

**Second Annual International Neurosurgery Conference on the Internet**

**LONG-TERM RESULTS OF GAMMA KNIFE  
RADIOSURGERY FOR BENIGN SKULL BASE  
MENINGIOMAS**

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# Aim of the study

- Evaluation of the effectiveness and toxicity of GKRS for benign skull base meningiomas to
- define the role of GKRS for benign skull base meningiomas and to
- provide further data for comparison with other treatment options.

## Literature - Microsurgery

- Arnautovic KI, Al Mefty O, Husain M. Ventral foramen magnum meningiomas. *J.Neurosurg.* 2000;92:71-80.
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- DeMonte F, Smith HK, Al Mefty O. Outcome of aggressive removal of cavernous sinus meningiomas. *J.Neurosurg.* 1994;81:245-51.
- George B, Lot G, Boissonnet H. Meningioma of the foramen magnum: a series of 40 cases. *Surg.Neurol.* 1997;47:371-9.
- Samii M, Tatagiba M. Experience with 36 surgical cases of petroclival meningiomas. *Acta Neurochir.(Wien.)* 1992;118:27-32.
- Samii M, Carvalho GA, Tatagiba M, Matthies C. Surgical management of meningiomas originating in Meckel's cave. *Neurosurgery* 1997;41:767-74

## Literature - Microsurgery

- Spallone A, Makhmudov UB, Mukhamedjanov DJ, Tcherekajev VA. Petroclival meningioma. An attempt to define the role of skull base approaches in their surgical management. *Surg Neurol* 1999;51:412-9
- Thomas NW, King TT. Meningiomas of the cerebellopontine angle. A report of 41 cases. *Br.JNeurosurg* 1996;10:59-68
- Bricolo AP, Turazzi S, Talacchi A, Cristofori L. Microsurgical removal of petroclival meningiomas: a report of 33 patients. *Neurosurgery* 1992;31:813-28
- Couldwell WT, Fukushima T, Giannotta SL, Weiss MH. Petroclival meningiomas: surgical experience in 109 cases. *J.Neurosurg.* 1996;84:20-8.
- Samii M, Klekamp J, Carvalho G. Surgical results for meningiomas of the craniocervical junction. *Neurosurgery* 1996;39:1086-94.
- Cusimano MD, Sekhar LN, Sen CN, Pomonis S, Wright DC, Biglan AW, Jannetta PJ. The results of surgery for benign tumors of the cavernous sinus. *Neurosurgery* 1995;37:1-9.

## Literature - Microsurgery

### Postoperative complications

total 30 % - 56%

CND (new or deteriorated)

transient 20 % - 44 %

permanent 16 % - 56 %

### Postoperative Mortality

0% - 9% (median 3,6%)

### Recurrence after 5 y

total removal 3,5% - 19 %

partial removal 25 % - 60 %

### Recurrence after 10 y

total removal 10 % - 33 %

partial removal 55 % - 75 %

### Possibility of total removal

60 % - 87,5%

## Literature – Radiotherapy

as adjuvant therapy after partial resection and for recurrent tumours or as primary option for inoperable lesions

- Mathiesen T, Lindquist C, Kihlstrom L, Karlsson B. Recurrence of cranial base meningiomas. *Neurosurgery* 1996;39:2-7
- Nutting C, Brada M, Brazil L, Sibtain A, Saran F, Westbury C, Moore A, Thomas DG, Traish D, Ashley S. Radiotherapy in the treatment of benign meningioma of the skull base. *J.Neurosurg.* 1999;90:823-7
- Connell PP, Macdonald RL, Mansur DB, Nicholas MK, Mundt AJ. Tumor size predicts control of benign meningiomas treated with radiotherapy. *Neurosurgery* 1999;44:1194-9.
- Glaholm J, Bloom HJ, Crow JH. The role of radiotherapy in the management of intracranial meningiomas: the Royal Marsden Hospital experience with 186 patients. *Int.J.Radiat.Oncol.Biol.Phys.* 1990;18:755-61.
- Goldsmith BJ, Wara WM, Wilson CB, Larson DA. Postoperative irradiation for subtotally resected meningiomas. A retrospective analysis of 140 patients treated from 1967 to 1990. *J.Neurosurg.* 1994;80:195-201.
- Mathiesen T, Kihlström L, Karlsson B, Lindquist C. Potential complications following radiotherapy for meningiomas. *Surg Neurol.* 2003 Sep;60(3):193-8; discussion 199-200.

