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Microsurgery of Gliomas

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Summary

The author describes his microsurgical operative technique used since 1980 for gliomatous tumours. Instead of extensive resection and lobectomy, a pergyral or intergyral persulcal approach with partial gyrectomy, interhemispheric, transsylvian and transventricular exposure of the tumour surface were used.

The resection of the tumour begins from its centre. In the first phase 1980–1982 bipolar coagulation, micro-sucker and pincer were used, since 1983 tumour resections have been performed with the CO_2 and Nd-Yag laser and CUSA. Tumours located in functionally important regions such as the speech area, thalamus, brain stem, etc. could be removed without additional morbidity and there was a rapid improvement in neurological deficits. The early prognosis of patients harbouring these tumours is improved thanks to minimized operative trauma. The quality of life during the recurrence free period is improved and surgery of recurrence is indicated more frequently than in the past. There is no evidence that these techniques influence the length of the total survival.

The use of CT and MRI improved the early diagnosis of small tumours and intraparenchymal lesions. This requires exact intra-operative localization and identification of the lesion. The technical aspects of these procedures are described. Thanks to the improvement in operative technique some limitations of surgery such as location, nature of the tumour and the age of the patient have lost much of their importance.

Keywords: Microsurgery of cerebral gliomas; new operative techniques; CO_2 and Nd-Yag laser; CUSA; operability of "inoperable gliomas"; clinical course.

The results of treatment of gliomas of the central nervous system are far from satisfactory. Apart from pilocytic astrocytomas of the cerebellum and extreme rare cases of other gliomas, cures are exceptional. The survival time depends on biological characteristics of the tumour and is also influenced by the degree of tumour removal. According to numerous clinical and morphological reports (Brain tumour registry in Japan, 1978, Müller *et al.* 1977, Takakura *et al.* 1982, Wüllenweber *et al.* 1973, Zülch 1956, 1971, 1979, Zülch, Mennel 1974) this survival time is longest when the so-called macroscopically total tumour removal with resection in apparently healthy tissue is performed with lobectomy. This destructive type of surgery is limited to selected locations. In the vast majority of cases extensive resection is connected with high mortality and morbidity.

The microsurgical technique provided the basis for a new approach in surgery of gliomas—*isolated tumour removal* (Pia 1983).

The aim of this clinical study, which started in 1980 was:

1. *to improve the morbidity* in patients with cerebral glioma for the period of survival and

2. *to remove gliomas* in so-called inaccessible and functionally important areas of the hemispheres, basal ganglias, thalamus, brain stem and spinal cord.

The *key for this approach* was a case of a 65-year-old patient, a physician, with a glioblastoma of the left angular region (H. N. 210114/1980). He presented with an almost complete angulary syndrome. His children asked for an operation because he expressed the desire to finish his language studies on classical Roman and Greek and especially because he wanted to take care of his severely handicapped wife as long as possible. The tumour was removed through a small craniotomy and approached from a 2 cm long incision of the involved angular gyrus. It was removed piece-meal beginning in its centre and going step by step to its margins. No spatulas were used; the only instruments which were applied were micro-sucker, small forceps and bipolar coagulation. The adjacent brain tissue was not touched. Immediately after the operation the clinical signs disappeared completely. The patient was discharged after 10 days. No X-ray therapy was performed. He was able to live a normal life for five and a half months, when he asked for a second operation because of the recurrence of symptoms. He was operated again six months after the first operation with the same technique and with the same spectacular result. He had a further four months of good quality of life.

