CRITICAL ESSAY.

ANÆSTHESIA BY SUBARACHNOID
INJECTIONS OF COCAINE IN THE LUMBAR
REGION : ITS USE IN GYNÆCOLOGY AND
OBSTETRICS.

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THE plan of inducing anæsthesia by the injection of a solution of cocaine into the subarachnoid space has been extensively adopted during the last two years, more especially on the Continent and in America. The literature of the subject is very extensive, and upwards of 1,500 cases have been operated upon by this method. The idea of producing anæsthesia by injections of cocaine into the spinal region undoubtedly originated with Dr. Leonard Corning, of New York, in the year 1885.* He carried out experiments on dogs, and also on the human being, by injecting solutions of cocaine between the laminæ of the lower dorsal vertebræ. He obtained definite analgesia, but in his early observations Dr. Corning did not appreciate the importance of injecting the solution directly into the subarachnoid space. He used a trocar or needle with syringe attached, and thus he was not able to recognise the presence of cerebro-spinal fluid, which is the only certain test that the needle has entered the subarachnoid cavity. In a recent paper, Dr. Corning reviews his early work on the subject, and lays special stress on the care which is necessary to obtain definite results, and to avoid the possible dangers of the method.†

Quincke‡ of Kiel in 1890 first used lumbar puncture as a diagnostic and therapeutic measure in cases of organic disease of the central nervous system, and since then this method has been widely adopted as a means of draining away cerebro-spinal fluid for the relief of pressure.

* *New York Medical Journal*, 1885, vol. xlii., p. 483.† *Medical Record*, 1900, vol. lviii., pp. 601-603.‡ *Berlin. Klin. Woch.*, No. 38, September 21, 1891.

PHYSIOLOGICAL ACTION OF COCAINE.—The drug has a most powerful toxic effect on the central nervous system, acting as a protoplasmic poison. Thus, 3 drops of a 10 per cent. solution applied to the medulla of a dog caused immediate respiratory paralysis and death.* Sicard in 1899† made numerous investigations in animals on the effects of saline solution, and also of cocaine injected into the subarachnoid space, and later used it as a method of treating the lightning pains of locomotor ataxia, with temporary relief. It was at first thought possible that the analgesia following spinal injection was the result of the action of the fluid on the nerve centres, or of increase of pressure in the subarachnoid space. Numerous researches, however, have shown that the analgesia is due to the specific action of the drug itself.‡

Tuffier and Hallion§ have made experiments on animals to decide whether the cocaine acts on the spinal cord or on the nerve trunks. They have shown that the effects are almost exclusively confined to the nerve roots, and that the anæsthesia does not depend to any appreciable extent on the impregnation of the cord itself by the cocaine. It seems probable that the cocaine solution injected into the lumbar subarachnoid space acts on the posterior roots and nerve endings through lymphatic absorption, rather than through the blood circulation in the cord. It has been shown experimentally|| that strychnine and ferrocyanate of sodium injected into the subarachnoid space pass directly into the nerve tissues through the lymph channels. This method of absorption may explain the extremely rapid action of cocaine. In some cases the cerebro-spinal fluid around the cord is small in amount, and hence the cocaine solution is not much diluted when it comes in relation to the nerve structures, and this accounts for the toxic effects on the nervous system so well marked in these cases.

Ravaut and Aubourg have recently studied the changes in the cerebro-spinal fluid after spinal cocainization. They have made a second lumbar puncture some hours after the injection, and evacuated some of the fluid with the object of diminishing tension and of relieving the headache which is often so severe. This second puncture usually relieved the pain, and it was observed that the

* Franck, *Archiv. de Physiologie*, vol. iv., 5th series, 1892.

† Société de Biologie, May 20, 1899.

‡ Nicoletti, Sicard, Tuffier, International Congress of Medicine, Paris, 1900.

§ Société de Biologie, November 3, 1900.

|| Levandowsky, *Zeitschrift für Klin. Medicin*, vol. xi., 1900.

¶ *Gazette Hebdom. de Médecine et de Chirurgie*, June 27, 1901.

more intense the headache, the greater was the pressure of the fluid in the subarachnoid space. In these cases the fluid came out in jets, and was turbid, whereas if the headache were only slight the liquid was clear, and escaped drop by drop only. The cerebro-spinal fluid was found microscopically to contain many polynuclear leucocytes which formed a distinct deposit, and in some cases a fibrinous coagulum was present. The quantity of cellular elements was in direct proportion to the severity of the headache. Twenty-one cases were examined some hours after the injection; once only was the fluid found to be normal. Repeated puncture at the end of three or four days showed that the liquid was now clear, and contained a small number of mononuclear leucocytes. At the end of eight to twenty days the fluid had become normal. These changes in the fluid are precisely those met with in cases of acute meningitis which recover. The cause of this reaction is certainly not any form of infection, nor can it be the result of the injection of the distilled water in which the cocaine is dissolved, as a similar reaction is seen if cerebro-spinal fluid is used as the medium. The cocaine itself seems to be the essential factor, which can be compared to that of a toxin. This explains all the inflammatory and exudative phenomena observed, and clinically the headache is the principal symptom. These changes in the fluid are always merely temporary, and 'do not justify the fears which have been entertained regarding the danger of spinal anæsthesia.' It is, however, a striking fact that the inflammatory reaction is always present, and if organisms were introduced by any mischance, serious meningeal symptoms would certainly ensue.

