Example of Evoked Potential Monitoring for a Neurogenic Tumor Positioned High in the Mediastinum

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Excision of a neurogenic tumor of the brachial plexus positioned high in the mediastinal space could potentially result in a functional disorder of the arm. We report on a case in which we performed evoked potential monitoring on a tumor located high in the mediastinum. We found large potential changes in the median and ulnar nerve areas and had a concern that the excision might injure the brachial plexus. We did a biopsy and intraoperative rapid histological diagnosis, which promptly revealed that the tumor was not malignant. Thus, we decided not to excise the tumor because the procedure could possibly injure nerves in the arm.

Key words: evoked potential monitoring, neurogenic mediastinal tumor, brachial plexus

Introduction

Mediastinal neurogenic tumors are often encountered by surgeons of thoracic medicine. In most cases, the tumor is benign and resection is standard therapy; however, for a tumor positioned high in the mediastinum, a resection might injure the brachial plexus. We present a case of a patient with a neurogenic tumor high in the mediastinum and adjacent to the brachial plexus, in which we used evoked potential monitoring during surgery.

Case Report

A 62-year-old man had a chest X-ray (Fig. 1) that revealed an abnormal shadow, high in the mediastinum. Chest computed tomographic (CT) scan confirmed the diagnosis of mediastinal tumor. For surgical treatment, the patient was referred to Hakodate Municipal Hospital, Japan. We found no subjective symptoms that were related to the mass. Magnetic resonance imaging (MRI) showed that the mass was adjacent to the right brachial plexus (Fig. 2); therefore, we suspected that the tumor originated from the nerve plexus. The operative strategy was to perform evoked potential monitoring to identify areas without neural activity to prevent injury to the patient during the surgery, take a biopsy, perform intraoperative rapid histological diagnosis, and resect the tumor. Before the operation, we explained to the patient and his family that we would not resect the tumor if it were benign because a resection could possibly damage motor and sensory nerves of the right arm.

We used a video assisted thoracic surgery (VATS) procedure, and administered anesthesia under separated tracheal intubation using epidural anesthesia without a muscle relaxant. Before the operation and in preparation...
for the evoked potential monitoring (Neuropack Σ; Nihon Kohden Tokyo, Japan), we inserted needles into areas of the radial, median, and ulnar nerves on the right palm (Fig. 3). For the VATS, we inserted two trocars into the fourth intercostal space and made a 3-cm incision in the third intercostal space. Observation with a scope revealed a mass of about 2 cm in diameter, located below the pleura parietals at a high position in the mediastinal space. There was a chorda at the surface of the tumor. We placed the probe of the evoked potential device on the surface of the tumor through the pleura (Fig. 4) and applied a 0.6-mA stimulation. At that time, the right arm twitched, and the electrography monitor (Fig. 5) showed large potential changes in the median and ulnar nerve areas. The response at the surface of the chorda was strongest, suggesting that the chorda was the nerve fiber itself. To prevent damage to the nerve during needle biopsy of the tumor, we avoided the chorda because it had reacted strongly to the evoked potential, and instead we selected the paracentesis area because it did not react to the evoked potential. Intraoperative rapid histological diagnosis promptly revealed that the tumor was not malignant. Even if the tumor were carefully resected, we still would have had concerns about injuring the nerve, resulting in functional disorder of the right arm. Since the tumor was benign, we only performed the biopsy. The final pathological diagnosis of the tumor was a neurilemoma. Over 3 years have passed since the tumor was found, and CT shows no change in size and shape of the tumor. We will follow up the patient at regular intervals.

