

D-1

LOCALIZED SWEATING AS PART OF A LOCALIZED CONVULSIVE SEIZURE

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In recent years, as the result of new evidence which has been presented, there has been a renewed interest in the question of the effect of the cerebral cortex on various autonomic, or vegetative, functions. Although direct evidence as to the influence of the cortex on vasomotor activity, intestinal activity, respiration, etc., has been obtained, evidence as to the influence of the cerebral cortex on sweating is meager. It is true that hundreds of cases have been observed in which a cerebral lesion resulted in hemiplegia associated with unilateral edema, vasodilatation and sweating. There has always been doubt as to whether this localized sweating was the direct result of the cerebral lesion or came about only because of the inactivity of the paralyzed extremities. Instances in which localized sweating has occurred as a result of cerebral stimulation or irritation are indeed few. The present case is an exceptionally clear example of the latter type.

REPORT OF A CASE

History.— E. R., a 54 year old Greek housewife, was referred by Dr. Arthur Martin, of Chicago. She was admitted to the Chicago Memorial Hospital on Dec. 15, 1942.

She had apparently been perfectly well until Dec. 10, 1942, when she suffered from a three minute episode of twitching of the left side of the face. This had been preceded by a "burning sensation" which arose from the pit of the stomach and traveled up to the face. She did not lose consciousness with this attack and felt no after-effects. At first such attacks occurred about once a day, but they rapidly increased in number and duration until at the time of admission to the hospital they were occurring about every half-hour and lasting five to ten minutes.

Except for the attacks described, the patient did not admit having experienced any other symptoms. There was no headache, nausea or vomiting, nor was there a history of any weakness or of other convulsions.

Because of language difficulties, the personal and family histories were not readily obtained. The facts which were elicited, however, were of a negative and noncontributory nature.

Examination.—The results of the general physical examination were entirely without significance. On neurologic examination the patient was found to be well oriented and cooperative. However, her knowledge of English was limited, and an accurate estimation of her intelligence could not be made. She was right handed. The visual fields were normal on gross confrontation tests. Visual acuity was normal. Ophthalmoscopic examination revealed that the margins of the disks were sharp and the disks flat. The ocular movements were full, and convergence was normal. There was no nystagmus. The pupils were round and equal and of normal size. They reacted normally to light and in accommodation. Sensation over the face was intact. The corneal reflexes were active and equal on the two sides. There was no evidence of involvement of the muscles of mastication. There was definite weakness of the left side of the face. This was more marked in the lower part of the face, about the mouth, but it involved also the left eyelids, and the left palpebral fissure was wider than the right. The musculature innervated by the remaining cranial nerves was not affected. Hearing seemed to be entirely normal. Sensation over the entire body was intact. There was no motor weakness of the extremities, and coordination and muscular development were normal.

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The tendon reflexes were active and equal on the two sides. The abdominal reflexes were active; the Babinski sign was not present.

Course of Illness.—Several convulsions were observed. They were all similar. The patient could first say that she was going to have an attack; then the left side of the face gradually began to contract, pulling the left corner of the mouth upward and the eyelids downward. Twitching of the musculature of the left side of the face then appeared and continued for approximately three minutes. There was also some involvement of the muscles of mastication, with rhythmic movement of the mandible. However, the patient did not bite her tongue. In none of the attacks were there any other convulsive movements, nor did she lose consciousness at any time. She was able to execute simple commands throughout the seizure. The pupils were equal and reacted normally to light. During the attack, the left side of the face began to sweat and became covered with small drops of perspiration, while the right side remained perfectly dry. The left axilla and left arm also became somewhat moist, but the rest of the body was in no way involved in this hyperhidrosis. After the attack was over and the perspiration was wiped away, sweating did not reappear until the next convulsive attack. However, it was present with each seizure which was observed.

The blood count and the results of urinalysis were entirely normal, and the Wassermann and Kahn reactions of the blood were negative. A roentgenogram of the chest and a cyclogram were also normal. Roentgenograms of the skull revealed no abnormality.

First Operation.—As it seemed clear that the patient was suffering from a lesion involving the lower precentral area on the right side, this region was exposed with the usual osteoplastic craniotomy on December 18. The patient had been anesthetized with pentothal sodium given rectally and ether administered intratracheally. The dura mater and the surface of the cerebral cortex appeared perfectly normal. The usual blunt needle was inserted into the cerebral substance in various directions without its encountering any alteration in resistance. The exposed cortex was then stimulated with a 60 cycle sinusoidal current. Apparently because of the use of pentothal sodium the results of this stimulation were far from satisfactory, and it was not possible to outline accurately the representation of the face in the precentral gyrus. However, a small portion of the cortex was removed from the lower end of an area which on stimulation gave rise to movement in both the left side of the face and the left arm. This bit of cortex appeared normal, as did the underlying white matter.