Bier of Kiel,* in April, 1899, was the first to demonstrate the efficacy of injection of cocaine solution into the lumbar subarachnoid space in producing surgical analgesia. He related numerous operations performed by him on the lower half of the body under its influence between August, 1898, and April, 1899. He injected 2 centimetres of a 1 per cent. solution of cocaine, and never exceeded 15 milligrammes of cocaine ($\frac{1}{8}$ grain). Tuffier of Paris, who has done so much to bring this method forward, read his first paper in November, 1899, and since then he has made numerous communications on the subject.† As the result of numerous researches, he has elaborated a technique which has been mainly followed by other

* *Deutsche Zeitschrift für Chirurgie*, 1899, vol. li., p. 361.

† *Semaine Médicale*, May 16, 1900, p. 167; *ibid.*, December 12, 1900, p. 429; *Analgésie Chirurgicale par voie Rachidienne*, 1901.

operators. The details of the method of Tuffier are briefly as follows: The injection is made between the laminæ of the fourth and fifth lumbar vertebræ. For this purpose a needle sufficiently long and firm to penetrate the tissues is required. Tuffier's needle is 4 inches long, and is best made of platinum with an iridium point. The point of the needle must be short, to avoid injury to nerve structures. The skin of the lower dorsal and lumbar region is made thoroughly aseptic. The patient is placed in a sitting posture, with the back well arched forwards. In this position the maximum amount of separation between the laminæ of the vertebræ is obtained. The spine of the fourth lumbar vertebra is now sought for and clearly identified. This is usually easy to do, but in stout patients, or if the spinous process is not well developed, a line joining the highest points of the iliac crests, which crosses the level of the fourth lumbar spine, may be adopted as a guide, and will be found to be reliable. The needle is now inserted 1 centimetre below and outside the spinous process, and directed vertically downwards and slightly inwards. It will enter the interval between the laminæ of the fourth and fifth lumbar vertebræ, and penetrate the subarachnoid space, as is shown by the escape of clear cerebro-spinal fluid through the needle. An ordinary Pravaz syringe is now attached to the needle, and 1 centimetre of a 2 per cent. solution of hydrochlorate of cocaine ($\frac{1}{3}$ grain) is very slowly injected. The needle is now withdrawn, and the minute puncture sealed by collodion. The strictest antiseptic precautions must be observed, the syringe and needle being boiled immediately before use. The cocaine may be sterilized by boiling just before the injection is made. Tuffier, however, always uses capsules specially prepared by repeated sterilization. It is essential that the cocaine solution be freshly made, as otherwise there is risk of its becoming inert.

This small operation is usually carried out without causing any pain to the patient, but difficulty may arise from several factors:

1. The needle may impinge on the bony lamina, or in cases of deformity of the vertebræ or ankylosis it may be impossible to enter the subarachnoid space. Under these circumstances the needle should be withdrawn and a fresh puncture made.
2. The needle may be apparently in the subarachnoid space, but as yet no fluid appears. This may be due to the point being entangled in the membranes, or the needle may have penetrated too deeply. A slight movement of rotation or withdrawal is usually sufficient to cause the fluid to run freely.
3. Blood may appear at the end of the needle, due to injury to

a vein. The needle must then be withdrawn and a fresh puncture made.

The analgesia commences almost immediately, and is usually complete in five to ten minutes. It may, however, be well marked two minutes after the injection, or fifteen to twenty minutes may be required in rare cases. The extent of the analgesia shows great variation. In many cases it reaches as high as the fourth rib, or even to the upper extremity.* It may be relied upon up to the level of the umbilicus, and usually there is complete cutaneous anæsthesia up to the ensiform cartilage. The duration of the analgesia is also somewhat uncertain. Usually it continues for an hour or a little more. It may, however, last for thirty minutes only, or up to three and a half hours. These irregularities in the extent, degree, and duration of the analgesia do not depend definitely on the dose of cocaine given, but appear to arise from personal idiosyncrasy. Some patients, indeed, appear to be insensitive to the drug unless given in large doses.