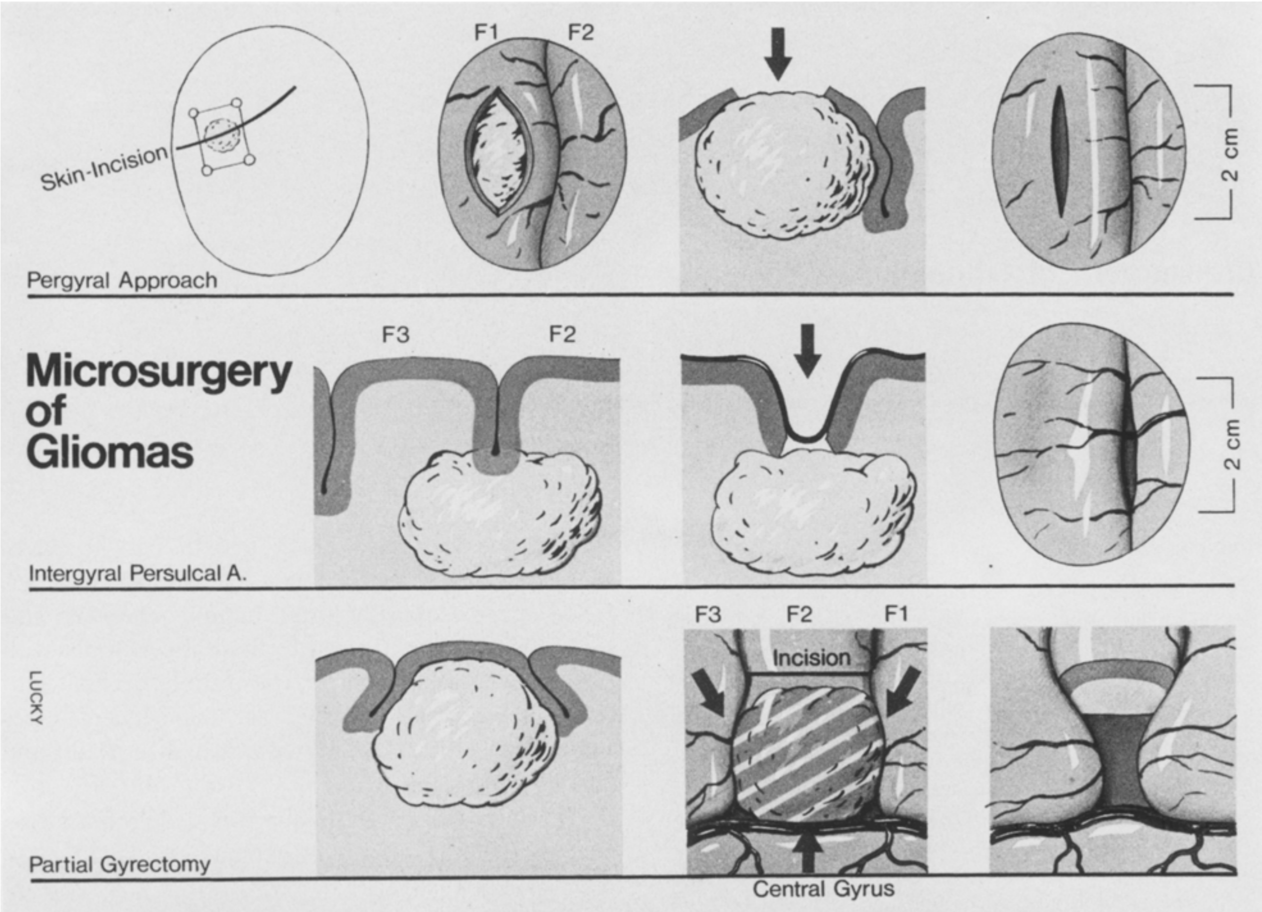


Fig. 1. Microsurgery of gliomas—pergyral approach, intergyral persulcal approach, partial gyrectomy

Since that time we have operated about 200 patients with gliomas of all types located in the areas of speech representation (Broca/Wernicke—and angularis region), motor, sensory, and optic cortex as well as patients with tumours of the corpus callosum, basal ganglia, thalamus, brain stem and spinal cord. Extensive and diffuse gliomas of these areas or diffuse tumours with involvement of medial structures were not operated.

The results of microsurgical treatment are encouraging, especially in patients with cortical and subcortical gliomas. Neurological defects disappeared or improved to the degree which permitted normal or sufficient function. In no case microsurgical removal resulted in a permanent aggravation of the clinical deficit.

Operative Technique

From the technical point of view two operative accesses and one procedure have been developed and described as:

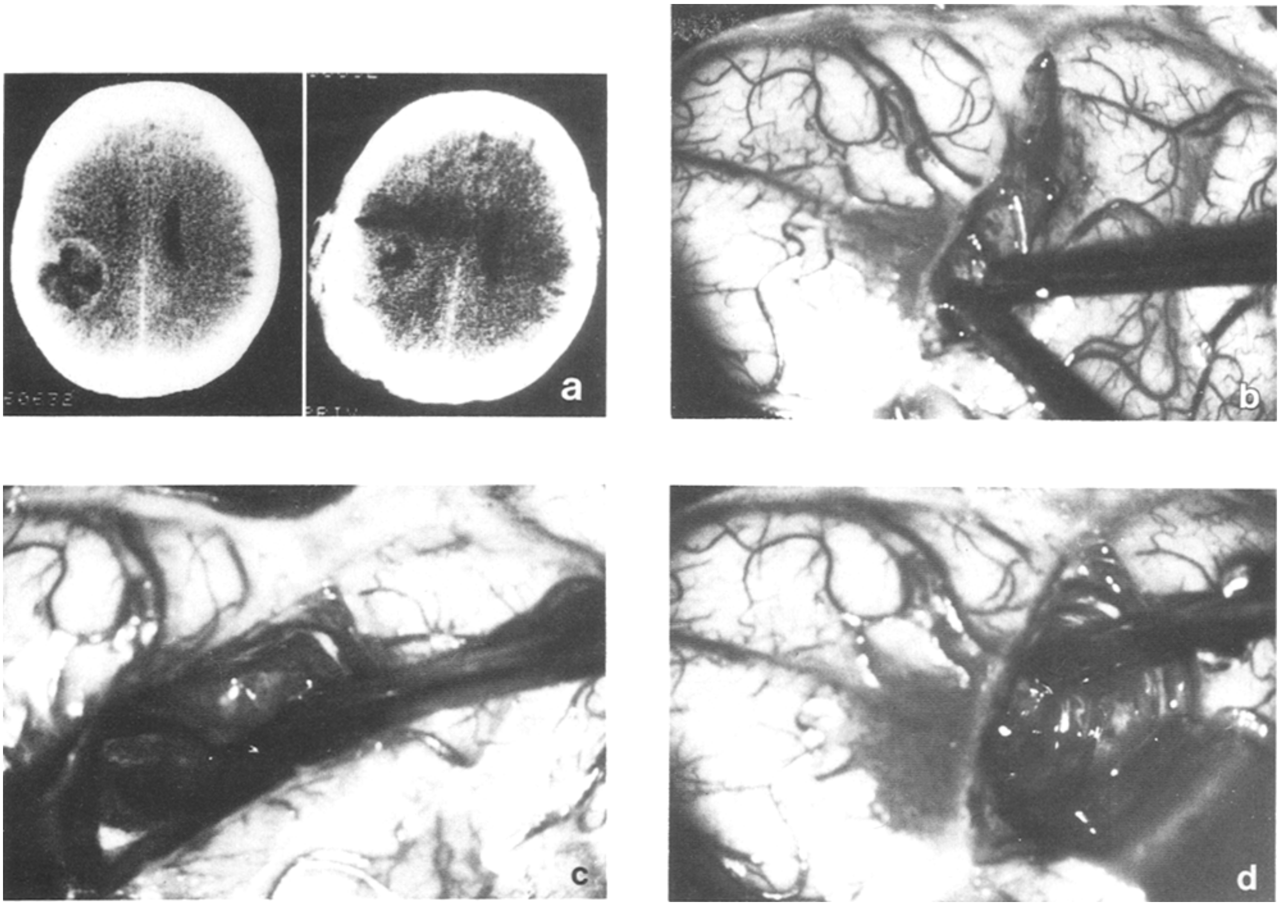
1. the pergyral approach,
2. the intergyral, persulcal approach and
3. the partial gyrectomy (Fig. 1).

