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# Inhomogene Dosisverteilung im Zielvolumen: Argumente und Evidenz

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Uniklinik Köln

# Agenda: pro inhomogener Dosisverteilung bei Hirnmetastasen

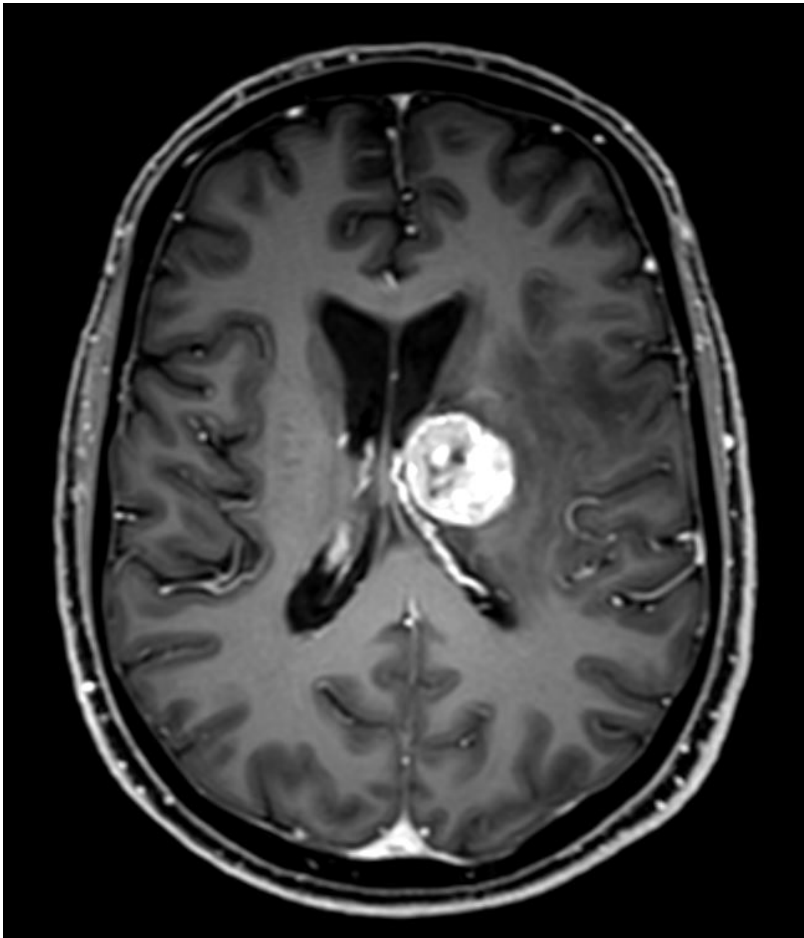
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1. Wachstumsmuster
2. Radiobiologie der Radiochirurgie
3. Physikalische Aspekte
4. Sonderform: Brachytherapie
5. Evidenz für inhomogene vs. homogene Dosisverteilung
6. Zusammenfassung

# Wachstumsmuster

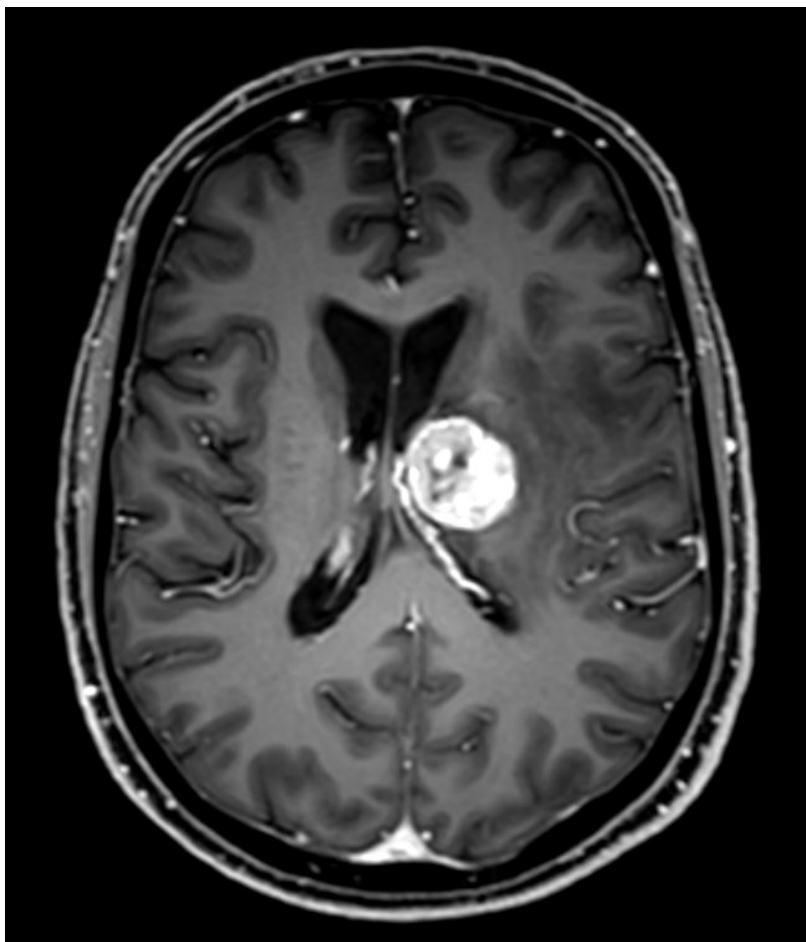
# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (MRT)

Metastase

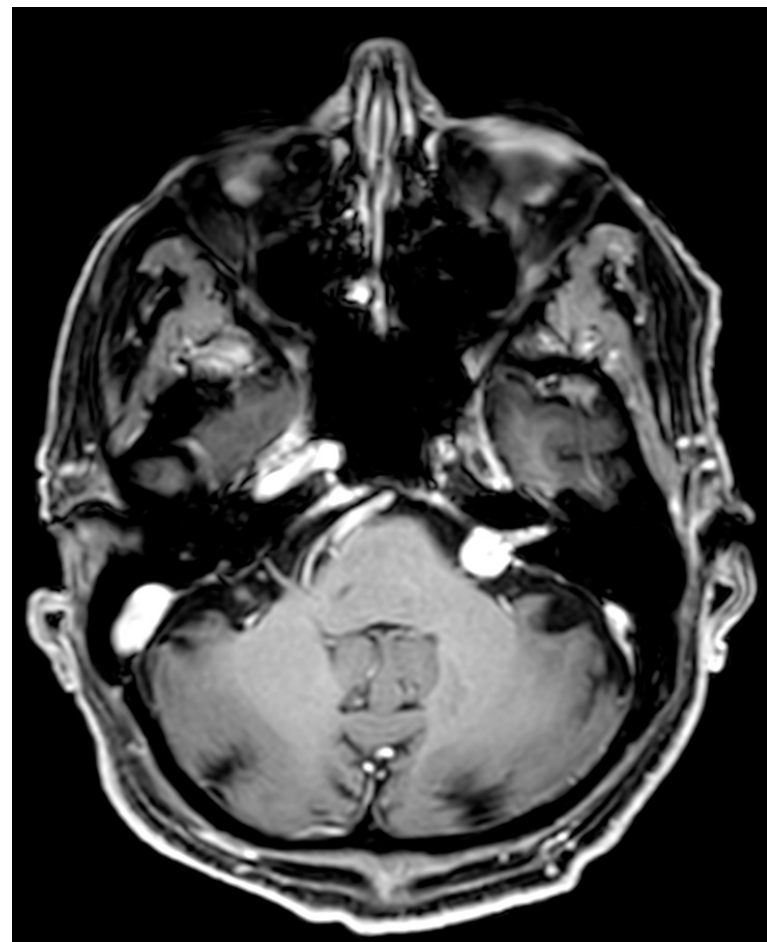


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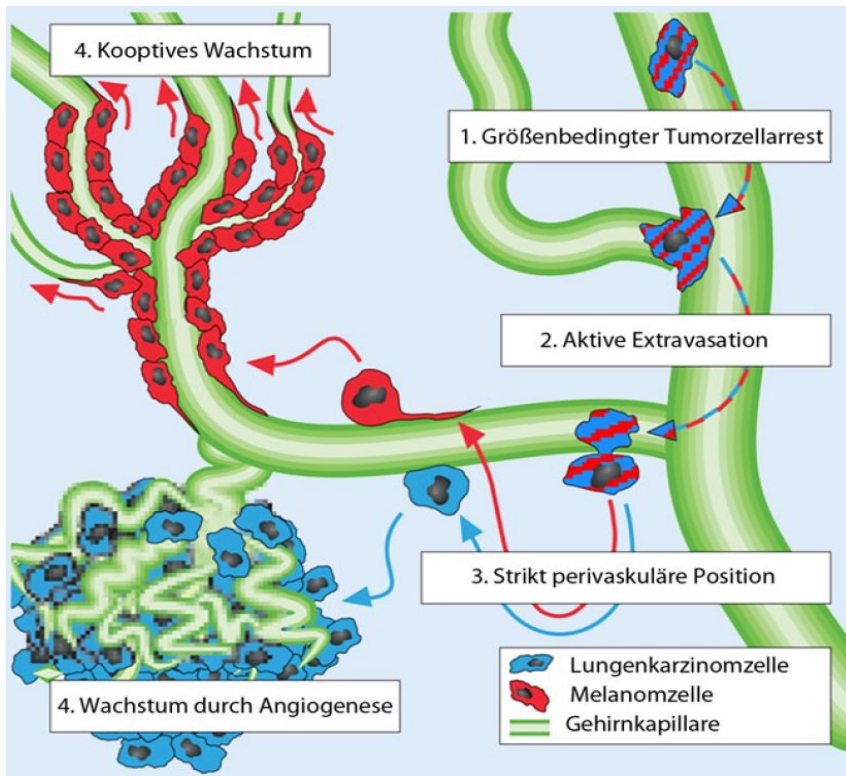


Vestibularisschwannom



# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (Schema)

## Metastase

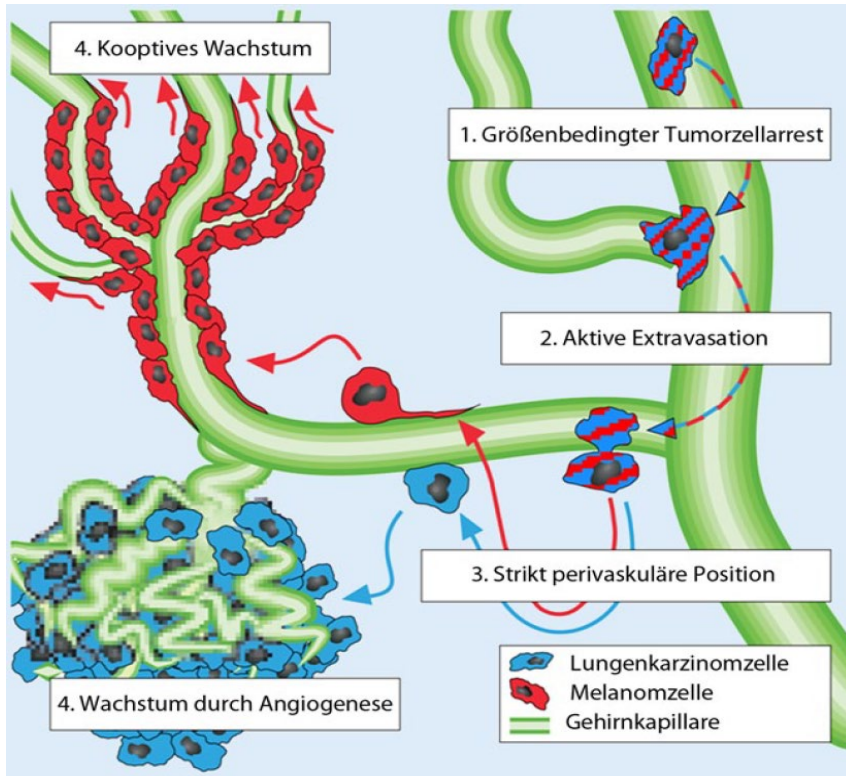


Quelle: Winkler et al. Onkologie 2014; 20: 10–19

Quelle: <https://neurochirurgie.insel.ch/erkrankungen-spezialgebiete/hirntumoren/vestibularisschwannom>