A valuable series of observations on the effects of cocaine injections have been recently made by Professor Pitres and Dr. Abadie,† based upon the careful examination of fifty cases. The conclusions arrived at are, shortly, as follows: 1. *Sensory Phenomena*.—The analgesia is not due to the direct effect of cocaine on the spinal cord, but to its influence on the posterior nerve roots lying in the cauda equina. This explains the great rapidity with which the analgesia may be induced in some cases. The analgesia is progressive, commencing with a slight diminution of sensation, and continuing up to complete insensibility to pain. It may commence in the thighs or perineum, or in the feet, or in diffuse areas of anæsthesia over the lower half of the body. The cutaneous sensibility to pain first disappears, closely followed by the abolition of the sense of temperature and pressure. The application of heat or cold only calls forth the sense of contact, which in some cases even disappears entirely. Tickling of the soles of the feet may be perceived, although the usual reflex is not called forth. As the effects of the cocaine pass away, sensibility to touch reappears, then the sense of pressure and temperature, and lastly the sensitiveness to pain. The sensation in the deeper tissues, muscle, bone, joints, etc., is abolished in direct proportion to the intensity of the cutaneous analgesia. Deep visceral sensibility, such as that of the peritoneum,

* Fowler, *Philadelphia Medical Journal*, November 3, 1900.

† *Archiv. de Neurologie*, October, 1901.

is never completely abolished, though much diminished. Relaxation of the sphincters is not observed with moderate doses of cocaine, though gas may escape from the anus during sickness.

2. *Motor Phenomena*.—A few minutes after the injection slight tremors, cramps, and fibrillary contractions are noticed in the lower limbs in about two-thirds of the cases. There is, however, no motor paralysis, and all voluntary movements can be executed, although more slowly than under normal conditions.

3. *Vaso-Motor Phenomena*.—The skin over the analgesic area does not show any alteration in colour or appearance; if a puncture is made, little blood escapes, showing the vaso-constrictor effects of the drug.

4. *Secretory Phenomena*.—In a large proportion of cases profuse sweating, with flushing of the face and upper extremities, is observed, whilst the analgesic areas remain dry and pale.

Pitres and Abadie have also made observations on fifteen cases of simple lumbar puncture, with the withdrawal of some cerebro-spinal fluid, varying from 5 to 30 c.c., but without the injection of cocaine. In these cases no epileptiform movements or contractures were observed, but the reflexes were diminished, or even abolished. Voluntary movements were unaffected.

CONDITION OF THE PATIENT DURING ANALGESIA.—A few minutes after the injection the patient has a feeling of 'malaise,' with some respiratory anxiety and weight at the epigastrium. Many patients also have sensations of heat and complain of thirst. These symptoms usually subside in fifteen to twenty minutes. Nausea occurs in 30 per cent. of cases, often associated with facial pallor. In a considerable proportion it is succeeded by vomiting of glairy mucus. This usually takes place within ten or fifteen minutes of the injection, and then ceases; exceptionally it may recur during the operation.

The pulse is slightly quickened, and the tension is lowered. In some cases it becomes small and frequent, often just preceding the nausea or sickness, and rapidly becomes normal after this has passed off. There is often slight respiratory anxiety, and if large doses of cocaine are used serious difficulty, or even danger, may arise from this cause.

CONDITION OF THE PATIENT AFTER ANALGESIA.—The patient usually feels very comfortable; the pulse and temperature are normal. Slight sickness may continue, but in many cases this is entirely absent. Tuffier states that he has never seen serious sickness. Headache, which may be very severe, comes on six to eight hours after the

injection. It is present in 90 per cent. of cases. In rare instances (2 per cent., Tuffier) it may persist for two, three, or four days, and in a few instances a 'late' headache has come on three or four days after the operation. The cause of the headache is not yet clearly elucidated. Tuffier considers that it depends on several factors. It follows simple lumbar puncture without any injection of cocaine. It is also aggravated if much cerebro-spinal fluid is drained away. Bier in a personal experiment lost a considerable quantity of fluid, and suffered severely for some days from headache and other nervous symptoms. The experiments of Ravaut and Aubourg would appear to show that the headache is due to increase of cerebro-spinal pressure, and also, perhaps, to changes in the fluid.

A rise of temperature, accompanied sometimes by a chill, or even a shiver, occurs in about half the cases within a few hours of the operation. It is usually slight, but may reach 103°. It subsides rapidly, and is of no special significance. The cause of this pyrexia is obscure. No changes in the urine or evidence of leucocytosis, such as would indicate disturbance of nutrition, have been detected.*

If during the operation there is evidence of cardiac depression or respiratory difficulty, such as has been met with by some operators, injections of strychnine should be given, and Tuffier recommends artificial respiration as likely to be beneficial, though he has never yet found any need to make use of it. Fowler of New York gives a full dose of strychnine before the operation in each case, and states that he has found it of great value in preventing any signs of depression.

