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THE USE OF PROLONGED CONTINUOUS SPINAL ANESTHESIA TO RELIEVE VASOSPASM AND PAIN IN PERIPHERAL EMBOLISM * † ‡

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The surgeon caring for patients with emboli is confronted with two major problems. The most important is the ischemia resulting from vascular obstruction. The other problem is the severe pain that accompanies the ischemia. The circulation to the involved area is disturbed primarily as the result of the organic obstruction caused by the embolus. An additional, although varying, amount of obstruction occurs as a result of the vasospasm which accompanies these vascular catastrophes. The relative proportion of the obstruction resulting from either of these two separate causes should influence the type of therapy used. The obstruction produced by vasospasm can be relieved by interrupting the sympathetic reflexes to the involved vessels and should be carried out first. If, following this, circulation is still inadequate, then the organic obstruction, or embolus, must be removed.

When tissue is suddenly deprived of its blood supply, as occurs in peripheral embolism, immediate and severe pain results. Large doses of opiates give only partial or temporary relief. The pain usually lasts for several days. The value of interrupting the sympathetic impulses to peripheral vessels in cases of embolism has been well established and is now a common practice (1). This may be accomplished by a regional block of the sympathetic nerves. In the lower extremities it may also

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be accomplished by the administration of a spinal anesthetic agent or by lumbar sympathectomy. Regional blocks and single injection spinal anesthesia provide only temporary relief of vasospasm. Sympathectomy is a major procedure and frequently these patients are not in condition to tolerate it. Prolonged continuous spinal anesthesia provides not only continuous relief of vasospasm, but likewise gives complete relief of pain. This method has been used in the management of 3 cases of peripheral embolism. In 3 other patients single injection spinal anesthesia was used to relieve pain and vasospasm.

Since the introduction of continuous spinal anesthesia by Lemmon (2) it has been used extensively for surgery, but we were unable to find an instance of its use to combat the pain and vasospasm that accompany emboli in the lower extremities.

TECHNIC

It is desirable first to administer a single injection spinal anesthetic. This will provide immediate and complete relief of pain and vasospasm without undue delay. It will, likewise, allow one to evaluate the circulation. If there is adequate improvement in circulation, embolectomy may be postponed or avoided. If embolectomy is to be done, continuous spinal anesthesia may be started. The most satisfactory technic for these long cases is that described in detail by Tuohy (3). The use of the ureteral catheter allows greater freedom of movement and eliminates many mechanical difficulties.

AGENTS

Procaine, 1 to 2 per cent in physiologic saline solution; pontocaine, 0.1 to 0.2 per cent in 10 per cent dextrose; nupercaine, 1:2,000 in 10 per cent dextrose; and metycaine, 1.5 per cent in Ringer's solution have been used with and without vasoconstrictor agents.

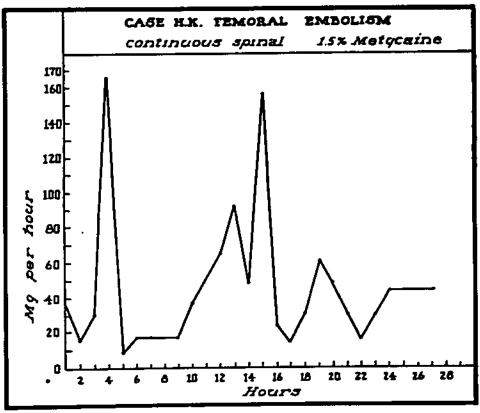
As to the effect of vasoconstrictor agents on the duration of anesthesia, we are not in a position to offer any definite opinion as to their individual merits. It is quite evident, however, that the use of vasoconstrictors intrathecally definitely increases the duration of the various spinal anesthetic agents.

From what has been pointed out previously, procaine is probably the agent of choice and perhaps best used in a 1 per cent solution. If this is inadequate, one should not exceed a 2 per cent solution for very prolonged cases. It has been noted that the effectiveness of the various agents diminishes as time progresses. This can be overcome by changing to another agent. This procedure is certainly more desirable than increasing the concentration of the agent in use. From the standpoint of avoiding neurologic complications, it is advisable to use the weakest concentration that will produce the desired effect.

CASE REPORTS

Case 1 (H. K.). A 48-year-old white woman entered the hospital with the chief complaint of severe pain in the right hip and leg. Four hours and fifteen minutes prior to hospital admission she was suddenly stricken with severe pain and inability to move her right leg. The patient gave a history of rheumatic heart disease with auricular fibrillation and congestive failure.

