RECOVERY FROM THE DECEREBRATE STATE ASSOCIATED WITH SUPRATENTORIAL SPACE-TAKING LESIONS

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Extensor rigidity occurring in the course of various intracranial diseases has been described in many publications. The level of impaired neurological function responsible for the appearance of this phenomenon was demonstrated by the classical experiments of Sherrington and his co-workers, whose “decerebrate” animals duplicated almost exactly the extensor rigidity seen in man. Anatomical studies of some patients who prior to death displayed the features of “decerebrate rigidity” have revealed hemorrhages in the upper brain stem.

It was recognized early that the exhibition of the decerebrate attitude was of grave prognostic import, especially when it came in the course of supratentorial space-taking lesions—hemorrhage, abscess, or tumor. In fact, it has been and unfortunately continues to be, the opinion of many neurologists and some neurosurgeons in particular that the supervision of the decerebrate attitude mitigates against if not actually precludes the possibility of recovery regardless of therapy. It is the purpose of this report to present evidence indicating that prompt definitive surgery may be followed by survival and, in many instances, by complete recovery.

For the purpose of this discussion, the decerebrate attitude may be described as essentially one of extensor rigidity; the head is retracted, upper extremities are adducted and internally rotated, forearms extended and hyperpronated, and hands flexed. The fingers are usually flexed at the metacarpophalangeal joints but extended and adducted distally. Variations of the posture are observed, including flexion of forearm or alternation between the extended and the flexed positions. In that case, extension usually returns following strong mechanical stimulus. The lower extremities have always been found to be extended, adducted and internally rotated. The large toes may be rigid in the “chronic Babinski” position following stimulus. The tonic neck reflexes of Magnus and DeKleijn have been reported but we have not observed their presence in this series.

Usually, alterations in the vital functions occur concomitantly with the appearance of the abnormalities of muscle tone: the pulse gradually increases in rapidity, respirations usually become rapid and blowing and are frequently characterized by irregular periods of apnea. The blood pres-
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sure may be elevated and the body temperature frequently rises precipitously if unchecked.

Abnormalities of pupillary function with respect to size and reactivity to light, and paresis of one or more of the extraocular muscles not infrequently accompany the decerebrate attitude.

During the past 20 years, a large number of patients manifesting this clinical phenomenon have been observed. The 19 patients selected for this report were studied on the Neurosurgical Service of Dr. Jefferson Browder at the Kings County Hospital, Brooklyn, New York over a period of 3 years (1947-1950) and all were personally observed by the author. In all instances supratentorial lesions were present and recovery followed appropriate surgical therapy.

In 14 cases bilateral extensor rigidity was present and in the remainder there was involvement of one or both extremities on one side. The underlying conditions included 12 subdural hematomas, 2 temporal lobe tumors, 1 frontal lobe abscess, 3 epidural hematomas, and 1 instance of dissolution of a temporal lobe following contact trauma of the head. In each case, operative treatment consisted of evacuation of the mass.

The duration of the decerebrate state before operation varied from less than 1 hour in 7 cases to as long as 20 hours in 2 instances. In 2 cases, the patients were admitted to the hospital in the decerebrate state with external evidence of contact trauma of the head but additional histories could not be obtained. In most cases, improvement following surgery was continuous but in 2 instances, evidence of rigidity reappeared after varying intervals and again disappeared following further appropriate surgical measures.

In only 3 cases were the pupils thought to be normal in size and in their response to light. They were widely dilated, equal and without reaction to light in 7 cases, unequal and fixed to light in 5, unequal with the dilated pupil fixed to light in 2, and unequal but reactive to light in 1. In no instance were the pupils "pinpoint." In 1 case the state of the pupils was not recorded. In those instances wherein the pupils were unequal, the larger was ipsilateral to the intracranial lesion in 6 instances and on the opposite side in 1. In the eighth case the lesion was a huge bilateral frontal epidural hematoma.

Increased intracranial tension as evidenced by papilledema was observed in only 7 cases but that is not remarkable because most of the symptoms were of relatively short duration. It has been our policy not to disturb the cerebrospinal fluid dynamics where there is clinical evidence of dysfunction of midbrain structures and for that reason the cerebrospinal fluid pressure was measured in only 6 cases. In 4 of these the pressure was between 240 and 340 mm. water and in the other 2 it was 100 mm. water or less.

