



UNIKLINIK
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Inhomogene Dosisverteilung im Zielvolumen: Argumente und Evidenz

Maximilian I. Ruge

Klinik für Stereotaxie und funktionelle Neurochirurgie,
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Uniklinik Köln

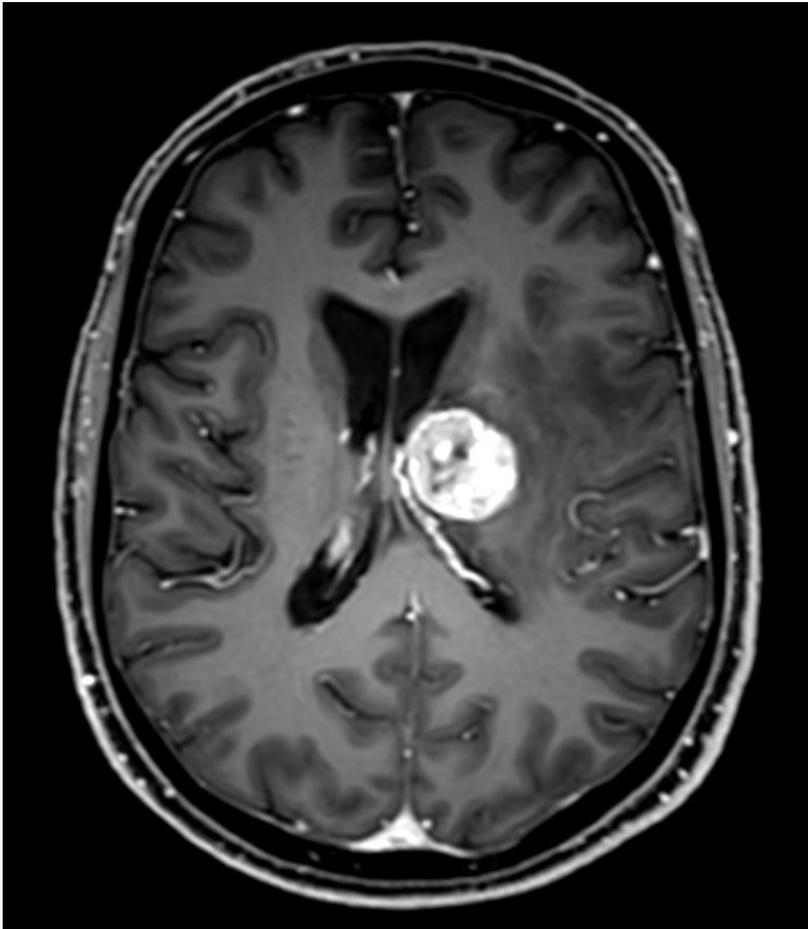
Agenda: pro inhomogener Dosisverteilung bei Hirnmetastasen

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

Wachstumsmuster

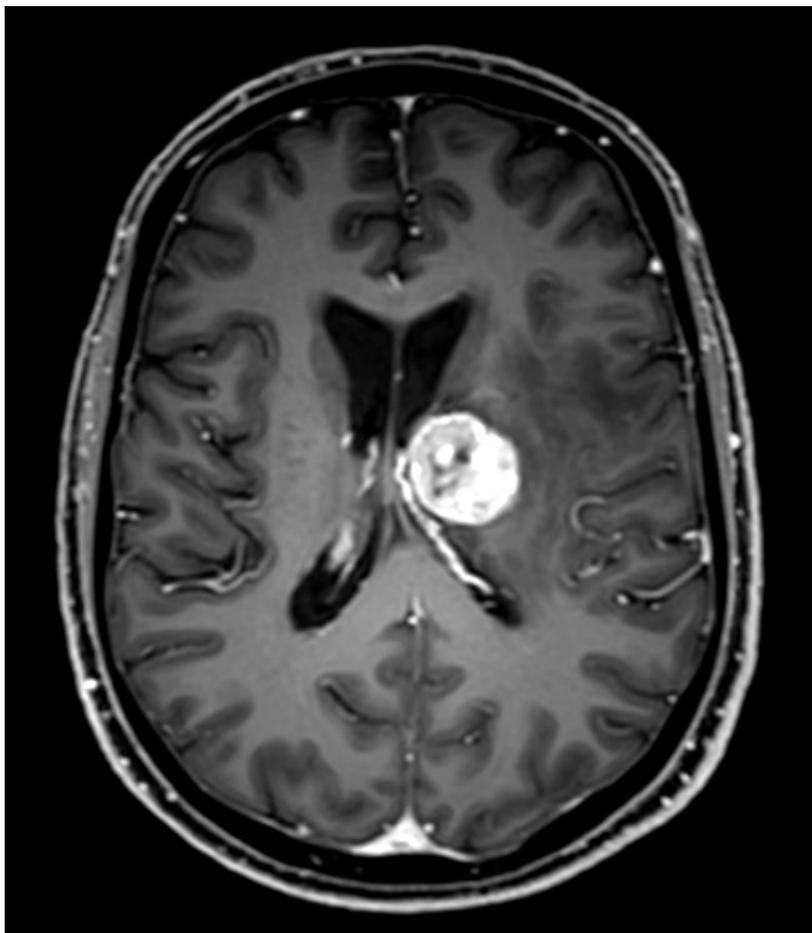
Wachstumsmuster: Metastasen vs. Vestibularisschwannom (MRT)

Metastase

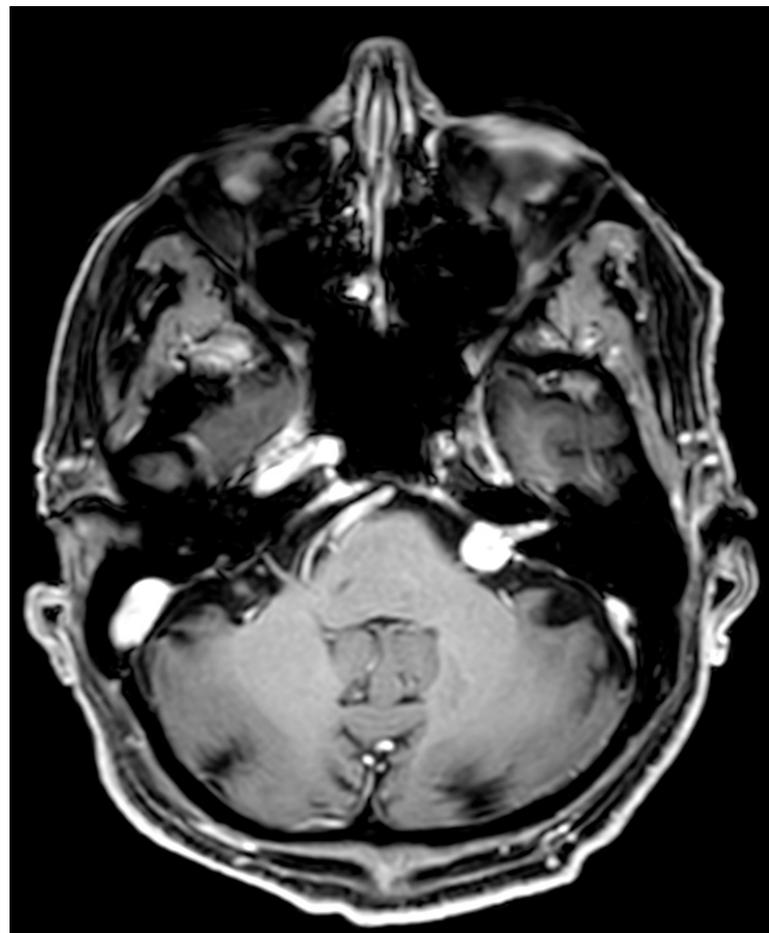


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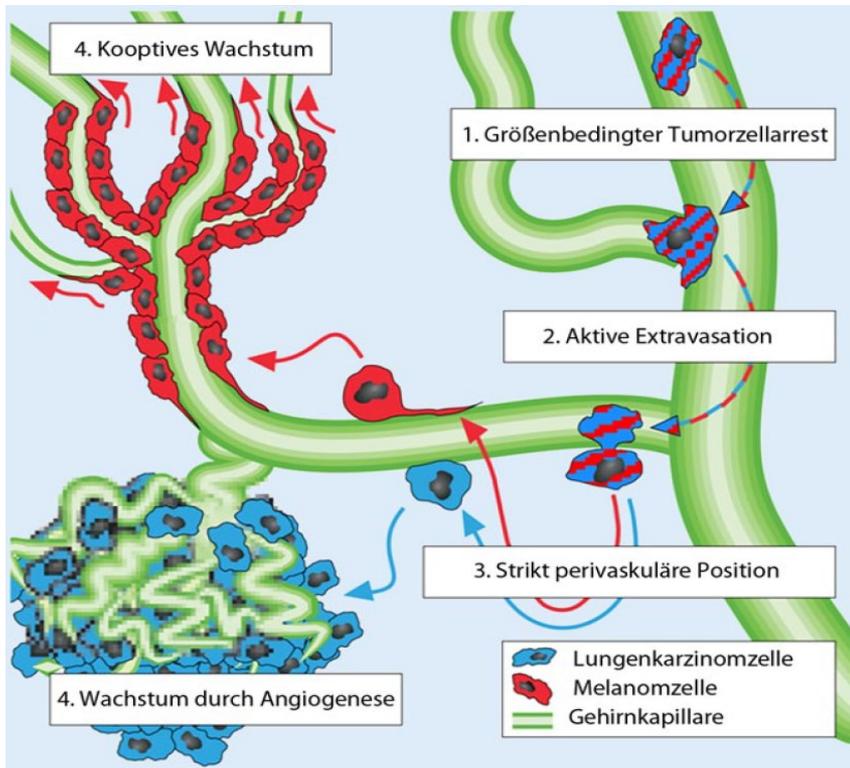


Vestibularisschwannom



Wachstumsmuster: Metastasen vs. Vestibularisschwannom (Schema)