REMEDIAL MEASURES FOR THE EFFECTS OF ANALGESIA.—Various attempts have been made to avoid the nausea and vomiting. Small quantities of morphia have been given with the injection or hypodermically, but without any good results. The headache is relieved by the application of cold; phenacetin, and antipyrin are also of benefit.

Marx has strongly advised the injection of $\frac{1}{100}$ grain of hydrobromate of hyoscine as a specific for the after-effects of the injection.

Experiments have also been made with a view of introducing a liquid of similar density to the cerebro-spinal fluid into the sub-arachnoid space. Thus, Guenard† has used cerebro-spinal fluid itself as a medium for dissolving the cocaine. He places a few drops of concentrated cocaine solution in the syringe, and draws off

* Tuffier, 'Analgesie Chirurgicale,' 1901, p. 20.

† *Semaine Médicale*, October 23, 1901.

sufficient cerebro-spinal fluid to dissolve it, and then injects the solution. Further study, however, appears to be necessary with the object of removing these disadvantages.

SURGICAL RESULTS OF SPINAL ANALGESIA.—A brief review may now be taken of the results that this method has given during the last two years. Tuffier states that he now has knowledge of 1,500 operations performed under spinal anæsthesia. His personal experience comprises 252 operations, and he regards the method as absolutely safe. In this series he had six deaths. Five of these could in no way be attributed to the method of anæsthesia. In one case, a patient with large ventral hernia, death occurred on the day after operation. She was known to have advanced mitral stenosis and multiple fresh emboli were present in the lungs. Tuffier does not consider the death was in any way brought about by the method of anæsthesia.

Galvani of Athens* records 150 operations performed by spinal anæsthesia. These included over 100 abdominal sections. All these operations were performed strictly according to the lines laid down by Tuffier. The puncture of the subarachnoid space was carried out without any difficulty in all but two cases. In these, after several attempts, it was found impossible to penetrate the space. This is a grave drawback of the method, though happily a rare one, and is due to some alteration of the vertebræ from scoliosis, or lack of development of the spinous processes, rendering the usual landmarks difficult to recognise. The analgesia was complete in nearly every case. In three patients, however, it appeared to be more or less imperfect. This is, however, a phenomenon not easy to analyze owing to the dread of pain which is felt during the operation by a certain class of patients. Professor Galvani did not observe serious symptoms in any of his cases. The most frequent trouble met with was the nausea and vomiting from which few patients were entirely exempt. The nausea arose ten to fifteen minutes after the injection, and was often followed by vomiting. This, however, rapidly ceased, the patients becoming 'calm and cheerful.' In a small number of cases vomiting occurred some hours later, and in one case was prolonged for two days. In twelve cases the bowels were relaxed during the operation, but no bladder symptoms were ever observed.

After the operation was concluded, the patients were usually quite comfortable, and often asked for food. The majority suffered from

* *Revue de Gynécologie et Chirurgie Abdominale*, July, August, 1901.

headache, often continuing for twelve hours and subsiding slowly. In two cases the headache continued for five days. The usual rise of temperature was also observed in a great proportion of cases, and sometimes was accompanied by a rigor. None of these troubles appeared in any way to influence the results of the operations.

Galvani considers that, whilst this method presents certain inconveniences, these are to be considered slight and merely temporary.

Fowler of New York has used this method in eighty-one cases.* In some of the earlier cases analgesia was imperfect owing to defective technique. Only once any symptoms arose to cause anxiety. This patient, however, suffered from chronic renal disease, and it is doubtful how far the symptoms could be attributed to the cocaine injection. Many of the cases were examined by Dr. Browning of New York, at intervals after the operation. No changes in the functions of the spinal cord or nerves could be detected. Analgesia was established at intervals varying from two to fifteen minutes after the injection. In one case nineteen minutes was required. In twenty-five carefully observed cases analgesia lasted over one hour in eighteen cases, and less than an hour in seven cases.

Several other American surgeons record cases. Goldan (twenty cases), Wallace Lee (seven cases), Murphy of Chicago, and others.† This method has also been extensively adopted by Roumanian surgeons, especially Racoviceanu-Pitesci (125 cases) and Severeanu (70 cases). The results of their experience were given at the International Congress of Surgery in Paris in August, 1900. The opinions of these surgeons were somewhat conservative as to the value of this method. Pitesci stated that he knew of two deaths having occurred in Roumania, but gave no details of the cases. And both surgeons had observed serious symptoms of collapse in some instances. It is, however, right to state that the dose of cocaine used by them ($\frac{2}{3}$ grain) were greater than the maximum safe dose as laid down by Tuffier.

Villar‡ records a series of thirty-six cases; in two cases he failed to induce analgesia; also a later series of forty cases in which the analgesia was perfect. Cases are also recorded by Denis§ (fifty-three), Kallionzoni|| (nine), and others.