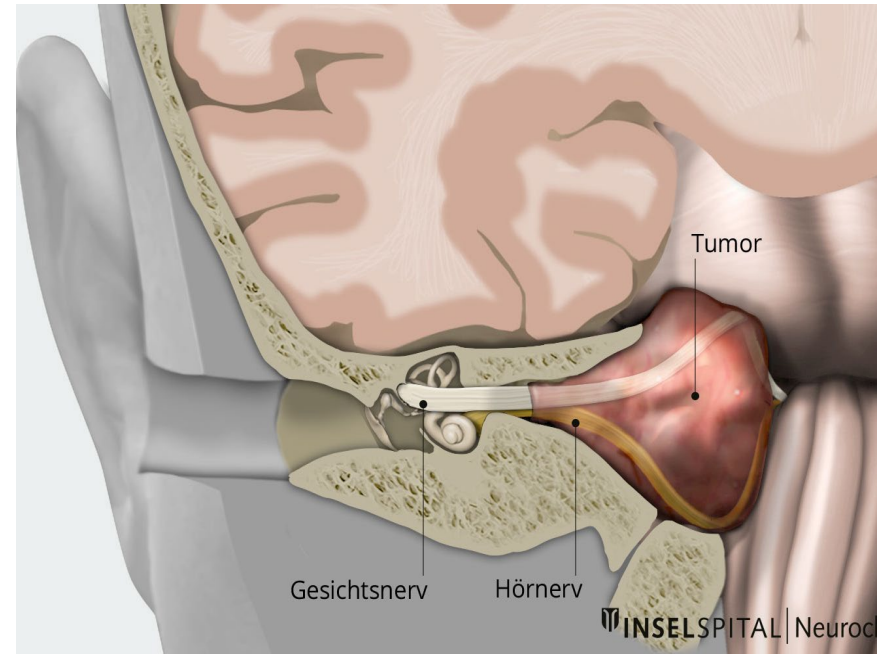
# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (Schema)

## Metastase



Quelle: Winkler et al. Onkologie 2014; 20: 10–19

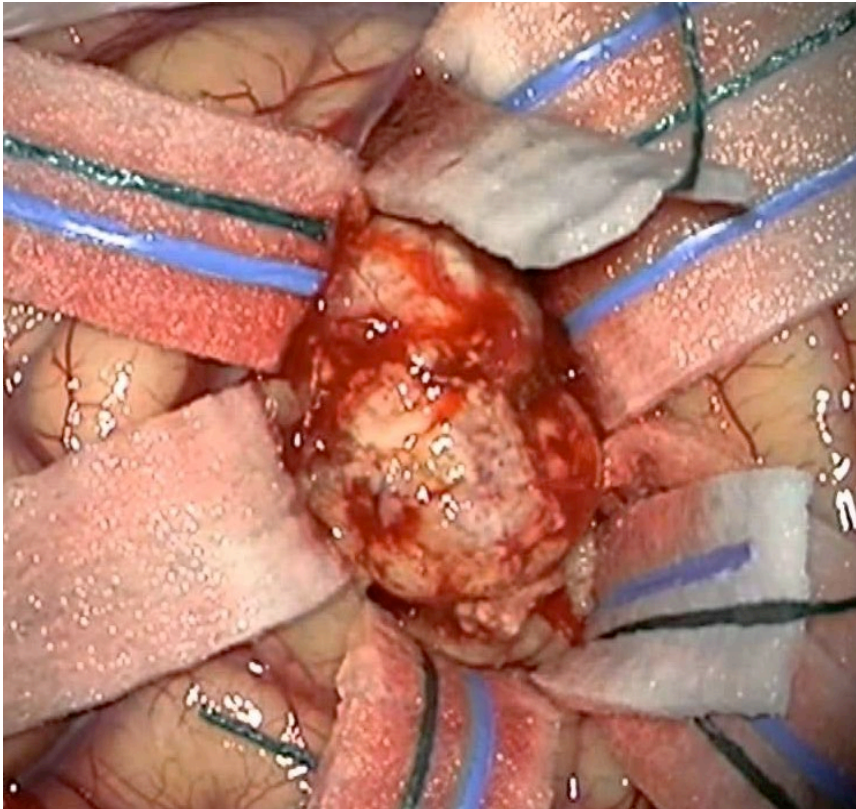
## Vestibularisschwannom



Quelle: <https://neurochirurgie.insel.ch/erkrankungen-spezialgebiete/hirntumoren/vestibularisschwannom>

# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

## Metastase



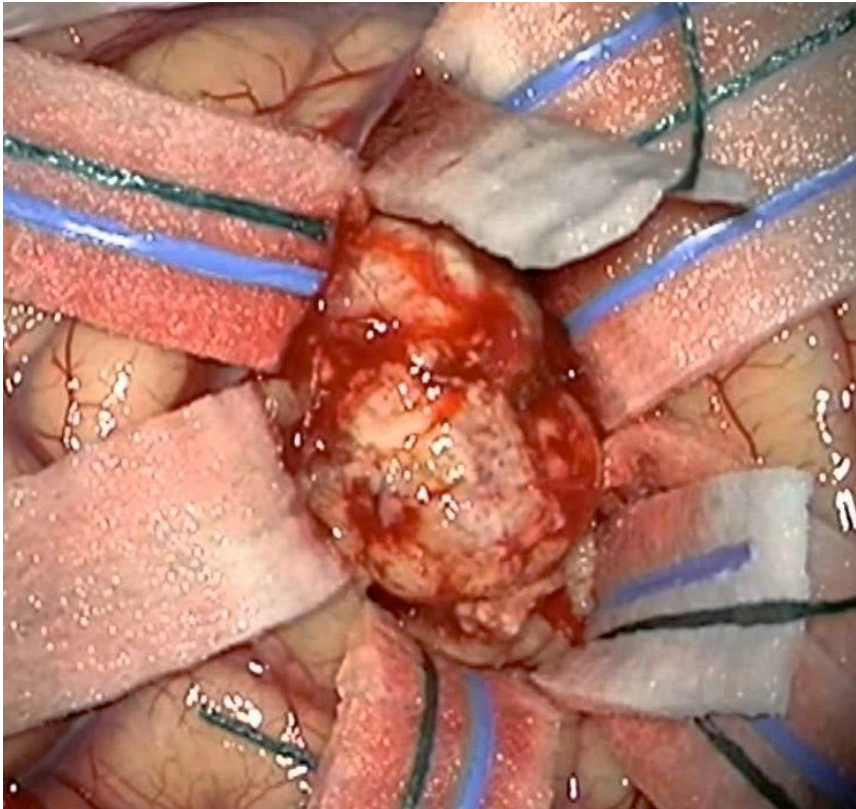
Quelle: Prof. S Grau, Centre of Neurosurgery, University of Cologne

