
Erasmus MC

University Medical Center Rotterdam



STEREOTACTISCHE RADIOTHERAPIE BIJ KINDEREN

SRT symposium Lab NL 2010

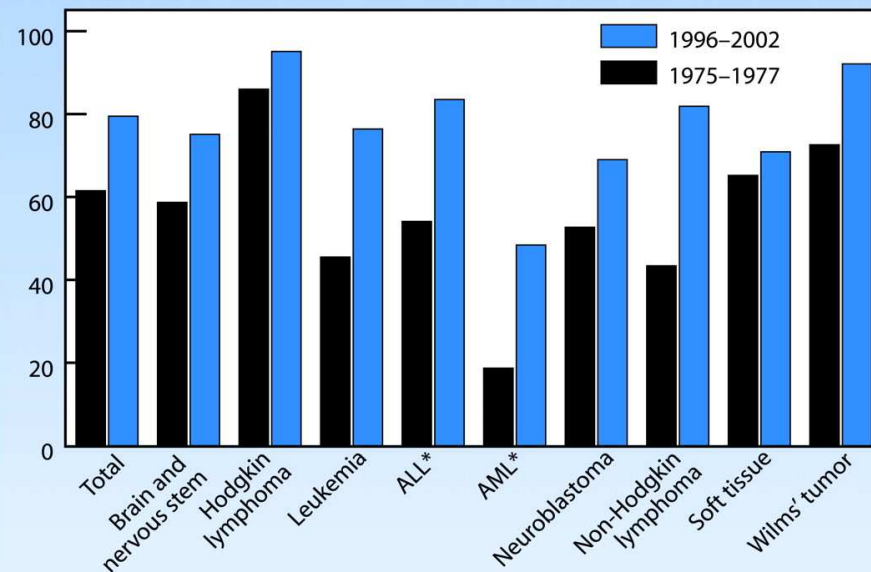
INTRODUCTIE

STAT BITE

Childhood Cancer Survival, 1975–2003

More and more children are surviving cancer. In the last 28 years, for which statistics are available, the percentage of children who survive for five years has increased from 61.5% to 79.5%, and the increase is even higher for certain cancer types. The difference between the 1975–77 relative survival and that in 1996–2002 is statistically significant. In this issue, researchers examine some of the problems childhood cancer survivors have in later life (See p. 890).

Percentage five year relative survival from childhood cancer, 1975–1977 vs. 1996–2002:



*ALL = acute lymphocytic leukemia, AML = acute myeloid leukemia.

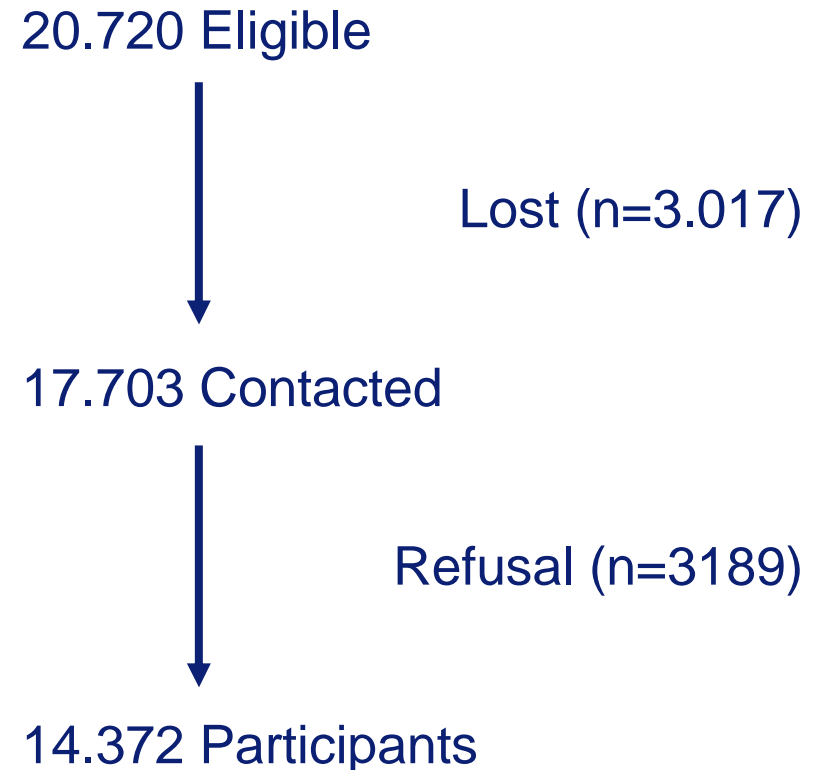
Source: SEER Cancer Statistics Review, 1975–2003 (National Cancer Institute); access at <http://seer.cancer.gov>.