Immediately after the operation there was no movement of the left arm. The convulsive movements of the left side of the face did not reappear until five days after the operation, when they were even more frequent than before.

Second Operation.—On December 24 the osteoplastic flap was again elevated. This time the patient was anesthetized with solution of tribromethanol U. S. P. administered rectally and ether given intratracheally. The brain appeared much the same as at the previous operation, but on this occasion stimulation with the same electric current succeeded in localizing the face area accurately. The area from which movements of the face could be produced lay approximately 1 cm. inferior to the area from which the bit of cortex had been removed at the first operation. The entire representation of the face in the precentral gyrus was removed. The cortex removed at the second operation measured approximately 2 cm. in length, 1 cm. in width and 1 cm. in thickness. The cortex did not appear abnormal. After it was removed, however, a small bit of gray tissue, at first thought to be a piece of cerebral cortex, was seen in the bottom of the cavity. In order to make the extirpation complete, this, too, was removed. As we proceeded deeper, however, this bit of gray tissue grew larger instead of smaller, and it was soon apparent that we were dealing with a large subcortical neoplasm. This tumor was gray, soft in consistency and very avascular. It underlay the entire face area and extended downward to the sylvian fissure. A large portion of the growth was removed. A decompression was made, and the wound was closed.

Postoperative Course.—Convalescence was uneventful. The patient had no further convulsive seizures. The left arm continued to be weak, but the left leg, which was temporarily paralyzed, rapidly recovered its function. The patient left the hospital in relatively good condition, twenty-three days after her admission. After a few months the symptoms again progressed, and she was later admitted to the Cook County Hospital, where she died. No autopsy was made.

Microscopic Examination.—Study of the tumor tissue removed revealed a highly cellular but relatively avascular neoplasm. The cells were rather small and uniform in size. They had rounded and ovoid nuclei, a few of which showed definite mitosis. The cytoplasm of these cells was indistinct. Many spherical masses of calcification were seen in some parts of the neoplasm. It was thought that this tumor was a typical oligodendroglioma.

COMMENT

There is little doubt that the localized convulsive seizures involving the left side of the face in this case were due to irritation of the face area in the precentral gyrus by the subcortical glioma. It seems clear that the paroxysmal attacks of localized sweating, involving exactly the same area and occurring at the same time as the convulsive movements, had the same cause.

An extensive survey of the medical literature reveals that similar instances of localized sweating, associated with jacksonian convulsive seizures, are rare. One of the earliest reports dealing with this phenomenon is to be found in the *London Medical Times and Gazette* for 1866. There, in a brief article, Russell¹ reported a "case of unilateral congestion and sweating occurring in epileptiform paroxysms."

The patient was a 38 year old night watchman who had suffered from two attacks of unconsciousness. These attacks began with a burning sensation in the left arm and left side of the face, which was associated with profuse sweating in the same areas. At this stage of the attack, he could not speak but was still conscious. Then the left side of his face contracted, and his head was drawn downward toward his left shoulder. The patient then lost consciousness and "became purple all over." Between these two major attacks, he had many episodes of localized sweating, involving the left side of the face and the left arm and lasting for five to fifteen minutes. Such attacks occurred three to four times a day for several days, and he would then be free from all attacks for as long as a fortnight. The sweating was always profuse, and occasionally the left eye watered during these attacks. There was no increase in salivation, and the pupils were equal and reacted normally throughout.

In the succeeding article in the same journal, Ramskill² reported a case of sweating on the right side of the face in a patient who had epileptic fits. This sweating did not occur in association with the fits (which were not described) but came on when the patient exerted himself. However, Ramskill cited briefly a case of Astie's in which a child suffered from localized sweating preceding convulsions. In that instance the parts involved in the sweating were also the ones involved in the convulsion. No further details were given. In none of these 3 cases was there any confirmation of the nature or location of the lesion responsible for the trouble.