1. The Pergyral Approach

The pergyral approach is indicated in cortico-subcortical gliomas, *i.e.,* in cases with direct involvement of the cortex by the tumour. The involved cortex is split in an extension of one or two centimetres and the tumour is removed piecemeal as described in our first case.

2. The Intergyral, Persulcal Approach

The intergyral, persulcal approach is the procedure of choice in subcortical gliomas. The arachnoid membrane is split between the adjacent gyri, which in turn are separated carefully to expose the sulcus over a distance of 1.5–2 cm. It is important not to injure the cortex of the gyri with its arteries and veins. The cortex



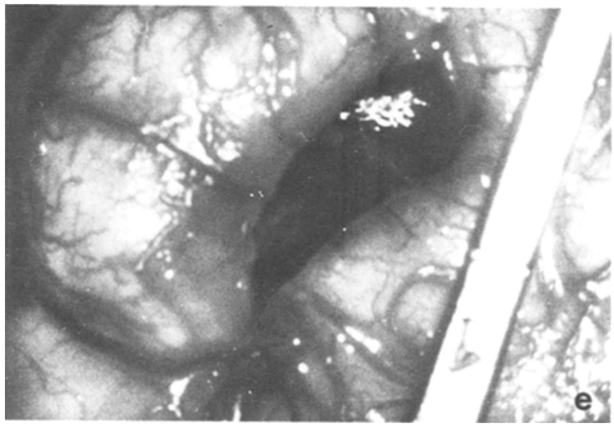


Fig. 2. Left-sided glioblastoma F_3—central region (H. E. S. 260632/1981). Intergyral approach between the end of F_3 and central convolution behind Broca (a), intergyral persulcal access and removal of glioblastoma (b), after removal adjacent intersulcal (c), and superficial cortex (d) of F_2 and F_3 are normal. Opening 2 cm. No defects. (e) Radio- and cytotherapy. Death after 6 months

of the sulcus and the white matter are opened until the tumour is exposed. Removal is piecemeal using small forceps and the bipolar pincer to control even the smallest bleedings. In cases of angioblastic gliomas and necrotic glioblastomas removal by microsucker and bipolar coagulation seems to be the safest method. Optimal illumination and magnification permit tumour removal through a small excision. The use of a spatula is only exceptionally necessary. This is demonstrated in a case of glioblastoma of the left fronto-lateral region located below the posterior part of the second and third frontal convolution on the left side (H. S. 260632/1981). The tumour was removed and isolated without injuring the cortex and the uninvolved white matter. Motor aphasia improved rapidly within few days (Figs. 2a–e). *Deep seated or large tumours* can be also removed with

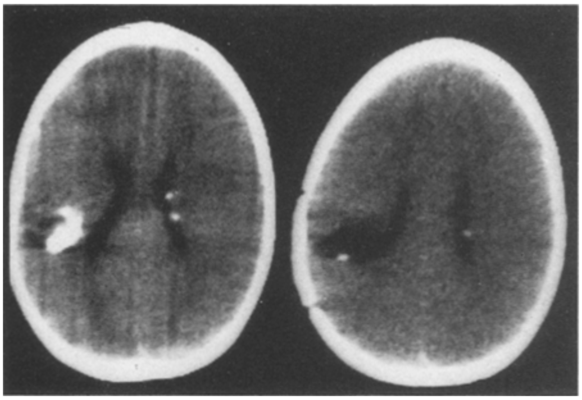


Fig. 3. Tuberous sclerosis with intra- and paraventricular astrocytoma (H. K. 081269/1982) below the angular region. Intersylvic, intergyral persulcal approach and removal, pre- and post-operative CT. Normal course over 3 years

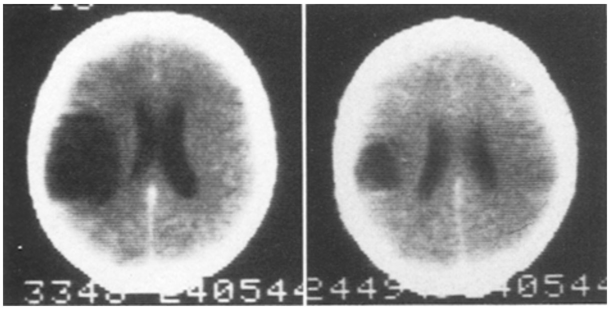


Fig. 4. Astrocytoma II/III of left-sided angular region (H. J. L. 240544/1982). Intersylvic, intergyral persulcal approach, removal; radiotherapy, normal course over 2½ years

minimal risks through an intergyral persulcal approach. This approach was used in a case of a para- and intraventricular astrocytoma connected with tuberous sclerosis (Fig. 3) and in a case of astrocytoma grade II (Fig. 4).

In both the instances the tumour was located beneath the angularis region on the left side and was removed from a small intergyral transsulcal approach between the posterior part of the third temporal convolution and the angular gyrus. The post-operative course was uneventful and there were no post-operative epileptic fits.