* *Medical News*, 1901, vol. lxxviii., pp. 1-5; *Philadelphia Medical Journal*, November 3, 1900.

† *Philadelphia Medical Journal*, November 3, 1900.

‡ *Semaine Médicale*, October 10, 1901.

§ *Revue de Médecine d'Algérie*, 1900, pp. 265-277.

|| *Revue de Chirurgie*, October, 1901, p. 440, e:c.

In a personal experience of eighteen cases of spinal anæsthesia,* performed strictly according to the technique of Tuffier, the following observations were made: Analgesia was absolutely complete in fifteen cases; in two slight pain was felt; and in one case, due to the injection not having reached the subarachnoid space, no analgesia was induced, and the operation (ovariotomy) was carried out under chloroform. The operations included seven abdominal sections—ovariotomy (2), Cæsarean section (1), oöphorectomy (2), ventro-fixation (1), exploration for myoma and pregnancy (1). The remaining cases were: amputation of cervix (1), ligature of uterine artery (1), perineorrhaphy (2), hæmorrhoids (2), curettage (2). In two cases posterior vaginal section was performed for pelvic sup-puration.

The operation was well borne in every case. Nausea and sick-ness occurred in 40 per cent. at some stage of the operation. In abdominal operations this is a disadvantage, and care is required to prevent the possibility of extrusion of bowel into the wound. All the patients made uneventful recoveries. In thirteen cases no vomiting whatever occurred after the operation, and in one case only was it severe—a case of acute pelvic peritonitis. Cephalalgia was observed in 70 per cent. of the cases. In two cases it was severe, and in one instance it continued for three days. Phenacetin in 10-grain doses given immediately after the operation appeared to mitigate the severity of the headache. A rise of temperature (100° to 101°) occurred within a few hours of the operation in the majority of cases. In one patient the temperature rose to 103° with a slight shiver; it then fell to normal, and remained so.

From this limited experience, the results obtained confirm the conclusions of Tuffier in every respect, and in patients who have a dread of general anæsthesia, or in whom for any reason it is undesirable, this method may be adopted with confidence. Certain details add much to the comfort of operating upon a conscious patient. Thus, it is well to put cotton-wool in the ears, and to place a handkerchief over the eyes of the patient. She should also be reassured at intervals during the operation. Silence should as far as possible be enjoined. If the patient complains of thirst, soda-water may be given, and does not increase the nausea, which, indeed, rarely persists beyond a quarter of an hour after the injection has been made. Spinal anæsthesia is not suitable for hysterical women, in whom the simple sensation of contact may suggest

* Lea, *Medical Chronicle*, December, 1901.

painful sensations. Cases of heart disease or arterio-sclerosis bear this method of anæsthesia very well (Tuffier).

In *extraperitoneal* operations this method is very satisfactory, and compares favourably with general anæsthesia. 'The future alone will show if it will replace it' (Tuffier).

In *intraoperative* operations the possibility of sickness occurring during the operation forms a serious inconvenience. In many intra-peritoneal operations some nausea may not be of serious importance, but in prolonged and difficult abdominal operations it is otherwise; and although Tuffier has had no accident of any kind, he does not advise that spinal anæsthesia should be generally adopted for these cases at the present time.

DANGERS OF SPINAL ANÆSTHESIA.—Although Tuffier regards the method as perfectly safe, the experience of other operators does not altogether go to prove this, and it is obvious that unless the technique is carried out with the greatest care serious results may follow. The possible sources of danger are :

1. *Mechanical Injury*.—This risk appears to be slight, and no cases of injury to the spinal cord or nerves have been recorded. The nerve structures float freely in the subarachnoid space, and the minute puncture of the needle is not likely to cause any serious damage to nerve structures in healthy subjects. In pathological conditions of the vertebræ or meninges, injury to the cauda equina has followed lumbar puncture (Quincke). Cadol* records a case of meningeal hæmorrhage following puncture in a patient with old tubercular lesions of the cord. It is also possible, if the needle is badly directed, to enter the intervertebral disc, or even the abdominal cavity.

2. *Sepsis*.—No cases of meningitis following subarachnoid injection have been as yet recorded. It is clear, however, that this is a real risk, and can only be avoided by the most careful aseptic precautions.

3. *Organic Nerve Changes*. — Nicoletti† of Naples has shown experimentally in dogs that no histological lesions of the cord follow subarachnoid injections of cocaine. Tuffier has examined over sixty of his cases up to twelve months after the injection, and has not found any evidence of structural or functional lesions of the nervous system.

4. *Toxic Symptoms*.—Many cases have been observed in which

* *Thèse de Paris*, 1900.

