Microsurgery for Acoustic Neurinoma
—Lateral Position and Preservation of Facial and Cochlear Nerves

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Summary
Twenty two cases of acoustic neurinoma were operated upon in the lateral position under an operating microscope during the past three years. Anatomical and physiological preservation of the facial nerve was successfully achieved in 19 cases. Electrical stimulation of the facial nerve using bipolar forceps proved to be very useful. Sound monitoring with tremorgraphy pick-ups on the face was designed for observation of facial movement driven by nerve stimulation. Hearing acuity could be preserved postoperatively in three large sized neurinomas with the aid of direct recording of action potentials on the cochlear nerve during surgery. Advantages of the lateral position and some instrumental improvements for surgery are discussed.

Key words: Acoustic neurinoma, facial nerve, cochlear nerve, action potentials, nerve stimulation, operating position, microsurgical instrument

Recently operative results of acoustic neurinoma have improved immensely with the aid of the operating microscope. During the past 3 years we operated on 22 cases of acoustic neurinoma in the lateral position. This paper reports the operating position, preservation of the facial and cochlear nerves and some improvements of surgical instruments for acoustic neurinoma.

Clinical Materials
Twenty two cases of acoustic neurinoma were operated on at Nagoya University Hospital or its affiliated hospitals by the first author. The ages of the patients ranged from 16 to 68 years and there were 13 females and 9 males. The sizes of the tumors were 4 cm or larger in diameter in 20 cases, i.e. 91% of the total cases. Papilledema was observed in 13 cases (59%) and hydrocephalus was found in 17 cases (77%) by PEG or CT scan. Preoperative neurological findings were ataxia in 11 cases, facial hypesthesia in 14 cases, facial weakness in 12 cases and hearing disturbance on the tumor side in all of the 22 cases.

Operative Procedure
All 22 cases were operated on in the lateral position under the operating microscope. Anesthesia was carried out by GOF inhalation under spontaneous respiration. The operation was performed with a lateral suboccipital approach. Special attention was paid to preservation of blood vessels, cranial nerves, and prevention of injury to the pons and the medulla oblongata.

Preservation of the Facial Nerve
For stimulation of the facial nerve we used the
conventional bipolar coagulating forceps which are electrically insulated except for 1 mm at the tips. The forceps were not connected to a high frequency coagulating generator but to an ordinary electronic stimulator. The stimulation was routinely 1 to 3 volts of 1 msec duration and the frequency was 2 to 4 Hz. After intracapsular decompression, electric response was examined by touching the tumor capsule with the bipolar coagulating forceps connected to the stimulator. Thus, location of the facial nerve was roughly detected on either the oral, ventral or caudal part of the tumor. During the procedure of décollement of the facial nerve from the tumor, the bipolar forceps were used for both purposes of décollement and stimulation of the facial nerve under continuous application of stimulating current. On the other hand, the surgeon could listen to the response of facial nerve stimulation as sound noise from our newly-designed sound monitor for muscle movements. The monitor consisted of a speaker, an amplifier and a pair of pick-ups for tremorgraphy which converted fine mechanical movements of the facial muscle into electric current. The pick-ups were attached to the upper eyelid over the orbicularis oculi muscle and the upper mouth lip over the orbicularis oris muscle on the operating side. In this way the surgeon could continue to operate for any number of hours without the need for another person to observe facial movements of the patient (Fig. 4).

Preservation of the Cochlear Nerve

Electro-cochleograms\(^1,8,10,11\) were obtained in 16 cases before surgery. Recording of the action potentials during surgery was performed in patients whose preoperative electrocochleogram showed positive electric activity in spite of deafness. The action potentials were driven by tone pips (1-8 KHz) from a speaker placed 1 to 3 meters from the ear. By recording with a silver ball electrode the amplitude of the action potentials decreased to about one half when the electrode was moved 8 mm off the cochlear nerve. Contrarily, using a sharp silver needle electrode the amplitude of the potentials disappeared abruptly by shifting the electrode 2 mm from the nerve. Recording of the potentials was successful in 6 out of 9 cases examined during surgery. In 3 out of these 6 cases, postoperative preservation of hearing was proved on audiograms.