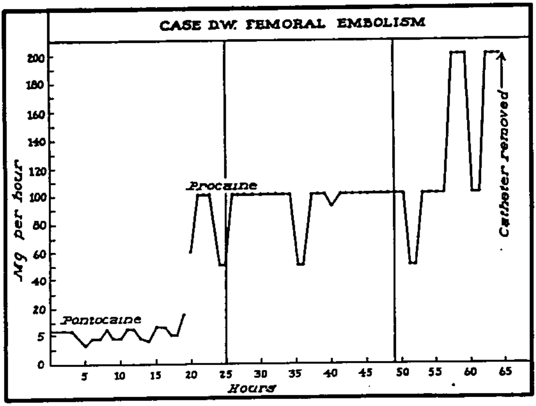
Five hours after admission, in spite of heavy sedation with morphine, the patient still complained of severe pain. At this time a lumbar sympathetic block was done, using 1 per cent metycaine. This procedure gave some relief; nevertheless she still complained of pain and was restless. Three hours later she again complained of severe pain. The right leg was cold and appeared to be getting darker. Seven and a half hours after the first lumbar sympathetic block a second block was done, using 1 per cent metycaine. This gave only



partial relief of the pain. Twenty-five hours after the onset of severe pain, right femoral embolectomy was performed under spinal anesthesia. She was returned to the ward in fairly satisfactory condition and, was free of pain for approximately six hours and thirty minutes. The severe pain returned, hence a continuous spinal anesthetic was started using 1.5 per cent metycaine. The metycaine was administered at intervals and in quantities sufficient to relieve the pain and vasospasm. The return of circulation was inadequate and an amputation had to be done. Continuous spinal anesthesia was maintained until completion of the high thigh amputation which was carried out twenty-six hours and fifteen minutes after the continuous spinal anesthesia was started. A total of 1,020 mg. of 1.5 per cent metycaine in Ringer's solution was used. Later, because of ischemia, it was necessary to do a reamputation of the leg. After a stormy convalescence a revision of the stump was made and the patient was discharged one hundred and sixty-nine days after admission. The patient occasionally voided voluntarily while continuous spinal anesthesia was being maintained. Although there was practically always complete sensory anesthesia from mid-way between the umbilicus and symphysis throughout the course of anesthesia, she always had motor function in the uninvolved leg. Careful neurologic examination before the patient was discharged failed to reveal any evidence of nerve damage due to the prolonged continuous spinal anesthetic.

Case 2 (*D. W.*). A 61-year-old white man with a four year history of coronary heart disease was admitted to the hospital. One hour before admission he experienced sudden and severe pain in his right foot. The pain was so severe that 1 grain of morphine sulfate was required before relief could be obtained.

On examination both feet were cold and circulation was poor. The right foot, however, was worse. The line of temperature demarkation passed about 6 inches below the knee. There was absence of sensation in the foot and loss of intrinsic muscle activity. Femoral and popliteal pulsations were present but no

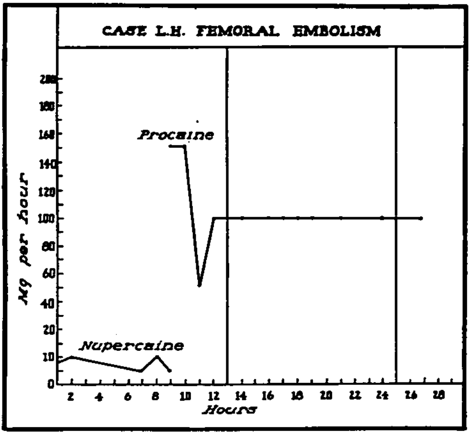


pulsations below this point were apparent. Unilateral spinal anesthesia was induced, using 6 mg. of pontocaine * in 10 per cent dextrose with epinephrine, 1:10,000. He obtained immediate relief of pain and the line of temperature demarkation moved downward about 4 inches. The circulation in the foot remained poor. It was apparent that if the leg was to be saved the embolus would have to be removed. Continuous spinal anesthesia was started and popliteal embolectomy performed four hours after the onset of symptoms. Immediately after embolectomy he was started on heparin and dicumarol. Following embolectomy the circulation improved. The limb was cooled with ice and the continuous spinal anesthesia maintained for sixty-nine hours and forty-five minutes. Pontocaine was used for the first twenty-five hours and forty-five minutes, when its effectiveness was reduced to almost nil, then 1.0 per cent procaine was used (see chart). It was noticed that when the ice was removed the pain was less and the circulation improved. We believe that the use of ice is definitely contraindicated in these cases. The patient was given dibenzyl-