† International Congress of Medicine, Paris, 1900.

serious, or even alarming, phenomena have manifested themselves during the operation or some hours afterwards. Reference has already been made to the cases mentioned by Pitesci and Severeanu, when great pallor, cold sweats, relaxation of the sphincters, with circulatory and respiratory weakness, were noted during the operation, necessitating energetic restorative measures. In these cases 2 centigrammes of cocaine ($\frac{2}{5}$ grain) were used, which is a larger dose than it is probably safe to adopt. Tuffier's maximum dose is $1\frac{1}{2}$ centigrammes, and he states that he has never seen any symptoms which caused anxiety either during the analgesia or afterwards.

5. *Imperfect Analgesia*.—In the early days of the method, failures to obtain complete analgesia were very frequent, either from defective technique, such as using too large a needle (Goldan), or from inert solutions of cocaine. Some patients, moreover, are peculiarly insensitive to the effects of cocaine. This has been specially noted in alcoholic patients. The duration of the analgesia is also somewhat variable, and in some cases it may not be complete for more than thirty minutes. If, however, the method of Tuffier be strictly followed, failures to induce complete analgesia are very rare.

6. *Deaths following Spinal Anæsthesia*.—At a recent meeting of the Société de Chirurgie of Paris (April, 1901), Tuffier states that, 'if a comparison is made between this and other methods of anæsthesia, we must distinguish between deaths during an operation and those which occur later. Up to the present spinal anæsthesia has not been followed by a fatal result during the operation.' The six post-operative deaths which have occurred in his practice he was unable to trace in any way to the method of anæsthesia.

Pitesci of Bucharest mentioned two deaths as having occurred in Roumania after spinal anæsthesia, but no details have as yet been published. Goilav* reported one case in which a fatal result followed the injection of cocaine, but the paper has not been available for review. Fowler† has not met with any serious symptoms in his series of eighty-one cases, and states that he is unaware of any recorded deaths having occurred in America. Lequeu‡ mentions two cases in which operations were carried out on patients who were considered unfit to take a general anæsthetic on account of their serious condition. Both patients died, but Lequeu does not attribute the deaths to the injection. In another case of acute intestinal obstruction death followed shortly after the operation, but the patient's

* *Revue de Chirurgie*, Bucharest, 1900, p. 250.

† *Medical News*, vol. lxxviii., 1901, pp. 1-5.

‡ *La Semaine Médicale*, November 13. 1901.

general condition was at the time so grave as to preclude the administration of a general anæsthetic. Broca,* at the Société de Chirurgie, Paris, recently mentioned a case in which death occurred eighteen hours after the operation, and was thought to be due to the spinal anæsthesia. The case, however, had been reported to him from Morlaix, and no details were given.

It is evident, then, that cases of death clearly resulting from this method of anæsthesia have yet to be recorded. It is, indeed, of the greatest importance that any such cases should be reported in full, so that a real comparison may be possible between the risks of this and other forms of anæsthesia.

Simple lumbar puncture may be followed by a fatal result, and Gumprecht† has collected from various sources eighteen cases. They were all in patients with organic disease of the central nervous system, and considerable quantities of fluid were withdrawn in many cases. The sudden evacuation of the cerebro-spinal fluid appears to paralyze the vital centres in the medulla. These cannot, however, be compared to ordinary cases of spinal anæsthesia in patients with a healthy nervous system.

It is worthy of note that Bier,‡ who may be called the founder of this method, advises circumspection in its use, and cautions us against the general adoption of spinal anæsthesia. He says that 'in its present form it does not merit the enthusiasm with which it has been adopted by some. It presents such marked advantages that we should seek to render its use entirely free from risks or drawbacks, and further researches should be made, with the object of finding an analgesic agent free from the risks of cocaine.'

Eucaine has proved practically useless, producing very incomplete anæsthesia.

Schwarz§ of Agram has recently used tropacocaine with success in sixteen cases. The dose required is larger than that of cocaine, but the disagreeable manifestations of the latter were absent, and he is of opinion that this drug will become generally used for spinal anæsthesia in the future.

THE USE OF SPINAL ANÆSTHESIA IN OBSTETRICS.

The first observations on the value of spinal anæsthesia by cocaine during delivery were published by Kreis,|| who related in detail six

* *La Semaine Médicale*, July 10, 1901.

† *Deutsche Med. Woch.*, June, 1900.

‡ Surgical Congress, Berlin, April 11, 1901.

§ *Centralblatt für Chirurgie*, February, 1901.

|| *Centralblatt für Gynäk.*, No. 28, 1900.

cases from the clinic of Professor Bumm at Bâle. In all of these delivery was effected without pain. Almost simultaneously Doléris related five cases at the Academy of Medicine in Paris (July 17, 1900), and since this time Doléris has used this method extensively. These cases, sixty-two in number, have been recorded in full by Malartic* in his thesis on the subject. From an experience of eighty cases, Doléris claims that cocaine has, in addition to its analgesic influence, a very decided 'oxytotic' effect on uterine contractions.† Dupaigne,‡ acting on the recommendation of Tuffier, used this method in several cases, and brought his results before the Academy of Medicine in August, 1900.

