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THE USE OF SCIATIC NERVE BLOCK FOR PRODUCING VASODILATATION OF THE LOWER EXTREMITY AND COMPARATIVE STUDY WITH PARAVERTEBRAL LUMBAR SYMPATHETIC GANGLION BLOCK *

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VASODILATATION of the lower extremity may be produced by interruption of the activity of the sympathetic nerve supply to the extremity, thereby greatly increasing the circulation to the part. Normally, the peripheral vessels in the extremity are kept in a greater or lesser degree of vasoconstriction in order to help regulate systemic temperature. This condition exists likewise in patients whose circulation is impaired by peripheral vascular disease (1).

Although many methods for producing vasodilatation of the lower extremity have been in use, a review of the literature (2–74) reveals little mention of the use of peripheral sympathetic interruption by means of anesthetic block of the sciatic nerve. In 1924, Taylor and Rice (75) treated 12 patients with tropical ulcer of the lower third of the leg by open injection of the sciatic nerve. They used 5 to 10 cc. of 15 per cent alcohol and obtained vasodilatation in all cases so treated. The healing of the ulcer was hastened in every case. In 1926, Davis and Kanavel (76) reported vasodilatation following severance of the sciatic nerve.

White (77, 78), in 1930, obtained hyperemia of the foot after sciatic nerve block in 2 cases. He stated that "Procaine infiltration of the sciatic trunk, where it leaves the pelvis through the greater sciatic foramen, should produce a nearly complete vasodilatation of the arteries of the lower leg and foot. This seems to be the case, as, in two instances, I have found an increase in the peripheral surface temperature comparable to that produced by spinal anesthesia, and by posterior splanchnic injection and by ganglionectomy. . . . If further experience bears out this observation, it will be the safest way to block the sympathetic fibers to the lower leg. Sciatic block is easiest to induce and causes the minimum discomfort to the patient."

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Since White's observation, no other reports on sciatic nerve block used for producing vasodilatation have appeared in the American literature. Scott and Morton (79), Ruth (80), and Patterson and Stainsby (81) mentioned White's 2 cases, but no additional cases in their papers. In the foreign literature, Nowicki (82), in Poland, in 1946 reported increases in temperature following sciatic block.

This study on sciatic nerve block was undertaken because, although the principle is not new, the application thereof is uncommon.

It has been shown that the arteries to the extremities receive their nerve supply mainly from the peripheral spinal nerves (83). Vascular sympathetic fibers run to the extremities by means of the somatic spinal nerves and not by way of the arteries. All vasomotor impulses leave the spinal cord by way of the white rami. They reach the sympathetic ganglions and are relayed to the spinal nerves by way of the gray rami, thereby reaching their peripheral destination. The vascular nerves are carried in the somatic nerves and are supplied to all the vessels including the capillaries in a manner that closely corresponds to the distribution of sensory innervation of the overlying skin of the lower extremity (84).

Sympathetic nerves to the extremity are vasoconstrictor in type. Interruption of the sympathetic nerves produces changes due to release of vasoconstrictor impulses. Therapy of peripheral vascular disease is directed toward increasing blood flow by overcoming vascular spasm, especially in collateral vessels, and by forcing as much blood as possible through the damaged vessels (85). Blocking the sympathetic nerves can now be put on a sound anatomic and physiologic basis since both afferent and efferent impulses are interrupted (86).

Medical research and clinical investigation concerned with peripheral circulation depend greatly on measurements of skin temperature, particularly the changes that occur when vasomotor nerves are blocked (87). The rise in surface temperature following direct injection into nerve trunks and the amount of resulting reflex vasodilatation after release of vasoconstrictor sympathetic control can be measured (88). Differences of 0.5 F. are significant if there is a difference in both feet (89).

The sciatic nerve carries the bulk of the sympathetic nerve supply to the lower extremity (90, 91, 92). A lesion completely involving the sciatic nerve results in foot drop, loss of the Achilles reflex, loss of sensation over the entire foot except for the region of the internal malleolus and in vasomotor changes such as edema of the foot, increase in foot temperature and dry skin (93, 94, 95). The sciatic nerve is the terminal branch of the sacral plexus. It is a flat ribbonlike nerve about 12 to 14 mm. wide and 4 to 5 mm. thick at its origin (94). It becomes round as it enters the thigh. The nerve is greater in Negro than in white males, having a greater number of fasciculi. There is also an asymmetry in size according to side. In whites, the right side is

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larger; in Negroes the left side is more often larger. In general, females have larger nerve fibers than males (96).