DOI: 10.1093/jnci/djj283

LATE TOXICITEIT

Childhood Cancer Survival Study

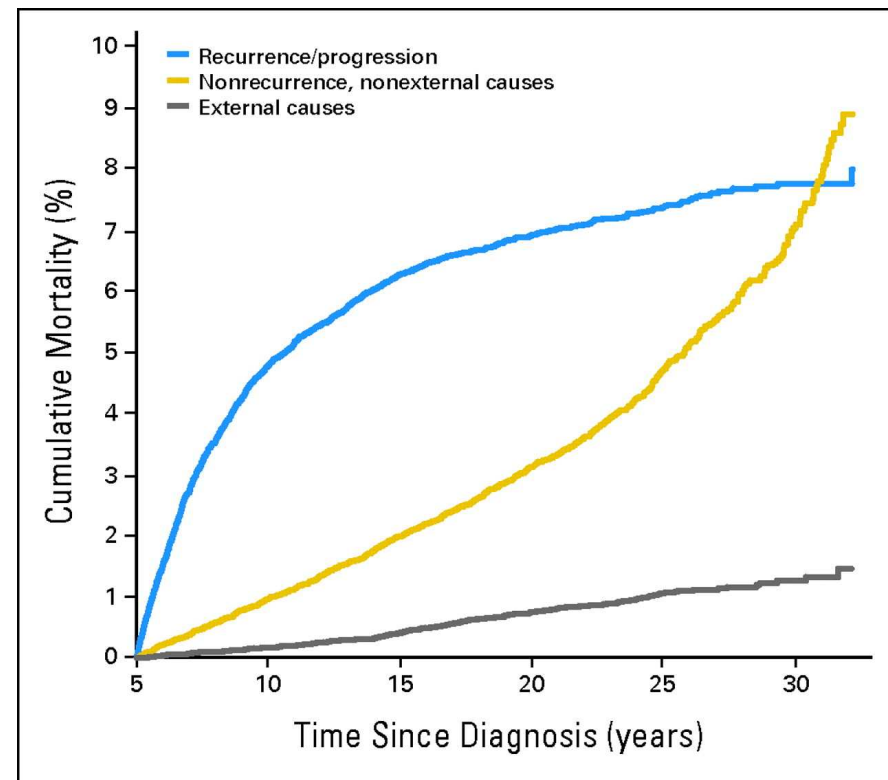
- * Retrospectief cohort geïnitieerd in 1994
- * Minimaal 5 jr overleving
- * Histologisch bevestigde diagnose kanker
- * Diagnose: 1970-1986
- * < 21 jaar bij diagnose
- * Follow up elke 2 jaar



LATE TOXICITEIT

Late Mortaliteit

	SMR	CI
Secundaire tumoren	15.2	13.9-16.6
cardiaal	7.0	5.9-8.2
pulmonaal	8.8	6.8-11.2