* Supplied through the courtesy of Winthrop Chemical Co.

b-chloroethyl-amine, with questionable results. It was necessary to catheterize him periodically during the prolonged administration of the spinal anesthetic agent. This condition persisted after spinal anesthesia was discontinued. A cystometrogram was done which showed slight atonia but the tonus was thought to be within the normal range. Definite mechanical obstruction was present; therefore, a transurethral prostatectomy was done three weeks later. Following this, micturition improved. The patient was discharged with a satisfactory limb and without evidence of neurologic changes.

Case 3 (*L. H.*). A 41-year-old white woman, a known cardiac invalid for six years, entered the hospital for treatment of this condition. Admission examination revealed auricular fibrillation with cardiac decompensation. The diagnosis at this time was rheumatic heart disease with acute congestive failure.



Four days after admission the patient complained of severe pain in the left leg with loss of cutaneous sensation. Physical examination revealed the left leg to be cold and blanched and this condition extended about 8 inches above the knee. There was femoral pulsation but no popliteal or dorsalis pedis pulsation. Three hours after onset a single injection spinal anesthesia with nupercaine was induced. There was immediate and complete relief of the pain; however, the circulation to the lower leg remained inadequate. Left femoral embolectomy was performed.

Following embolectomy the circulation rapidly improved. The patient remained comparatively free from pain for approximately twelve hours following the administration of the first single injection spinal anesthetic. Because of the return of pain, continuous spinal anesthesia, using nupercaine, 1:2,000 was induced. This proved effective in relieving the pain for about eight hours, after which time increasingly larger amounts of the anesthetic agent were required. Because of this, procaine, 2 per cent solution, was substituted for the nupercaine solution. Procaine proved quite satisfactory in relieving pain. During the last twenty hours of the time the catheter was in place a total of 3,000 units of penicillin was given, or 1,000 units with each of the last three injections. The efficiency of procaine in producing anesthesia was not altered by the presence of pencillin. Dramatic recovery followed embolectomy; however, the patient died as a result of multiple cerebral emboli seven days later.

Case 4 (*G. M.*). A white man, 52 years old, entered the hospital because of pain in the calf of the right leg. The history revealed sudden onset of pain in the right calf two weeks before hospitalization. The pain had been almost continuous and was followed by cyanosis and numbness of the foot and ankle. The patient had received pavex positive-negative pressure therapy but without improvement in circulation or relief of pain.

Examination revealed the right leg to be colder than the left, with marked cyanosis of the foot and toes. There was loss of position sense and sensory anesthesia extended to the ankle. Pain and tenderness were elicited on palpation over the course of the deep vessels up to about 4 inchs above the right knee. There were no pulsations in the popliteal or dorsalis pedis vessels but the femoral pulse was present. Three and one half hours after admission the patient was given a spinal anesthetic of 5 mg. of nupercaine in a total volume of 8 cc. This gave immediate and complete relief of pain for five hours and thirty minutes. No improvement was noted in the circulation, and spinal anesthesia was not repeated. The pain persisted for several days, decreasing in magnitude, and two weeks later an amputation below the knee was performed. Following the amputation the patient made an uneventful recovery.

Case 5 (*J. W.*). A 43-year-old white woman entered the hospital with a long history of rheumatic heart disease with auricular fibrillation and mitral stenosis. Two hours before admission she noticed generalized aching in the entire left leg. This was soon followed by numbness, severe pain and inability to use her leg.

On examination, the left leg was livid and cyanotic. It was cold from the mid-thigh region downward. The femoral pulsation was present at the inguinal ligament but none was elicited below this level. Paravertebral sympathetic block with 1 per cent metycaine was done immediately, with only slight improvement of the circulation and practically no relief of the pain. About one hour later a unilateral spinal anesthetic was induced using 5 mg. pontocaine, 1.0 mg. of neosynephrin ‡ in 1 cc. of 10 per cent dextrose. This procedure gave complete relief of pain and at the same time there was marked improvement in the circulation. The patient had complete relief of pain for eighteen hours after which it was easily controlled with papaverine, 0.1 Gm., together with mild sedation. No further therapy was given except for dicumarol. Recovery was uneventful and she was discharged from the hospital eight days later.