Spinal anæsthesia was speedily adopted in America, where it is especially associated with the name of Marx, who has now used it in over 100 cases.§ The technique in no way differs from that for surgical operations described above. In some cases, however, it is impossible for the patient to sit forwards, and the injection must then be made in the left lateral position. Great care is also necessary to avoid involuntary movements on the part of the patient, such as may be caused by the sudden onset of painful uterine contractions during the injection.

The analgesia produced is usually complete for all the pains of labour—the uterine contractions, dilatation of the cervix, vaginal and vulval distension, and the painful lumbar radiations. Further, it is possible to perform all the usual obstetric operations, although exception may be made to those procedures which require the introduction of the hand into the uterus, since cocaine appears to have a distinct influence in promoting uterine contraction.

Delivery by forceps, craniotomy, and symphyseotomy (Porak) have been frequently performed under its influence. Doléris|| records a case of Cæsarean section under cocaine, with complete absence of any pain or evidence of shock. Professor Sinclair of Manchester in May, 1901, used this method in a case of Cæsarean section in which general anæsthesia was thought inadvisable on account of bronchitis. The patient was perfectly at ease throughout the operation, which lasted thirty-five minutes. The uterus contracted well, and there was an entire absence of shock or cardiac depression.

* *Thèse de Paris*, 1901.

† *Bulletin Médical*, February 13, 1901.

‡ *Annales de Gynécologie*, January, 1901.

§ *Medical Record*, October 6, 1900; *Philadelphia Medical Journal*, November 10, 1900.

|| *Thèse de Malartic, Obs.*, lxii., p. 77.

Complete analgesia may be relied upon for one and a half to two hours; in rare cases it may continue for four hours (Dupaigne). The analgesia may be prolonged by repeated injections, and Marx states that he has been able to maintain complete anæsthesia for eight hours in this way. The short duration of the analgesia is, however, a decided drawback to the general adoption of this method to relieve the pains of labour. Further repeated injections are not free from risk, owing to the toxic effects of cocaine. Marx* states that the injection should be given when the os is three-quarters dilated in multiparæ, and at the stage of full dilatation in primiparæ. The injection is usually followed by cramps and trembling of the lower limbs, nausea and sickness, headache, and a rise of temperature. These symptoms rapidly subside, but Reclust† has observed cases in which the sickness persisted for three to five days.

INFLUENCE OF COCAINE ON UTERINE CONTRACTION.—Clinical experience has shown that the contractions of the uterus continue regularly under the influence of cocaine. Dupaigne found that the uterine contractions were increased in force and frequency, and considered that the duration of labour was distinctly lessened.

The 'oxytocic' action of cocaine on the uterine muscle has been especially insisted upon by Doléris.‡ He states that the uterine contractions increase in force and frequency, dilatation of the cervix is more rapid, and the second stage of labour is shortened. He further believes that uterine retraction after delivery is more complete, and thus the risk of hæmorrhage is diminished. In cases of uterine inertia he has observed the pains to return with remarkable vigour after the injection of $\frac{1}{8}$ grain of cocaine. In the case of Cæsarean section Doléris noted that the uterus remained firm and contracted after delivery of the child and whilst the sutures were being applied, and 'in no previous case had he observed such thorough and prolonged contraction.' Doléris believes, further, that injection of cocaine may bring about uterine contractions, and he gives the details of two cases: (1) A patient seven months pregnant with a macerated foetus. After being under observation three weeks, 1 centigramme of cocaine was injected. Uterine contractions commenced in a few minutes, and labour was completed in six hours. (2) A multipara pregnant eight months was suffering from advanced tuberculosis. A few minutes after the injection the uterus con-

* *Medical Record*, October 6, 1900.

† *Bulletin Médical*, March 20, 1901, p. 254.

‡ *Ibid.*, February 13, 1901.

tracted vigorously, and labour was completed in four and a half hours.

In a case of placenta prævia, with severe hæmorrhage, an injection of cocaine was followed by uterine contraction and cessation of hæmorrhage even before the membranes were ruptured. Other observers, however, have not as yet confirmed the observations of Doléris on the 'oxytocic' effects of cocaine in labour, and in looking through the records of cases it is noteworthy that forceps have been applied very frequently. Thus, Kreis used forceps in three out of six cases, and Marx, in forty cases, found forceps necessary in sixteen.

Porak, Rouville, and Puech* have all observed cases in which the injection of cocaine appeared to distinctly diminish the force of the uterine contractions, and a study of the cases of Doléris as recorded by Malartic† shows that in several instances the uterine contractions appeared to weaken after the injection.