3. Partial Gyrectomy

Partial gyrectomy seems to be an appropriate procedure for small localized benign or semibenign gliomas restricted to one gyrus and the subcortical areas as shown in Figs. 5a–d (M. W. 110238/1982). An astro-

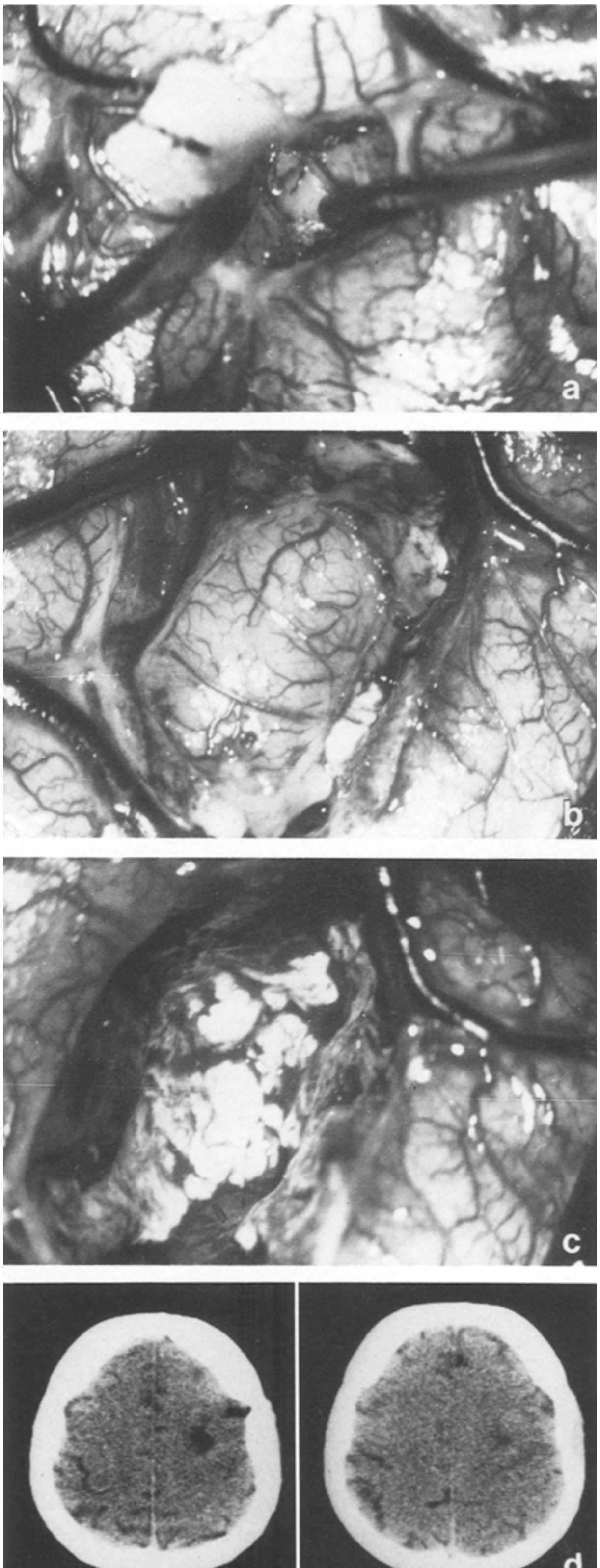


Fig. 5. Astrocytoma III at the end of F_2 (M. W. 110238/1982), partial gyrectomy, integyral approach between F_2 and F_3 (a), complete isolation of the end of F_2 (b), defect after removal with tumour (c), post-operative CT (d), infrequent fits over 1½ years

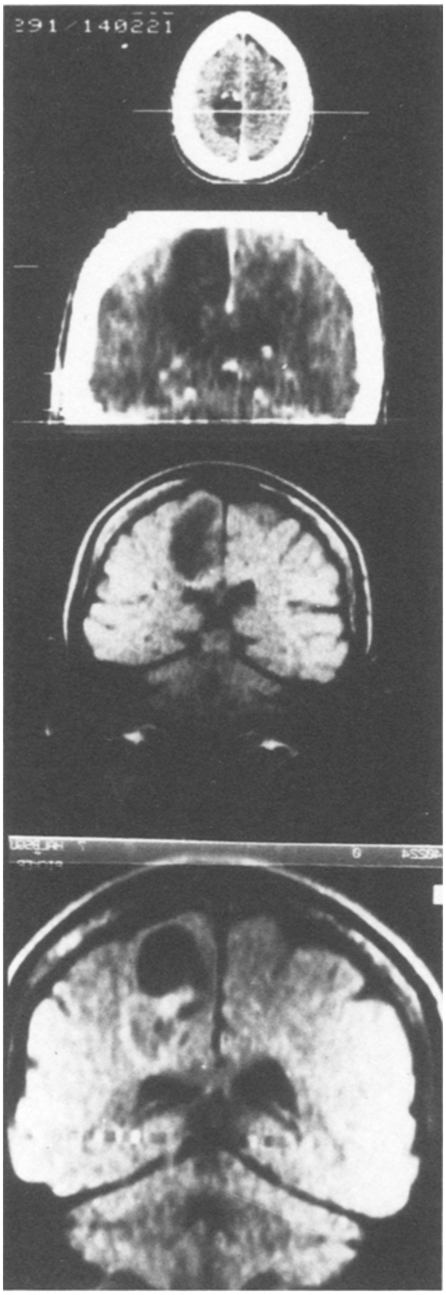


Fig. 6. Glioblastoma of left central convolutions (E. P. 140211/1985). CT and MRI with and without Gadolinium. Tomour-removal via interhemispheric pergyral approach by CO_2 laser and CUSA. Increased hemiparesis for two weeks. Normalization. 1 month

cytoma located in the posterior part of the second frontal convolution was removed through an intergyral transsulcal approach between F_1 and F_2 and F_2 and F_3, and F_3 and central sulcus. The cortex and vessels of the adjacent first and third convolution and motor cortex remained intact. There were no post-operative deficits.

For the last two years the operative management of gliomas has been considerably influenced by:

1. *the development of imaging techniques*, such as high resolution CT, MRI with application of paramagnetic substances (Gadolinium), improved early diagnosis of the tumour and the possibility to differentiate between the tumour and surrounding oedema. The possibility to localize the lesion exactly and to define its relation to the neighbouring structures (Fig. 6) is supported by the technique of external marking and projection of the tumour contours on the scalp. This permits a limited exact approach and identification of the smallest growths (Fig. 7) (Pia and Ishii 1984, 1985).

