Four-Hand Suction-Irrigation Technique Leads to Gross Total Resection and Long-Term Progression-Free Survival in Fourth Ventricular Ependymoma

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■ BACKGROUND: **Gross total resection is often avoided in posterior fossa ependymoma surgery because of the fear of permanent neurologic deficits after operation. However, the extent of resection is a major prognostic factor for progression-free and overall survival. This study evaluates the outcome of posterior fossa ependymoma gross total resection in adult patients using a 4-hand suction-irrigation technique at the floor of the fourth ventricle.**

■ METHODS: **All surgical procedures for posterior fossa ependymomas performed since 2001 in the Department of Neurosurgery, University Medicine Greifswald were analyzed.**

■ RESULTS: **Eight patients (2 women and 6 men; mean age, 41.9 years; range, 29–56 years) underwent surgery for posterior fossa ependymoma. All tumors were World Health Organization grade II. Tumor adherence was found to be in the caudal rhomboid fossa (between the obex and striae medullare, but below the facial colliculus) in all patients. The 4-hand suction-irrigation technique led to gross total resection in all patients (100%), without significant permanent neurologic deficits after surgery. None of the patients got further treatment (chemotherapy, radiation therapy, or second surgery). In none of these patients, tumor recurrence was seen on magnetic resonance imaging after a mean follow-up of 102 months (range, 14–181 months).**

■ CONCLUSIONS: **Long-term progression-free survival in adult patients suffering from posterior fossa ependymoma is possible by gross total resection without adjuvant radio- or chemotherapy. By careful bimanual microsurgical dissection using the 4-hand suction-irrigation technique and avoidance of bipolar coagulation on the floor of the fourth ventricle, the risk for permanent neurologic deficits is low.**

INTRODUCTION

Ependymoma is a rare entity and accounts for approximately 2% of all intracranial tumors.[1,2] It frequently arises in the posterior fossa,[1-3] which is the typical location for pediatric ependymomas, but is described for adults and elderly patients as well.[4,5] Because of their adherence to the floor of the fourth ventricle, posterior fossa ependymomas present a major challenge to neurosurgeons.[6] Gross total resection (GTR) is often avoided because of the fear of permanent neurologic deficits after surgery,[4,7-9] but the extent of resection is a major prognostic factor for progression-free and overall survival.[6,10] The adherence of the tumor to the floor of the fourth ventricle is the most critical part during resection. However, accurate descriptions of the best microsurgical technique in this region are lacking in the literature.

We had the impression that a high GTR rate is possible without significant permanent morbidity using the 4-hand suction-irrigation technique at the side of tumor adherence and that long-term progression-free survival is feasible without adjuvant radiotherapy. Therefore, we analyzed our data of all adult patients who underwent surgery for posterior fossa ependymomas.

MATERIALS AND METHODS

All surgical procedures for posterior fossa ependymomas performed since 2001 in the Department of Neurosurgery, University

Key words
- Four-hand suction-irrigation technique
- Gross total resection
- Long-term follow-up
- Posterior fossa ependymoma

Abbreviations and Acronyms
CPA: Cerebellopontine angle
GTR: Gross total resection
MRI: Magnetic resonance imaging

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Medicine Greifswald were analyzed. Subependymomas were excluded because they represent a different entity with a different neurobiologic behavior.[11] Special attention was paid to the intraoperative extent of resection and the magnetic resonance morphologic and clinical long-term follow-up. All magnetic resonance images were independently assessed by a neuroradiologist (S. L.). In addition, tumor grading, tumor extension, anatomic site of tumor origin, and complications were analyzed. The 4-hand suction-irrigation technique for tumor dissection at the floor of the fourth ventricle is described. The study was approved by the local ethics board.

Video

Video available at WORLDNEUROSURGERY.org

Surgical Technique

After induction of general anesthesia, neuromonitoring (cranial nerves VII, VIII, IX, X, and XII) was applied. Patient positioning depended on the tumor extension, but was usually in prone position with a 3-pin fixation. Because a major tumor part extended laterally in the cerebellopontine angle (CPA) in patient 7, lateral positioning was used. After a midline skin incision (except in patient 7), a suboccipital craniotomy was performed. Cottonoids were placed in the foramen magnum after opening of the dura to reduce the risk of spinal seeding. All tumors were resected by the telovelar approach, except in patient 7.