## Literature – Radiotherapy

as adjuvant therapy after partial resection and for recurrent tumours or as primary option for inoperable lesions

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**complications post radiationem**

3,6% - 19 %

**tumourcontrol**

after 5 y

76 % - 92 %

after 10 y

77 % - 82 %

**Mathiesen T, Kihlström L, Karlsson B, Lindquist C. Potential complications following radiotherapy for meningiomas. *Surg Neurol.* 2003 Sep;60(3):193-8; discussion 199-200**

- 25 (out of 45) patients developed neurological worsening 3-12 months after RT without (!!!) tumor recurr./progress
- CT and MR showed compatible white matter changes

**Symptoms:**

- personality changes with withdrawal from social life, not working, hospitalization (n=11)
- decreased vision (n=7)
- other cranial nerve deficits (n=2)
- vertigo and balance problems (n=4)
- major motor deficit (n=4)
- pituitary and/or hypothalamic dysfunction (n=3)

**The four patients with major motor deficits (2 paraplegia, 2 monoparesis) had previous multiple surgery !!!**

**16 of these 25 patients (= 64 %) with adverse reactions later developed tumor recurrence !!!**

## Literature – LINAC based radiosurgery

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- **Engenhart R, Kimmig BN, Hover KH, Wowra B, Sturm V, van Kaick G, Wannemacher M.** Stereotactic single high dose radiation therapy of benign intracranial meningiomas. *Int.J.Radiat.Oncol.Biol.Phys.* 1990;**19**:1021-6
- **Villavicencio AT, Black PM, Shrieve DC, Fallon MP, Alexander E, Loeffler JS.** Linac radiosurgery for skull base meningiomas. *Acta Neurochir.(Wien.)* 2001;**143**:1141-52
- **Chang SD, Adler JR, Jr.** Treatment of cranial base meningiomas with linear accelerator radiosurgery. *Neurosurgery* 1997;**41**:1019-25

## Literature – LINAC based radiosurgery

| author                | # pat. | months fu         | tumour vol.            | marg. dose        | contr.rate | compl. |
|-----------------------|--------|-------------------|------------------------|-------------------|------------|--------|
| Engenhardt<br>1990    | 17     | 1 – 60<br>(40)    | n/a.                   | n/a               | 94 %       | 53 %   |
| Chang<br>1997         | 55     | 17 – 81<br>(48,8) | 0,45 – 27,65<br>(7,33) | 12 – 25<br>(18,3) | 98 %       | 24 %   |
| Villavicencio<br>2001 | 56     | 6 – 66<br>(26)    | n/a                    | 12– 18,5<br>(15)  | 95 %       | 9 %    |

**Engenhardt et al. reported 1 therapy associated death !**

# GKRS in benign skullbase meningiomas the Graz experience

April 1992 – June 1999; n= 200

## Observation time > 5 years

5 -12 years (median 7,9)

### Sex

|        |        |                     |
|--------|--------|---------------------|
| Male   | (20 %) | 40                  |
| Female | (80 %) | <u>160</u>          |
|        |        | <b>200</b> patients |

### Age

10 - 81 years (median 57)

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**101 PRIMARY TREATMENTS**

based on MRI and CT due to:

- advanced age
- medical infirmity
- patient's preference

if no compression to the optic nerve,  
chiasm or tract was present

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## 99 SECONDARY TREATMENTS

0.2 – 195.1 months (median = 3.1 months)  
after the last microsurgical operation

| Treatment strategy<br>in large tumors | Pat. | Interval<br>(months)    |
|---------------------------------------|------|-------------------------|
| Three-staged treatment                | 1    | 4.6 and 83.3            |
| Two-staged treatment                  | 3    | 4.6 - 6.2<br>(median 6) |

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## Anatomical distribution of the tumours

|                         |            |
|-------------------------|------------|
| <b>CAVERNOUS SINUS</b>  | <b>69</b>  |
| <b>PETROCLIVAL</b>      | <b>44</b>  |
| <b>SPHENOID WING</b>    | <b>32</b>  |
| <b>CEREBELLPONTINE</b>  | <b>21</b>  |
| <b>OLFACTORY GROOVE</b> | <b>13</b>  |
| <b>ORBITA</b>           | <b>10</b>  |
| <b>SELLA</b>            | <b>4</b>   |
| <b>FORAMEN MAGNUM</b>   | <b>7</b>   |
| <hr/>                   |            |
| <b>TOTAL</b>            | <b>200</b> |