Quelle: Rosahl et al. Laryngo-Rhino-Otol 2017; 96: S152–S182

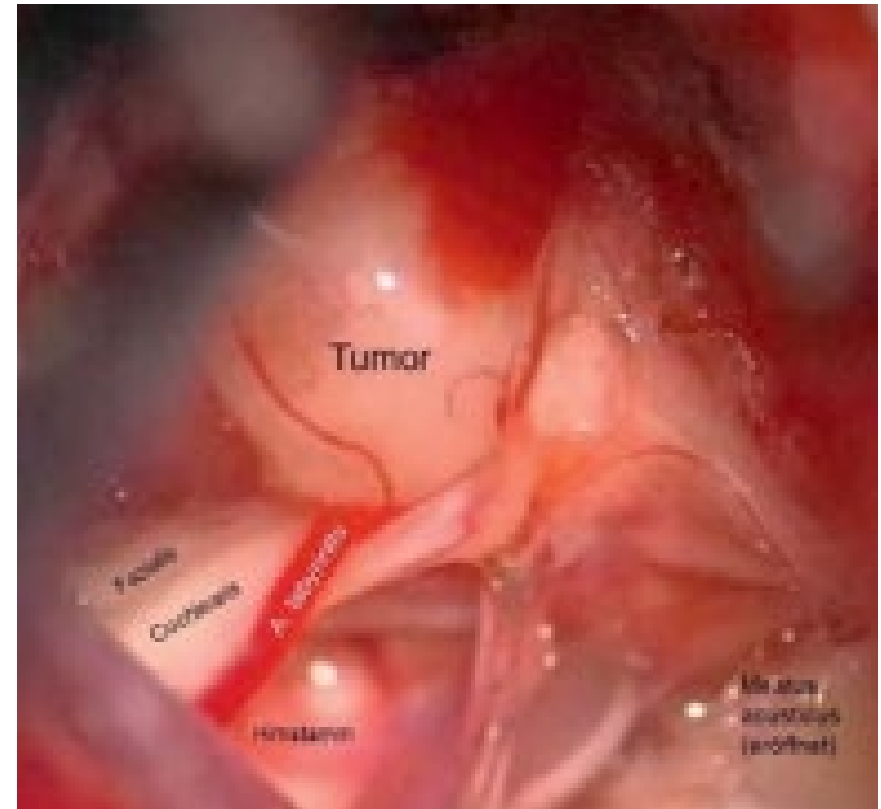


# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

Metastase



Vestibularisschwannom

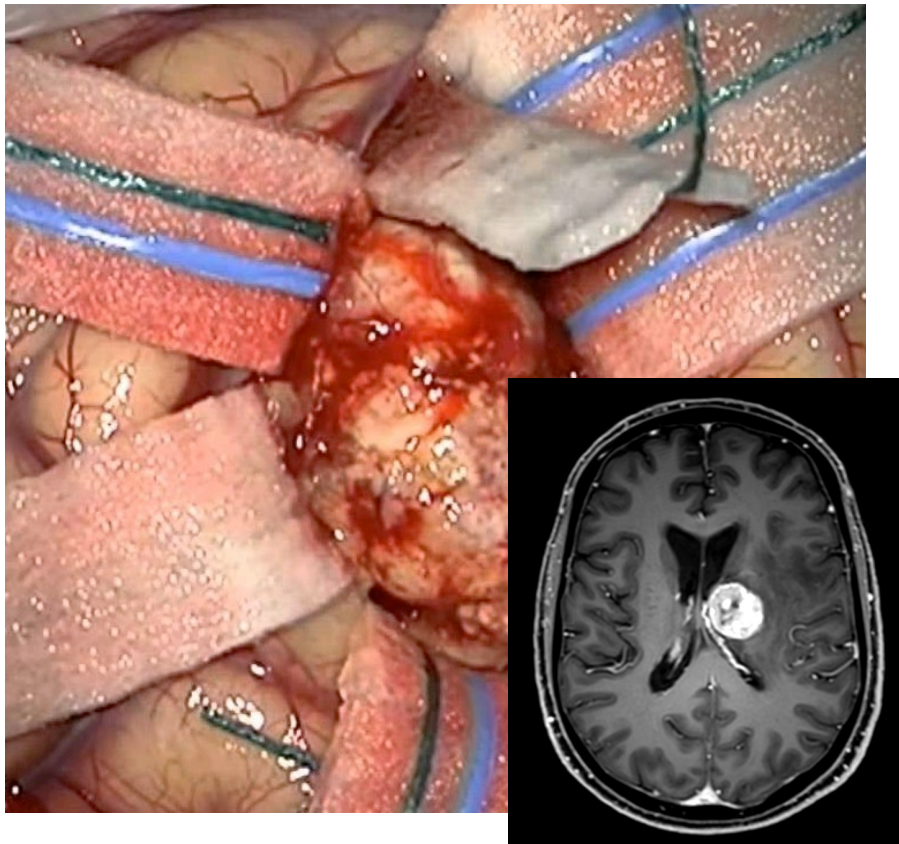


Quelle: Prof. S Grau, Centre of Neurosurgery, University of Cologne

Quelle: Rosahl et al. Laryngo-Rhino-Otol 2017; 96: S152–S182

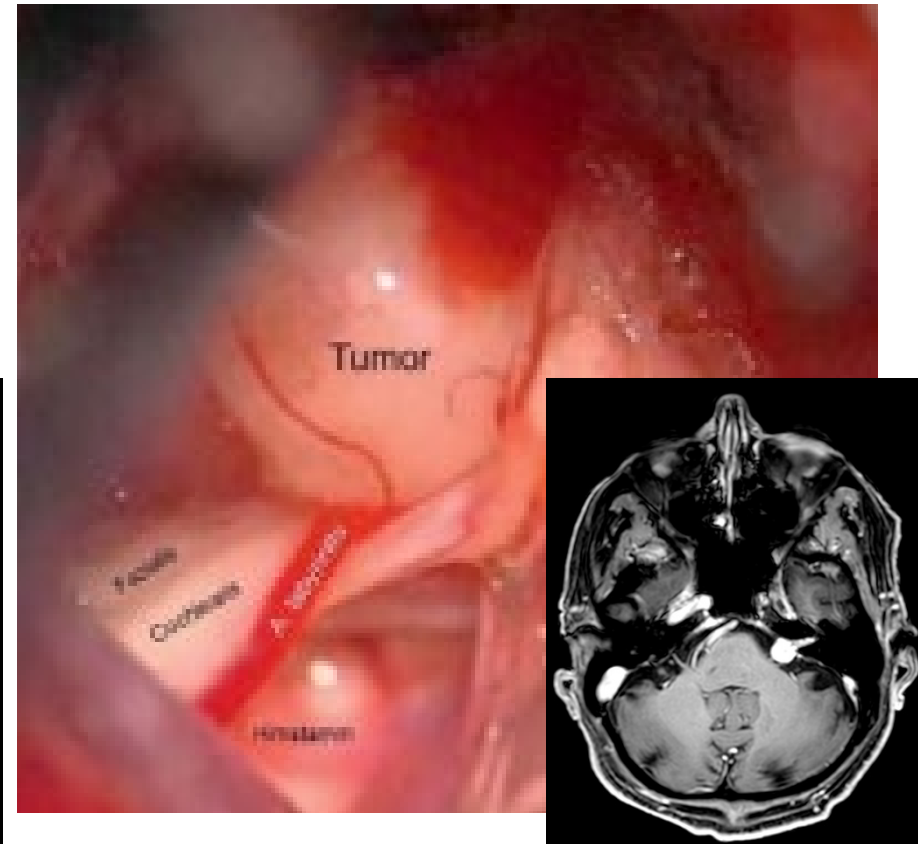
# Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