Ehrenfest,‡ having noticed the frequency with which it has been found necessary to terminate the labour by artificial means, observes that in these cases the active help of the abdominal muscles is wanting. The patient is not conscious of the uterine contractions, although she is able to exert the abdominal muscles when requested to do so. This voluntary effort on the part of the patient is generally agreed to be an important factor in concluding the second stage of labour. If further experience confirms this by showing that the percentage of artificial deliveries is greater after spinal cocainization than under normal conditions, the use of this method would certainly be contra-indicated as a means of mitigating the pains of labour, since, in spite of all care, instrumental deliveries show a greater mortality than deliveries effected by natural means alone.

THE RISKS OF SPINAL ANÆSTHESIA IN OBSTETRICS.—The toxic phenomena are as a rule slight, and rarely cause any serious inconvenience. Marx believes that hydrobromate of hyosine ($\frac{1}{100}$ grain) has a specific effect in relieving the headache and other symptoms. Goldan§ of New York observed alarming symptoms in one case after injection of $\frac{3}{8}$ grain in a primipara. The respiration became very rapid—60 per minute—and the pulse 140 per minute, with extreme pallor. The patient, however, made a good recovery, though

* *Gazette des Hôpitaux*, July 27, 1901.

† *Thèse de Paris*, 1901.

‡ *Medical Record*, December 22, 1900.

§ *Medical News*, 1900, p. 719.

the headache was very intense for forty-eight hours. Marx has never observed any serious symptoms in over sixty cases. And Doléris has adopted it in seventy-eight cases without any accident or bad effects. Up to the present time no deaths have been recorded from the use of this method in labour.

INFLUENCE OF COCAINE ON THE FŒTUS.—If the dose of 1 centigramme ($\frac{1}{8}$ grain) be not exceeded, the injection is without influence on the condition of the fœtus. If, however, larger doses are given, slowing of the foetal heart-sounds is observed, and in some cases the child has been born in an asphyxial condition. In those instances in which the cocaine acts powerfully as a stimulant to the uterine muscle, the circulation of the fœtus may be seriously impeded, and it is probable that its life may be endangered, though no foetal deaths appear to have been definitely traced to this cause.

INFLUENCE ON THE PUERPERIUM.—The involution of the uterus appears to be somewhat hastened, and there is less tendency to the formation of blood-clots and after-pains. Few detailed observations have, however, as yet been made. The lacteal secretion is normally established, and the child's nutrition is well maintained (Malartic).

INDICATIONS FOR USE.—The influence of cocaine on the uterine muscle in promoting contractions, which appears to be very definite in a large proportion of cases, limits the sphere of usefulness of this method in obstetric practice, as when complete muscular relaxation is required for podalic version or other intra-uterine manipulations.

Gueniot in a communication to the Academy of Medicine of Paris on January 22, 1901, lays down the following conditions as contra-indicating the use of cocaine in labour :

1. Disease of the heart or great vessels.
2. Chronic disease of the respiratory organs.
3. Chronic affections of the central nervous system.
4. The absence of facilities for securing complete asepsis.

Gueniot admits the following conditions as suitable for the use of cocaine :

1. Any obstetrical operation requiring anæsthesia, with the exception of those in which it is necessary to introduce the hand into the uterine cavity.
2. Excessive pain during labour.
3. Prolonged labour owing to feeble or irregular contractions of the uterus, in the absence of any obstruction.
4. In conditions tending to hæmorrhage, such as uterine inertia, placenta prævia, etc.

Spinal anæsthesia has been used in obstetrics for two distinct purposes: (1) to mitigate or remove the pain of labour; (2) as a method of analgesia for the performance of obstetric operations. The duration of the analgesia is insufficient to render labour free from pain, unless repeated injections are given. This plan exposes the patient to the risk of toxic symptoms, and also to the dangers of repeated puncture of the subarachnoid space, and hence cannot be generally advisable. It is, however, possible to give the injection when the os is nearly or fully dilated, and so to produce analgesia through the second stage of labour; but under these circumstances small quantities of chloroform give very good results. It has been held by some that chloroform tends to produce hæmorrhage after delivery, but it has been shown (Lucas, Championnière, Schroeder, Budin*) that hæmorrhage after the administration of chloroform is not more frequent than in normal cases. If, however, a distinct tendency to hæmorrhage is present, spinal anæsthesia by cocaine may by its stimulating action on the uterine muscle possess certain advantages. Up to the present time it appears to have been adopted in over 200 cases without any serious accident.

Puech,† in reviewing the subject, considers that up to the present spinal anæsthesia has not rendered better service in obstetrics than the general anæsthetics. It is not capable of producing painless labour, and in operative work the advantages over chloroform are not established. Further, this method requires great care, with special apparatus and facilities, and hence can hardly be generally adopted in obstetric practice.

* Budin, 'Traité d'Accouchements.' t. iv., 1901, p. 182.

† *Gazette des Hôpitaux*, July 27, 1901.