At first the tumor border to the cerebellar tissue was identified. The posterior inferior cerebellar artery and its branches were exposed. Then, debulking of the tumor with the aid of ultrasonic aspiration was performed. Finally, the tumor was dissected from the floor of the fourth ventricle. Before resecting the tumor from the floor of the rhomboid fossa, the floor was mapped to identify the nuclei of the cranial nerves and the facial colliculus with the aid of neurostimulation. Dissection of the tumor from the rhomboid fossa was done with 2 forceps according to the traction-countertraction principle, which per se is well known as the neurosurgical technique, but not described in the context of the resection of the adherent part in fourth ventricular ependymoma: with the tumor forceps the tumor was lifted and with the sharp-pointed anatomic forceps the tumor was dissected from the floor staying exactly at the tumor margin (**Figure 1A** and **Video 1**). When the tumor was very sticky, the branches of the anatomic forceps were carefully spread to find the dissection plane (**Figure 1B** and **Video 1**). The dissection was performed under continuous irrigation with saline to keep the dissection plane clear even when some bleeding from the tumor occurred. The assistant was irrigating with one hand and holding the suction with the other hand (4-hand suction-irrigation technique).[12] For these microsurgical dissections we use Fehling Instruments (Karlstein, Germany). Bipolar coagulation was strictly avoided at the floor. Hemostasis was achieved by irrigation and oxidized cellulose (Surgicel [Ethicon, Neuchatel, Switzerland]). Tumor extension into the lateral recess (foramen of Luschka) or even into the CPA was resected using the same technique. The lower cranial nerves on the right side were encased by the ependymoma in patient 7, but could be kept intact both anatomically and functionally. After meticulous hemostasis had been achieved, the dura was closed in a watertight fashion, and the bone flap was replaced and fixed with mini-plates. Then, the wound was closed in layers. After surgery, the patients were observed for 24 hours in the intensive care unit.

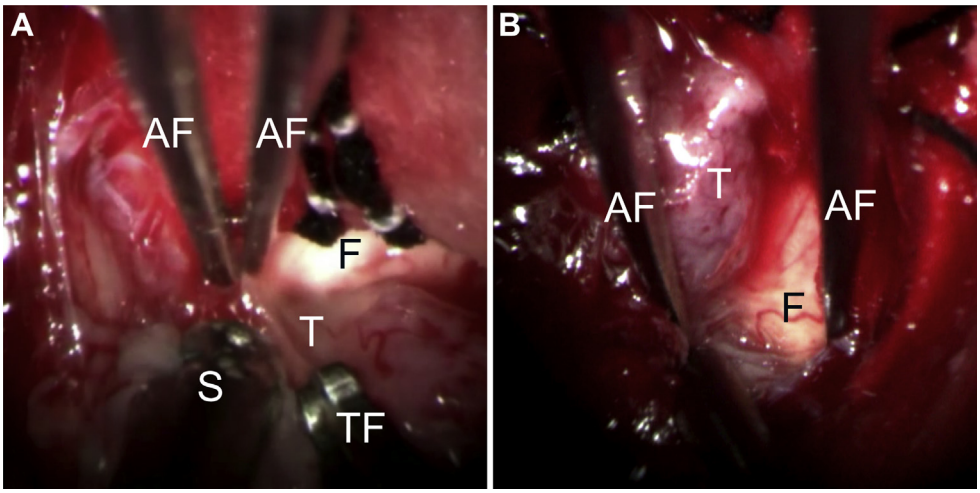

Figure 1. Four-hand suction-irrigation technique. (**A**) The tumor is lifted with the tumor forceps and dissected from the floor with sharp-pointed anatomic forceps, staying exactly at the tumor margin. The dissection is performed under continuous irrigation with saline to keep the dissection plane clean even when some bleeding obscured the view. The assistant is irrigating with one hand and holding the suction with the other hand (4-hand suction-irrigating technique). Bipolar coagulation is strictly avoided at the floor. (**B**) When the tumor is very sticky, the branches of the anatomic forceps were carefully spread to find the dissection plane. AF, anatomic forceps; F, floor of the fourth ventricle; S, suction; T, tumor; TF, tumor forceps.