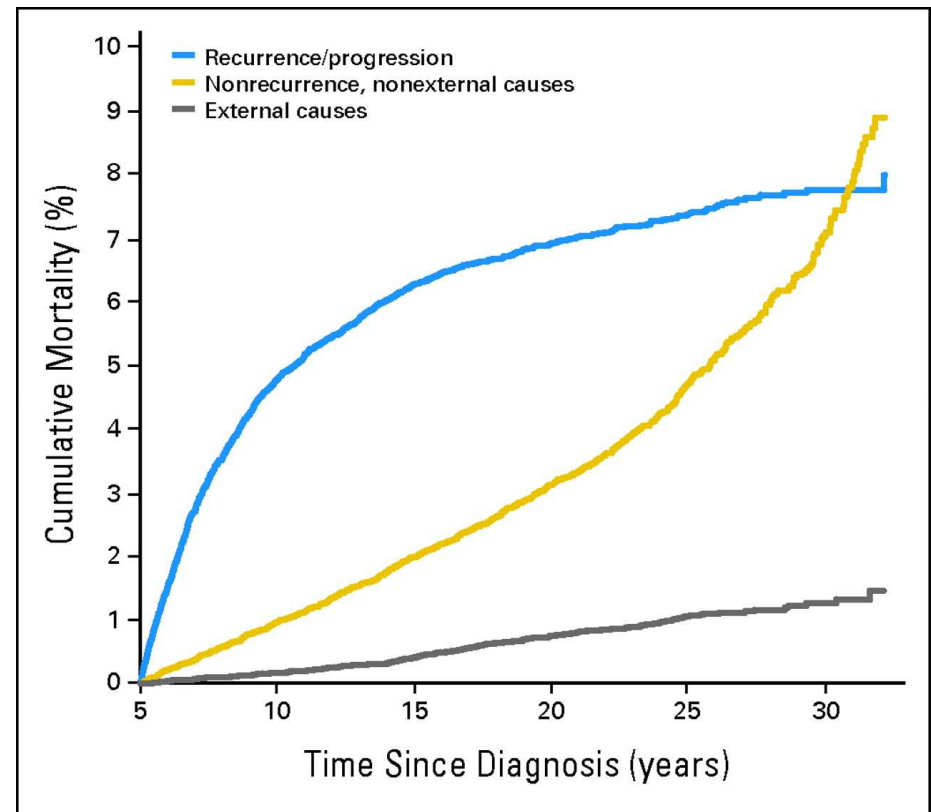


Armstrong, G. T. et al. J Clin Oncol; 27:2328-2338 2009

LATE TOXICITEIT

Late Mortaliteit (Sec maligniteit)

	RR (95 %)	CI
Radiotherapie	2.9	2.1-4.2
Alkylating agents	2.2	1.6-3.0
Epipodophyllotoxin	2.3	1.2-4.5



Armstrong, G. T. et al. J Clin Oncol; 27:2328-2338 2009

Table 4. Relative Risk of a Chronic Health Condition among Cancer Survivors, According to the Type of Tumor and Treatment, as Compared with Siblings.*

Cancer Diagnosis or Treatment Exposure	Relative Risk (95% Confidence Interval)		
	Grade 1–4	Grade 3 or 4	≥2 Conditions
Siblings	1.0	1.0	1.0
All cancer groups	3.3 (3.0–3.5)	8.2 (6.9–9.7)	4.9 (4.4–5.5)
Bone tumor	10.3 (8.9–12.0)	38.9 (31.2–48.5)	10.7 (8.9–12.8)
Central nervous system tumor	7.1 (6.3–8.2)	12.6 (10.3–15.5)	12.4 (10.5–14.6)
Hodgkin's disease	4.6 (4.2–5.1)	10.2 (8.3–12.5)	8.7 (7.4–10.2)
Sarcoma	3.5 (3.1–4.0)	8.9 (7.2–11.0)	5.2 (4.4–6.2)
Non-Hodgkin's lymphoma	3.2 (2.8–3.6)	6.8 (5.3–8.6)	4.3 (3.6–5.2)
Neuroblastoma	2.0 (1.7–2.4)	4.7 (3.5–6.4)	2.5 (2.0–3.2)
Leukemia	2.2 (2.0–2.4)	4.1 (3.4–5.1)	2.8 (2.5–3.3)
Wilms' tumor	1.9 (1.7–2.2)	4.1 (3.2–5.4)	2.5 (2.0–3.1)
No chemotherapy or radiation	1.5 (1.3–1.7)	1.2 (1.0–1.5)	1.3 (1.1–1.5)
Chemotherapy			
Any chemotherapy	3.2 (2.9–3.4)	8.1 (6.8–9.6)	4.5 (4.0–5.0)
Alkylating agent	3.8 (3.5–4.2)	9.9 (8.3–11.8)	5.6 (5.0–6.4)
Anthracycline	4.3 (3.9–4.7)	11.0 (9.2–13.1)	5.8 (5.0–6.6)
Radiation therapy			
Any irradiation	3.4 (3.1–3.6)	7.9 (6.6–9.4)	5.2 (4.6–5.9)
Brain irradiation	3.1 (2.8–3.3)	7.0 (5.8–8.5)	4.8 (4.2–5.5)
Chest irradiation	4.7 (4.3–5.2)	10.6 (8.8–12.7)	8.2 (7.1–9.4)
Abdominal irradiation	3.7 (3.3–4.0)	8.8 (7.3–10.6)	5.8 (5.1–6.7)
Pelvic irradiation	4.2 (3.8–4.7)	10.5 (8.6–12.7)	6.8 (5.9–7.9)
Surgery			
Splenectomy	4.7 (4.2–5.2)	10.2 (8.3–12.5)	8.5 (7.2–10.0)
Nephrectomy	2.1 (1.8–2.4)	4.7 (3.5–6.2)	2.7 (2.2–3.4)
Specific combinations			
Chest radiation plus bleomycin	7.8 (6.2–9.8)	13.6 (9.8–18.7)	13.3 (10.1–17.6)
Chest radiation plus anthracycline	6.0 (5.2–6.9)	13.0 (10.4–16.3)	9.7 (8.1–11.8)
Chest radiation plus abdominal or pelvic irradiation	4.7 (4.2–5.2)	10.9 (8.9–13.2)	8.5 (7.3–9.9)
Anthracycline plus an alkylating agent	4.3 (3.9–4.8)	10.9 (9.0–13.1)	6.0 (5.2–6.9)
Abdominal or pelvic irradiation plus an alkylating agent	4.0 (3.6–4.4)	10.0 (8.2–12.1)	6.2 (5.4–7.2)