Discussion

The treatment of first choice for neurogenic mediastinal tumors is, as a rule, resection. Most thoracic surgeons will select resection as the standard response. On the other hand, it was reported that the weakness increased in 30.4% of operated patients when tumors originating from the brachial plexus were completely excised via the cranial or frontal approach. Moreover, the author has had experience dyskinesia of the right first finger in a patient following resection of a neurogenic tumor located high in the right mediastinum, similar to the present case. Therefore, care is required when excising tumors located high in the mediastinal space. A technique that used
Evoked potential was introduced. There is no objection to a complete resection if a neurogenic tumor high in the mediastinal space is malignant. On the other hand, consideration is necessary in benign cases without subjective symptoms. It is thought that excision should not be performed if neurological disorders might be the result, and motor and sensory functions are damaged, for example, plexus brachialis damage and Horner syndrome. There is a possibility of surgery causing a neurological disorder even if a nerve is not severed. Conversely, if the possibility of any surgery-related neurological disorder is low, it is necessary to excise such tumors. Scans of CT and MRI imaging indicating malignancy of a tumor and its relation to the brachial plexus are vital because they help us determine the preoperative excision adjustment. In addition, the ability to ascertain any physical relationship between the tumor and relevant nerves using an electrophysiological approach would surely be useful when making the judgment on whether to excise the tumor or not, and that is the approach we adopted in the present case.

There are no reports on techniques where evoked potential stimulation has been added to the procedure, and the decision whether or not to excise a tumor located high in the mediastinum was based on the results of the stimulation tests during the surgery. However, the method of using electrically conducted impulses during the excision of an auditory nerve or a spinal cord tumor is reported to be useful.2, 3) Evoked potentials are used to avoid facial nerve damage when auditory nerve tumors are excised, and preliminary strategies for use of this technique have been established. The technique applied in this area first involved stimulation at 0.6 mA. During the operation on an auditory nerve tumor, the stimulation strength is made in the range of 0.2–3.0 mA, and the stimulation strength of 0.6 mA that we had used was low in comparison to this range. It seems possible that, if a tumor has risen from the brachial plexus, a clear change to the evoked potential monitor would be caused by stimulation strength such as 0.6 mA. Therefore, there is a possibility of causing postoperative nerve damage even if a careful flaking-off operation is performed, and it is necessary to refrain from excision if the tumor is benign. On the other hand, if there is a weak response from a strong stimulation, the tumor might not have originated from nerves of the brachial plexus. In such a case, the tumor should be excised because the possibility of nerve damage is thought to be low. There is to date no standard stating whether it is necessary to refrain from excision regarding stimulation strength and reaction. It is entrusted to the operator's judgment whether finally to excise. If similar cases can be collected in the future, it might be possible to establish a general standard.

If it is doubted that a tumor had originated from the brachial plexus, it might be best to approach the operation from the neck. However, the low invasive VATS approach via the thoracic cavity was adopted in the present study. Because most of the tumor projected into the thoracic cavity and was thought to be benign, the operation ended with only the biopsy.
Though most neurogenic tumors in adults are benign, it is best to confirm that, by performing a biopsy by thoracoscopy. Because the diagnosis can be made based on the removal of only a small amount of tissue, a needle biopsy is usually sufficient. However, it is necessary to take care even with this procedure due to the possibility for the needle biopsy to damage the plexus brachialis. To avoid nerve damage, we performed the needle biopsy by avoiding the area on the tumor that had elicited a large evoked potential during the stimulation. Follow-up might be necessary in those cases where the tumor is not excised because there are a few reports where a benign neurogenic tumor has become malignant postoperatively. It is possible to assess malignant change with CT imaging. In such a case, excision of the tumor should be considered. Besides, when the tumor size increases in a short period or the shape changes markedly, it is also necessary to consider excision.

A neurogenic tumor in the mediastinal space can be almost completely excised with VATS. A tumor high in the mediastinal space may also be excised with VATS. However, it is important to note the position brachial plexus and the sympathetic nerves. If a flaking-off operation with an adequate operative field cannot be carried out to avoid nerve damage, it may be necessary to perform an open chest operation rather than an excision under a thoracoscope.

The usefulness of the use of the evoked potential in the present case is as follows. The relationship between the tumor and plexus brachialis can be assessed based on the reaction of the evoked potential. As a result, the operative approach to the tumor can be appropriately selected, namely complete resection, partial resection or biopsy, the risk of nerve damage can be decreased, and it can contribute to avoiding postoperative dysfunction of an arm.

References