Metastase

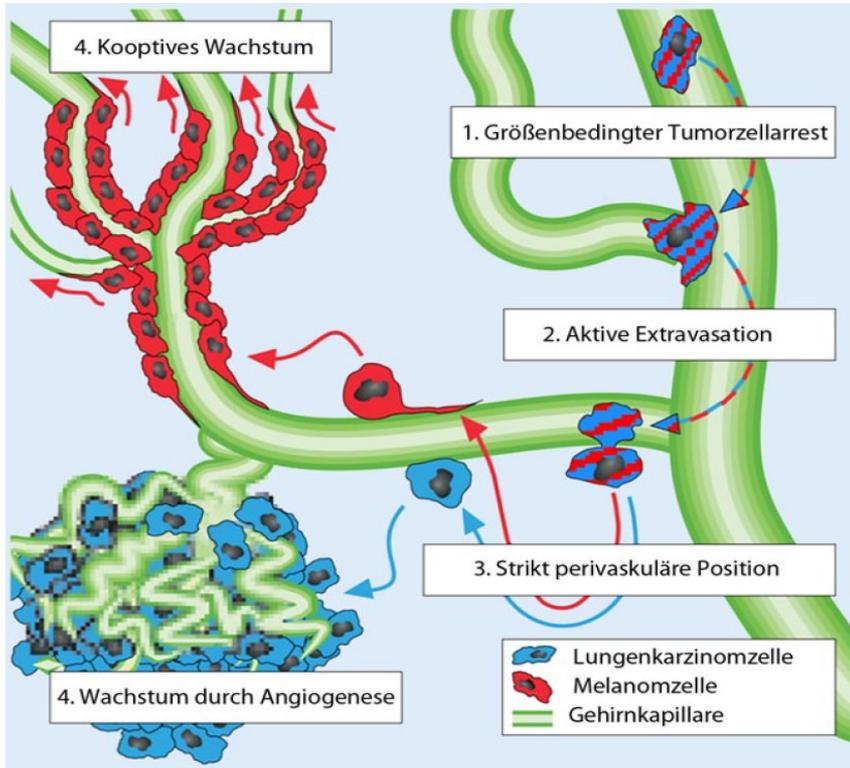


Quelle: Winkler et al. Onkologie 2014; 20: 10–19

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

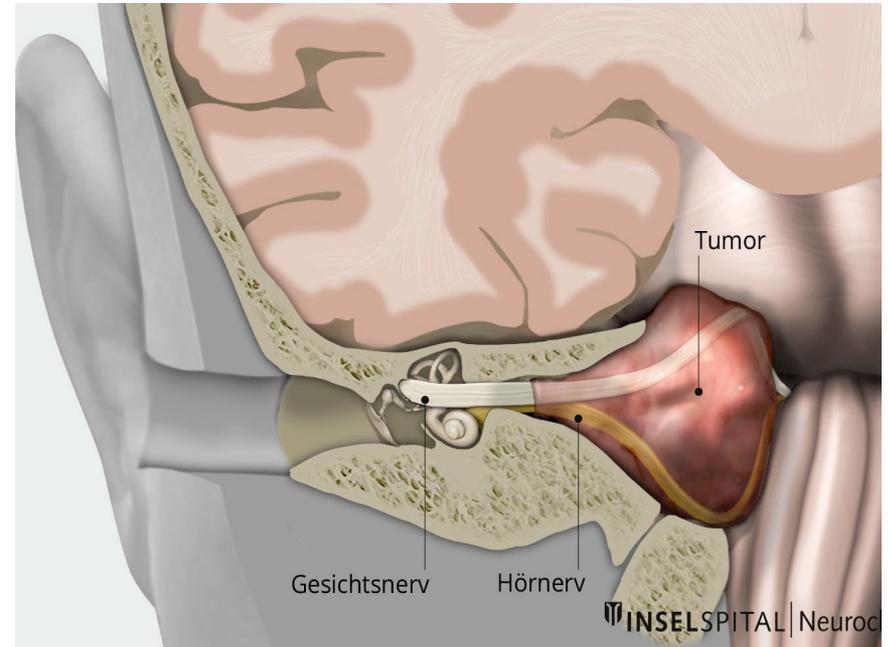
Wachstumsmuster: Metastasen vs. Vestibularisschwannom (Schema)

Metastase



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

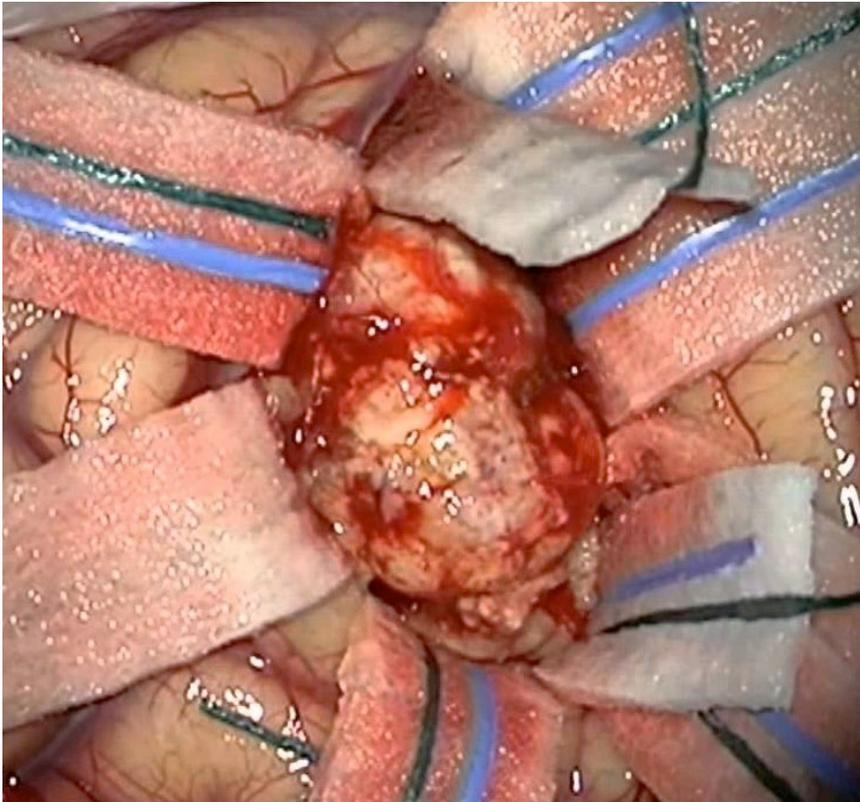
Vestibularisschwannom



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

Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

Metastase

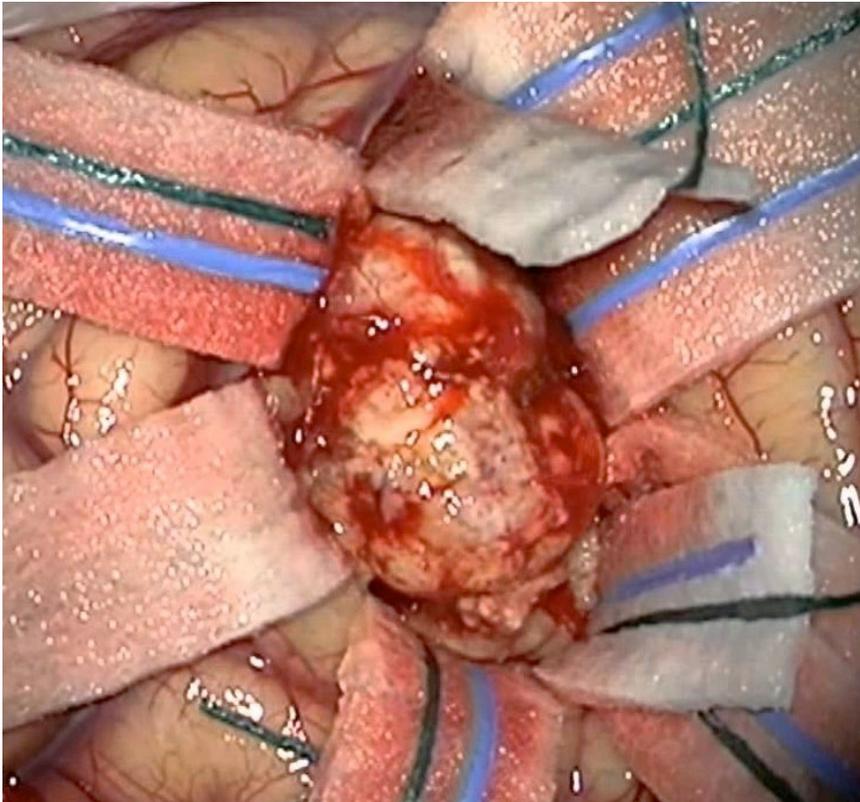


Quelle: Prof. S Grau, Centre of Neurosurgery, University of Cologne

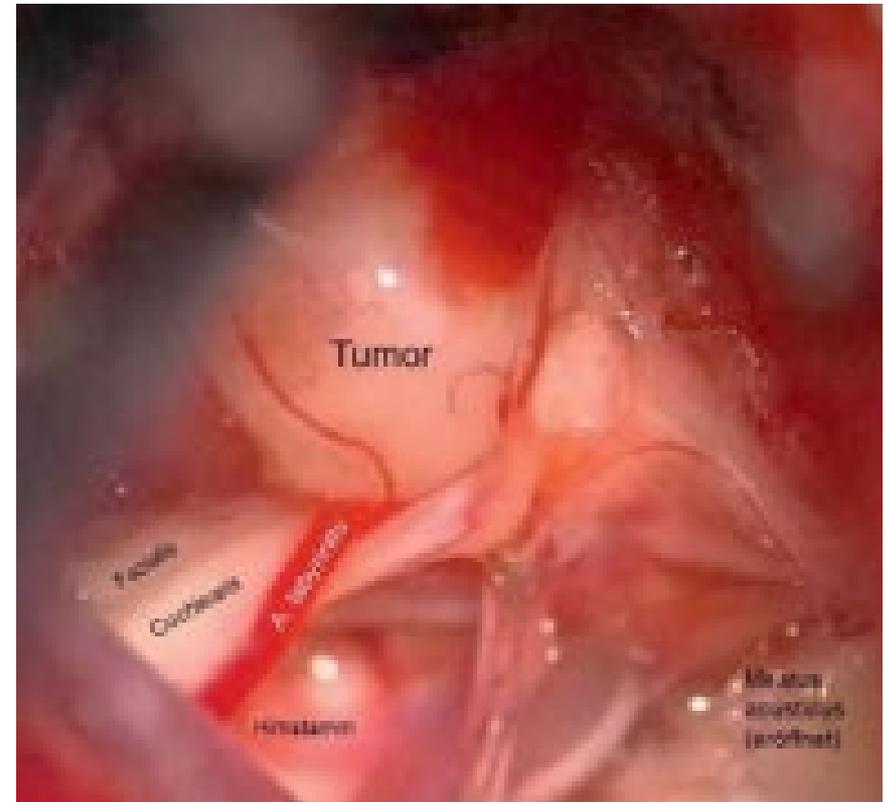
Quelle: Rosahl et al. Laryngo-Rhino-Otol 2017; 96: S152–S182

Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

Metastase



Vestibularisschwannom

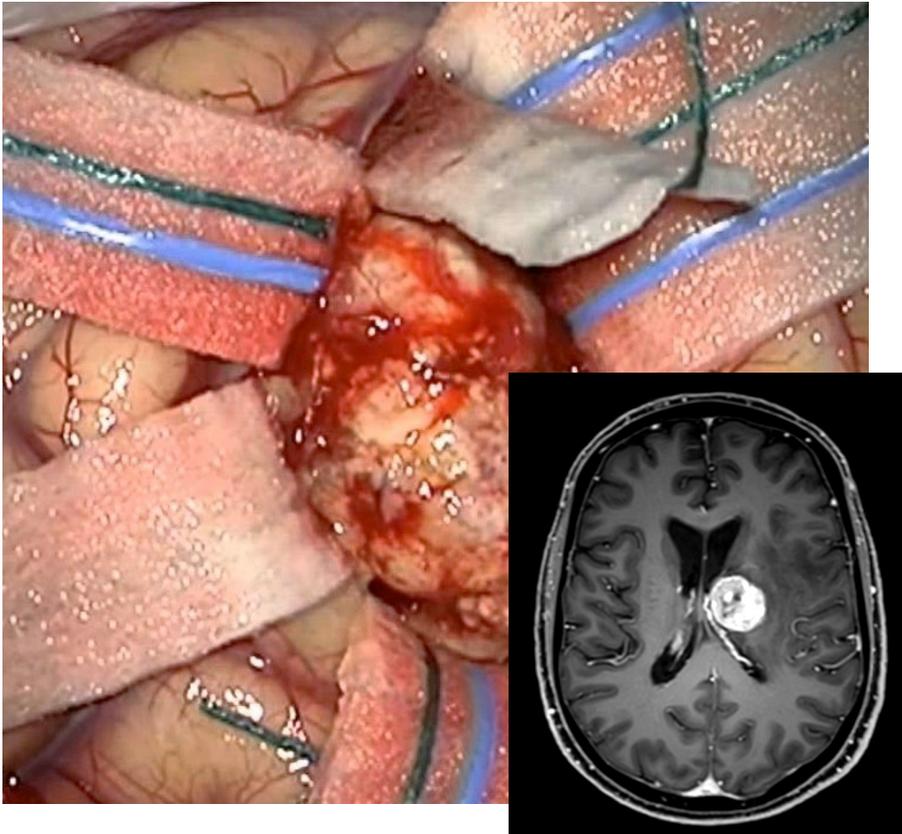


Quelle: Prof. S Grau, Centre of Neurosurgery, University of Cologne

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

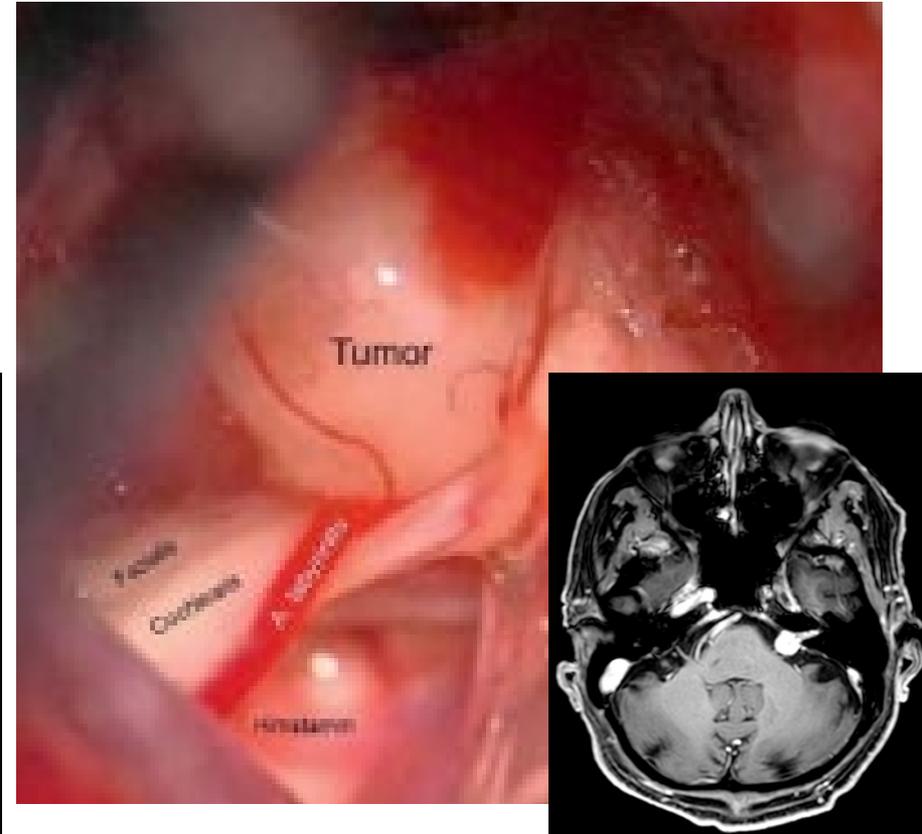
Wachstumsmuster: Metastasen vs. Vestibularisschwannom (intra OP)