* Each row represents an individual multivariate regression model, adjusted for the age at the time of the study, sex, and race or ethnic group.

Bijwerkingen van radiotherapie

GROEI STOORNIS

Bot

Spiereen

Organen

CZS BESCHADIGING

FERTILITEIT

HUID VERANDERINGEN

SECUNDAIRE TUMOREN

CZS Bijwerkingen van radiotherapie

NEUROCOGNITIEF= IQ drop

Korte termijnsgeheugen en concentratie

HORMOON DEFICIENTIES

GH deficiëntie

Gonadotrophines, ACTH, TSH

zeldzaam diabetes insipidus

GROEI STOORNISSEN

Optische-neuropathie

Radionecrose

Thrombose arteria cerebri media

DOEL STEREOTAXIE

Maintain or Improve Local Control

Reduce Side Effects

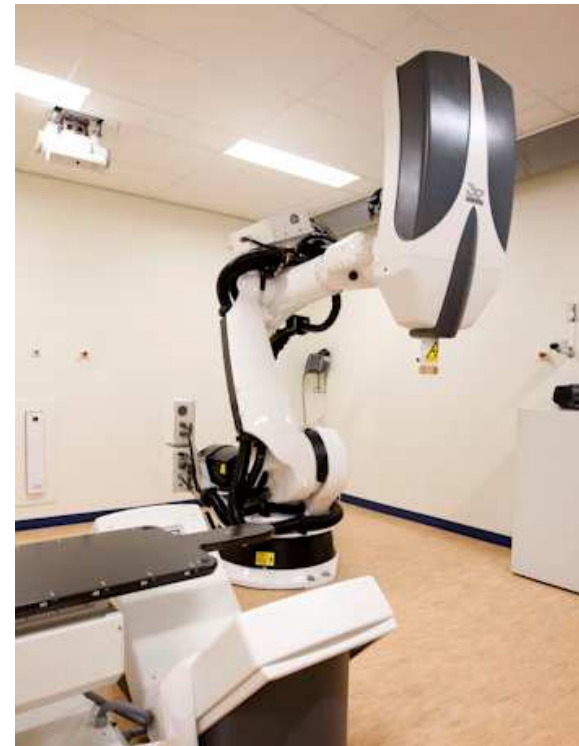
Stereotactische radiotherapie in het Erasmus MC



Soort bestralingstoestellen:

conventionele Linac

Cyberknife



Erasmus MC



SRT met conventionele Linac



Toestel ook geschikt voor
conventionele RT

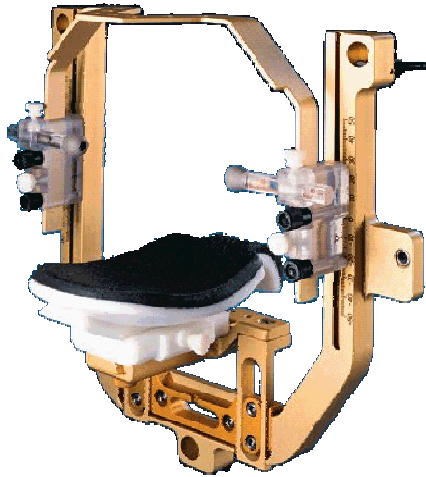
Intracraniele en KNO tumoren

6 MV

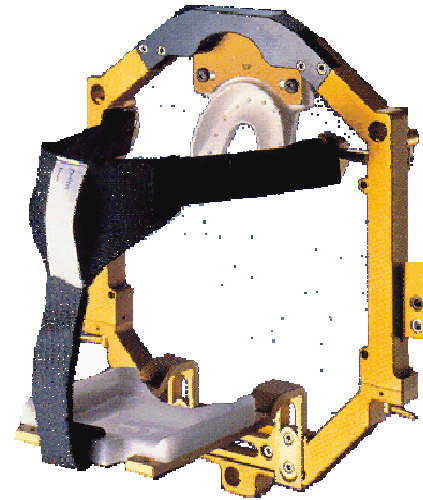
Rotatie bestraling (cone) +
statische velden (mMLC)

