## Appendicular Tremor as a Late Complication of Intracerebral Hemorrhage

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Schlitt M, Brown JW, Zeiger HE, Galbraith JG. Appendicular tremor as a late complication of intracerebral hemorrhage. Surg Neurol 1986;25:181-4.

A 23-year-old woman without demonstrable risk factors for cerebral hemorrhage was admitted after the acute onset of hemiparesis of the left side. A computed tomography scan showed a small right thalamic hemorrhage. Cerebral angiography was normal, and she was managed conservatively. Three months after the original ictus the patient developed severe tremor on the left side. Angiography again revealed no abnormalities and the tremor was successfully treated with a stereotaxic thalamic lesion superimposed on the area of the hemorrhage. The patient's disease, its treatment, and the current knowledge of the anatomy and physiology of movement disorders are reviewed.

KEY WORDS: Resting and intention tremor; Intracerebral hemorrhage; Stereotaxy

Movement disorders occur in basal-ganglia, cerebellar, and cerebrovascular disease, as well as being sequelae of trauma. Cerebrovascular disease results in movement disorders by causing stroke syndromes, most of which are thrombotic or ischemic. As only 10% of stroke syndromes are due to hemorrhage [5], movement disorders after such events are unusual. The following report details the course of a young woman without known risk factors for intracerebral hemorrhage, who suffered a hemorrhagic stroke and subsequently developed a severe resting and intention tremor in the extremities contralateral to the brain lesion. A stereotaxic lesion placed in the same location as the hemorrhage successfully controlled the patient's movement disorder. The cause of the patient's tremor is postulated, and current knowledge of the anatomy and physiology of movement disorders is reviewed.

## Case Report

A 23-year-old, right-handed woman suffered the rapid onset of weakness and numbness of the left side of her body. Upon transfer to a nearby hospital, a computed tomography (CT) scan was performed (Figure 1). The study disclosed a small high-density lesion believed to represent a hemorrhage in the right thalamus. The patient was transferred to the University of Alabama at Birmingham.

A review of the medical history failed to reveal blood dyscrasias, use of oral contraceptives or drugs, or hypertension. Examination revealed a moderately dense hemiparesis of the left side, more severe in the arm than in the leg, a mild to moderate upper-motor-neuron facial weakness on the left side, and diminution of pinprick sensation over the left side of the face and body. The tendon reflexes were diminished throughout the left side, and there was no response to plantar stimulation on the left. Although oriented in all respects when aroused, the patient was lethargic. The general physical examination disclosed a blood pressure of 110/70. There were no thoracic, cervical, or cranial murmurs. No peripheral evidence for bacterial endocarditis could be found. Elective intubation was carried out and the patient was admitted. Spinal fluid examination was not performed.

By the next morning the patient's obtundation had cleared, and extubation was accomplished. An angiogram on the seventh hospital day was normal. Throughout the hospitalization the patient's blood pressure never exceeded 120/90. A moderately dense left hemiparesis persisted, and the patient was discharged in the care of her mother on the twelfth hospital day.

Four months after the original ictus, the patient returned for a follow-up visit, and reported the onset 1 month earlier of "shaking" in her left arm and to a lesser degree, in her left leg. Examination revealed a mild hemiparesis of the left side. Hyperactive reflexes were present throughout the left side. The plantar response was extensor, and the tone on the left side was slightly increased relative to that of the right. Her left arm was constantly affected at rest by a moderate-amplitude tremor

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Figure 1. CT scan performed after the onset of hemiparesis.

(3 cycles per second) involving the forearm, hand, and wrist. Volitional action produced a coarse-amplitude tremor (3-5 cycles per second) involving the shoulder, arm, and forearm. The patient was readmitted.

A repeat CT scan was interpreted as normal, as was a second angiogram. Evaluation for possible bacterial endocarditis was unproductive, although mitral valve prolapse was found on echocardiography. Neurologic consultation was obtained; medications were not recommended and therefore, plans were made for a cryothalamotomy.

The stereotaxic procedure was performed under local anesthesia. Ventriculography revealed an intercommissural distance of 25 mm. Utilizing the Todd-Wells stereotaxic device (Codman and Shurtleff, Boston, Massachusetts), the target was placed 17 mm posterior to the anterior commissure, 1 mm below the anteriorposterior intercommissural line, and 13.5 mm to the right of the midline. The tip of a Cooper cryoprobe (Frigitronics, Shelton, Connecticut) was placed on this target through a precoronal burr hole, and a 4-minute cryolesion was induced. The procedure was terminated when a mild drift of the outstretched left arm was noted. The subsequent examinations in the hospital revealed an 80% reduction of the action tremor and an almost complete abolition of the resting tremor. Another CT scan (Figure 2) showed the location of the cryolesion.

The patient was last seen 23 months after the original ictus. She noted that she occasionally suffered episodes of tremor lasting 30 minutes. The hemiparesis had become more hypertonic, though the strength on the left



Figure 2. CT scan performed after cryothalamotomy.

was essentially unchanged. There was no tremor at rest and only a slight action tremor. The patient's major complaint at that time was "stiffness" of the left hand, which tended to be flexed at the wrist and hyperextended at the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints. A minimal upper-motor-neuron facial palsy on the left side persisted, as did minimal diminution of pinprick sensation throughout the left side.