The sciatic nerve is made up of ventral and dorsal roots of the fourth and fifth lumbar and the first, second and third sacral nerves. The common level of union of these roots is at the anterior border of the great sciatic foramen below the pyriformis muscle. It descends between the greater trochanter of the femur and the ischial tuberosity through the posterior surface of the thigh to the level of its lower third. There it divides into the tibial and peroneal nerves. This division may occur at any point between the sacral plexus and the popliteal notch. The sciatic nerve really consists of two nerves in one sheath, the tibial from the anterior divisions and the peroneal from the posterior divisions. After the sciatic nerve leaves the sciatic foramen it lies on the posterior surface of the ischium. It is accompanied by the small sciatic nerve and artery and is covered by the gluteus maximus muscle. It is described as being midway between the greater tuberosity and the tuber ischium. In reality, it is closer to the ischial tuberosity, depending on the position of the lower extremity. The nerve is covered by skin and fascia only at the lower border of the gluteus maximus muscle and at the entrance of the nerve into the popliteal space (94). Before it divides into its terminal divisions the sciatic nerve gives off branches to the thigh muscles and the hamstring muscles (97).

METHOD OF STUDY

A total of 53 nerve blocks was performed—42 sciatic nerve blocks and 11 paravertebral lumbar sympathetic ganglion blocks.

The patients, both male and female, were kept in a room where the temperature fluctuation could be maintained at a minimum. Patients remained in this room for one-half hour before the block, with both extremities uncovered and exposed to room temperature. The skin temperature of each toe, the heel and the ankle was measured and recorded before the nerve block. After nerve block, the temperature of the toes, heel and ankle of each foot was measured and recorded at approximately five minute intervals for approximately one hour.

For comparative study, in four instances paravertebral lumbar sympathetic block was performed on one side first and sciatic block on the other immediately afterward. In the other instances, the two blocks were performed at different times. In all cases, the method of nerve blocking and temperature recording was identical except in three instances (blocks 8, 9 and 25) where a different drug was used for local anesthesia.

The temperature recordings were traced on graphs, thereby representing the results of this experimental study. Bar graphs were used to represent the results of the comparative study.

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NERVE BLOCK TECHNICS

Sciatic Nerve Block.—The technic used is essentially that described by Labat (98) and modified by Judovich (99). The patient lies on the side opposite to the one being injected, with the knee brought up so that the thigh is flexed on the trunk at an angle of about 135 degrees. The midpoint of the uppermost portion of the greater trochanter of the femur is located and the posterior superior iliac spine is palpated. A line is drawn connecting these two landmarks. This line is bisected and a perpendicular is drawn to about 3 cm. down from the midpoint. A skin wheal is raised at this point and a 3½ inch 22 gauge needle inserted in a downward direction until the needle point reaches the ischial spine (approximately 2 to 3 inches, or 5 to 8 cm., depending on the size of the patient). The sciatic nerve crosses over this bony point as it makes its exit from the sciatic notch, so that paresthesias may be obtained before bone is reached. Injection of procaine is made when paresthesia is obtained. The patient is forewarned that he will experience the paresthesia, after which numbness of the leg will ensue for about forty-five minutes.

Anesthetic solutions: (1) 10 cc. of 1 per cent procaine (5 cc. of 2 per cent procaine hydrochloride diluted with 5 cc. of dolamine solution); (2) 10 cc. of 1.5 per cent metycaine. This solution was used in three instances in which no response was obtained with procaine.

Paravertebral Lumbar Sympathetic Nerve Block.—The technic used is essentially the one described by Lundy (100), Judovich (99) and White (101). The patient lies prone on the table with a pillow under the abdomen so that the lumbar vertebrae will be elevated and their spinous processes easily palpated. The spinous processes of the lumbar vertebrae are located and wheals raised 3.5 cm. laterally. A 3½ inch 22 gauge needle is passed directly downward to the transverse process. The needle is then partially withdrawn and reinserted cephalad so as to clear the transverse process. The needle is inserted for a distance of 2 to 3 cm. beneath the transverse process. Contact is made with the lateral border of the vertebral body where the sympathetic ganglion is located and, after careful aspiration, 5 cc. of 2 per cent procaine is injected in each segment desired. Only two or three ganglions were injected. The second lumbar sympathetic ganglion was always injected since it has been shown that the only lumbar ganglion which is constant in position and connections is the second lumbar ganglion (102).