## Metastase



Quelle: Prof. S Grau, Centre of Neurosurgery, University of Cologne

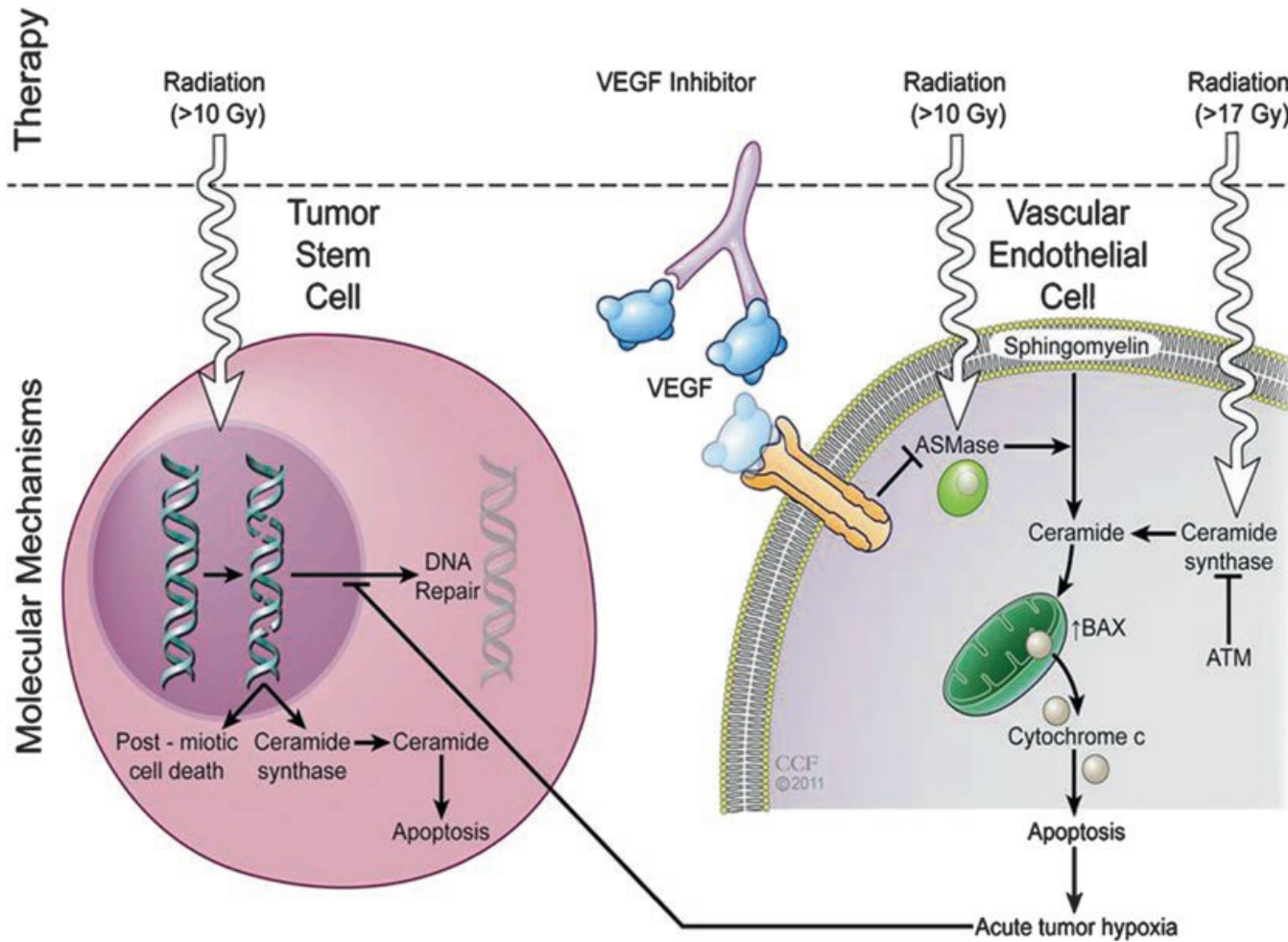
## Vestibularisschwannom



Quelle: Rosahl et al. Laryngo-Rhino-Otol 2017; 96: S152–S182

# Radiobiologie der Radiochirurgie

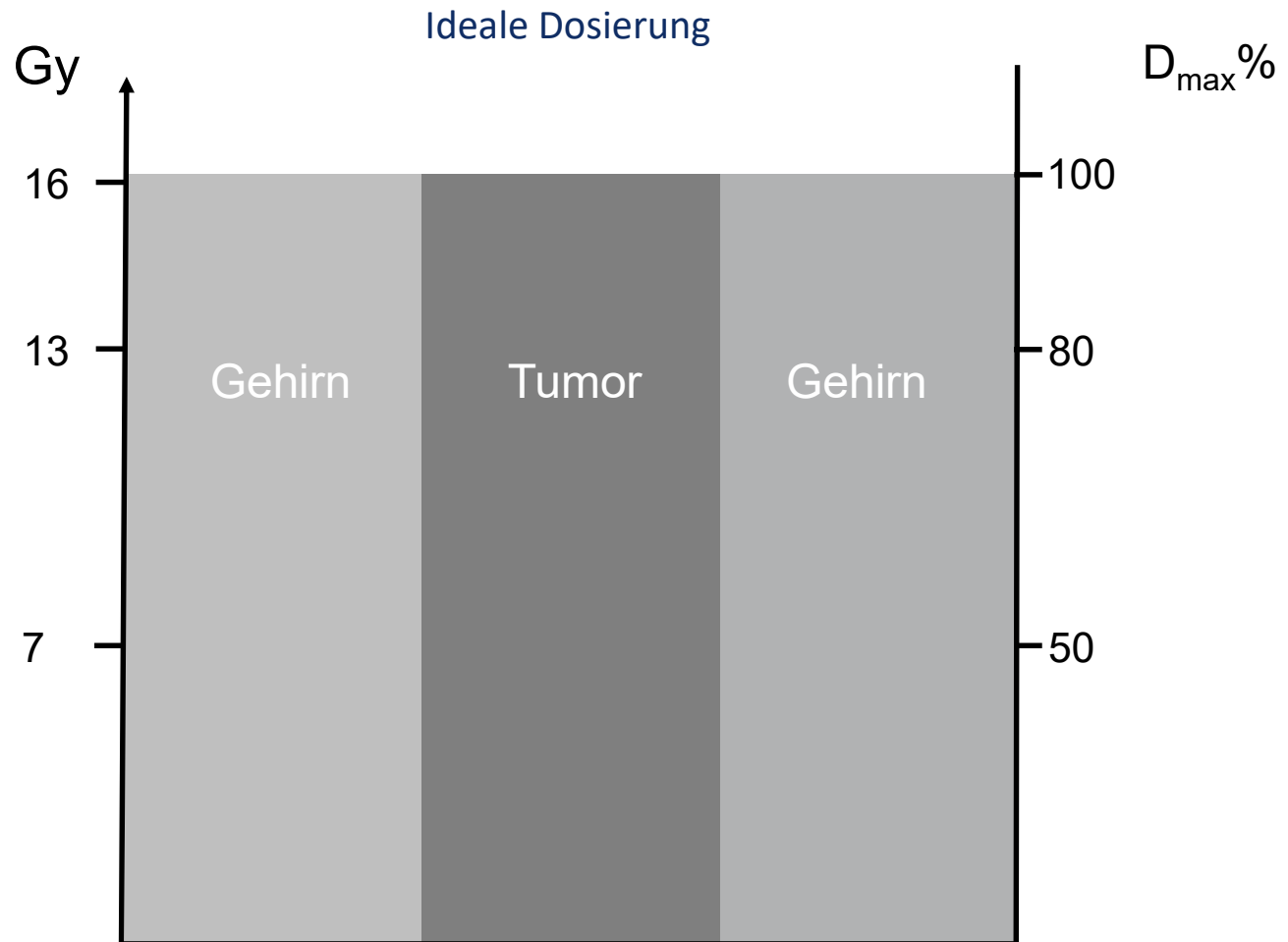
# SRS - Radiobiologie



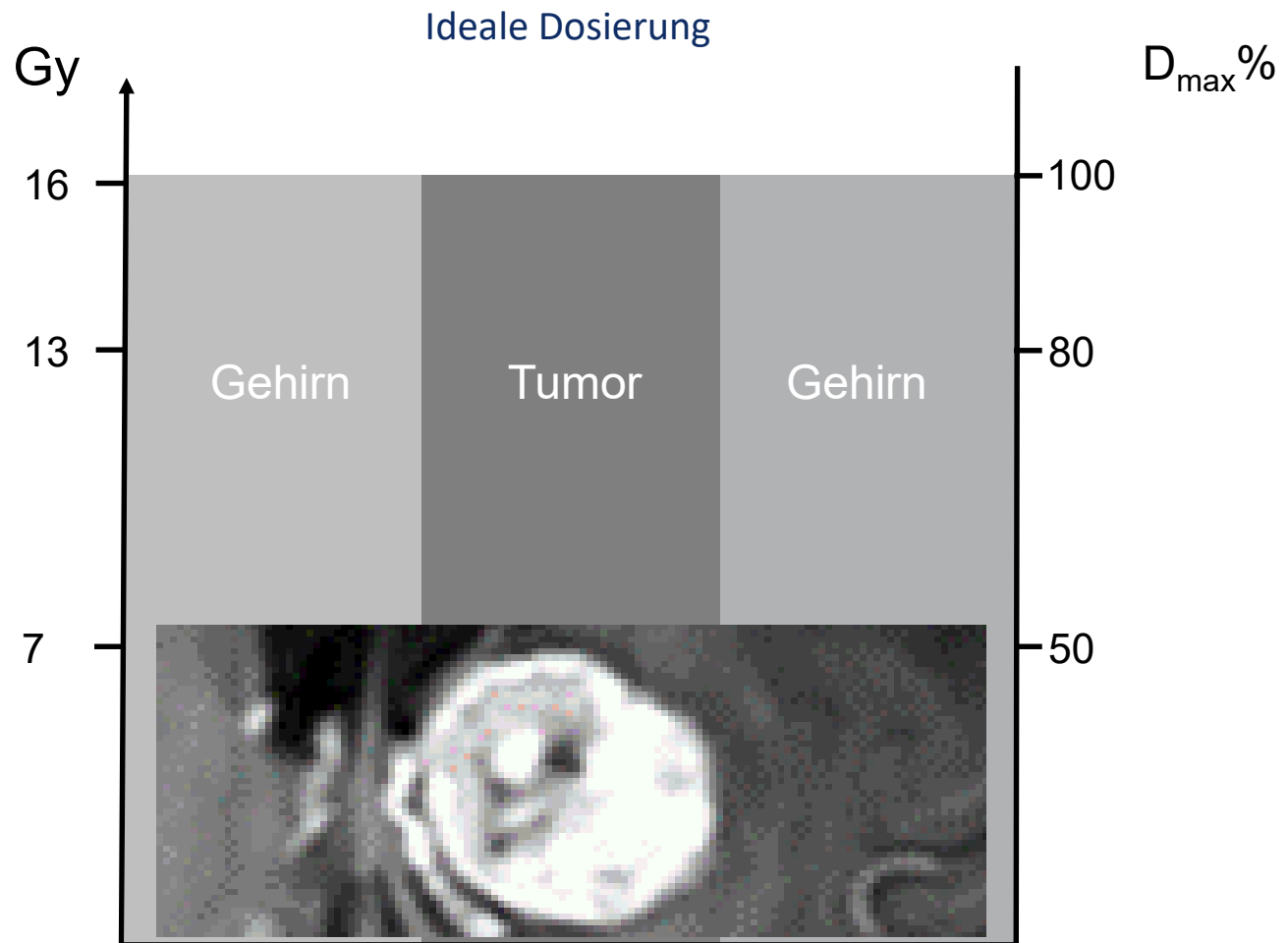
Quelle: Conti et al. (Hrsg) Cyberknife Neuro-Radiosurgery. Springer 2020

# Physikalische Aspekte

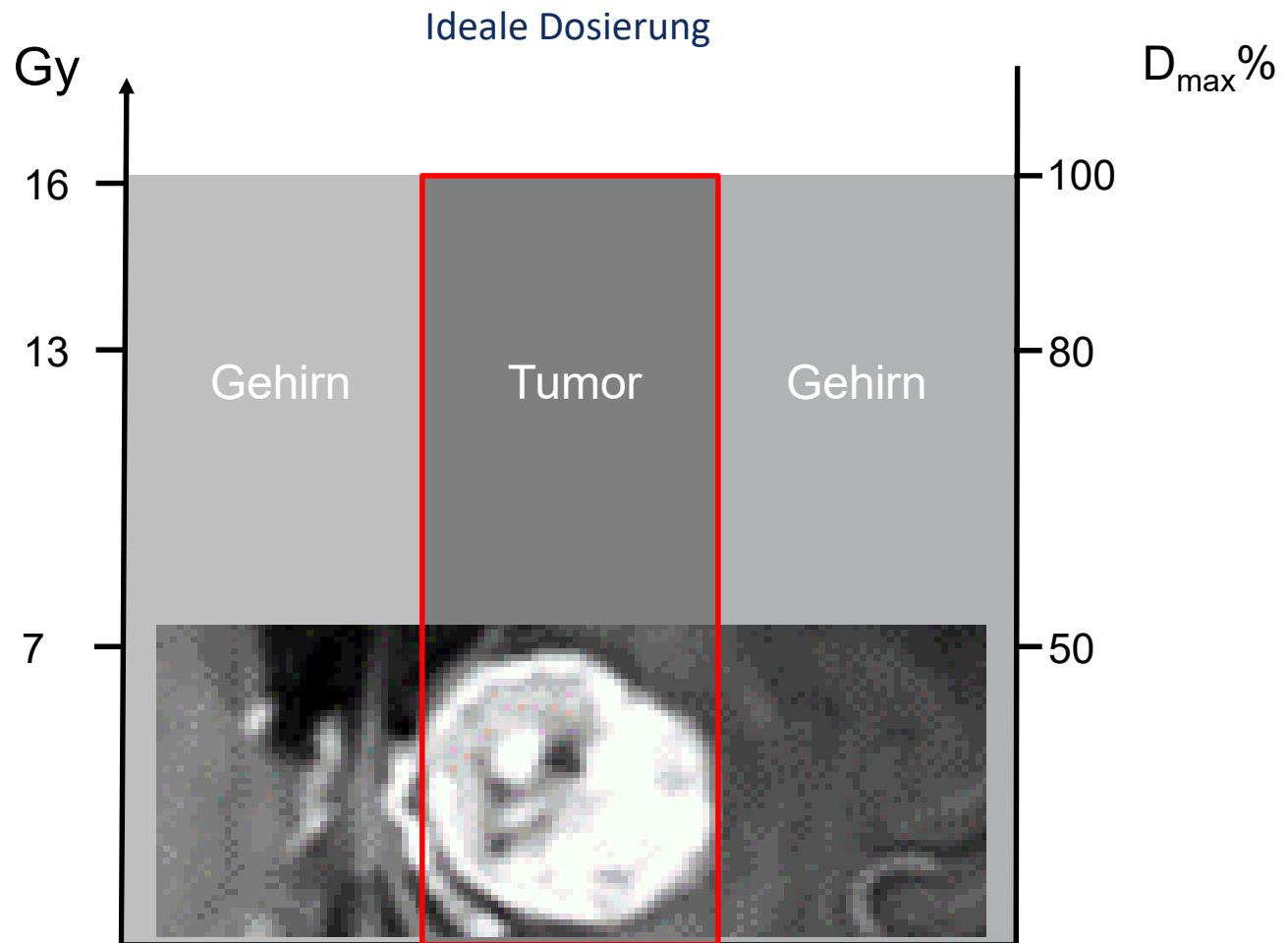
# Räumliche Dosisverteilung



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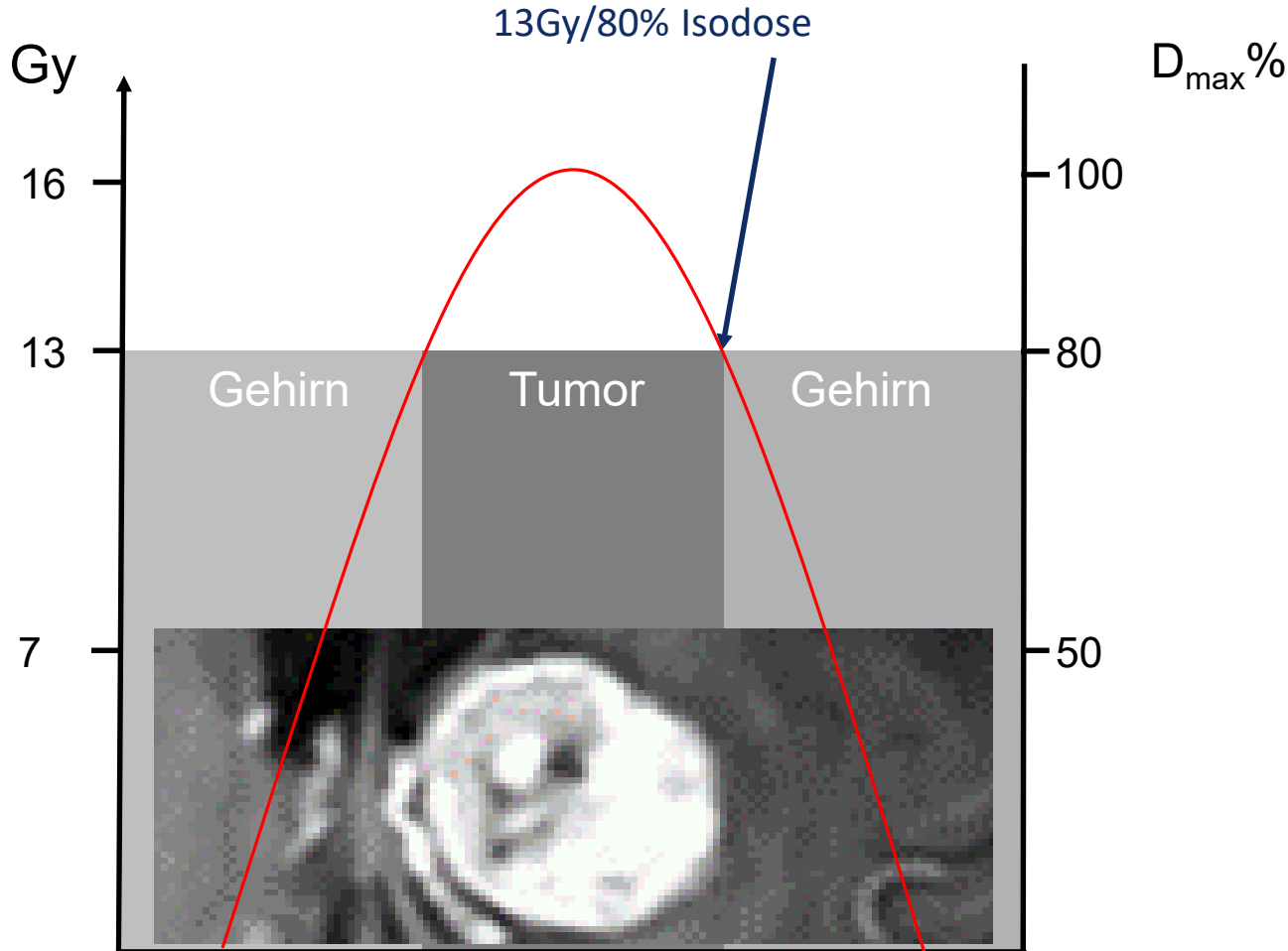