In his discussion of the cortical control of perspiration, von Bechterew³ cited several interesting reports but, unfortunately, did not supply the references, and we have been unable to locate the original reports. According to von Bechterew, Senator⁴ observed a patient who had suffered a stroke and as a result was left with cortical ataxia and convulsions which involved the left arm. These localized convulsive seizures were associated with very noticeable sweating which was also restricted to the left arm. Autopsy revealed "softening in the corresponding part of the cortex." Adamkiewicz⁵ reported a similar case, but there was no autopsy or other confirmation of the nature or location of the lesion. Morselli⁶ observed a patient with hyperhidrosis of the right side of the face. A glioma was present

1. Russell: A Case of Unilateral Congestion and Sweating Occurring in Epileptiform Paroxysms, *M. Times & Gaz.* 1:366, 1866.

2. Ramskill: Sweating on One Side of the Face in a Patient Who Had Epileptic Fits, *M. Times & Gaz.* 1:367, 1866.

3. von Bechterew, W.: (a) Der Einfluss der Hirnrinde auf die Thränen, Schweiss, und Harnabsonderung, *Arch. f. Anat. u. Physiol. (Physiol. Aht.)*, 1905, pp. 297-305; (b) Die Wirkungen der Gehirnrinde auf die Schweisssekretion, in *Die Funktionen der Nervencentra*, Jena, Gustav Fischer, 1911, pp. 1729-1733.

4. Senator, cited by von Bechterew.^{3b}

5. Adamkiewicz, A., cited by von Bechterew.^{3b}

6. Morselli, E., cited by von Bechterew.^{3b}

in the left frontal lobe. This report is confused by von Bechterew's statement that "the cervical sympathetic seems also to have been involved." Pandi⁷ had a case of post-traumatic convulsions of the left arm and paralysis of the left side of the face. There was no demonstrable vasomotor disturbance. Sweating occurred on the left side of the face in association with the convulsive attacks.

More recently, Toporkoff⁸ reported 2 cases with bearing on this problem. In the first instance, a 5 year old boy who had fallen from a table at the age of 3 months began to have convulsive seizures about two weeks thereafter. These convulsive attacks started in the right hand and foot but were preceded by profuse perspiration in the right inguinal region and on the right side of the scrotum. In the second instance, a student gave a history of generalized convulsions during a five year period following an attack of typhoid fever. Profuse sweating of the right hand and arm up to the elbow preceded every convulsive attack.

Guttman,⁹ in an article on the relation of the nervous system to sweating, discussed a case in which clonic convulsions of the left hand were associated with profuse sweating of the left hand, arm and axilla. Operation revealed a meningioma in the right precentral region. Guttman and List¹⁰ studied perspiration in a series of patients, using the starch and iodine test devised by von Minor.¹¹ In these patients, who were suffering from various neurologic disorders, they induced sweating by the use of external heat, the administration of hot drinks, etc. Among their patients were 4 with jacksonian convulsions. In these subjects the amount of induced perspiration was disproportionately great in the area involved by the convulsive attacks. Two of these patients suffered from traumatic epilepsy, the convulsions involving the right hand. In 1 of these 2 patients only the third, fourth and fifth fingers were involved, and the induced perspiration was greatest on these digits. In the other patient a gunshot wound had involved the left rolandic area. The convulsions began in the right lower extremity, and the induced sweating was especially pronounced over the right thigh. Still another patient had a glioma in the left precentral region, which resulted in jacksonian convulsions of the right arm. In this patient the induced perspiration was greatest over the right upper extremity.

There are several experimental studies on animals related to this problem. In 1902, Gribocedov,¹² working in von Bechterew's laboratory, observed that on stimulation of the sigmoid gyrus in young cats he could produce visible sweating on the foot pads of the contralateral extremities. In order to exclude the possibility that this was the result of muscular contraction, rather than the direct effect of cortical stimulation, the experiments were carried out on curarized animals, with the same results. Winkler¹³ likewise obtained sweating on stimulation of

7. Pandi, cited by von Bechterew.^{2b}

8. Toporkoff, N.: Die lokale Schweisssekretion bei Epilepsie, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **98**:279-282, 1925.

9. Guttman, L.: Die Schweisssekretion des Menschen in ihren Beziehungen zum Nervensystem, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **135**:1-48, 1931.

10. Guttman, L., and List, C. F.: Zur Topik und Pathophysiologie der Schweisssekretion, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **116**:504-536, 1928.

11. von Minor: Ein neues Verfahren zu der klinischen Untersuchung der Schweissabsonderung, *Deutsche Ztschr. f. Nervenhe.* **101**:302-308, 1928.