2. Extensive study of *microsurgical anatomy, topography and technique* (Seeger 1978, 1980, 1982, 1983, 1984) had a considerable impact on the choice of the approach and the method of tumour removal.

Thus, we witness a considerable advance in the identification and location of the *smallest tumours and small intraparenchymal lesions*.

The key case was an observation in a *42-year-old patient (M. W. 110238/1982)*. He had two generalized epileptic fits, no neurological deficits, normal EEG, carotid angiography and normal computerized tomography. It was the MRI investigation only, which showed a focus of increased signal in the posterior part of the F_2 on the right side (Fig. 8a). At operation the cortical surface and the intergyral cortex of F_1, F_2, and F_3 were normal under magnification and the electrocorticogram showed no abnormalities. Electrical silence was disclosed when the electrodes were placed subcortically in F_2 (Channel 11) (Fig. 8b). Partial gyrectomy of the posterior part of F_2 in an extension of 2.5 cm was performed following its isolation from F_1, F_3 and the central sulcus. The removal tissue appeared to be normal when examined under the operation microscope. Histology revealed an astrocytoma grade II, it was further graded as III by the central tumour registry laboratory. Post-operative MRI shows the operative defect within the larger area of increased signal activity (see Fig. 8a).

Since that time we have had a series of similar patients usually aged between 30 and 40 who presented with a single epileptic fit in whom only the MRI was abnormal.

Furthermore there were a few cases of small *cavernomas* with a positive CT and abnormal MRI.

Technical principles of surgery described above apply particularly to such cases. The approach is chosen according to the external markings on the skull surface, supplemented by subcorticography or stereotactically introduced needle. As shown in Fig. 7 the smallest approach, in this case transsylvian intragyral-transsulcal, was used to remove a small cavernoma located below the Broca area, *i.e.*, behind the foot of the left central convolution. For a large glioblastoma (Fig. 6) an interhemispheric pergyral approach below the central gyrus was used.

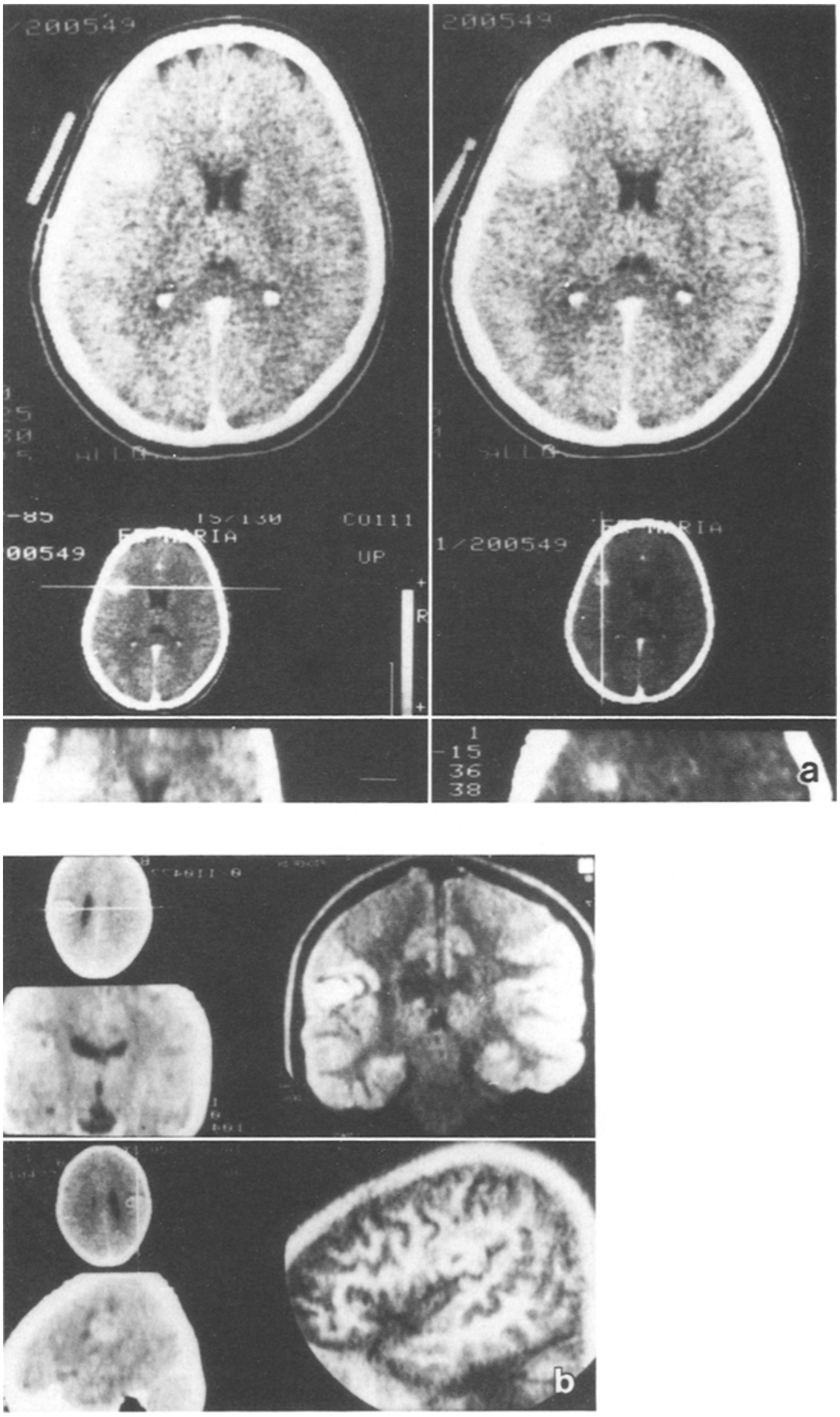


Fig. 7. Cavernoma below the Broca region (M. J. 200549/54) (a) and below Broca and central convolution (S. T. 110477/85) (b), exact localization by CT with marking (a) and MRI (b). Intersylvic, integral persulcal approach and removal with CUSA in both cases. Normal course. No signs 6 months, 5 months respectively

3. The tissue and structures adjacent to the tumour are less traumatized when a "no-touch" technique provided by vaporizing and cutting capabilities of *CO_2 laser*, coagulation and shrinking capabilities of *Nd-Yag laser* are applied. Nearly atraumatic tumour dissection and removal with *CUSA* permitted approach of the tumours located in the central regions (Pia and Ishii 1984).

