDICATION (Main Substance) ...
Atropine grs. 1/150 ...

SURGEON: Dr. W. T. ...

OPERATIVE: Cæsarean Section

<table>
<thead>
<tr>
<th>CRN. A.N.A.A.</th>
<th>CARBAMATE</th>
<th>INDUCTION AGENT</th>
<th>Duration (Hrs.)</th>
<th>Miss.</th>
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<td>45</td>
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</table>

SUMMARY: ...

REMARKS: Baby cried spontaneously ...
Marked increase in urine output, albuminuria disappeared ...
Discharged April 20, apparently normal ...

Fig. 3. Anesthesia record of case 6.

Turbances developed. Continuous spinal anesthesia, by the catheter technique, was instituted as described in Case 1. In this case smaller doses of anesthetic solution were administered slowly so that the resultant level of analgesia extended only to the tenth or eleventh dorsal segment. This regimen was continued for twenty-six hours, during which period the patient underwent a convolution. The decrease in the blood pressure level was only moderate, and the headache was only partially relieved.

Case 14.—A 35-year-old multipara began to have convulsions four hours after delivery. She gradually became semicomatose; edema, hypertension and oli-
guria developed. In twenty-four hours the output of urine was 125 cc. Continuous spinal anesthesia was induced and the blood pressure reading fell to 120 mm. systolic and 90 mm. diastolic, the patient became clear mentally and the urine output increased to 3800 cc. during the first twenty-four hours and to 5200 cc. the following twenty-four hours. Anesthesia was discontinued after forty-eight hours. The patient was discharged apparently well but with some residual renal damage.

**Preeclampsia**

*Case 6.*—This patient, suffering from a mild preeclamptic condition, was admitted April 9, 1949. The blood pressure reading was 145 mm. systolic and 95 mm. diastolic. She had no other signs or symptoms of toxemia. After four days of more or less active labor, a diagnosis was made of mild cephalopelvic disproportion. During this period the blood pressure level gradually rose and slight albuminuria developed. Cesarean section was performed, using single dose lumbar analgesia. Figure 3 illustrates the results following conduction anesthesia. The blood pressure decreased rapidly from 210 to 140 mm. systolic and from 110 to 80 mm. diastolic. The pulse rate decreased and the output of urine increased greatly.

The postoperative course was uneventful and the patient was discharged on April 20, 1949, apparently well in every respect.

*Case 9.*—This 37-year-old primipara was admitted with a diagnosis of mild preeclampsia. The blood pressure was 160 mm. systolic and 110 mm. diastolic, and the urine contained albumin 1+ and a few erythrocytes. Delivery was conducted with single dose spinal anesthesia, utilizing 9 mg. of a hypobaric pontocaine solution, 0.1 per cent, to which had been added 9 mg. of neo- symephrin to prolong the anesthesia. The blood pressure level rapidly decreased to 140 mm. systolic and 80 mm. diastolic, and in a few minutes became stabilized at approximately 130 mm. systolic and 75 mm. diastolic. The baby cried spontaneously on delivery. The mother's postpartum course was uneventful.

The patient was symptom-free at the time of discharge. The blood pressure was 130 mm. systolic and 80 mm. diastolic and urinalysis gave negative results. Figure 4 illustrates the uneventful operative course.

Cases 10, 15 and 17 were similar in most respects to Case 9, and were managed in the same manner, with comparable end results.

In Cases 5, 11, 12, 13 and 18 to 22 cesarean section was performed under single dose spinal anesthesia similar to that used in Case 6. The operative and postoperative courses were uneventful in each instance.

**Mortality**

There were no maternal deaths in this series of cases. Only 2 fetal deaths occurred: a dead macerated fetus was delivered by cesarean section in Case 2. The fetus was known to be dead before operation. In Case 16, the baby died on the fourth day.

**Incidence**

Statistics vary with different centers but the average incidence of toxemia in some clinics is 20 per cent in the southern states and 6
Fig. 4. Anesthesia record of case 9.

per cent in the northern states (1, 3, 5). The incidence of convulsive eclampsia at the Margaret Hague Maternity Hospital, for example, is 0.3 per cent; the immediate maternal mortality is 10 per cent and the fetal mortality, 33 per cent (7).

During the last six years the incidence of residual hypertension in patients who have had eclampsia has been less than that reported earlier. This lowered incidence is believed to be the result of more radical management of preeclampsia.
TREATMENT OF ECLAMPSIA

Broadly speaking, the treatment of patients with eclampsia has been divided into three phases: prophylaxis, treatment of symptoms and termination of pregnancy. Only the second division, treatment of symptoms, will be considered since the other two are self-explanatory.

Numerous agents and methods have been used, most of which are familiar to all physicians. Reference will be made only to the common methods of management of convulsions.