12. Gribocedov, A. S.: Ueber die Rindencentra der Schweisssekretion, *Obozr. psikiat.* 1902, no. 7; cited by Bechterew.^{2b}

13. Winkler, F.: Die Cerebrale Beeinflussung der Schweisssekretion, *Arch. f. d. ges. Physiol.* **125**:584-594, 1908.

the motor cortex of cats, but this was not localized to the contralateral extremity. Schwartz¹⁴ stimulated the motor cortex in cats after extirpation of various other parts of the cortex and concluded that the integrity of the premotor area was necessary for the galvanic cutaneous response. The close correlation of the galvanic cutaneous response and the amount of perspiration is, of course, well known.

Langworthy and Richter¹⁵ reported on two sharply circumscribed areas of the cat's cerebral cortex which when stimulated would give rise to an increased galvanic cutaneous response from the foot pads, which was quantitatively greater on the contralateral side. One of these areas was anteromedial and the other posterolateral to the motor area. Caudal to this, "stimulation of the corticospinal, corticopontine, rubrospinal, and vestibulospinal tracts elicited action currents, indicating stimulation of the sweat glands." Wang and Lu¹⁶ also studied the effects of stimulation of the frontal cortex of the cat on the galvanic cutaneous response. They found (1) that stimulation was followed by a latent period of over one second before increase in the galvanic response was noted; (2) that this response was obtained even after both the ventral and the dorsal spinal roots were sectioned; (3) that section of the tuber cinereum and adjacent regions did not abolish the response, and (4) that section of the cerebral peduncle on the rostral border of the pons abolished it completely. In contrast to this, Spiegel and Hunsicker,¹⁷ working with cats, severed separately the centrifugal fibers from the thalamus, the cerebral peduncles and the pyramidal tracts without abolishing the galvanic cutaneous response. They therefore concluded that either pyramidal (corticopontile) or extrapyramidal (corticothalamic) pathways may be utilized in the cortical control of sweating.

In man, Penfield and Boldrey¹⁸ reported that "perspiration seems to have occurred once as a result of low precentral stimulation." Guttman¹⁹ described a case of Foerster's in which stimulation of the left precentral gyrus gave rise to muscular contraction of the right abdominal wall, and stimulation a little posterior to this, to sweating localized to the right abdominal wall.

This body of evidence, both clinical and experimental, seems to leave little doubt that the cerebral cortex exercises some control over sweating, just as it does over many other vegetative functions. Furthermore, all of the evidence seems to indicate that it is the motor areas, i. e., the sigmoid gyrus in the carnivora and the precentral region in primates, which are primarily concerned with sweating. There is, of course, nothing in the evidence presented here which would exclude other portions of the cortex from similar control. Neither is there any evidence indicating that any other portion of the cortex is likewise concerned with this function.

14. Schwartz, H. G.: Effect of Experimental Lesions of the Cortex on the "Psychogalvanic Reflex" in the Cat, *Arch. Neurol. & Psychiat.* **38**:308-320 (Aug.) 1937.

15. Langworthy, O. R., and Richter, C. P.: The Influence of Efferent Cerebral Pathways upon the Sympathetic Nervous System, *Brain* **53**:178-193, 1930.

16. Wang, G. H., and Lu, T. W.: Galvanic Skin Reflex Induced in the Cat by Stimulation of the Motor Area of the Cerebral Cortex, *Chinese J. Physiol.* **4**:303-326, 1930.

17. Spiegel, E. A., and Hunsicker, W. C., Jr.: The Conduction of Cortical Impulses to the Autonomic System, *J. Nerv. & Ment. Dis.* **83**:252-274, 1936.

18. Penfield, W. G., and Boldrey, E.: Somatic Motor and Sensory Representation in the Cerebral Cortex of Man as Studied by Electrical Stimulation, *Brain* **60**:389-443, 1937.

19. Guttman, I.: Die Schweisssekretion des Menschen in ihrer Beziehungen zum Nervensystem, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **135**:1-48, 1931.

SUMMARY

The case is described of a 54 year old woman with an oligodendroglioma in the postero-inferior part of the right frontal lobe, directly beneath the face area of the precentral gyrus. As a result of this tumor, she suffered from localized convulsive seizures, involving the left side of the face. Associated with these convulsive seizures were attacks of localized sweating, which were most pronounced on the left side of the face but to a less extent involved also the left arm and the left axilla. The limited literature on this subject is reviewed. From the available evidence, it is concluded that the precentral cortex exercises some control over sweating.