Case 6 (*J. C.*). A 43-year-old white man entered the hospital with a history of pain in the left leg of three days duration. Examination of the left leg showed a definite line of demarkation midway between the knee and ankle, with gangrene of the left foot. It was thought at that time that block of the sympathetic nerves would not alter the outcome. He had had rheumatic fever for several years. There was mitral stenosis with regurgitation and auricular fibrillation. Eleven days after the hospital admission the patient experienced severe pain in the right leg. Two hours and thirty minutes later a spinal anesthesia was administered using pontocaine, 0.5 per cent in 10 per cent dextrose with epinephrine, 1:10,000. Anesthesia lasted for approximately eight hours and after its effects had subsided there was very little pain in the right extremity. The circulation in the right leg was markedly improved and embolectomy was not necessary. Later, amputation of the left leg was carried out and the patient was discharged from the hospital with a good right leg.

DISCUSSION

Continuous spinal anesthesia has been maintained for twenty-six hours and fifteen minutes, sixty-nine hours and forty-five minutes, and forty-three hours in 3 individual cases (Chart 1). In Case 1, in which anesthesia was maintained for twenty-six hours and fifteen minutes, metycaine, 1.5 per cent in Ringer's solution, was used exclusively (Case 1). A total of 1,020 mg. of metycaine was used. This case showed a very definite diminution in the effectiveness of metycaine to produce satisfactory anesthesia as time progressed.

CHART 1

PROLONGED CONTINUOUS SPINAL ANESTHESIA

SUMMARY

Case	Total Hours	Agent	Concentration of solution Per Cent	Total Dose	Hours of Administration	Dose in Mgms. Per Hour
(1) H. K.	26′ 15″	Metycaine	1.5	1,020	26′ 15″	45
(2) D. W.	69′ 45″	Pontocaine	0.1 to 0.2	129	25′ 45″	5
		Procaine	1.0	4,450	44′ 00″	111
(3) L. H.	43′ 00″	Nupercaine	1:2,000	36.7	9′ 10″	4
		Procaine	2.0	1,200	33′ 50″	35

In the case in which anesthesia was maintained for sixty-nine hours and forty-five minutes pontocaine, 0.1 per cent in 10 per cent dextrose, was used initially and throughout the first twenty-five hours, during which time 129 mg. was used. At the end of this time there was a definite decrease in effectiveness of the pontocaine. In checking the mechanics of the technic to determine whether the anesthetic solution was reaching the subarachnoid space properly, spinal fluid was allowed to drain out of the catheter. The spinal fluid had a definite pink tinge which, upon microscopic examination, was found to be due to red blood cells. One per cent procaine in physiologic saline solution was substituted for the pontocaine dextrose solution. The 1 per cent procaine solution was satisfactory in relieving the pain, but there was progressive diminution in its effectiveness. A total of 4,450 mg. of procaine was used during the last forty-four hours. The red blood cells in the spinal fluid most likely were not the result of trauma since the spinal fluid was initially clear and again became clear when physiologic saline solution was substituted for the hypertonic dextrose solution.

In the case in which anesthesia was maintained for forty-three hours, nupercaine, 1:2,000, with epinephrine, 1:20,000, in physiologic saline solution was used for nine hours. A total of 36.7 mg. of nupercaine was used. At the end of this time the effectiveness of the nupercaine was definitely diminished. Therefore, it was decided to change to 2 per cent procaine. This proved satisfactory in relieving the pain throughout the remainder of the treatment period. A total of 1,200 mg. of procaine was used.

CHART 2

PROLONGED CONTINUOUS SPINAL ANESTHESIA
SUMMARY

Case	Time from Onset to Sympathetic Block	Technic of Blocking Sympathetics	Time from Onset to Surgery	Operative Procedure	Results
(1) H. K.	9′ 30″ Block	Paravertebral Block	58′ 45″	Amputation (High Thigh)	Poor
	33′ 30″ Cont. Spinal	Continuous Spinal			
(2) D. W.	2′ 00″	Spinal	4′ 00″	Embolectomy	Excellent
(3) L. H.	3′ 5″	Spinal	3′ 30″	Embolectomy	Excellent (Died 1 week later from cerebral emboli)
(4) G. M.	2 weeks	Spinal	4 weeks	Amputation	Poor
(5) J. W.	2′ 00″	Paravertebral Block Sympathetic Block	No Surgery	None	Poor
	4′ 00″	Spinal	No Surgery	None	Excellent
(6) J. C.	2′ 30″	Spinal	No Surgery	None	Excellent

Embolectomy was done in each of these cases. In 2 cases (Cases 2 and 3) embolectomy was done within four hours of onset and the results were excellent. In 1 case it was performed twenty-four hours after onset and a subsequent thigh amputation was necessary (Case 1). It is generally agreed that embolectomy this long after onset of symptoms is a futile procedure.