The degree of recovery varied between absence of any residual to severe and incapacitating defects requiring continued institutional confinement. Of those individuals having no demonstrable residual neurological disturbi-
ances, 3 had had extensor rigidity bilaterally and 2 had had unilateral involvement. The 2 patients with tumors recovered with no residual other than that resulting from the neoplasms and should be classed an excellent result. Mild residua, such as paresis of one or more extremities or persistent extraocular muscle dysfunction that did not interfere with rehabilitation, were present in 5 of those patients who had had bilateral rigidity and in 1 in whom the rigidity had been unilateral. One patient in this group had a residual of homonymous hemianopsia. The remaining 6 patients had such severe disturbances in motor function or intellectual capacity that rehabilitation was not possible or continual institutional confinement was required. Thus it may be considered that in 13 of the 19 patients of this series the outcome was reasonably satisfactory. It is of interest to note that there was no correlation between the duration of the decerebrate attitude prior to operation and the eventual outcome, and that both of the patients who had repeated periods of decerebration made satisfactory recoveries.

DISCUSSION

The presence of hemorrhages in the brain stem associated with supratentorial hemorrhage was reported in the pathological studies of Attwater\(^4\) and Greenacre\(^10\) before their clinical significance was appreciated. Shortly after the publication of Sherrington’s observations on the decerebrate state in animals, Wilson\(^29\) called attention to the parallel between the attitude seen in those animals and that accompanying certain diseases in man. In 1921, Jefferson\(^11\) reported 2 cases of epidural hematomas wherein bilateral extensor rigidity was observed prior to death. No gross alterations in the brain stems were found, and the conclusion was drawn that physiological interruption of brain-stem pathways had resulted from alteration in the circulation to their area. With this conclusion we are in agreement. Additional articles\(^6,26,27,28\) describing the decerebrate attitude in man appeared, and the presence of hemorrhage in the brain stem was demonstrated only in some of the cases.

There was much speculation as to the cause of the alteration in blood supply to the brain stem associated with supratentorial lesions. Adolf Meyer\(^14\) had called attention to the fact that supratentorial tumors were frequently associated with herniation of portions of the brain under the falx and through the tentorial incisura. He suggested\(^15\) the possibility that these herniations might play a part in the disturbed function of the brain stem. Vincent, David, and Thièbaut\(^25\) correlated the presence of herniation of the medial aspect of the temporal lobe through the incisura tentorii associated with supratentorial tumors, and the alterations in the brain stem formulating the syndrome of the early and late effects of this phenomenon. They also called attention to the fact that the removal of cerebrospinal fluid via the lumbar route may increase the degree of herniation and result in further damage to the midbrain structures. Since then, numerous contributions\(^1,2,5,8,12,16,19–21,24\) of both clinical and pathological natures have con-
firmed their observations. It now seems fairly well established that herniation of the medial aspect of the temporal lobe through the incisura tentorii (the so-called "temporal pressure cone") can produce alterations of the blood supply to the brain stem and result in the appearance of the decerebrate attitude.

The temporal pressure cone and its attendant features have been produced experimentally\(^\text{19}\) by increasing the intracranial tension with the aid of artificial masses in the epidural or subdural spaces over the cerebral hemispheres. The decerebrate state so produced was reversible if the pressure was relieved promptly. Some observers have expressed the opinion that a similar situation might occur in man. However, surgeons have hitherto seemed reluctant to undertake operative measures in the presence of decerebrate rigidity. We have been able to find only three previous reports in the literature in which there is mentioned the recovery of patients in whom extensor rigidity developed in the course of supratentorial space-taking lesions. Reid\(^\text{19}\) mentioned a patient who, after the introduction of air into the ventricles, became rigid, stopped breathing and had a fixed dilated pupil. Rapid recovery ensued after releasing the intraventricular pressure. Gallagher and Browder,\(^8\) in a review of a series of 100 cases of epidural hemorrhages, reported the presence of extensor rigidity in 38 of them. Of these patients, 30 showed evidence of bilateral involvement and in the other 8 the limbs only on one side were involved. Operative intervention in 19 of the former resulted in 4 recoveries, and 6 of the patients with unilateral decerebrate attitudes survived after removal of the hematomas. In a recent report of epidural hemorrhages in children, Campbell and Cohen\(^4\) mentioned the presence of decerebrate attitude in 4 patients who recovered following removal of the clots. Nelson\(^\text{18}\) discussed involvement of the brain stem in the presence of subdural hematoma with particular reference to disturbances in eye movements. Six cases were reported, and in 4 instances recovery followed evacuation of the hematomas. In no cases was the decerebrate attitude recorded, but the evidence of disturbance in function of midbrain and pontine structures seems clear. Although good results are not to be expected in all instances, there is sufficient indication, as shown in the few previous reports and our cases, that surgery should not be withheld even though there is evidence of impairment of function of midbrain and pontine structures.