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## TREATMENT MODALITIES

|  |                        |                         |
|--|------------------------|-------------------------|
| <b>Tumor volume</b>                    | <b>0.38 - 89.9 ccm</b> | <b>median = 6.5 ccm</b> |
| <b>Isodose line</b>                    | <b>20 - 80 %</b>       | <b>median = 45 %</b>    |
| <b>Margin dose</b>                     | <b>7 - 25 Gy</b>       | <b>median = 12 Gy</b>   |
| 7 Gy, 8 Gy and 25 Gy: very early cases |                        |                         |
| <b>Isocenters</b>                      | <b>1 - 21</b>          | <b>median = 6</b>       |

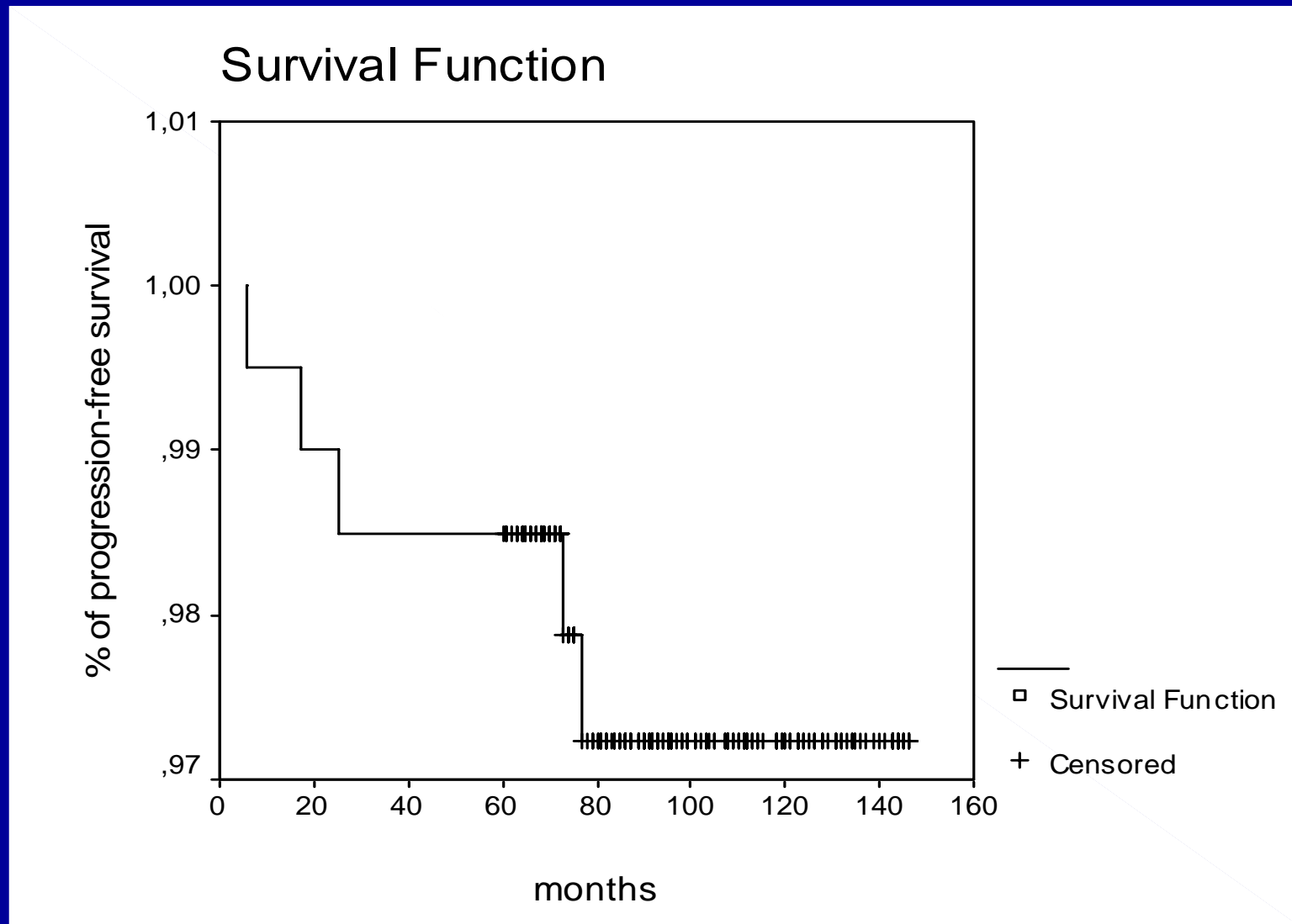
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## Neuroradiological follow-up