Metastase



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

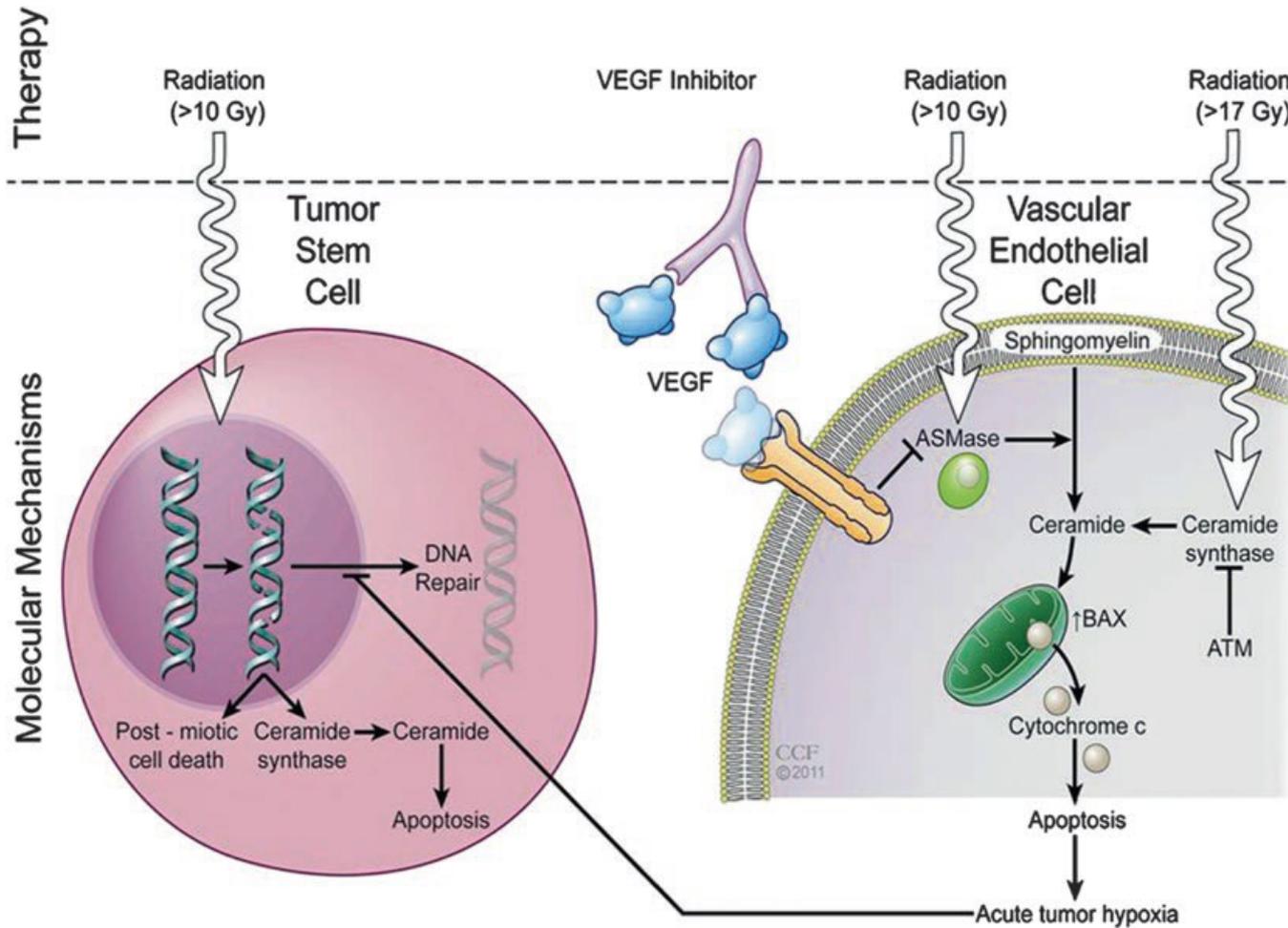
Vestibularisschwannom



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

Radiobiologie der Radiochirurgie

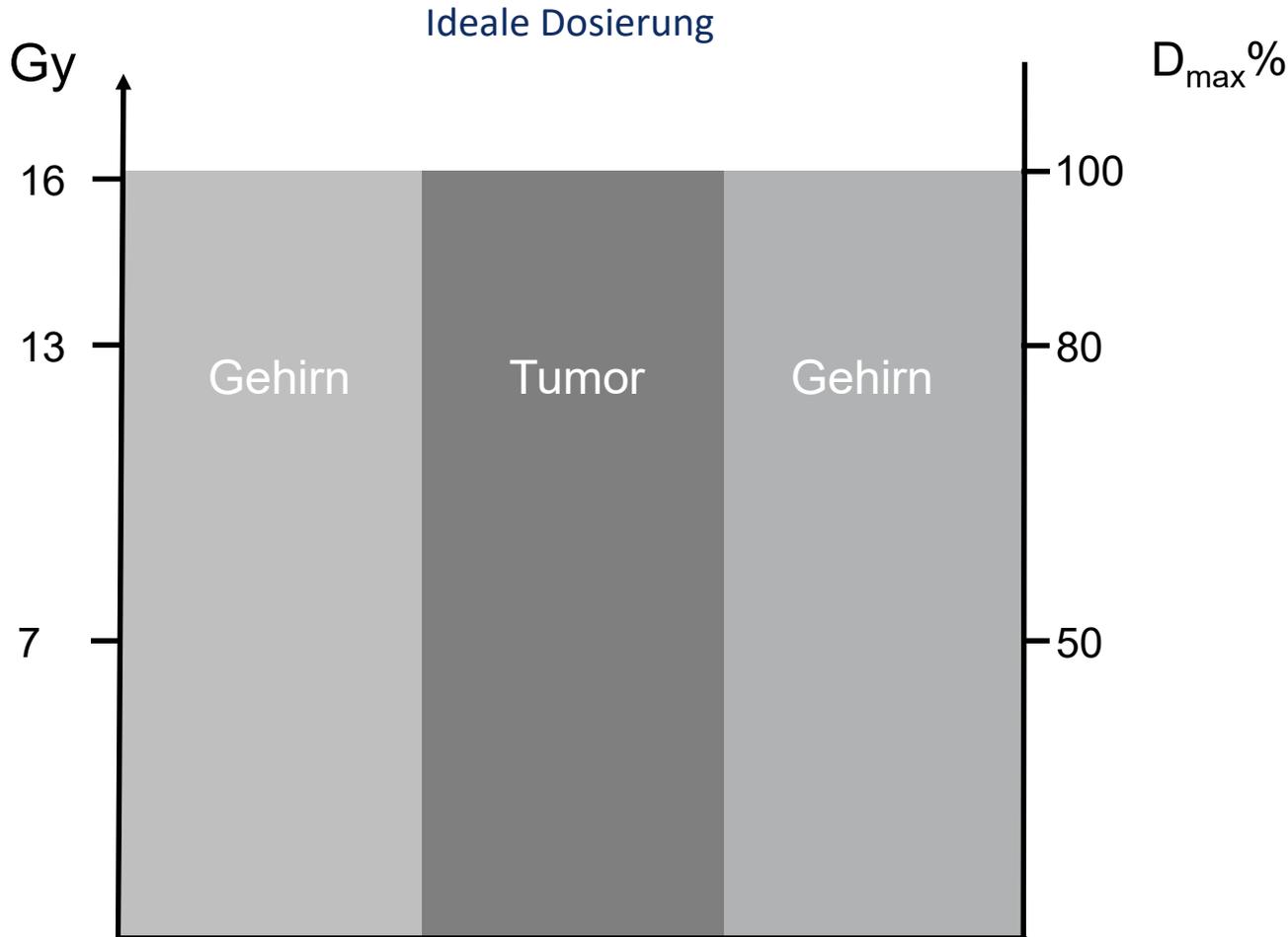
SRS - Radiobiologie



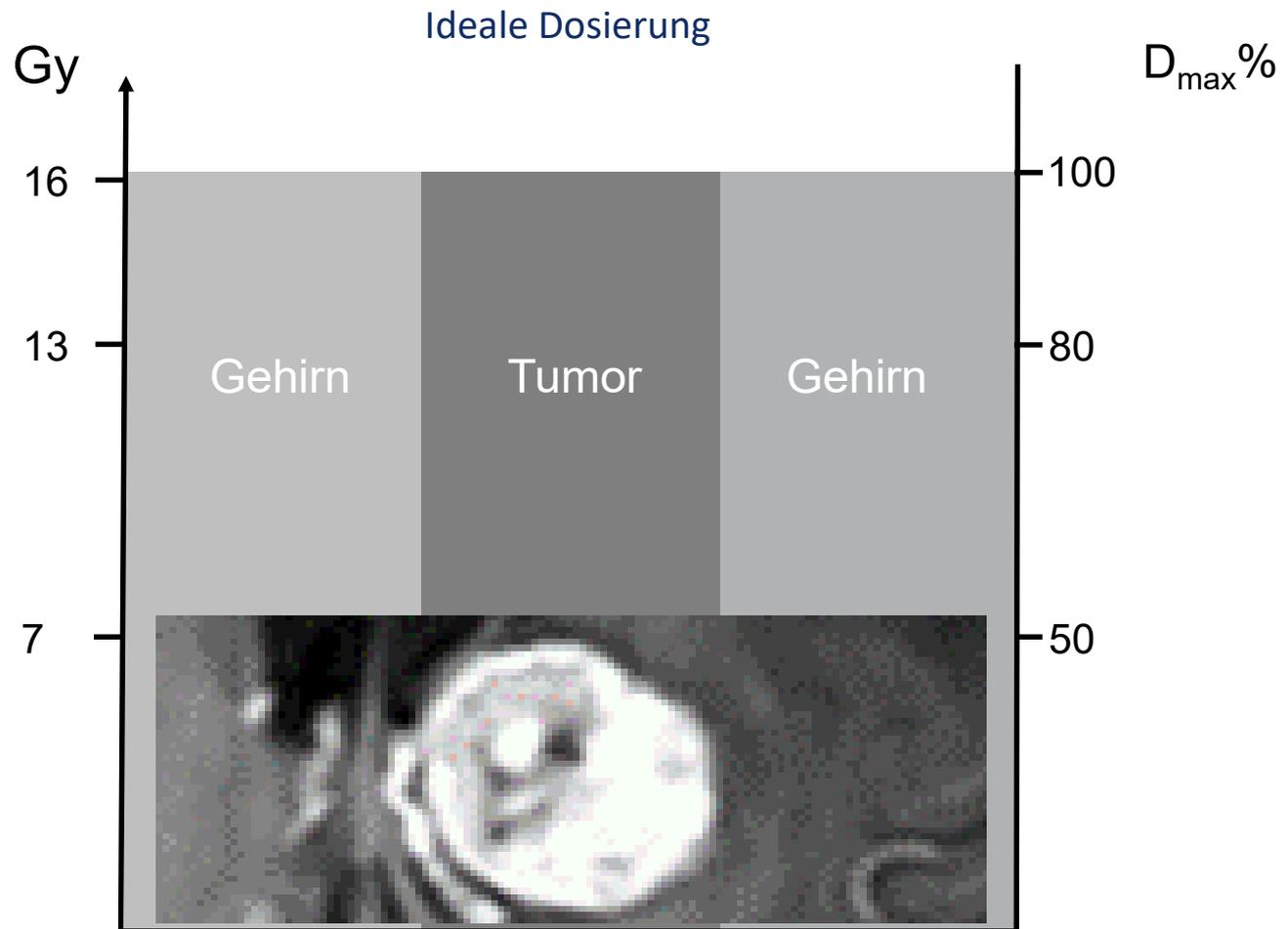
Quelle: Conti et al. (Hrsg) Cyberknife Neuro-Radiosurgery. Springer 2020