## Discussion

Movement disorders occurring as a result of vascular disease are most frequent in the elderly, and generally occur in association with arterial hypertension [15]. These movement disorders can be choreiform or ballistic, and in some instances have responded to drug therapy. Lesions in the subthalamic nucleus and in the dorsomedian nucleus of the thalamus have been found in two patients at autopsy. Tremors similar to those reported here have been described after trauma [2]. The lesions producing these dyskinesias were generally in the midbrain. One patient with a low attenuation lesion in the parietal white matter, thought to be due to an embolus from a carotid dissection, had a tremor of similar type [3]. The reported case is the first in which a hemorrhagic lesion producing tremor has been shown by CT scan to be in the thalamus. A lesion in this location would bridge the anatomical gap between previously reported lesions, lending strength to the concept of a "tremor axis" extending from the cerebellum to the red nucleus, to the ventral lateral thalamus, and from there to the white matter of the parietal lobe.

The method described here has been used success-

fully at the University of Alabama at Birmingham over the last 20 years for control of tremor due to parkinsonism, cerebellar disease, and trauma. The procedure is performed under local anesthesia, and both the ventriculography required for localization and the probe placement utilized for lesioning are accomplished through a single precoronal burr hole. A cryogenic lesion placed in virtually the identical location as the original hemorrhagic lesion successfully controlled the patient's dyskinesia.

Reports of movement disorders in association with thalamic lesions are not new [8,10,12]. In fact, the patient in this case manifests an incomplete "syndrome thalamique," which in its fully developed state consists of loss of sensation; hemiataxy; astereognosis; hemiparesis; abnormal movements; and paroxysmal, often intolerable, pain contralateral to the lesion. It is fortunate that she has been spared the intractable pain.

The tremor that resulted from the patient's vascular accident was the consequence of a disturbance in the complex circuitry of the pyramidal and extrapyramidal systems. Such a thalamic lesion could perturb this circuitry by one of several suggested mechanisms. The first of these is that the healing hemorrhage could have become an irritative focus in the nucleus ventralis lateralis-nucleus ventralis anterior (VL-VA) complex, exaggerating its normal excitatory discharge to the motor cortex [2,22] (Figure 3, A). This suggested mechanism is supported by the report of similar tremors after trauma in which recorded potentials from the nucleus ventralis lateralis were synchronous with the tremor [2]. Another possibility is that the lesion may have disrupted the pallidal GABAergic discharge to the VL–VA complex [9,21,22] via the thalamic fasciculus or related fiber tracts [6,7] (Figure 3, B). This disruption could have occurred in the area where the pallidal efferents, crossing through the internal capsule, enter the ventromedial region of the thalamus [7,14], as the residual mild hemiparesis would indicate some involvement of the internal capsule in the lesion. This loss or reduction of the normal GABAergic inhibitor influence would result in an overactivity of the discharge of VL–VA to the motor cortex [22], and hence the resulting tremor.

Another possibility is based on the fact that the original thalamic lesions appears to be located in the more posterior part of the thalamus, where the intralaminar thalamic nuclei or their efferent fibers to the striatum could be included in a small residual lesion (Figure 3, C). The intralaminar nuclei, by their thalamostriate efferents [4,16,20,23], are known to provide a nonspecific multisensory input to the neostriatum [18], which converges on inputs from the cortex (including the sensory cortex [11]) and the substantia nigra [17]. The resultant normal integrative activity of these and other inputs in the striatum is essential for the variously described role it plays in motor behavior [18,19,22] through its normal discharge to the globus pallidus, and hence its normal discharge to VL-VA. Thus, the loss of the intralaminar thalamic input to the striatum would result in a perturbation of the striatal integration and, in turn, its abnormal discharge via the globus pallidus to VL-VA with the resultant overactivity of the cortical-VL-VA-cor-



Figure 3. Schematic diagram of circuits involved. <u>A</u>, <u>B</u>, and <u>C</u> indicate possible location of lesions giving rise to tremor. Abbreviations used: <u>GABA</u>, y-aminobutyric acid; <u>MGP</u>, medial globus pallidus; <u>SNr</u>, substantia nigra pars reticulata; <u>SNc</u>, substantia nigra pars compacta; <u>VAIVL</u>, ventral anterior and ventral lateral nuclei of the thalamus; <u>LGP</u>, lateral globus pallidus; <u>STN</u>, subthalamic nucleus; <u>LH</u>, lateral babenula; <u>NTPP</u>, nucleus tegmenti pedunculopontinus; <u>SC</u>, superior colliculus; <u>LC</u>, locus coeruleus; <u>R</u>, raphe. Reproduced with permission from reference 22. Copyright 1983 by Annual Reviews Inc.

tical loop [13,22] and the subsequent tremor. The report of Adams and Malamud [1], which suggested that degeneration of the centromedian intralaminar nucleus was the cause of choreiform movements exhibited by their patient, lends support to this hypothesis for tremor production.

In any of the postulated sites for the lesion, the resultant perturbed discharge of VL–VA to the cortex appears to be the offending element in tremor production in this case. The ablative cryogenic lesions placed in the nucleus ventralis lateralis alleviated the tremor by removing or at least reducing this perturbation (Figure 3).

Spontaneous intracerebral hemorrhages are often devastating events; such episodes are usually associated with arterial hypertension. In the absence of elevated blood pressure other possible causes of intracerebral hemorrhage should be diligently sought. Movement disorders can occasionally be late complications of intracranial hemorrhage or traumatic events. In patients who have otherwise made a good recovery from a cerebrovascular accident or trauma, surgical interruption of the abnormal circuits at the level of the thalamus remains an effective manner by which to control tremor not amenable to medical therapy.

We extend our thanks and acknowledgments to Drs. Penney and Young and to *Annual Reviews in Neuroscience* for their assistance in preparation of this manuscript.

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