An ultrasonic aspirator is particularly useful in surgery of gliomas and permits preservation of super-

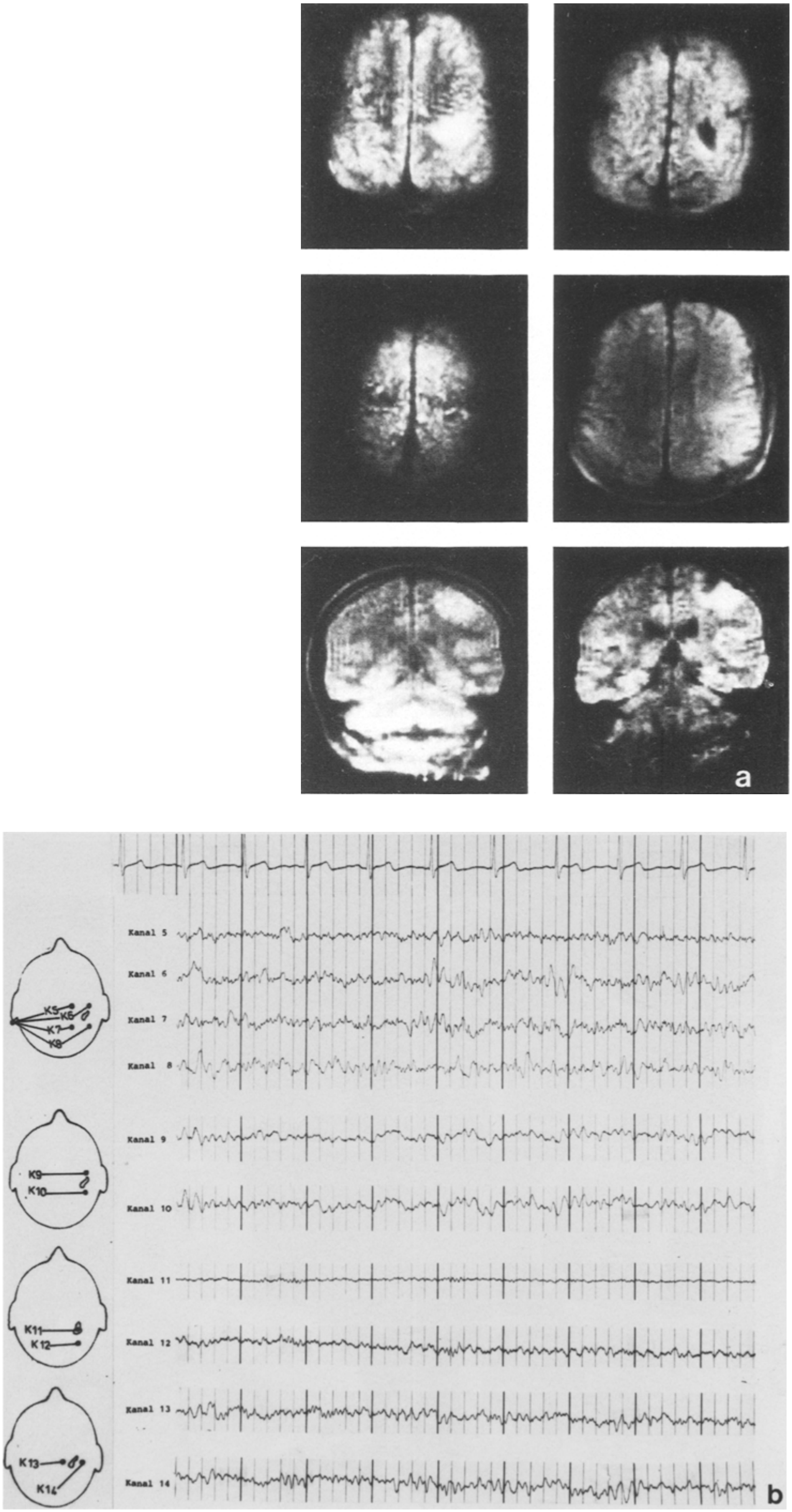


Fig. 8. See Fig. 5. MRI findings pre- and post-operatively (a), cortico- und subcorticography with bioelectrical silence (Channel 11) inside the tumour with "normal tissue" (b)