|   |            |                 |
|---|------------|-----------------|
| <b>Tumour control</b>   | <b>196</b> | <b>(98 %)</b>   |
| • <b>Reduced tumor volume</b>                                       | <b>113</b> | <b>(56,5 %)</b> |
| • <b>Unchanged tumor size</b>                                       | <b>83</b>  | <b>(41,5 %)</b> |
| • <b>Progression of tumor</b><br>(17, 25, 74, 77 months after GKRS) | <b>4</b>   | <b>( 2 %)</b>   |
| • <b>Central necrosis</b>   | <b>39</b>  | <b>(19,5%)</b>  |

# GKRS in benign skullbase meningiomas - the Graz experience April 1992 – June 1999; n= 200



GKRS in benign skullbase meningiomas -  
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April 1992 – June 1999; n= 200

Clinical follow-up:

|                              |                 |                 |
|------------------------------|-----------------|-----------------|
| <b>Stable Status</b>         | <b>108 pts.</b> | <b>(54,0 %)</b> |
| <b>Clinical Amelioration</b> | <b>83 pts.</b>  | <b>(41,5 %)</b> |
| Complete restitution         | 21 pts.         | (10,5 %)        |
| <b>Clinical worsening</b>    | <b>9 pts.</b>   | <b>( 4,5 %)</b> |
| transient                    | 7 pts.          |                 |
| contralateral infarction     | 1 pts.          |                 |
| <b>Total</b>                 | <b>200 Pat.</b> | <b>(100%)</b>   |

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**Salvage Surgical Procedures:**

**Tu-progression + clinical worsening**

**3 Pat.**

Double vision (1), CN III palsy (1) → restitution

Hemiparesis (1) → amelioration

**Tu-Progression + stable clinical condition**

**1 Pat.**

(no worsening after microsurgery)

**Clinical deterioration without tu-progression**

**1 Pat.**

(worsening of a preexisting visual field deficit

5,5 months after GKRS of a partially resected sinus cavernosus meningioma. No amelioration after microsurgery)

**Total**

**5 Pat. (2,5%)**

# GKRS in benign skullbase meningiomas - the Graz experience

April 1992 – June 1999; n= 200

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## Complications after GKRS:

### **Transient:**

**4 Pat. (2%)**

Cephalaea (1), increased epileptic activity (1)

→Restitution after dexamethasone due to peritumoural edema

2 newly developed trigeminal neuralgias (12, 16 months after

GKRS resp. ) → restitution without medication

### **Permanent:**

**1 Pat. (0,5%)**

visual worsening due to radiation damage of the  
optic apparatus (although < 8 Gy)

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### **Total:**

**5 Pat. (2,5%)**

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## Long-term Tumour Growth Control of Meningiomas after GKRS

| Author            | observation | pat. | Tumor control                   |
|-------------------|-------------|------|---------------------------------|
| Kondziolka (1999) | 5 - 10 yrs  | 99   | 93%                             |
| Kobayashi (2001)  | 5 - 9 yrs   | 54   | 88.9%                           |
| Own series        | 5 - 12 yrs  | 200  | 98.5% 5 years<br>97,2% 10 years |

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**Long-term results after GKRS  
of Skull Base Meningiomas**

| <b>Author</b>            | <b>Morbidity</b> | <b>Complications</b> |
|--------------------------|------------------|----------------------|
| <b>Kondziolka (1999)</b> | <b>5%</b>        | <b>13%</b>           |
| <b>Kobayashi (2001)</b>  | <b>10%</b>       | <b>13.8%</b>         |
| <b>Own series</b>        | <b>4%</b>        | <b>2.5%</b>          |

No Mortality after GKS

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## CONCLUSION I

- **Microsurgery should be the first choice of treatment in cases with progressive neurological deficit - especially if required for visual pathway decompression, but the option of additional GRKS may modify the degree of resection.**

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## **CONCLUSION II**

- **Patients with recurrent or residual basal meningiomas should rather receive GKRS than undergo repeated open resection.**
- **GKRS should be performed more often as primary alternative treatment esp. in elderly or clinically disabled patients with close and frequent follow-up.**