# Räumliche Dosisverteilung

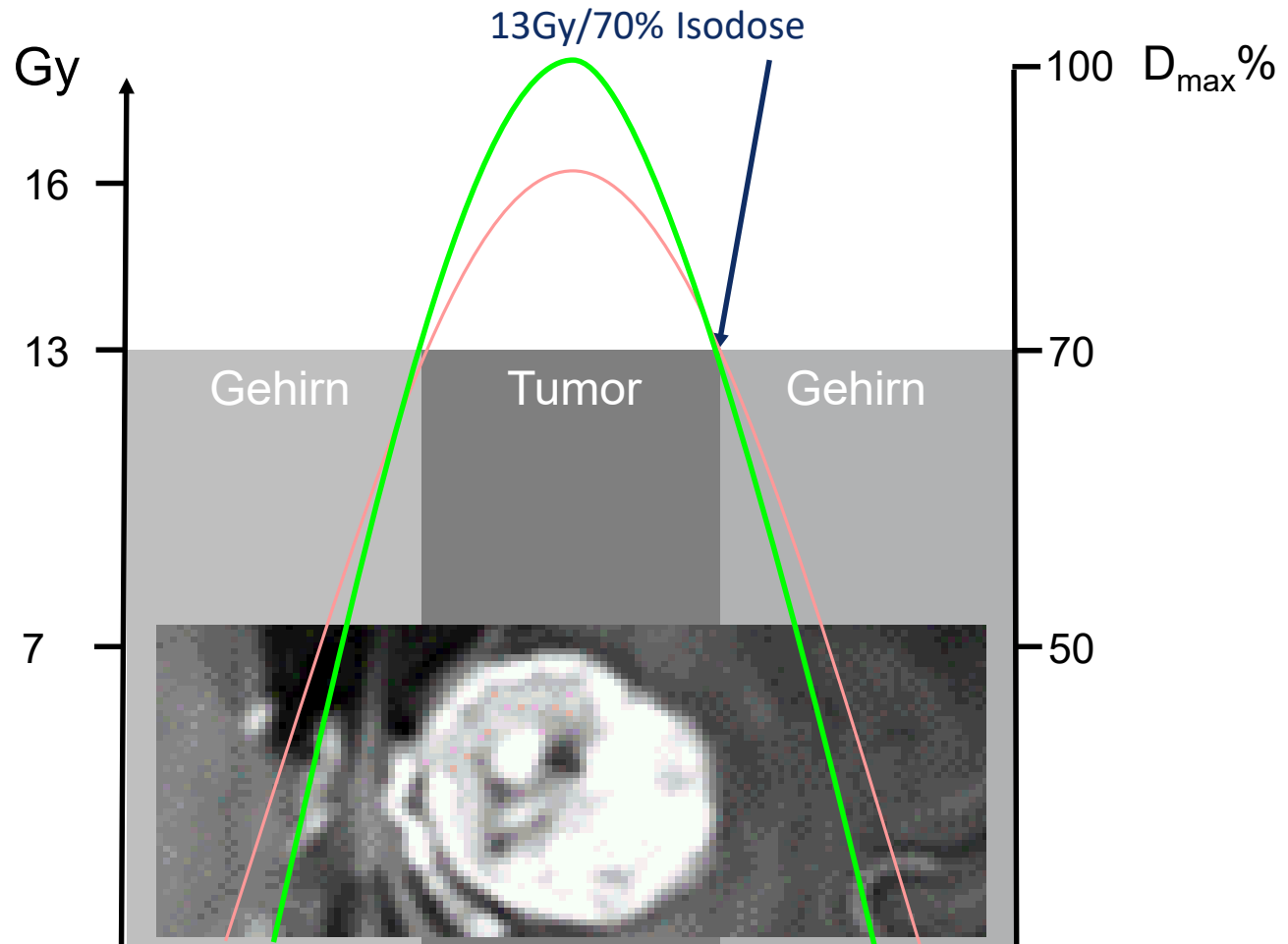




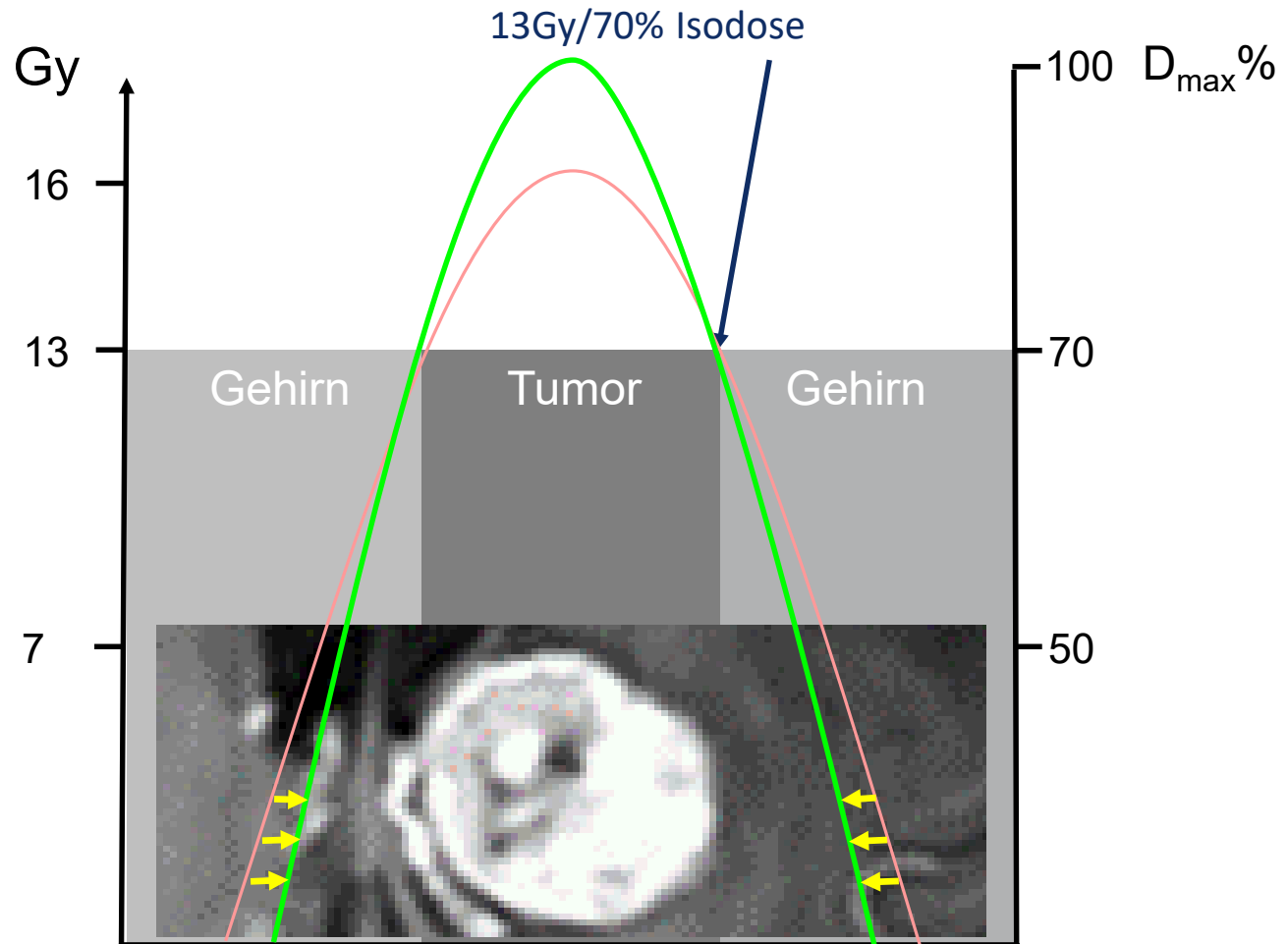
# Räumliche Dosisverteilung



# Modulation des Dosisgradienten



# Modulation des Dosisgradienten



RESEARCH

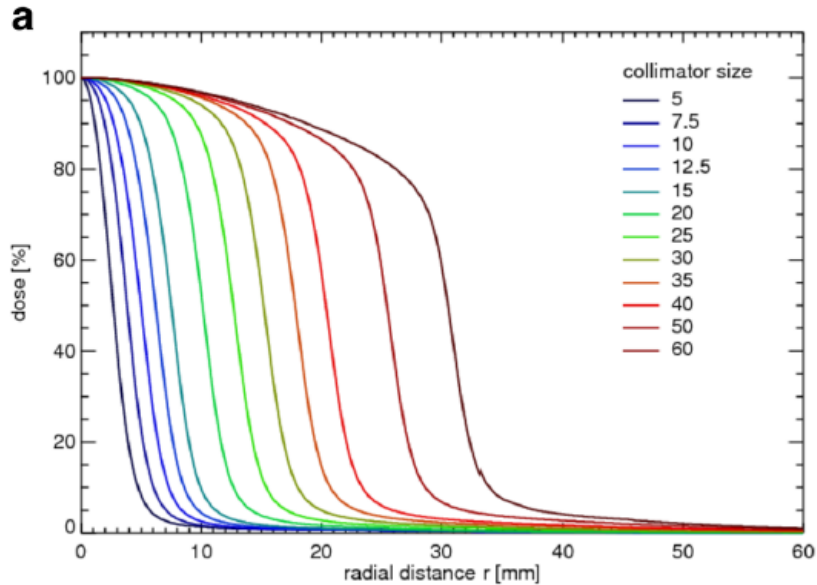
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# Radiotoxicity in robotic radiosurgery: proposing a new quality index for optimizing the treatment planning of brain metastases