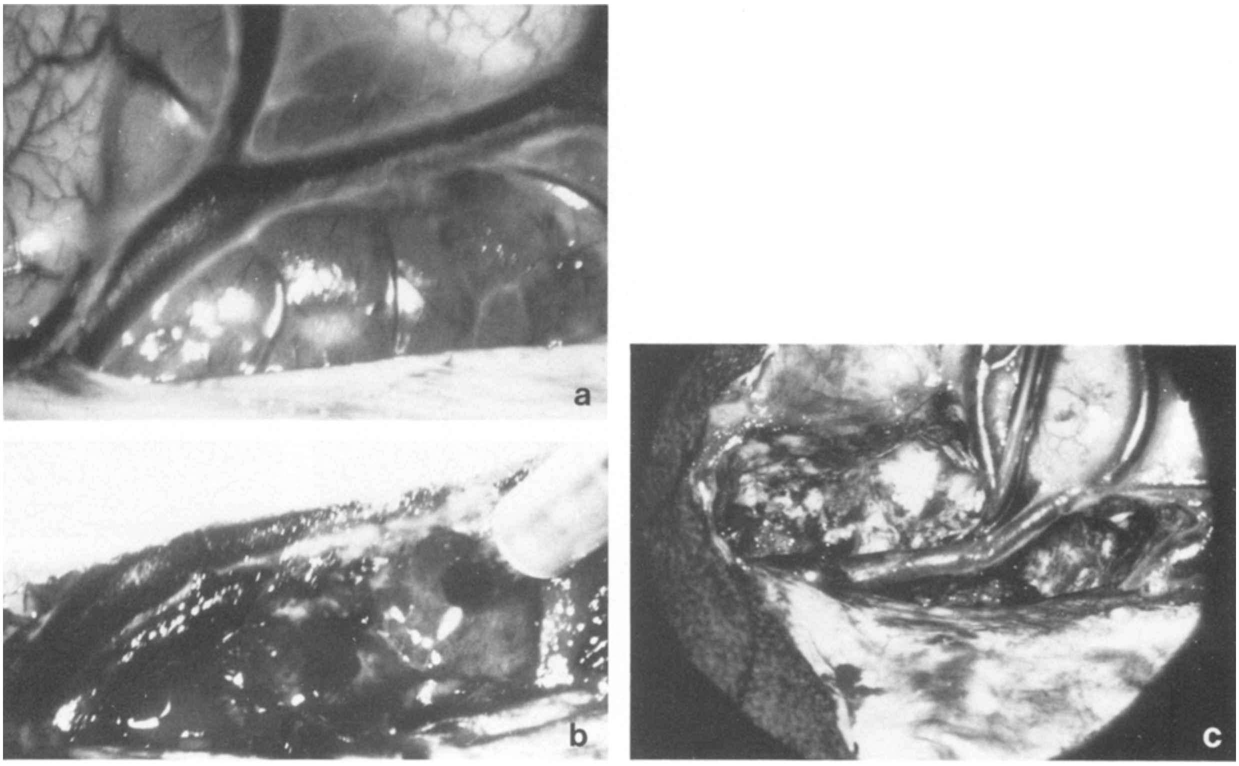


Fig. 9. Right-sided astrocytoma III F_1 (B. K. 150358/1984). Rather circumscribed angioblastic tumour (a), preparation and removal with CUSA and CO_2 laser (b), after resection with intact arterial and venous system (c), Radiotherapy. Normal after 6 months

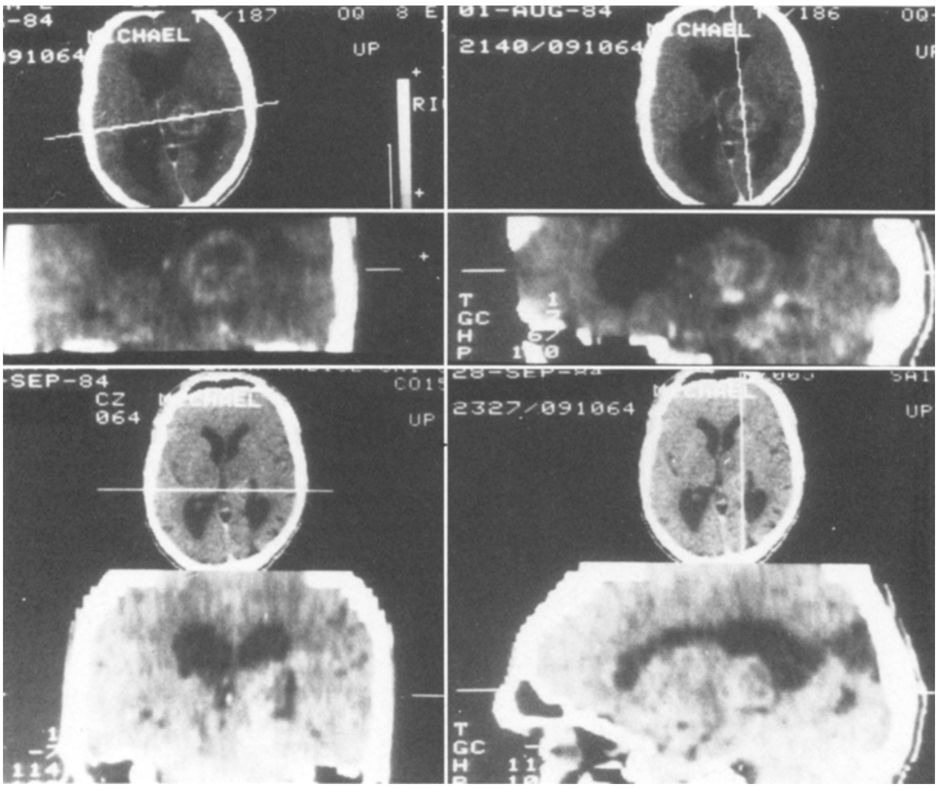


Fig. 10. Astrocytoma III of right thalamus (M. O. 091164/1984). Pre- and post-operative CT. Intergyral-transsulcal-transventricular approach. Removal by ND-Yag laser and CUSA. Radiotherapy. Regression of hemiparesis and hypaesthesia. Normal after 1½ years