The Veratrum compounds, barbiturates, magnesium sulfate, mor- phine and so forth, will control the convulsions in most instances and, to a lesser extent, the hypertension. Of more importance, however, is the maintenance of an adequate output of urine to aid either in preventing eclampsia in patients with severe preeclampsia or in treating patients who have eclampsia. McGee demonstrated that diminution of urinary output occurs following depression of the blood pressure level by barbiturates. Similar results have been obtained with large doses of morphine and other depressants. Conduction anesthesia, on the other hand, causes an increase in the output of urine, as shown in table 1 and illustrated by Cases 2, 3, 7 and 14. In general, the present day treatment of eclampsia is more radical than formerly and, therefore, termination of pregnancy is considered if the toxemia does not improve. Most authors, however, endeavor to treat patients with eclampsia by less radical means than cesarean section whenever possible. Undoubtedly, mortality and morbidity rates of both mother and baby are greater following radical treatment of eclampsia than with normal vaginal delivery. The course in Case 1 indicates that the reduction of blood pressure can be controlled by conduction anesthesia and thus it is possible to wait for the processes of labor to effect delivery by the vaginal route.

PROGNOSIS

Chesley (7) stated that a definite prognosis cannot be given in individual cases but the probability of recurrence of the toxemia can be predicted if certain data concerning eclampsia are at hand. The most significant factors bearing upon a favorable prognosis are:

1. The blood pressure at the first visit, before the onset of toxemia, should not be above 120 mm. systolic.
2. During the toxemic state the blood pressure reading should not be above 160 mm. systolic.
3. The duration of toxemia should not be more than one week.
4. The blood pressure level and urinary findings should return to normal by the tenth day after delivery.
5. The ratio of weight to height is important. The increase in weight should not exceed 2.2 pounds a week.

This series of cases indicates that the hypertensive crisis of eclampsia can be accurately controlled and the average blood pressure
reading can be maintained below the critical level of 150 mm. of mer-
cury by conduction anesthesia. It decreases the duration of the
toxemia to a period of less than one week even in severe cases and
hastens the return to normal of the blood pressure and urinary output.
Even in the most severe cases, the output of urine and the blood pres-
sure level had returned to normal before the tenth day postpartum.

It is generally recognized that permanent hypertension often begins
with or follows preeclampsia or eclampsia. Conduction anesthesia
decreases the incidence or severity, or both, of this hypertension.

This method of treatment brings up questions of great interest to
the obstetrician. Is conduction anesthesia able to relieve a pre-
eclamptic or eclamptic syndrome long enough to permit the carrying of
a nonviable fetus to viability without increasing the maternal risk? Like-
wise, if eclampsia occurs later in pregnancy, does conduction
anesthesia permit carrying the fetus to term without increasing the
hazard to mother or baby? It appears that relieving the ischemia and
breaking the vicious cycle induced by eclampsia enable the fetal and
maternal mechanisms to exist in harmony a little longer than when
this cycle is not broken. We hope to answer this question later.

Suggestions

Level of Analgesia.—It is important that the segmental level of
analgesia is sufficiently high to relieve renal ischemia. Block of the
lower extremities alone will increase the vascular bed by 600 to 800
cc. and thus cause a slight drop in blood pressure, with only minimal
relief of symptoms. This is all that is accomplished by the accepted
treatment of phlebotomy, which apparently is still employed at leading
obstetric centers. Case 7 illustrates this point; improvement was not
as dramatic or rapid as in the other cases.

Blood Pressure.—The blood pressure must be checked accurately
and frequently to prevent a precipitous fall to low levels with re-
sultant peripheral vascular failure and other signs of shock.

It must also be kept in mind that the decrease in systolic blood
pressure is proportionately greater than the decrease in diastolic
pressure. A pulse pressure of sufficient magnitude must be maintained
to insure adequate circulation, particularly of the heart muscle. In
Case 8, because of a fixed diastolic pressure of 110 to 120 mm., it would
not have been safe to decrease the systolic pressure below 150 to 160
mm.

Infection.—Penicillin should be given throughout the period of con-
duction anesthesia to prevent infection locally at the site of the
catheter and to minimize pulmonary complications.

Local Anesthetic Agent.—Block of the sympathetic and sensory
nerves is more important than block of the motor nerves in these cases;
therefore a dilute, relatively nontoxic agent is preferable. I believe
that a hypobaric pontocaine solution of 0.05 to 0.1 per cent dilution satisfies this condition. In addition, the spread of this solution intrathecally is readily and accurately controlled by gravity (8, 9). It is important that the anesthesiologist select an agent and a type of conduction with which he is familiar. For instance, some authorities probably prefer caudal anesthesia in the management of eclamptic patients (5, 10, 11).

SUMMARY AND CONCLUSIONS

In eclampsia, spasm of the terminal arterioles, especially marked in the kidneys, apparently occurs.

The effects of conduction anesthesia on eclamptic patients are illustrated graphically. Briefly, they are: (1) marked decrease in blood pressure; (2) cessation of convulsions; (3) increase in output of urine and (4) relief of headache, visual disturbances, and so forth.

A series of 22 cases is reported in which various forms of toxemias of pregnancy were present. The effects of conduction anesthesia in these cases are outlined briefly. Conclusions cannot be drawn from this small series but an analysis of the results obtained indicates that conduction anesthesia plays an important role in the management of eclampsia. This series now includes 34 cases of eclampsia. There have been no maternal deaths and the foetal mortality rate has been relatively low.

REFERENCES