Improvement of Surgical Instruments for Acoustic Neurinoma

The multipurpose fixation head frame, which had been previously reported by the authors,\(^9\) was applied with the patients in the lateral position. The self-retaining brain retractors could be safely fixed in the exact position with the aid of this frame (Figs. 1, 2). The most helpful aspect of the frame for surgery of acoustic neurinoma was the application of a four-pronged hook held by a self-retaining retractor fastened to the frame. The four-pronged hook caught the medial surface of the tumor and retracted the tumor in the dorsolateral direction to make it easier to obtain enough space between the tumor and the pons. The hook could be used just like a third hand of the surgeon (Fig. 3).

Operative Results

Complete removal of the tumor was performed in 17 cases. In 3 other cases, only a small percentage of tumor mass was left around the facial nerve. In two cases, more than 10% of the tumor mass was left. Postoperative complications were temporary facial palsy in 18 cases, temporary abducens nerve palsy in 7 cases, CSF rhinorrhea in one case and mild intermittent fever in 12 cases. No serious complications were experienced and 20 patients returned to their former jobs. One patient
returned to the hospital for the treatment of hydrocephalus. Another patient died 16 months postoperatively and autopsy revealed a large infarction in the pons around the remaining tumor. The facial nerve was anatomically and physiologically preserved and recovered its function in 19 out of 22 cases (86%). The facial nerve was sacrificed in 3 cases due to technical difficulty or by error at the beginning of the series. Concerning postoperative improvement or maintenance of hearing acuity, audiogram showed 3 successful cases in which the size of the tumors was 35, 40 and 45 mm, respectively. Improvement of hearing disturbance on the non-affected side was observed in 3 cases.

**Discussion**

Advantages of the sitting position for surgery of acoustic neurinomas have been frequently reported by various authors\(^3,^5,^7,^12\) over the years. The merits of the lateral position have also been discussed by Mount\(^6\) and Grunnert.\(^4\) The lateral position is suitable in cases of
increased intracranial pressure with advanced hydrocephalus, especially when an experienced neuroanesthesiologist is not available. In the lateral position normal intracranial pressure is easily maintained under spontaneous respiration and air embolization never occurs. Another advantage of the lateral position is the fact that less or no retraction of the cerebellum is necessary because the cerebellum sinks away by its own gravity and consequently less damage is done to the cerebellar cortex. There is less physical fatigue on the part of the surgeon in this position than in the sitting position because his hand can be held horizontally under the ordinary perpendicular axis of an operating microscope. Perhaps the only disadvantage of the lateral position is pooling of blood and CSF at the bottom of the operating field.

Use of the bipolar coagulating forceps for stimulation of the facial nerve is advantageous as most neurosurgeons are well accustomed to use them and both stimulation and décollement can be done without exchanging instruments. Electric insulation of the forceps is absolutely essential for this purpose because the stimulating current should be applied near the threshold to avoid current spread. If conventional uninsulated forceps are used, the stimulating current escapes when mistakenly touching the proximal part of the forceps with the surrounding tissue outside the microscopic field. When only conventional forceps are available, silastic tubing or a piece of self-adhesive plastic drape can be applied for insulation. The procedures of both stimulation and décollement can be carried out continuously for hours in this way. Thus the sound monitor of the facial movements is useful because the surgeon can detect the location of the facial nerve by listening to the sound without asking the anesthesiologist to watch the patient’s face under the drape. In our experiences, stimulation of the proximal part of the facial nerve elicits a weaker response than that of its distal part near the internal auditory meatus. Search for the intracanalicular part of the facial nerve in the first place is occasionally easier not only from an anatomical but also from a physiological point of view when discovery of the facial nerve is difficult. As documented by Erickson et al., 2) recovery of postoperative facial nerve paresis was experienced within one year in almost all cases in which the nerve was anatomically preserved.

Postoperative preservation of hearing acuity was confirmed in 3 cases by audiograms. In all these cases the onset of hearing disturbance began within one year before surgery. Though postoperative improvement of hearing was not often experienced in cases with large tumors in our series, further refinement of our surgical technique in the future should make this possible. In order to detect the location of the cochlear nerve and preserve it, we recorded action potentials from the cochlear nerve in the operating field. As far as the authors know, this is the first report in the literature in which action potentials of the human cochlear nerve have been successfully recorded. In this way, the cochlear nerve can be discriminated from the nerve bundle of intermedius, facial and vestibular nerves and, moreover, residual physiological function of the nerve can be detected.

References

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