Physikalische Aspekte

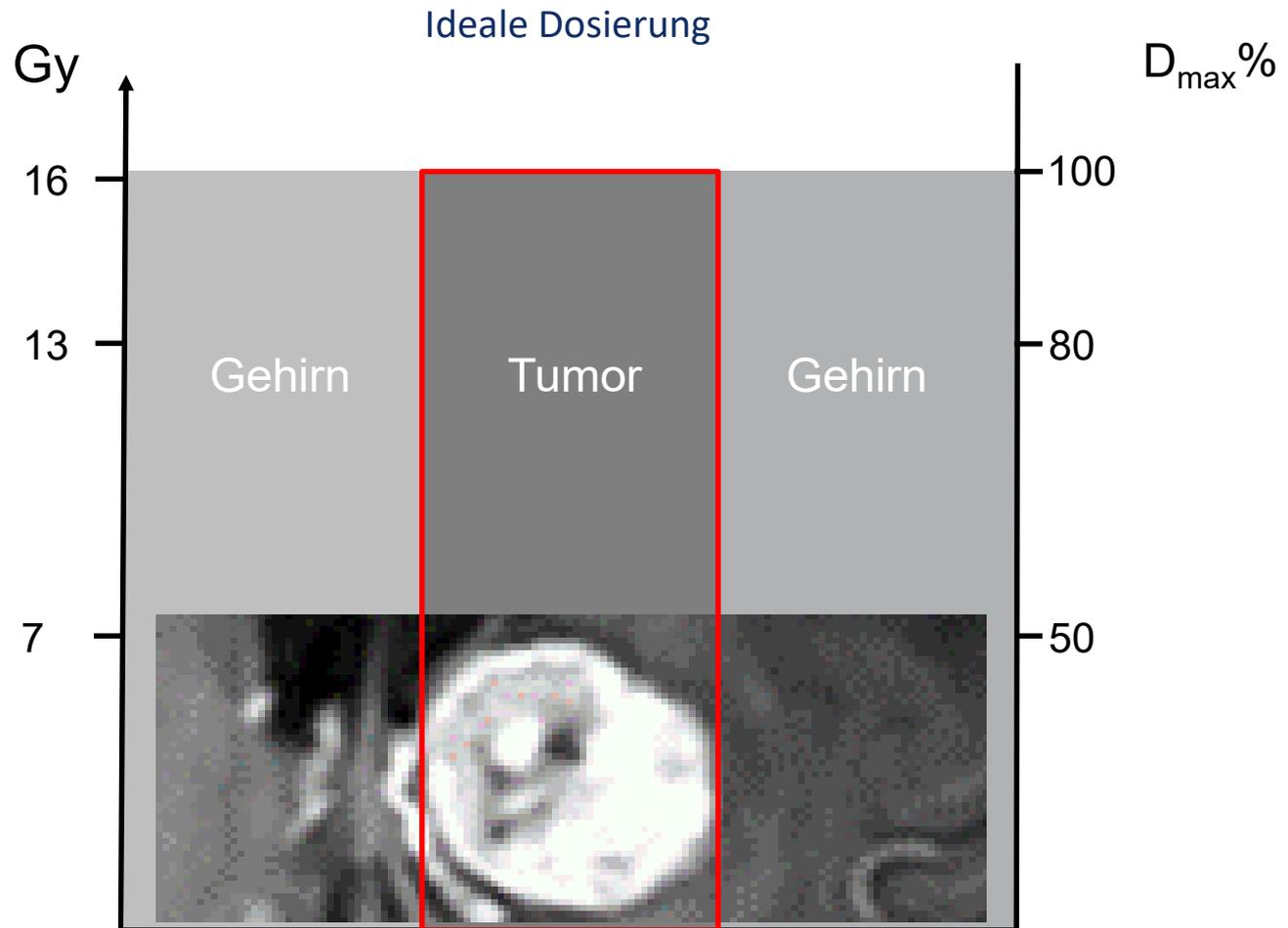
Räumliche Dosisverteilung



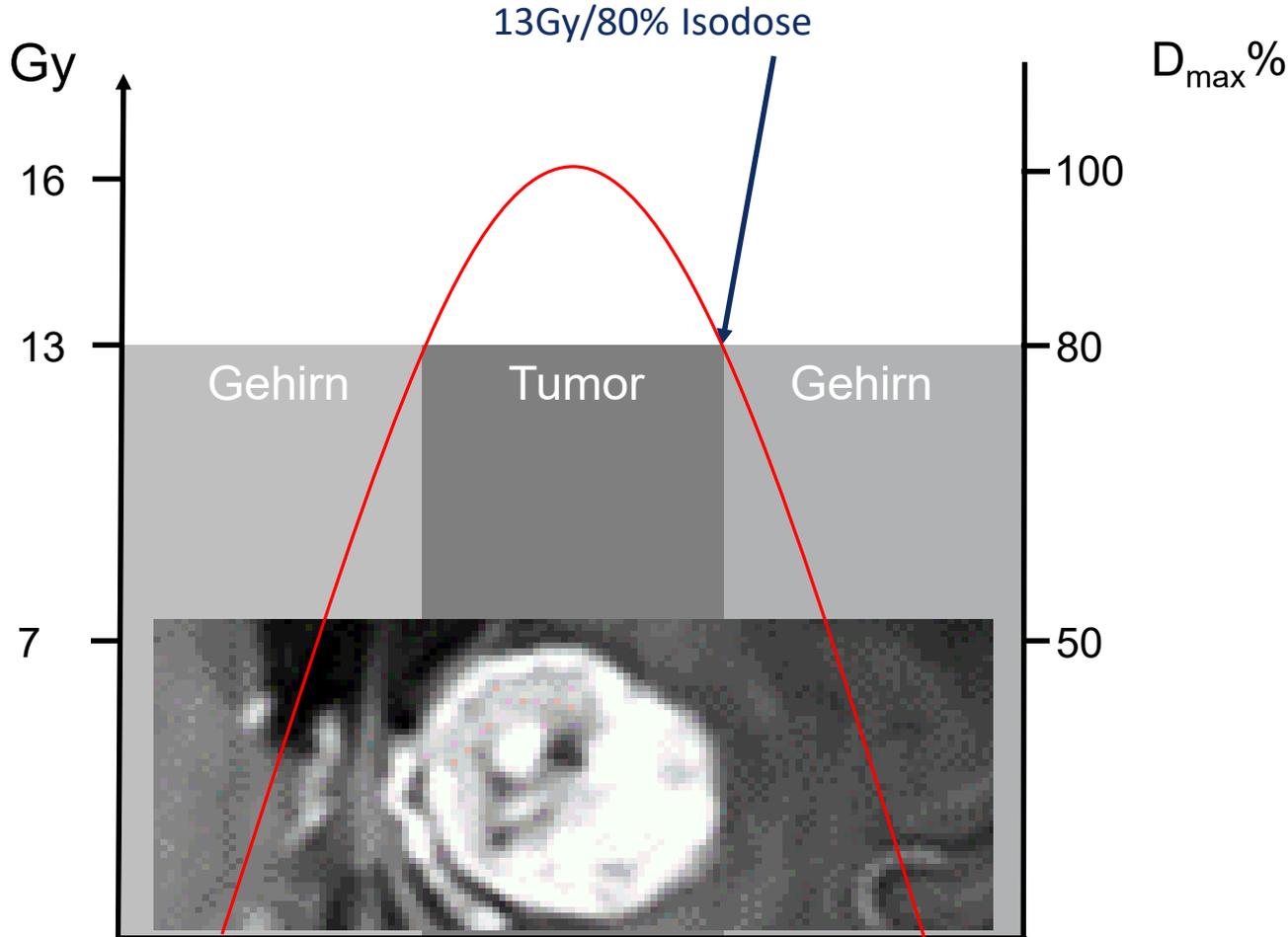
Räumliche Dosisverteilung



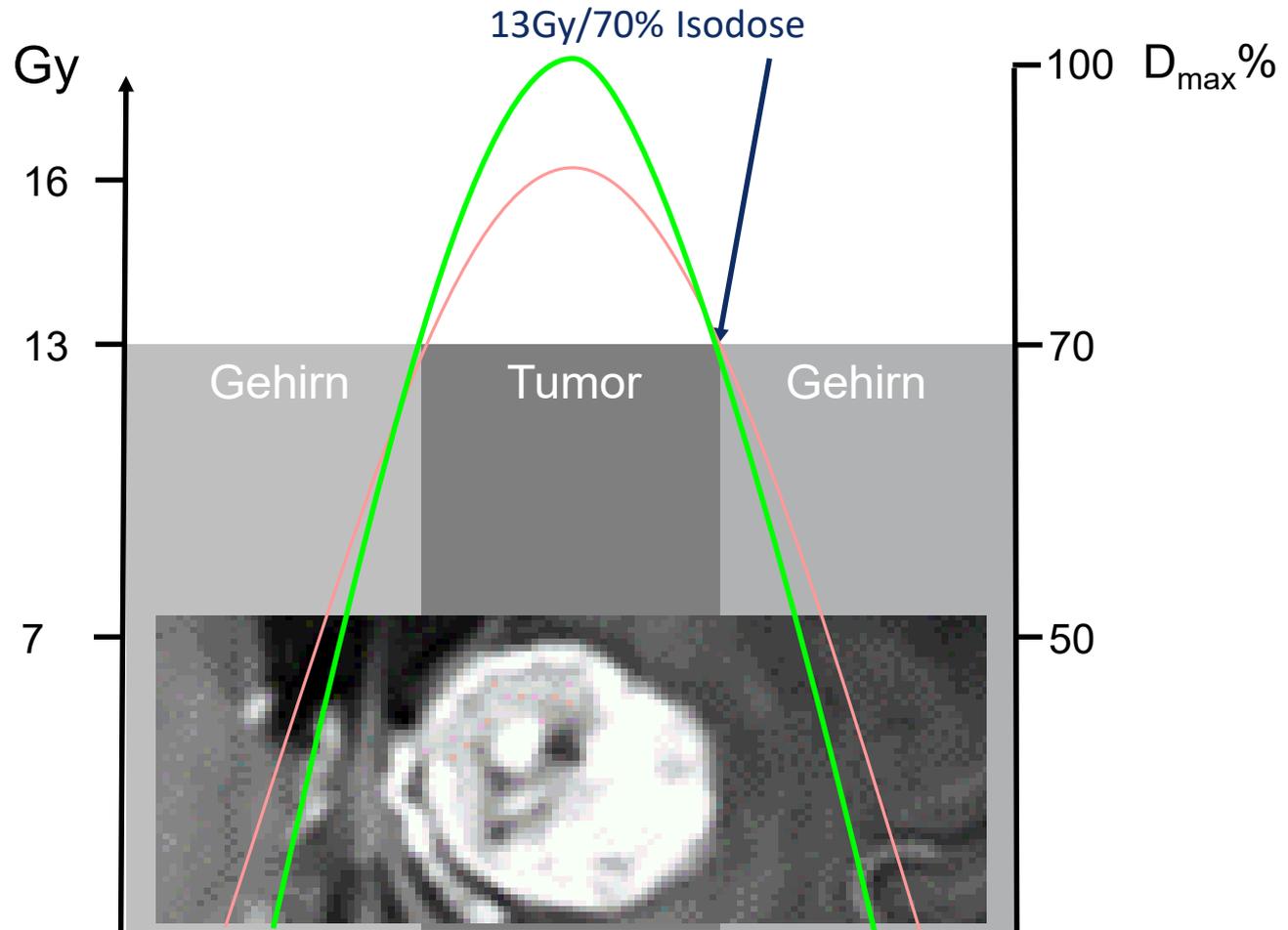
Räumliche Dosisverteilung



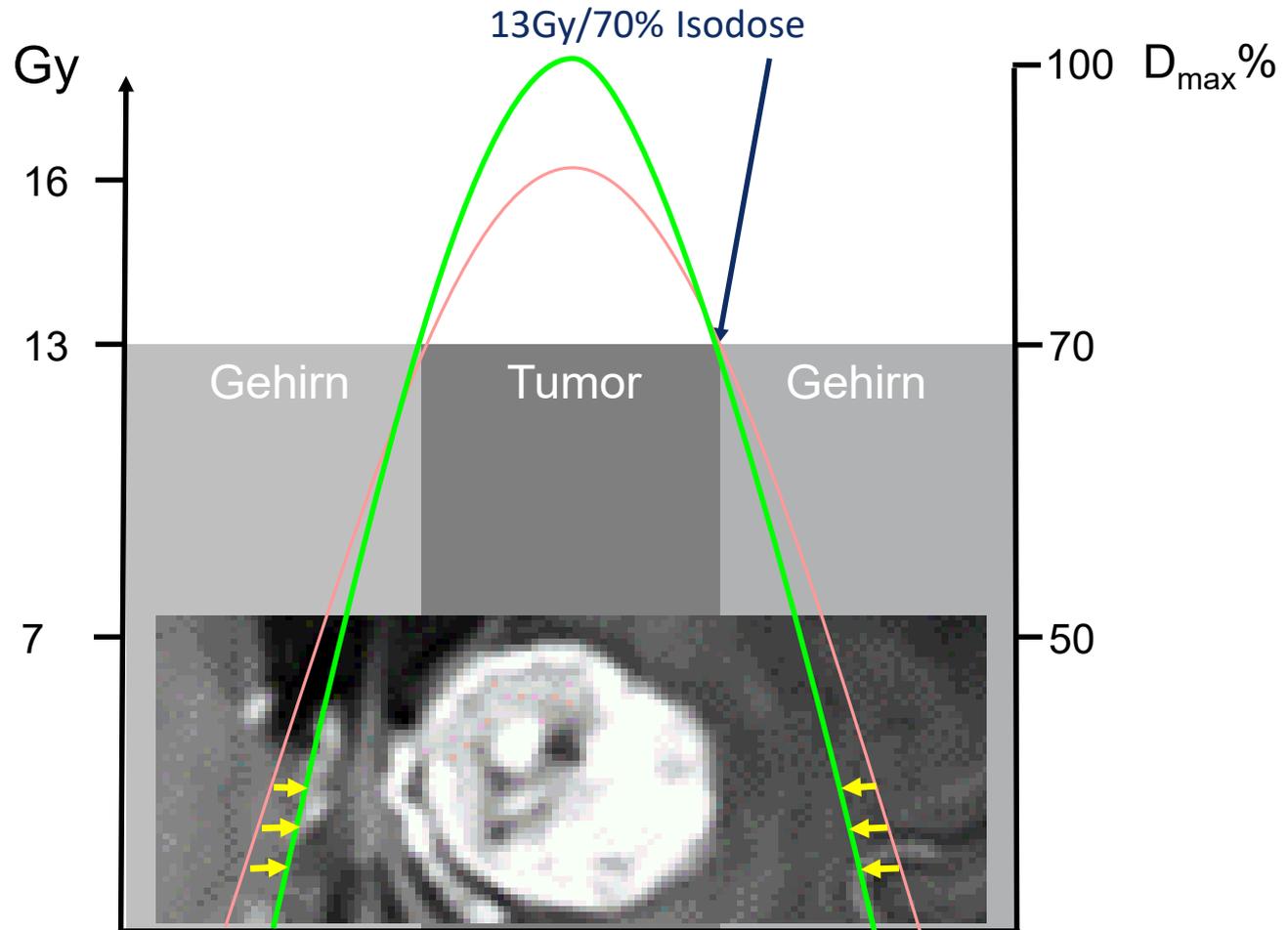
Räumliche Dosisverteilung



Modulation des Dosisgradienten



Modulation des Dosisgradienten



RESEARCH

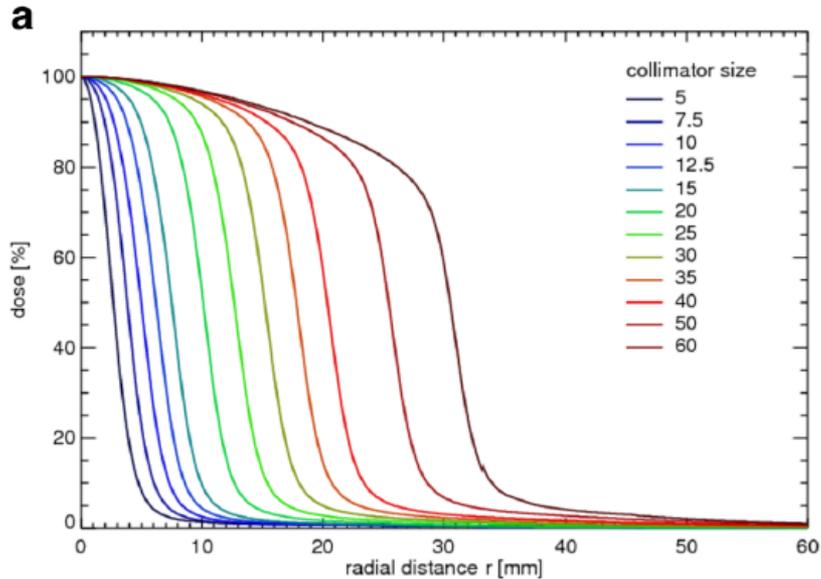
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Radiotoxicity in robotic radiosurgery: proposing a new quality index for optimizing the treatment planning of brain metastases