Alexandra Hellerbach<sup>1\*</sup>, Klaus Luyken<sup>1</sup>, Mauritius Hoevens<sup>1</sup>, Andreas Gierich<sup>1</sup>, Daniel Ruelß<sup>1</sup>, Wolfgang W. Baus<sup>2</sup>, Martin Kocher<sup>2</sup>, Maximilian I. Ruge<sup>1</sup> and Harald Treuer<sup>1</sup>

## Radialer Dosisverlauf eines einzelnen CK-Kollimator-Stehfelds



RESEARCH

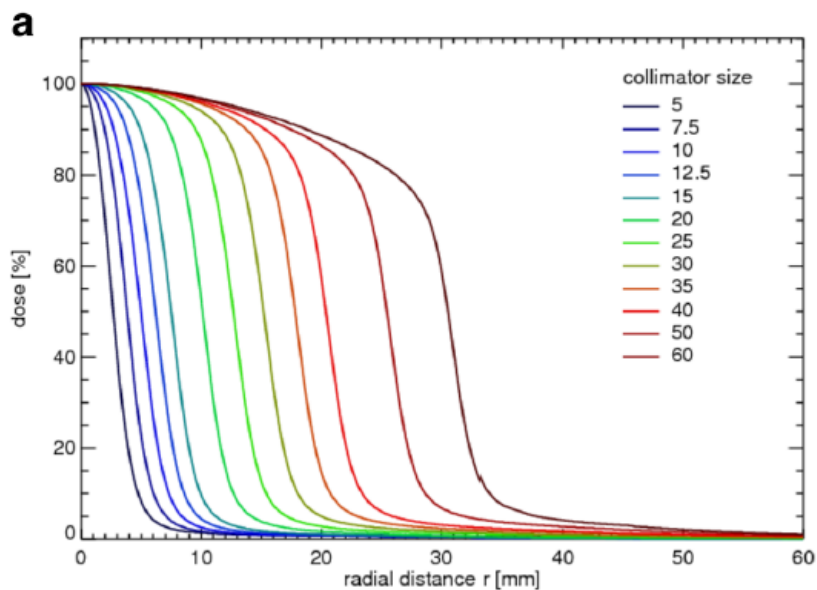
Open Access



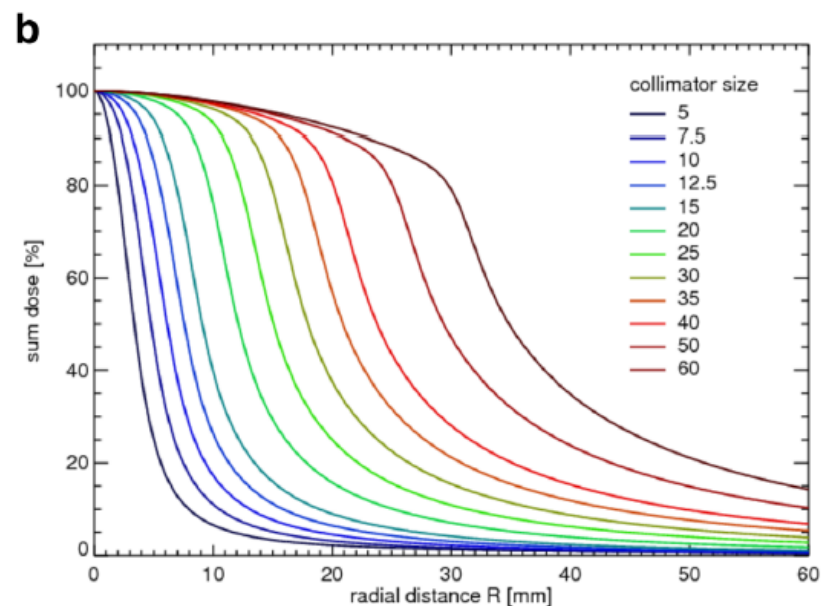
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## Radialer Dosisverlauf eines einzelnen CK-Kollimator-Stehfelds



## Radialer Dosisverlauf einer isozentrischen Bestrahlung mit einem CK-Kollimator



RESEARCH

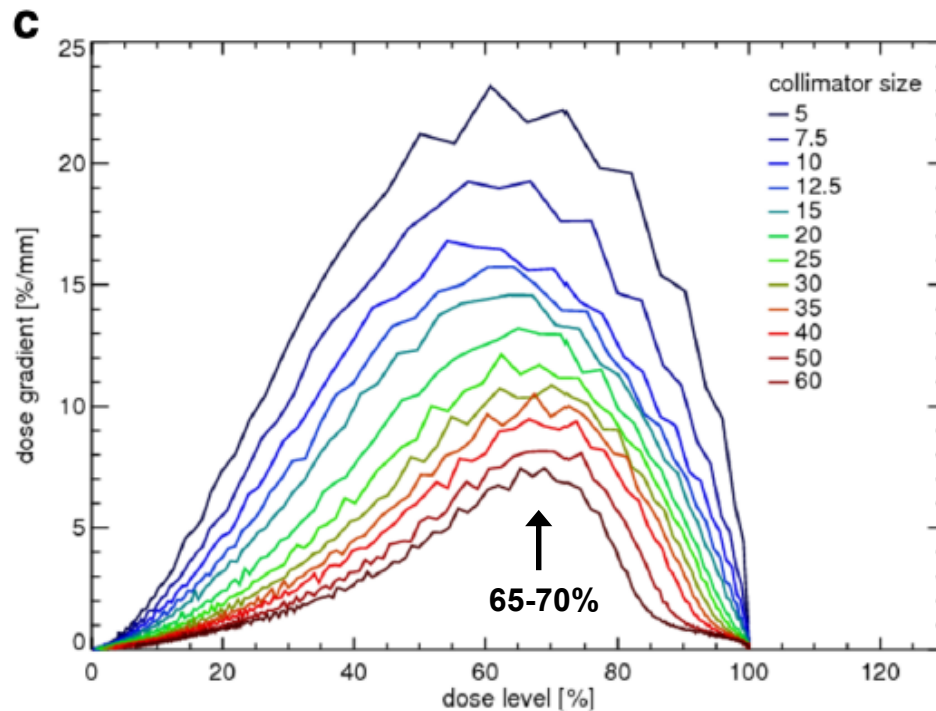
Open Access



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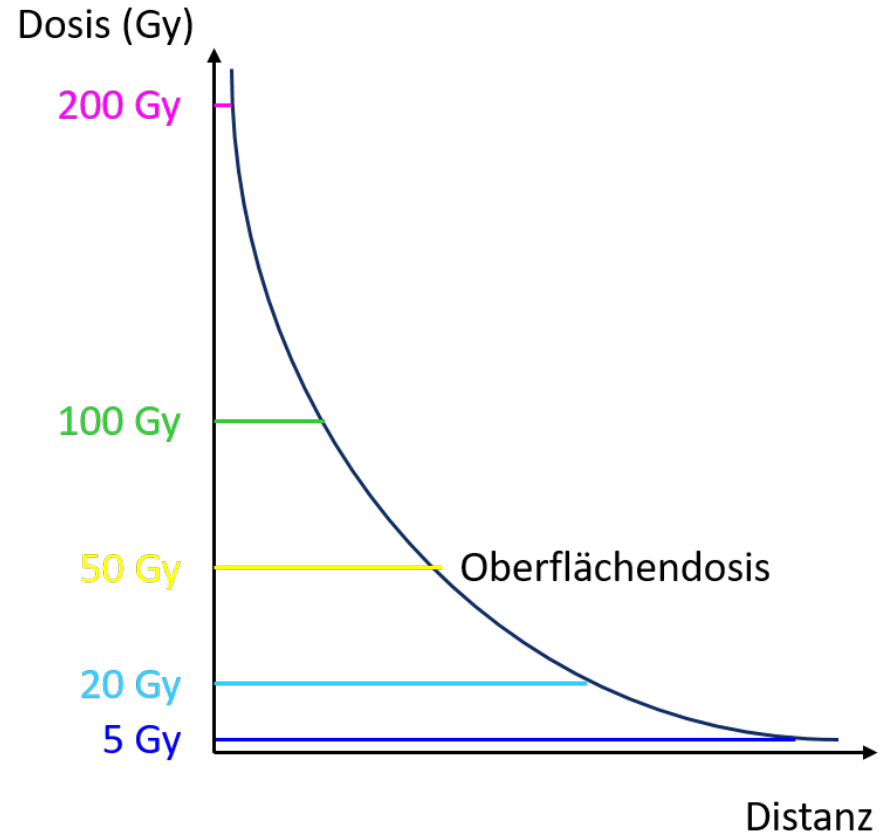
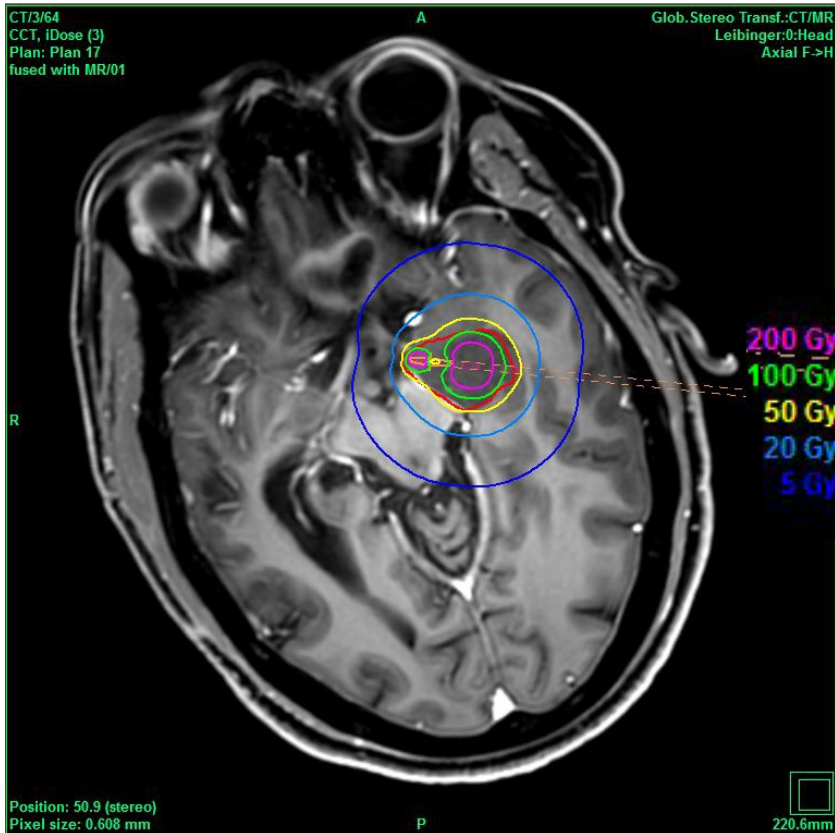
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## Dosisgradient (%/mm) einer isozentrischen Bestrahlung mit einem CK-Kollimator