Temperature readings were obtained with the McKesson dermalor. This instrument employs the use of a resistance thermometer, the principle of which is that certain metals have a high coefficient of change of resistance with temperature. If a coil of such wire is held against the skin, the skin temperature can be deduced from the electrical resistance of the coil at that moment. The difference between resist-

ance thermometer and thermocouple measurements is that in the thermocouple the only energy available is the thermo-electric electromotive force at the junction, whereas in the resistance thermometer the energy comes from a battery and the temperature being measured controls this (87).

All temperature readings were in degrees Fahrenheit.

RESULTS

The results of this experimental study were charted. Figures 1 and 2 are representative examples of these graphs. These graphs are uniform in that rise in temperature is plotted against time elapsed since performance of the nerve block. The straight line represents the leg or lumbar ganglions which have been injected; the broken line represents the control side.

In those instances in which sciatic nerve block has been performed on one side and paravertebral block on the other, the results of sciatic block are represented by a straight line and the results of the paravertebral block by a broken line.

The bar graphs, of which figure 3 is an example, representing the composite results of the comparative study between sciatic nerve block and lumbar sympathetic ganglion block, were plotted so that the temperature before nerve block and the maximal temperature reached after nerve block are compared. These results were readily visible as well as the temperature of the control side which accompanies them. In some cases the temperature of the control leg was decreased.

COMMENT

Anesthetic block of the sciatic nerve results in vasodilatation of the vessels of the foot. This is evident by the rise in surface temperature which follows nerve block. Temperature rises varied from 0.5 F. to 22 F. The more complete the block, the greater the degree of vasodilatation. The amount of vasodilatation is, of course, dependent upon the amount of vasoconstrictor influence which has been eliminated. Likewise, the amount of vasodilatation is also dependent upon the elasticity of the vessel walls. Suffice it to say that total sympathetic paralysis of the foot will be obtained with sciatic nerve block. Following sciatic nerve block, the foot is warm and dry and the superficial vessels are distended. These are the criteria of interruption of the sympathetic supply to the extremity. Rise in temperature is noted within ten minutes after sciatic nerve block, and reaches a maximum within twenty to thirty minutes. The increase in temperature is sustained for at least one hour after nerve block.

Patients experience no discomfort from the motor paralysis which occurs with the block, nor do they mind the sensory anesthesia of the extremity which accompanies it. They seem to feel at ease and enjoy

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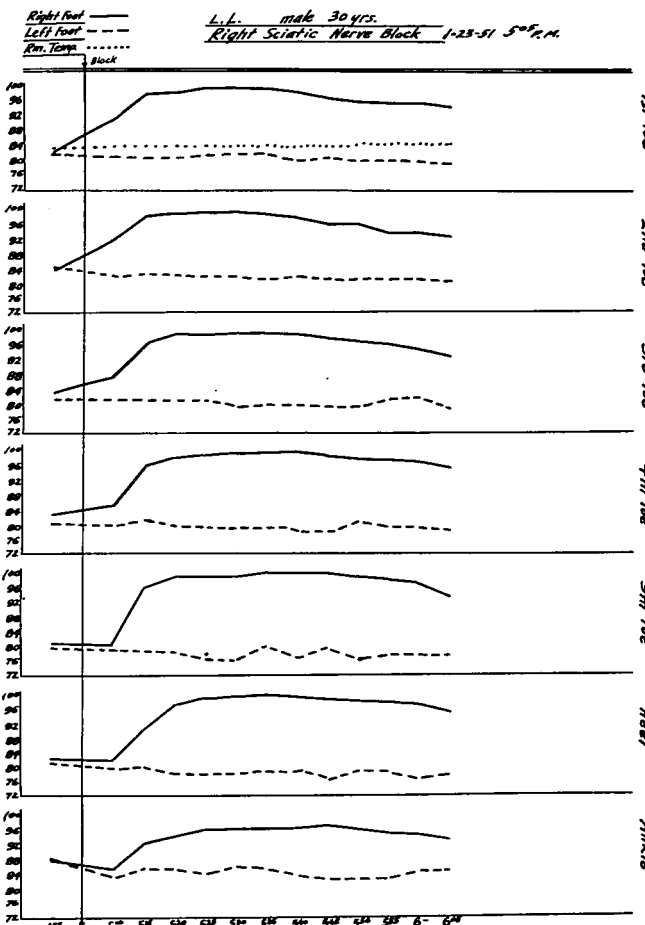

FIG. 1.

the increased warmth of the foot. Both motor loss and sensory loss last only about forty-five minutes after block. The patients have a sense of well-being after the anesthesia wears off. Two patients with intermittent claudication were treated by sciatic nerve block and ob-

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tained relief from symptoms. Ochsner (103) believed that relief of intermittent claudication proves that there is an increase in blood flow to the muscles. Barcroft and Edholm (104) have also shown that blood flow in muscles is more than doubled by release of sympathetic tone.