Alexandra Hellerbach^{1*}, Klaus Luyken¹, Mauritius Hoevens¹, Andreas Gierich¹, Daniel Ruelß¹, Wolfgang W. Baus², Martin Kocher², Maximilian I. Ruge¹ and Harald Treuer¹

Radialer Dosisverlauf eines einzelnen CK-Kollimator-Stehfelds



RESEARCH

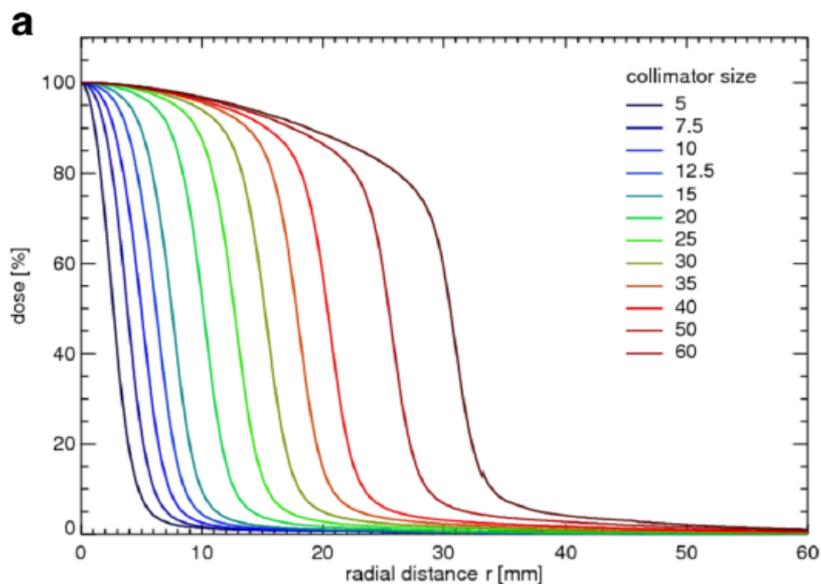
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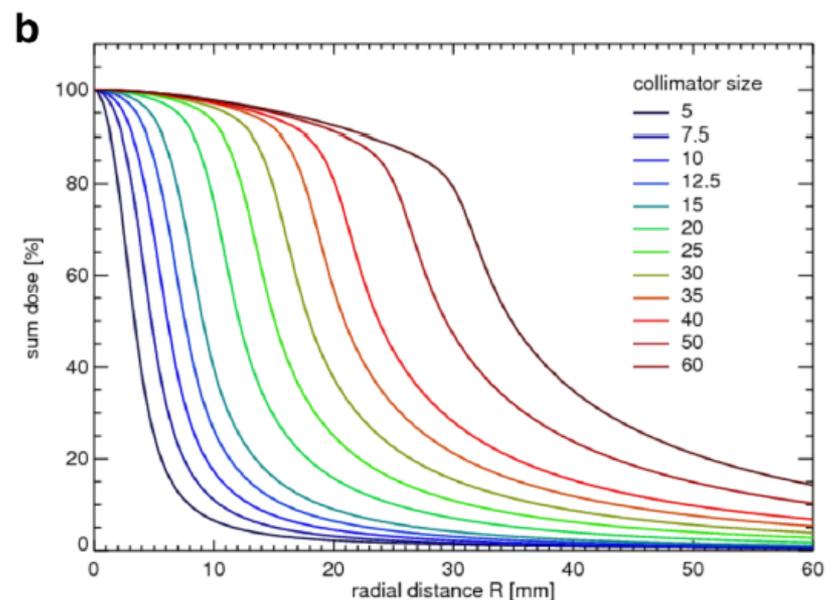
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Radialer Dosisverlauf eines einzelnen CK-Kollimator-Stehfelds



Radialer Dosisverlauf einer isozentrischen Bestrahlung mit einem CK-Kollimator



RESEARCH

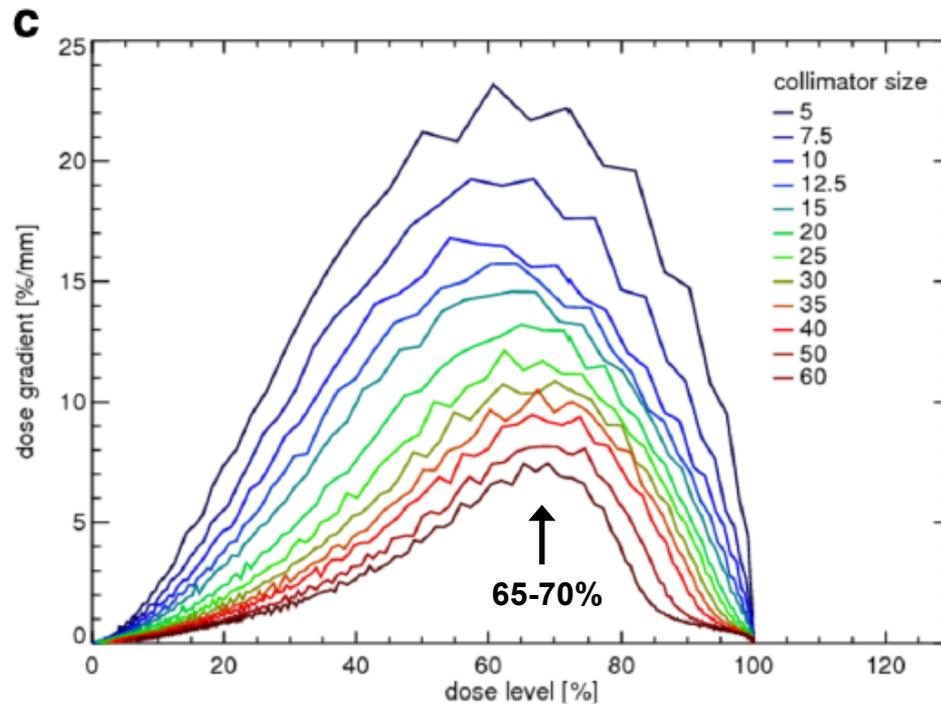
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Radiotoxicity in robotic radiosurgery: proposing a new quality index for optimizing the treatment planning of brain metastases

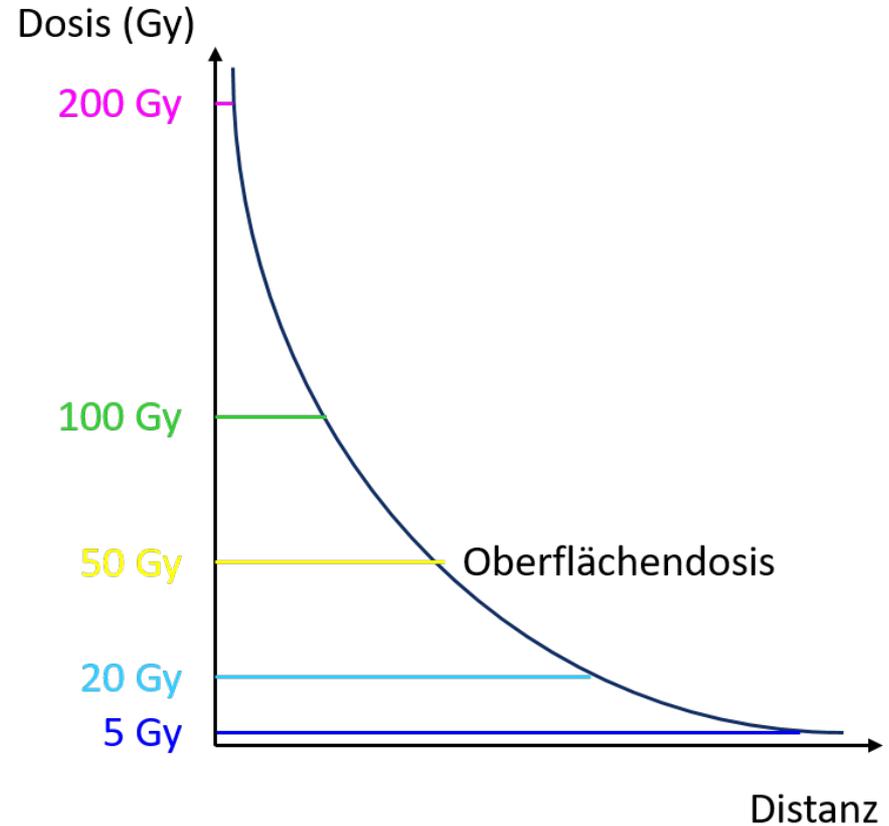
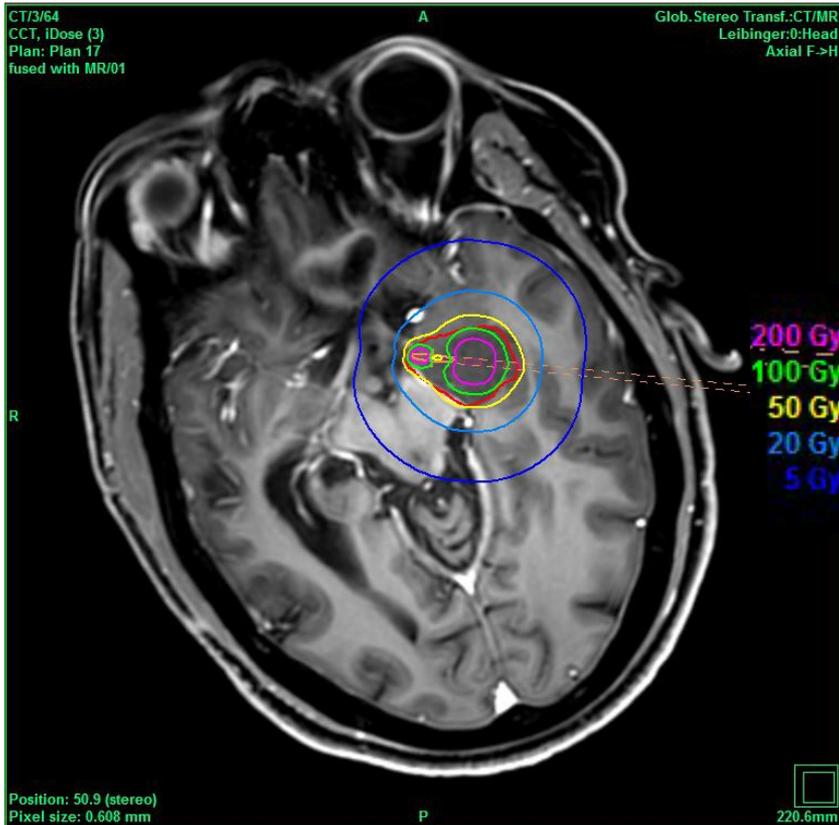
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Dosisgradient (%/mm) einer isozentrischen Bestrahlung mit einem CK-Kollimator