In addition to 3 patients who had prolonged continuous spinal anesthesia, 3 others were treated for embolism of the lower extremity

(Chart 2, Cases 4, 5, and 6). Each of these 3 patients was given single injection spinal anesthesia as recommended previously. In 2 of the cases it was administered within four hours of onset (Cases 5 and 6). Relief of pain was immediate and complete. There was improvement of circulation to such an extent that embolectomy was not necessary. Recovery was satisfactory. In one the onset was about two weeks before hospital admission (Case 4). A single injection spinal anesthetic was given to this patient soon after admission without any improvement in circulation. Amputation became necessary.

The results further emphasize the fact that if therapy to peripheral embolism is to be effective it must be instituted early and followed until adequate circulation is restored and maintained. Although this fact has been pointed out many times (1), it still is not fully appreciated and too many patients go untreated.

Summary

Six cases of lower extremity embolism are reported. In 3 cases embolectomy was performed and each of these patients received prolonged continuous spinal anesthesia lasting twenty-six hours and fifteen minutes, sixty-nine hours and forty-five minutes, and forty-three hours respectively. The remaining 3 patients received a single injection spinal anesthesia and in 2 of these it was the only therapy necessary. In the other case the leg was not viable at the time the spinal anesthetic was administered and amputation had to be done. Spinal anesthesia not only relieves vasospasm but also gives complete relief of the severe pain that accompanies this condition.

No neurologic changes were noted in any of the cases in which prolonged continuous spinal anesthesia was employed. It was noticed, however, that despite the agent used, the relative duration and effectiveness of the anesthetic agent became progressively less, and in 2 of the 3 cases two agents were used to prolong the anesthesia to sixty-nine hours and forty-five minutes and forty-three hours, respectively. A total of 4,450 mg. of procaine was used in 1 case over a forty-four hour period.

Single injection anesthesia and prolonged continuous spinal anesthesia are valuable aids in the treatment of peripheral embolism. In some instances, surgical removal of the embolus may not be necessary when adequate block of the sympathetic nerves to the involved extremity is maintained. Surgical intervention should not be delayed when there is questionable improvement following the sympathetic block. The use of cooling by any method should be avoided.

Delay and procrastination have no place in the treatment of peripheral embolism.

Since these cases were reported, continuous spinal anesthesia using pontocaine, 1:1,000 was maintained for sixty-five hours and ten minutes in a patient having an embolus in the right posterior tibial artery. It provided immediate and complete relief of pain with marked improvement of the circulation. Embolectomy was not necessary. The patient was discharged in good condition without evidence of neurologic damage.

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1. The U. S. Army Medical Department announces the availability of opportunities for advanced training and experience in the various special fields of medicine and surgery in overseas Army hospitals. These hospitals are registered with the American Medical Association, and this training may be acceptable by the specialty board as part of the period usually required to be spent in limited practice and experience prior to admission for examination. Interested members of the medical profession who have completed the formal training requirements for certification in one of the special fields are eligible to apply for these positions. On 1 January 1948 the following opportunities will be available, and will be kept open until filled:

Specialty	*No. of Openings*
Eye, Ear, Nose and Throat	7
Obstetrics and Gynecology	14
Anesthesia	*7*
Ophthalmology	3
Otorhinolaryngology	3
Neurosurgery	1
Orthopedic Surgery	5
Thoracic Surgery	1
Plastic Surgery	1
Radiology	11
Internal Medicine	24
Dermatology	3
Neuropsychiatry	15
Pediatrics	10
Cardiology	2
Pathology	1

(There are also 21 positions in general surgery and 5 positions in urology, but these boards specify "supervised practice" and it has not yet been determined whether or not the hospitals will be approved by these boards. However, full approval of these specialties is being sought and inquiries are invited.)

(Continued on page 257)