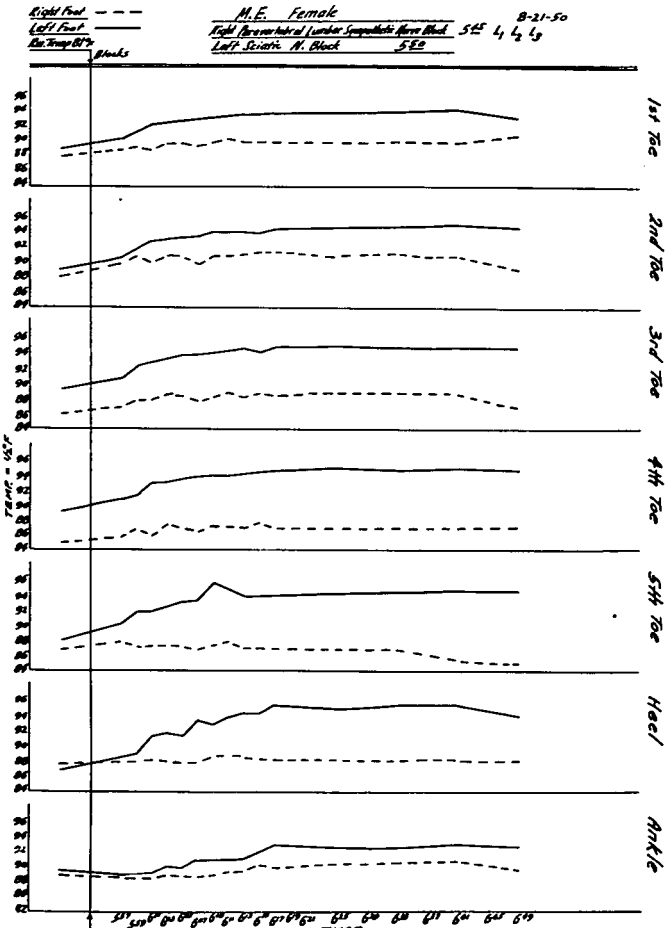

FIG. 2.

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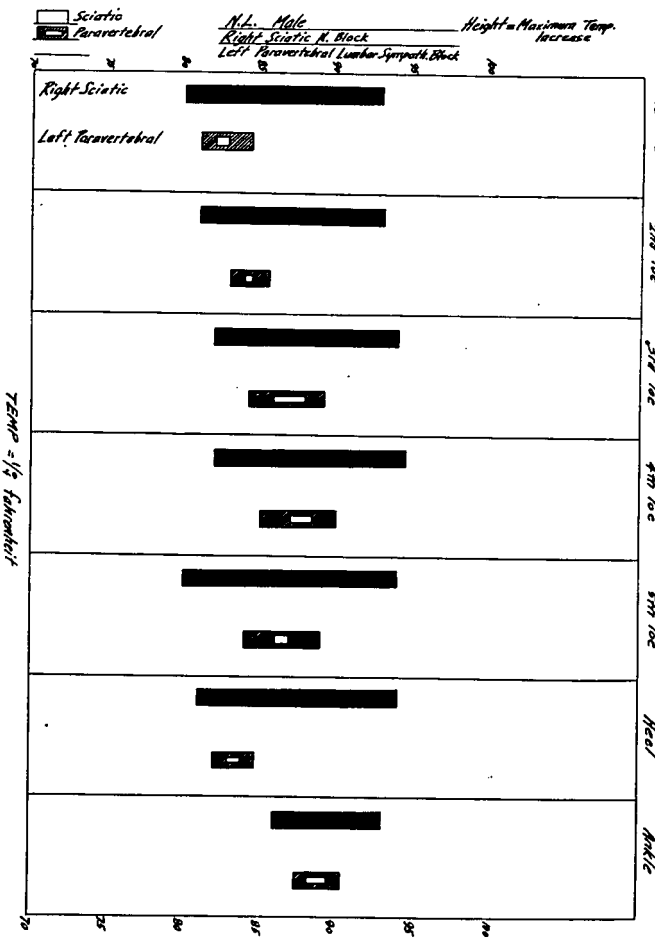

FIG. 3.