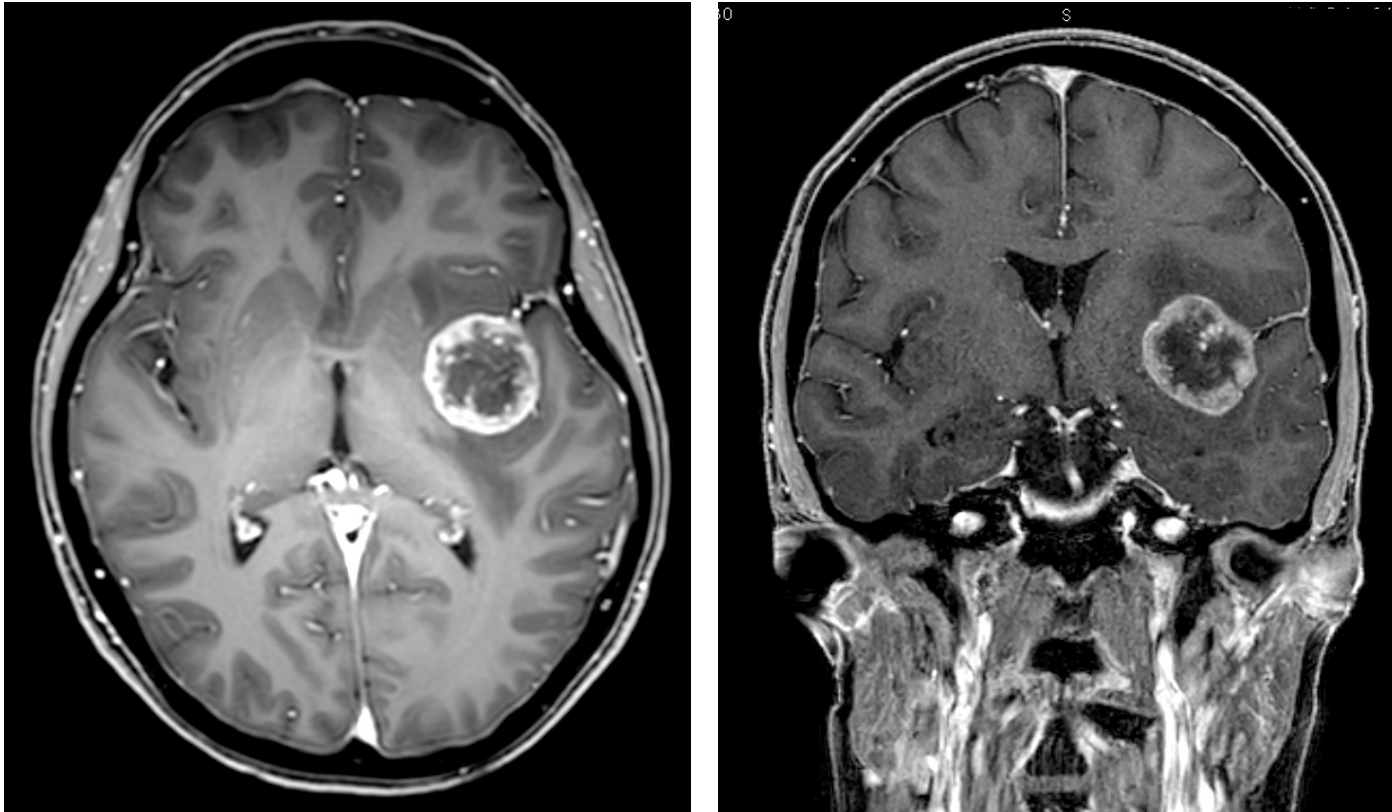
# Sonderform Brachytherapie

# Spezialtechnik: Stereotaktische Brachytherapie (125 Jod Seeds)





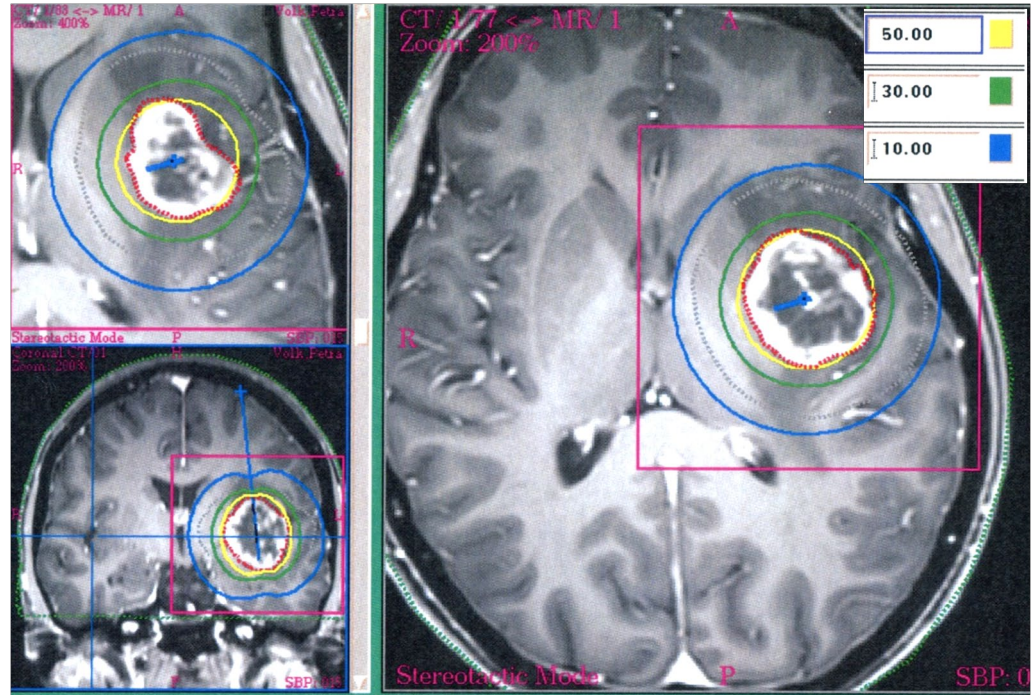
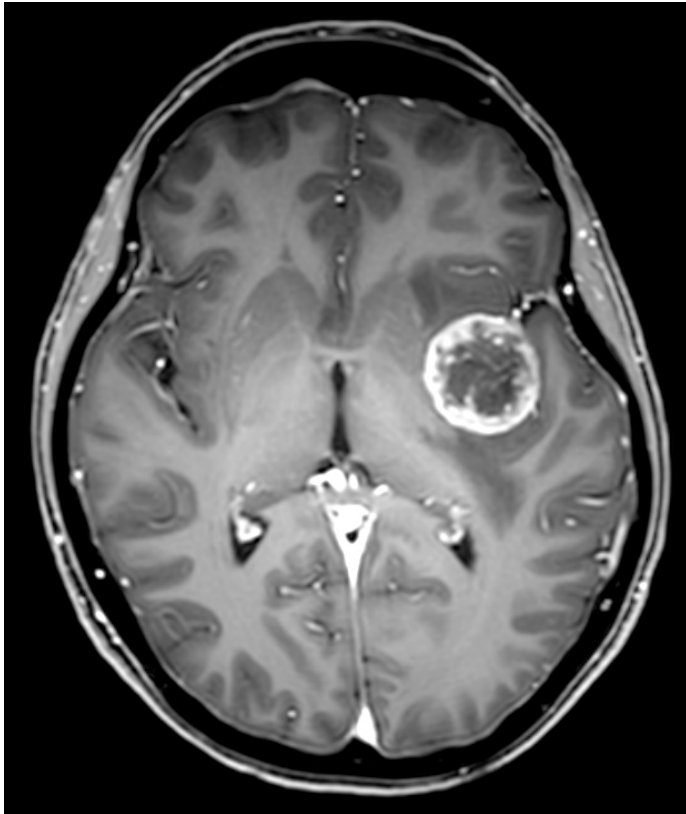
# Fallbeispiel: Stereotaktische Brachytherapie



MRT (10/2015) einer 52 jährige Patientin, Adeno Ca. der Lunge ED 7/2014, Z. n Resektion und Radio-Chemotherapie, systemisch stabil.

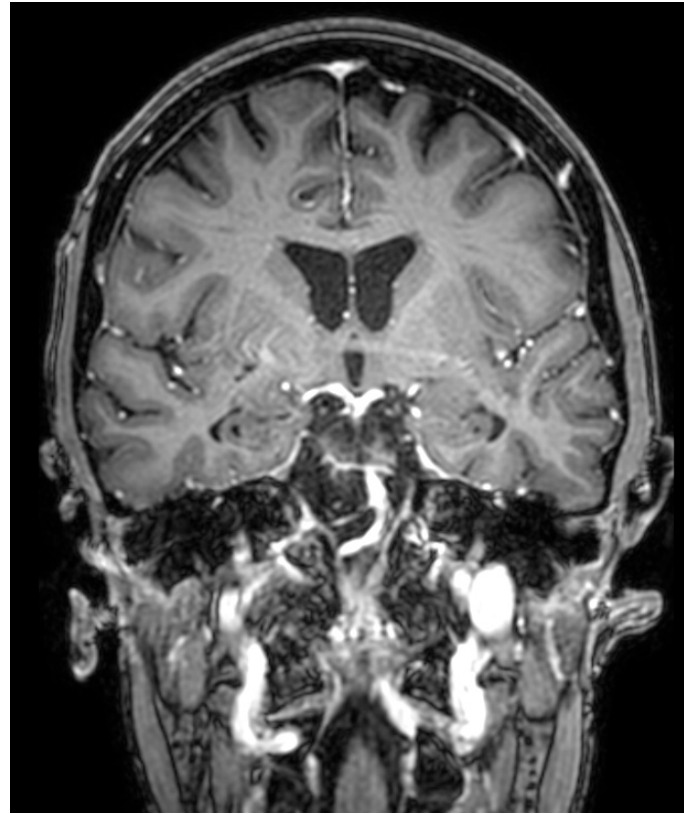
Neurologisch: passagere Sprachstörung, Missempfindungen rechter Arm

# Fallbeispiel: Stereotaktische Brachytherapie



Stereotaktische Brachytherapie ( $^{125}\text{Jod}$  Seeds; Oberflächendosis 50 Gy; 42 Tage)

# Fallbeispiel: Stereotaktische Brachytherapie



MRT (07/2022) Neurologisch unauffällig, systemisch stabil.

Evidenz



ELSEVIER



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Inhomogeneous tumor dose distribution provides better local control than homogeneous distribution in stereotactic radiotherapy for brain metastases

François Lucia<sup>a,b,\*</sup>, Stéphane Key<sup>a</sup>, Gurvan Dissaux<sup>a</sup>, Gaëlle Goasduff<sup>a</sup>, Anne-Sophie Lucia<sup>a</sup>, Luc Ollivier<sup>a</sup>, Olivier Pradier<sup>a,b</sup>, Ulrike Schick<sup>a,b,\*</sup>

<sup>a</sup>Radiation Oncology Department, University Hospital, Brest, France; <sup>b</sup>LaTIM, INSERM, UMR 1101, University of Brest, ISBAM, UBO, UBL, Brest, France

- Homogene vs. inhomogene Dosisverteilung bei fraktionierter stereotaktischer RT (SRT)
- **134 Pat. mit Hirnmetastasen** ( 114 Pat. mit  $\leq 2$ ; 20 Pat. 3-6); (Intervall: 2014 – 2017)
- **„modulated arc therapy“ mit LINAC** (TrueBeam™ STX LINAC)
- Zielparameter: Lokale Kontrolle; Radionekrose



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## Gruppe I

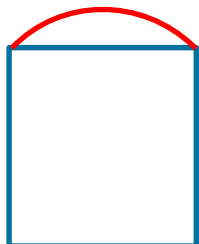
n = 91 Pat. mit 136 Met.