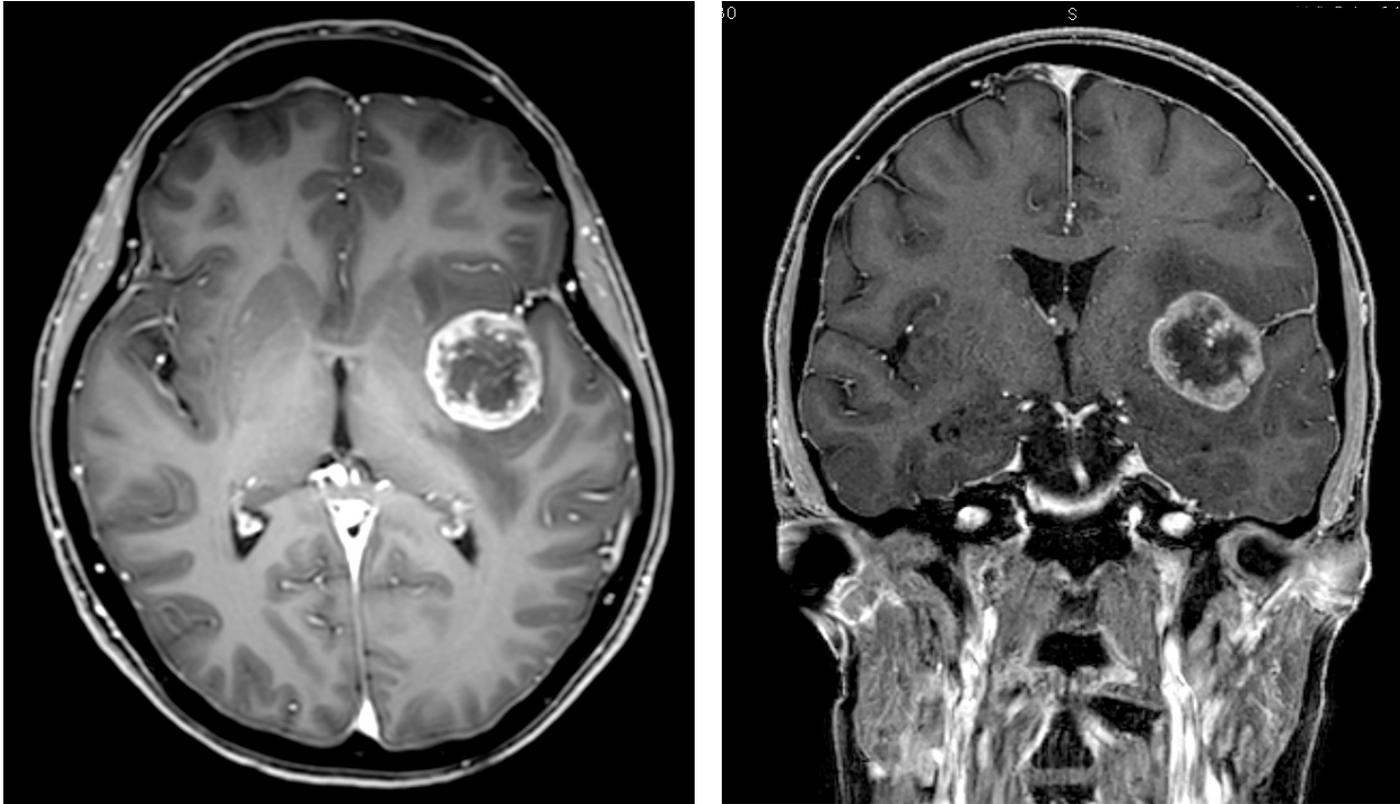


Sonderform Brachytherapie

Spezialtechnik: Stereotaktische Brachytherapie (125 Jod Seeds)



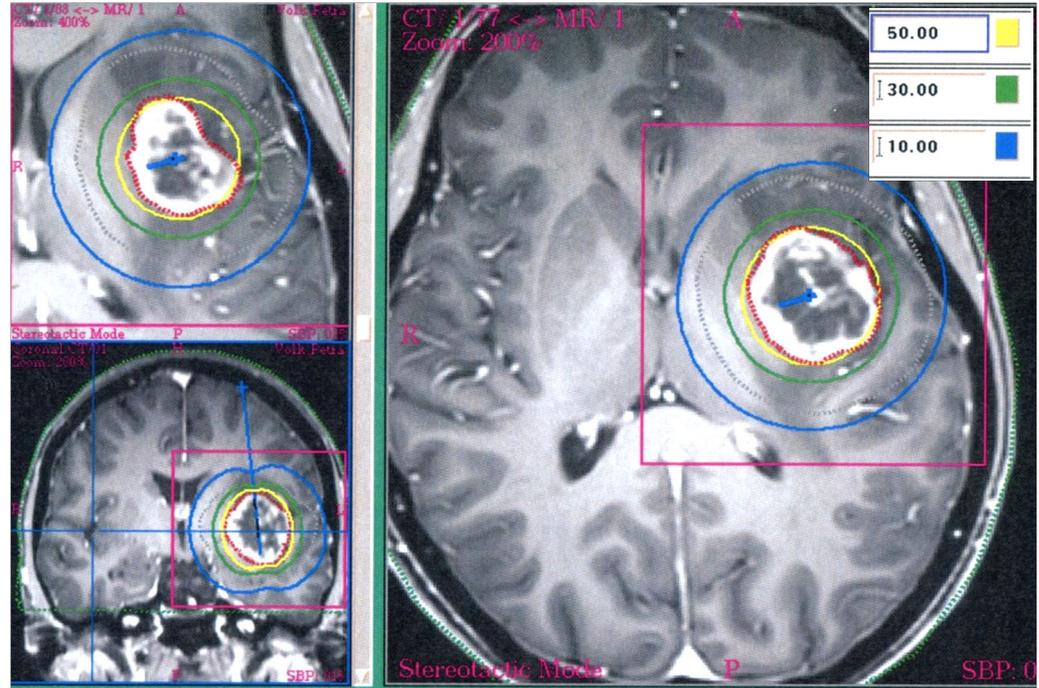
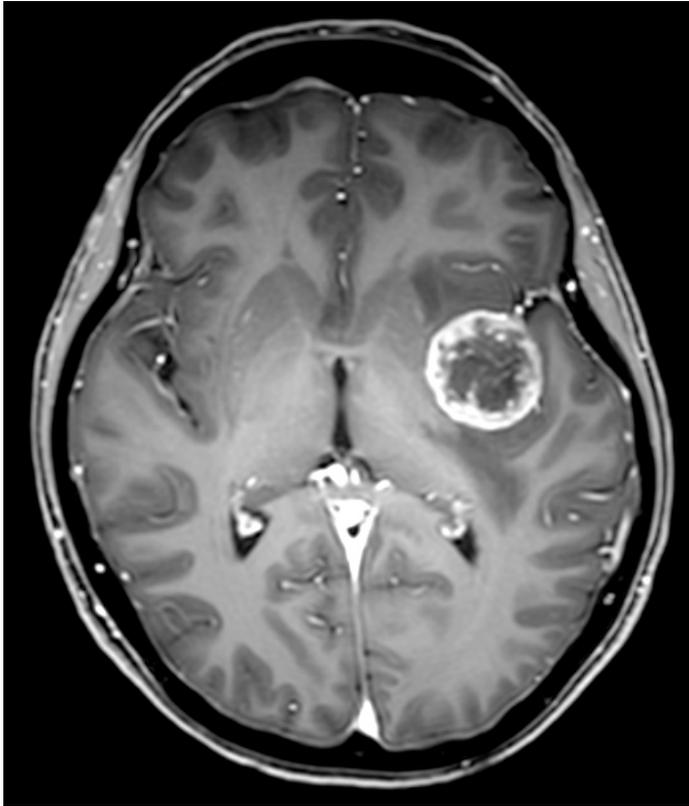
Fallbeispiel: Stereotaktische Brachytherapie



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

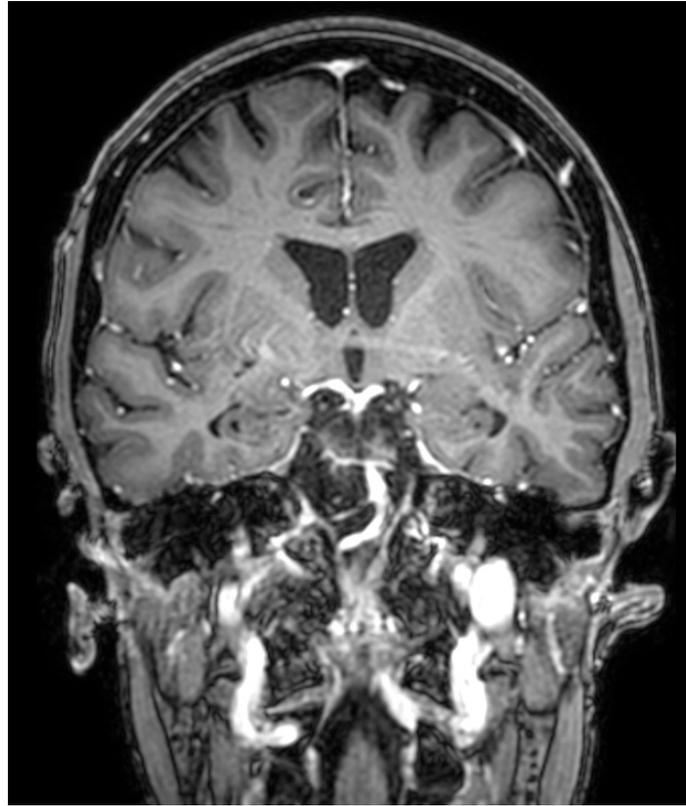
Neurologisch: passagere Sprachstörung, Missempfindungen rechter Arm

Fallbeispiel: Stereotaktische Brachytherapie



Stereotaktische Brachytherapie (^{125}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^{a,b,*}, Stéphane Key^a, Gurvan Dissaux^a, Gaëlle Goasduff^a, Anne-Sophie Lucia^a, Luc Ollivier^a, Olivier Pradier^{a,b}, Ulrike Schick^{a,b,*}

^aRadiation Oncology Department, University Hospital, Brest, France; ^bLaTIM, 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 ≤ 2 ; 20 Pat. 3-6); (Intervall: 2014 – 2017)
- **„modulated arc therapy“ mit LINAC** (TrueBeam™ STX LINAC)
- Zielparame^{ter}: Lokale Kontrolle; Radionekrose



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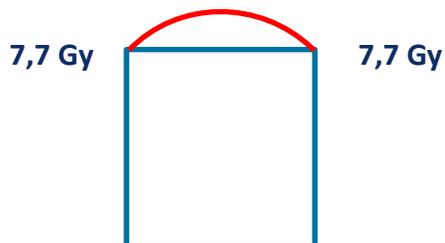
Gruppe I

n = 91 Pat. mit 136 Met.