Sciatic nerve block is easy to perform and is without reported complications. No complications occurred in this series. Judovich and Bates (99) have reported more than 2000 sciatic nerve infiltrations without harm to the nerve supply.

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Comparison between sciatic nerve block and paravertebral lumbar sympathetic ganglion block shows that sciatic nerve block is as effective as lumbar sympathetic block in increasing the temperature of the foot. The amount of vasodilatation obtained is the same or sometimes greater with sciatic nerve block than with lumbar sympathetic block. In the cases in which sympathetic block was performed on one side first and then sciatic block performed on the other, the rise in temperature of the foot was more rapid, more sustained and greater with sciatic block than with lumbar sympathetic ganglion block.

The lumbar sympathetic blocks were painful to the patients no matter how carefully the procedure was carried out. Back pain and soreness persisted for several days after block. One complication was encountered in this series, although several complications have been reported in the literature.

The complication which occurred in this series was cerebrovascular accident following lumbar sympathetic ganglion block. Case 36 P, a 63 year old white man, became completely disoriented, and athetoid movements and incoherent speech developed one-half hour after block. Right hemiplegia followed soon afterward. De Sousa-Pereira (105) reported a similar cerebrovascular accident. Other complications following lumbar sympathetic block which have been reported are: paraplegia (106); vertebral osteomyelitis (106); subarachnoid tap (107); acute aseptic meningitis (108), neuritis (109–111) and death (112).

In many of the cases studied, another important phenomenon was demonstrated. This has been called "hematometakinesia" by Ochsner, DeBakey (113) and their associates. This is the "borrowing-lending" hemodynamic phenomenon. This phenomenon explains the decrease in temperature of the opposite leg when vasodilatation is produced on the other side. As the temperature of the one leg increases, that of the other leg decreases. When vasodilatation is present, the blood comes from the vascular bed of the body. It is accomplished by adjustment of the vascular bed and without change in total volume. This is an important factor in therapy of peripheral vascular disease.

CONCLUSIONS

Sciatic nerve block produces a maximal degree of vasodilatation of the foot which cannot be exceeded and which is seldom equaled by paravertebral lumbar sympathetic ganglion block.

Sciatic nerve block offers a means of determining the degree of vasoconstrictor tone and the extent of vasodilatation which can be produced by interruption of the sympathetic pathways.

Sciatic nerve block is easy to perform and causes little discomfort to the patient. No complications occurred in this study and none have been reported in the literature.

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Intermittent claudication of the foot may be relieved by sciatic nerve block.

Lumbar sympathetic ganglion block is more difficult to perform, less accurate and more painful to the patient. One complication occurred in this study and many complications have been reported in the literature.

ADDENDUM

Since presentation of this paper, another complication of paravertebral lumbar sympathetic block has been reported, namely, retroperitoneal hemorrhage, by Learned, L. O., and Cahoon, R. F., in *Anesthesiology* 12: 391–396 (May) 1951.

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SCIENTIFIC SESSION, Regency Room, Hotel Sherman

"Reactions to Local Anesthetic Drugs,"
John E. Steinhaus, M.D., Madison.

"Blood Transfusion Problems,"
Albert M. Wolf, M.D., Chicago.

"Controlled Hypotension,"
Max Sadove, M.D.

Business Meeting, Hotel Sherman
Bryce K. Ozanne, M.D., Moline, President
Election of Officers

DINNER, Hotel Sherman

Speaker: Bernard K. Galston, M.D.
Demonstration of Hypnosis

Tuesday, May 13

CLINICAL DEMONSTRATIONS

St. Luke's, Presbyterian,
Illinois R. and E., Michael Reese, and
Wesley Memorial Hospitals

SCIENTIFIC SESSION, Regency Room, Hotel Sherman
Lewis C. Hitchner, M.D., President-Elect

"Care of the Patient During Mitral Commissurotomy,"
John W. Pender, M.D., Rochester, Minn.

"Proteins in Relation to Surgery and Anesthesia,"
Gordon McNeil, M.D., Chicago.

Title to be Announced
Jacob J. Jacoby, M.D., Columbus, Ohio.

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