3 x 7.7 Gy

99% Isodosenlevel

D max: 8,1 Gy

7,7 Gy



7,7 Gy

## Gruppe II

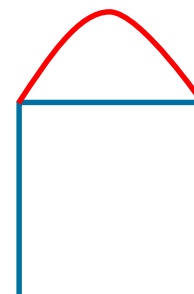
n = 43 Pat. mit 72 Met.

3 x 7,7 Gy

70% Isodosenlevel

D max: 11,0 Gy

7,7 Gy



7,7 Gy



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n = 91 Pat. mit 136 Met.

3 x 7.7 Gy

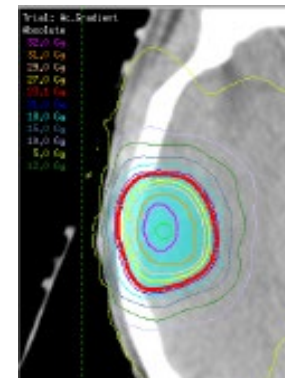
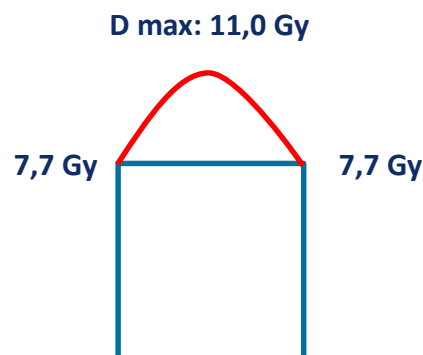
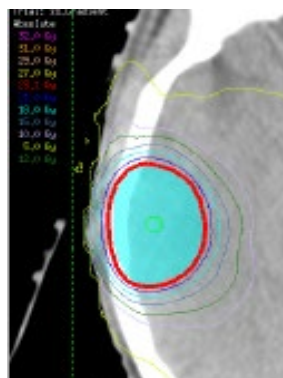
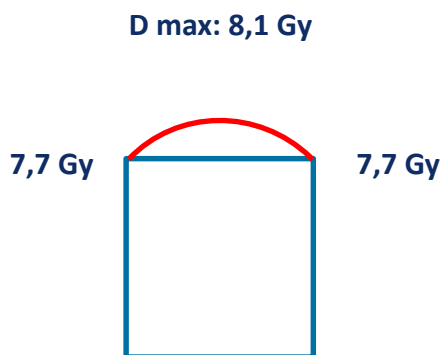
99% Isodosenlevel

### Gruppe II

n = 43 Pat. mit 72 Met.

3 x 7,7 Gy

70% Isodosenlevel



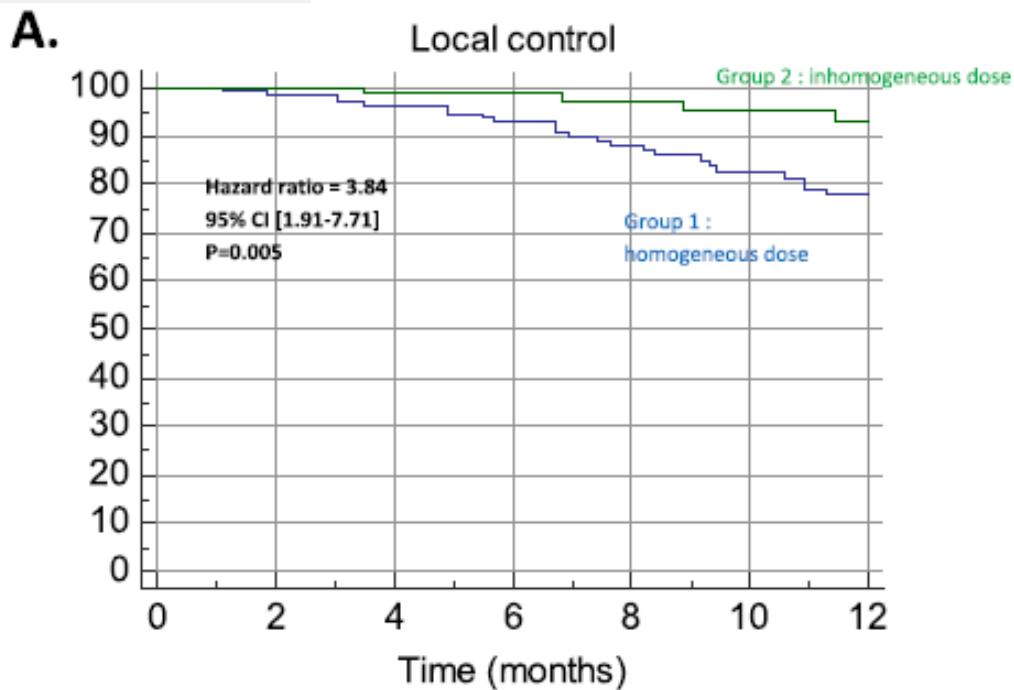


Inhomogeneous tumor dose distribution provides better local control than homogeneous distribution in stereotactic radiotherapy for brain metastases



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Number at risk

Group: 1

136 127 120 110 88 72 54

Group: 2

72 72 71 71 64 41 31





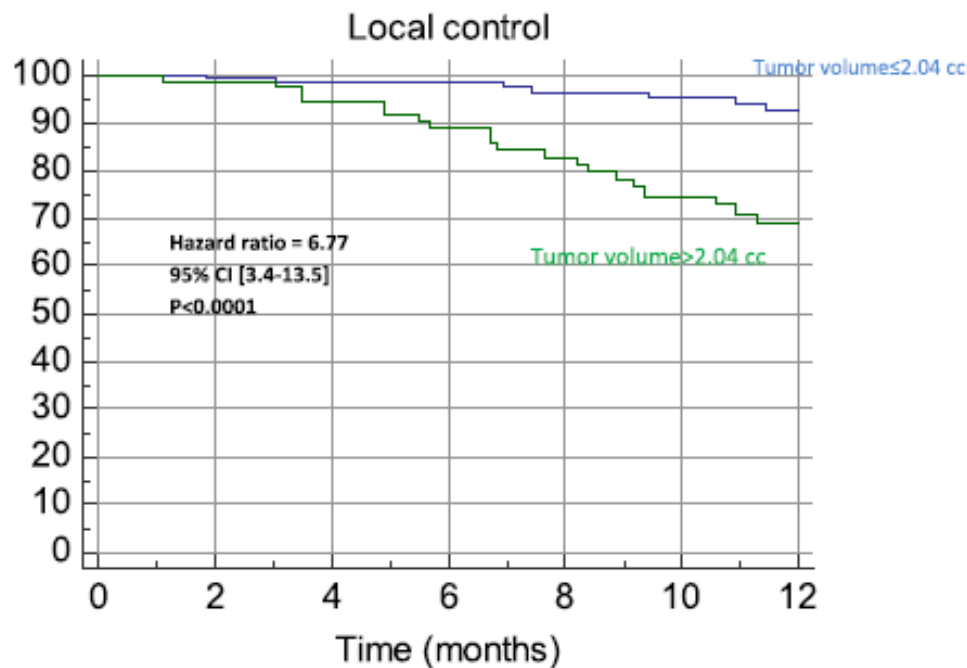
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**B.**



Number at risk

Group: Tumor volume ≤ 2.04 cc

134 127 123 120 97 71 53

Group: Tumor volume > 2.04 cc

74 72 68 61 55 42 32

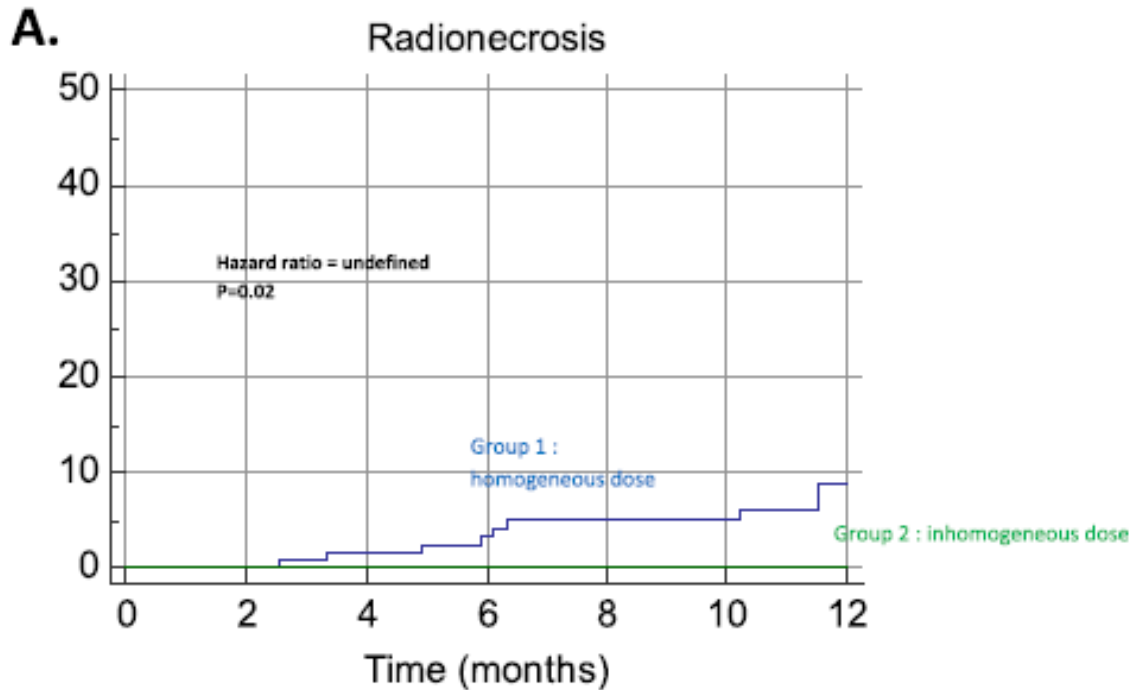


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## Konklusion:

Inhomogene Dosisverteilung zeigt **signifikante**

- Verbesserung der lokalen Kontrolle
- Reduktion der Radionekrose

# Zusammenfassung

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## Inhomogene Dosisverteilung

- Für zerebrale Metastasen aufgrund des Wachstumsmusters geeignet
- Zeigt steilsten Dosisgradienten bei 65 – 70% Isodose (*robotische LINAC Radiochirurgie*)
- Verbessert die lokale Kontrolle
- Reduziert Radionekrose



**Vielen Dank für ihre Aufmerksamkeit!**