As has been noted previously, only few observations relative to spinal fluid pressure or appearance were made in this series. The observations of Smyth and Henderson\(^\text{20}\) on simultaneous measurements of the ventricular and spinal fluid pressures showed that the pressure in the lumbar canal is not necessarily an index of intracranial pressure. The experiments of Dill and Isenhour\(^7\) demonstrated that it is the supratentorial hypertension as opposed to generalized increase in pressure along the cerebrospinal axis that is a factor in the production of pathological alterations in the brain stem. Others have pointed out that withdrawal of spinal fluid may increase the difference in pressures between the supra- and infratentorial spaces and
further impair the circulation of the midbrain and pons. It is believed that little additional information of diagnostic importance is to be gained by spinal puncture in the presence of the decerebrate attitude and that further harm could ensue from this procedure.

Inequality of the pupils and disturbances in their reactivity to light was observed in most of our patients. In many, paresis of one or more extraocular muscles was also noted. However, it was not possible, from these studies, to determine whether alterations in function resulted from disturbance along the course of the 3rd and 6th cranial nerves or at their nuclei of origin. One patient had a residual of visual field defect which could not be attributed to involvement of the optic radiation by tumor or direct injury to the temporal lobe. It seems likely that this could be the result of infarction of the calcarine cortex, as demonstrated first by Adolf Meyer. This phenomenon has since been discussed and demonstrated in pathological specimens by a number of observers. Malthy has reported the appearance of visual field disturbances in the course of subdural hematoma with subsequent recovery after evacuation of the subdural collections.

Three methods of treatment have been suggested for the relief of the effect of the temporal pressure cone on the midbrain. Foremost among these is the prompt evacuation of the offending mass by a suitable surgical procedure. This was carried out in 18 of our cases. In 8, liquid subdural collections were evacuated through simple trephine openings and in the case of the abscess, 60 cc. of pus were aspirated through a ventricular cannula. In the remaining 9 cases, osteoplastic craniotomies were made and the hematomas or tumors removed under direct vision. A second procedure was first suggested by Vincent, et al. who mentioned the possibility of amputating the swollen temporal lobe, the medial aspect of which had herniated through the tentorial incisura. In effect, this was carried out in 1 patient of this series who suffered a contusion and dissolution of a temporal lobe as a result of trauma. In this instance, as a procedure of desperation, the pulpiified temporal lobe was aspirated and irrigated out through two ventricular cannulas. In retrospect, it would probably have been a more sound surgical procedure if an open craniotomy had been done and the temporal lobectomy performed under direct vision. It seems to us that this procedure holds some possibility of effecting improvement in certain instances of severe cerebral trauma providing the affected side can be identified prior to the operation.

The third procedure that has been suggested is that of relieving the constricting ring formed by the free edge of the tentorium by sectioning that structure directly. Munro and Sisson have recently reported the survival of some patients with severe cerebral trauma following this procedure. They believe that this not only provided relief of the direct compression of the midbrain by the edge of the tentorium, but also released cerebrospinal fluid dammed up under pressure in the subtentorial space. We have sectioned the tentorium in instances of severe cerebral trauma wherein signs of decerebrate attitude were present without benefit.
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It should be emphasized that any sign indicative of midbrain dysfunction should be a signal for immediate definitive surgery. One cannot foretell when the alterations in the midbrain structures will become irreversible and in delay the opportunity for obtaining benefit from operative intervention may be lost.

SUMMARY AND CONCLUSION

1. It seems well established that the decerebrate state associated with supratentorial space-taking lesions is a result of impairment of circulation in the brain stem secondary to herniation of the medial aspect of the temporal lobe through the incisura tentorii (the temporal pressure cone).

2. Nineteen cases are reported wherein recovery from the decerebrate state followed appropriate surgical procedures.

3. It is emphasized that any sign indicative of midbrain dysfunction occurring during the course of supratentorial space-taking lesions should be a signal for immediate definitive surgery.

REFERENCES