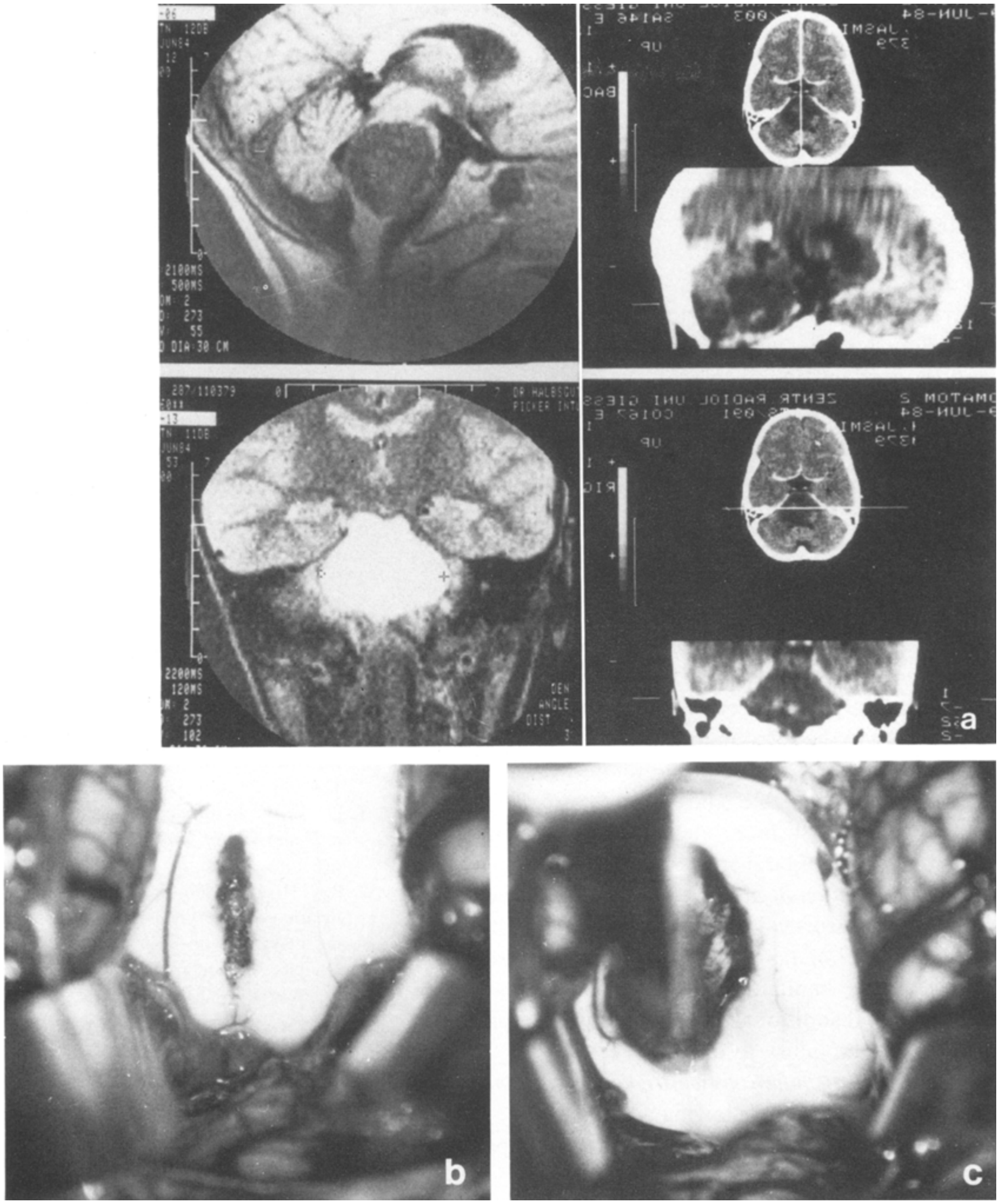


Fig. 11. Pontine polymorphic astrocytoma IV (a) (J. H. 110379/1984), midline cutting of rhomboid fossa by CO_2 (b), tumour removal with CUSA (c), after total excision (d). Normal course for 2 days, death 3 days later because of acute rebleeding

ficial deep vessels; tumour remnants can be removed with CO_2 or Neodym-Yag laser (Figs. 9a–c).

It became also possible to remove circumscribed tumours in the *thalamus* (Fig. 10) or in the *brain stem.* The risk of removal of such lesions is diminished thanks to performing the tissue cut with a CO_2 laser and resection of the tumour tissue with CUSA or in combination with a laser (Figs. 11a–d). The use of these instruments seems to be most advantageous for *intramedullary tumours* particularly of the cervical spine (Pia and Braunsdorf 1986).

The above techniques applied for several intracranial processes permitted tumour surgery in the advanced age in patients aged over 70 and even over 80 years (Pia *et al.* 1984). Uneventful courses after such surgery with recovery of neurological function indicates remarkable plasticity of the central nervous system of the elderly (Pia 1985).

Advantages of microsurgical management of gliomas combined with laser and CUSA are as follows:

1. *small craniotomy* centred on the tumour avoiding the damage to the surrounding brain tissue, sometimes encountered when a large craniotomy is used.
2. Smallest possible and *direct approach to the tumour* from the surface, interhemispheric or intersylvian route with pergyral or intergyral persulcal incision.
3. *Preservation of not involved structures*—cerebral cortex and subcortical white matter arteries and veins.
4. *Removal of tumour piecemeal starting from the centre* with a minimum of adequate instruments in order to avoid additional damage through compression with a spatula, injury to the vessel, etc.

The results of microsurgical removal of gliomas are encouraging with the following advantages:

1. A rapid and uncomplicated post-operative course.
2. A rapid improvement of clinical signs and symptoms.
3. The possibility of operating on so far unapproachable cortical, subcortical and central gliomas.
4. An improvement in spontaneous and operative morbidity and thus improvement in the quality of life over the recurrence-free period.

It is still impossible to say whether isolated removal of the tumour influences the survival time when compared with so far practiced extensive resections. Our clinical impression is that there is no difference. There is no doubt that the early prognosis is improved because of lack or minimal post-operative morbidity thanks to less traumatic surgery and less post-operative tissue reaction and oedema.

This new operative technique for glioma influences the *global strategy of surgery of these tumours.* Recurrences are going to be operated more frequently than in the past because the survival time can be prolonged with preservation of the quality of life. It seems also that this new surgical approach will influence the indications for X-ray therapy and chemotherapy of these lesions.

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