3 x 7.7 Gy

99% Isodosenlevel

D max: 8,1 Gy



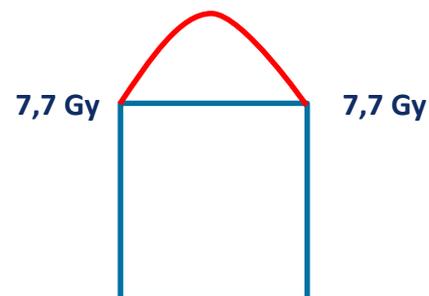
Gruppe II

n = 43 Pat. mit 72 Met.

3 x 7,7 Gy

70% Isodosenlevel

D max: 11,0 Gy





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



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Gruppe I

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3 x 7.7 Gy

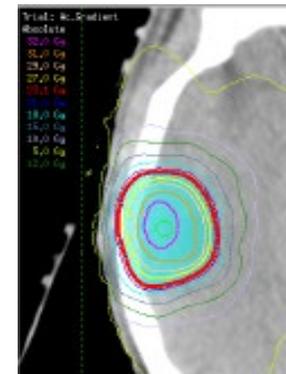
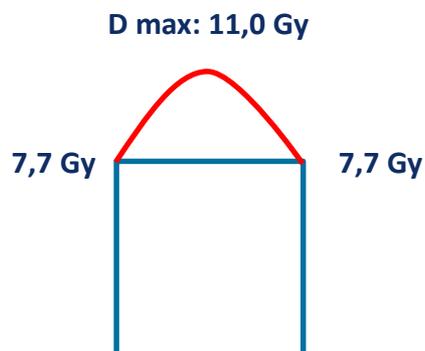
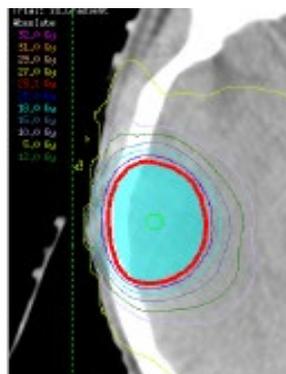
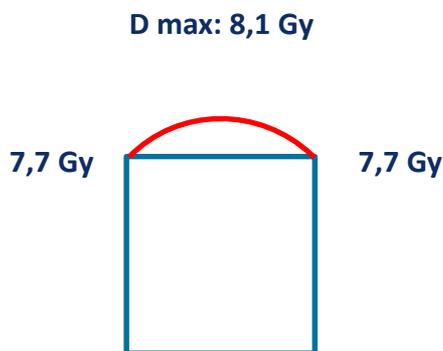
99% Isodosenlevel

Gruppe II

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3 x 7,7 Gy

70% Isodosenlevel



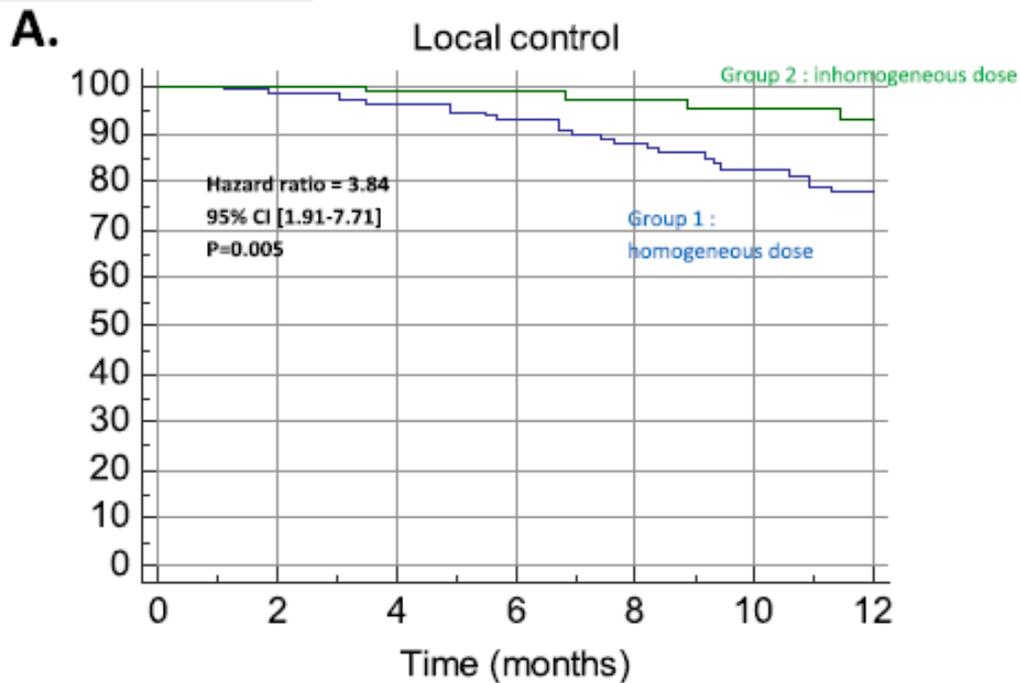


Inhomogeneous tumor dose distribution provides better local control than homogeneous distribution in stereotactic radiotherapy for brain metastases



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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



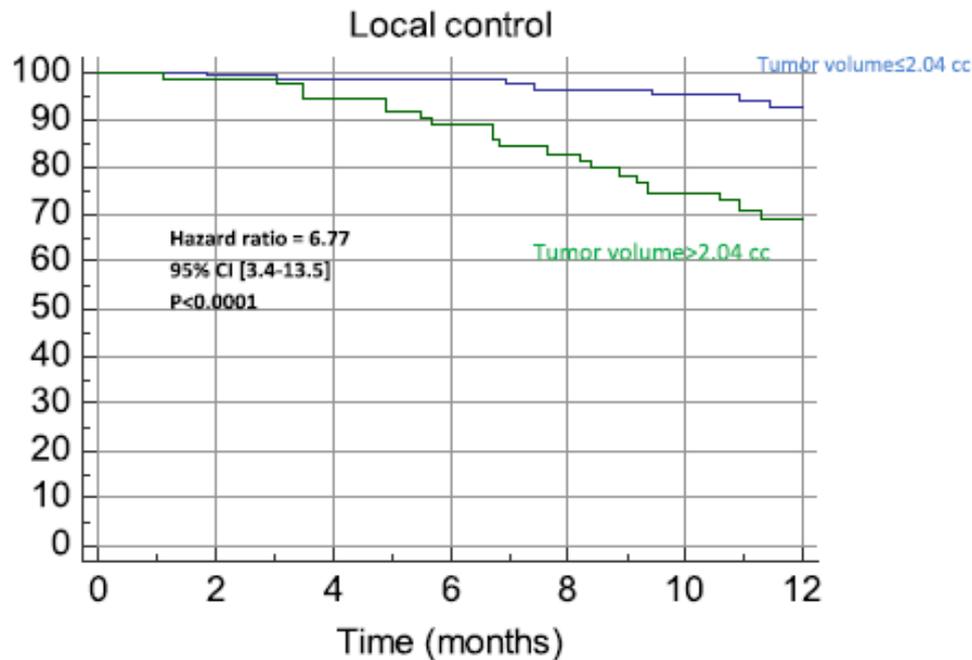
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B.



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

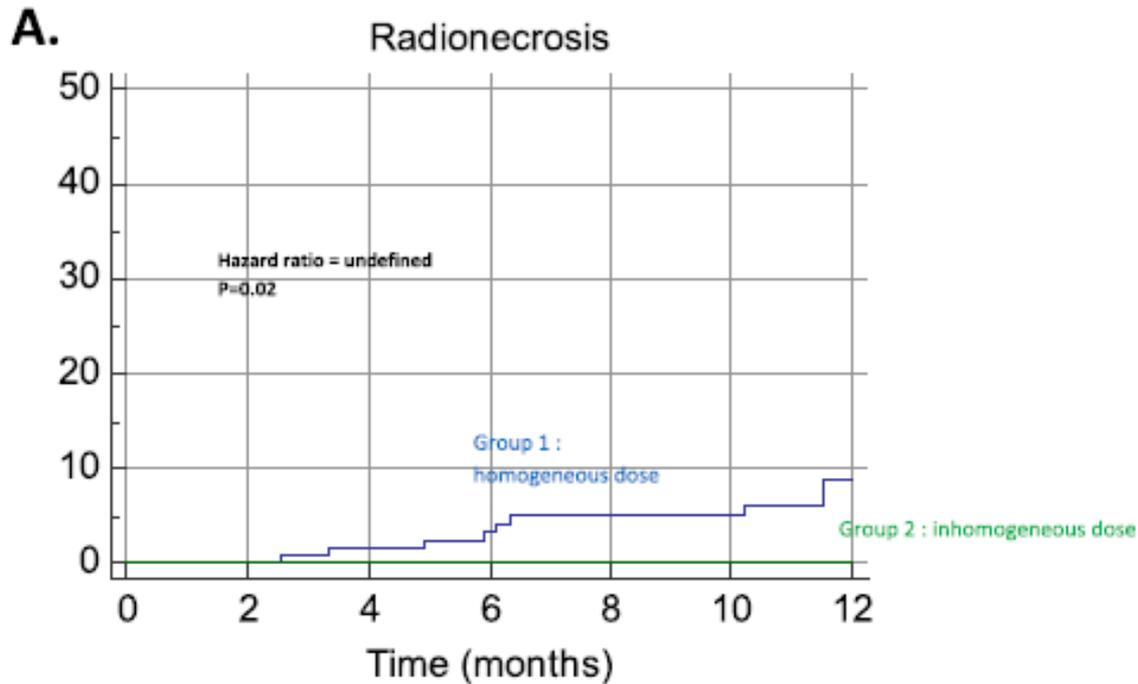


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Konklusion:

Inhomogene Dosisverteilung zeigt **signifikante**

- Verbesserung der lokalen Kontrolle
- Reduktion der Radionekrose

Zusammenfassung

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!