M.b.v. een frame (GTC-, KNO en
invasief frame)

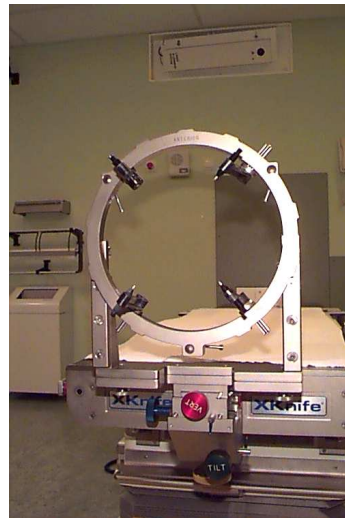
Frames (Rotterdam)



TLC



GTC

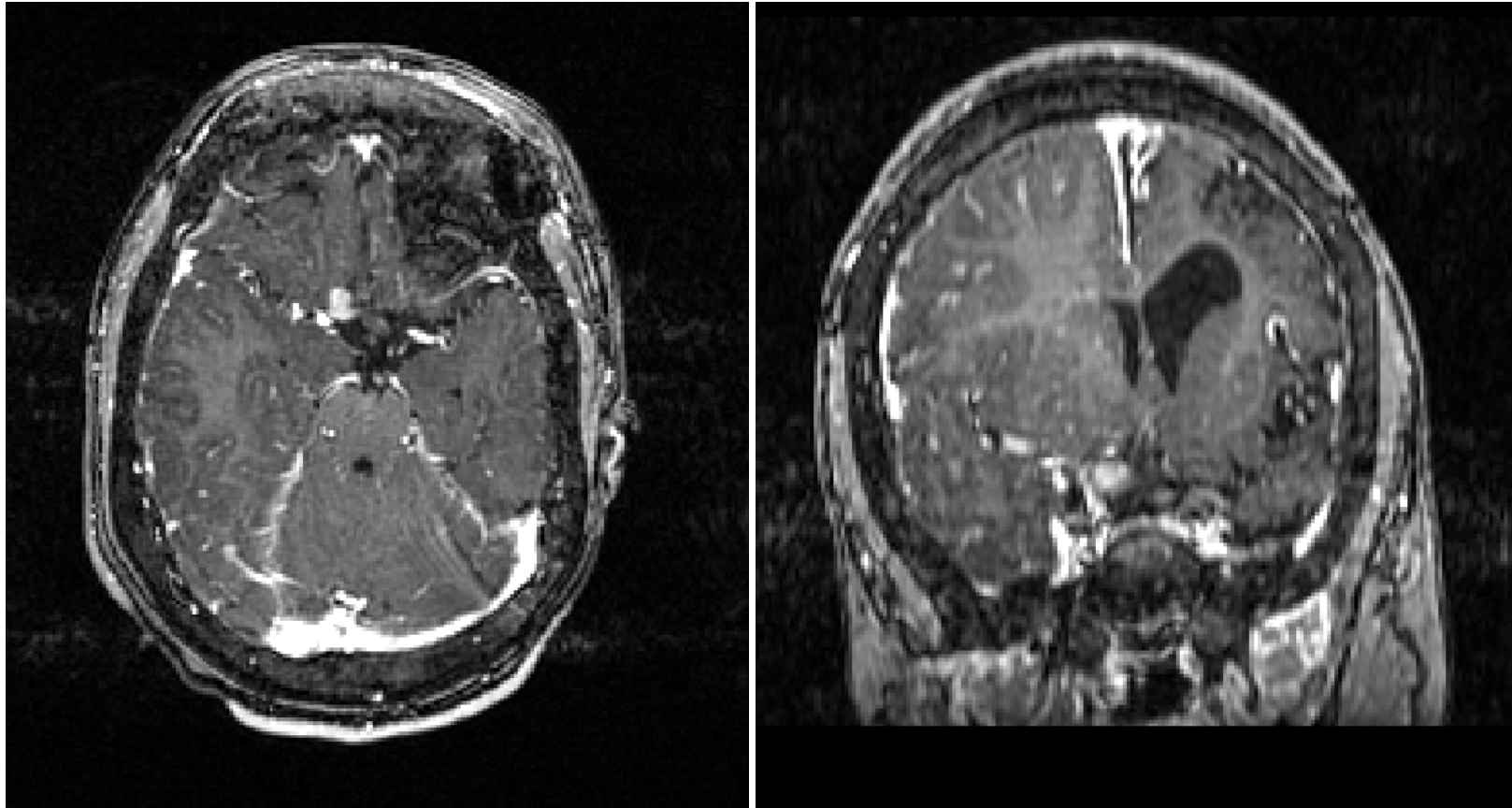


BRW

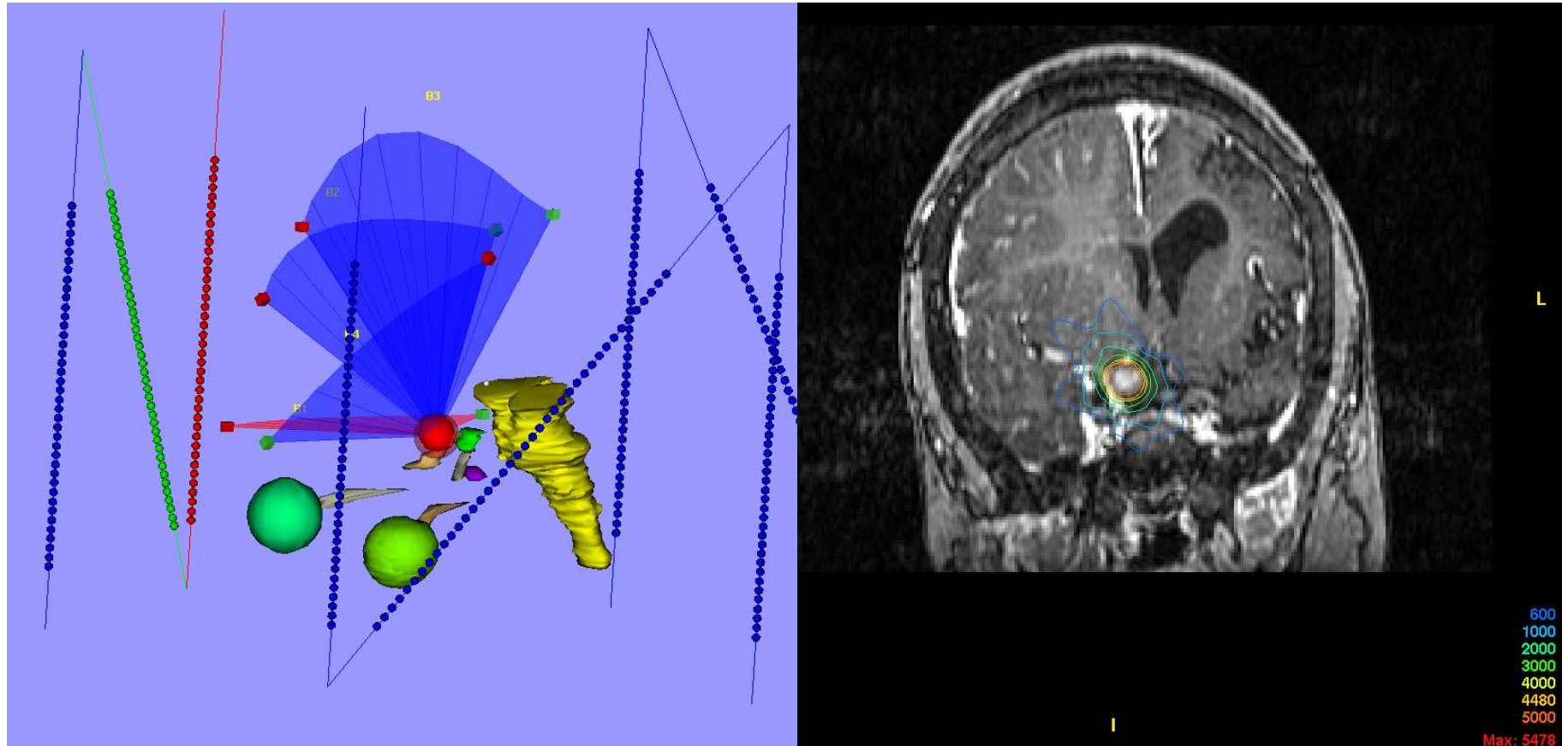




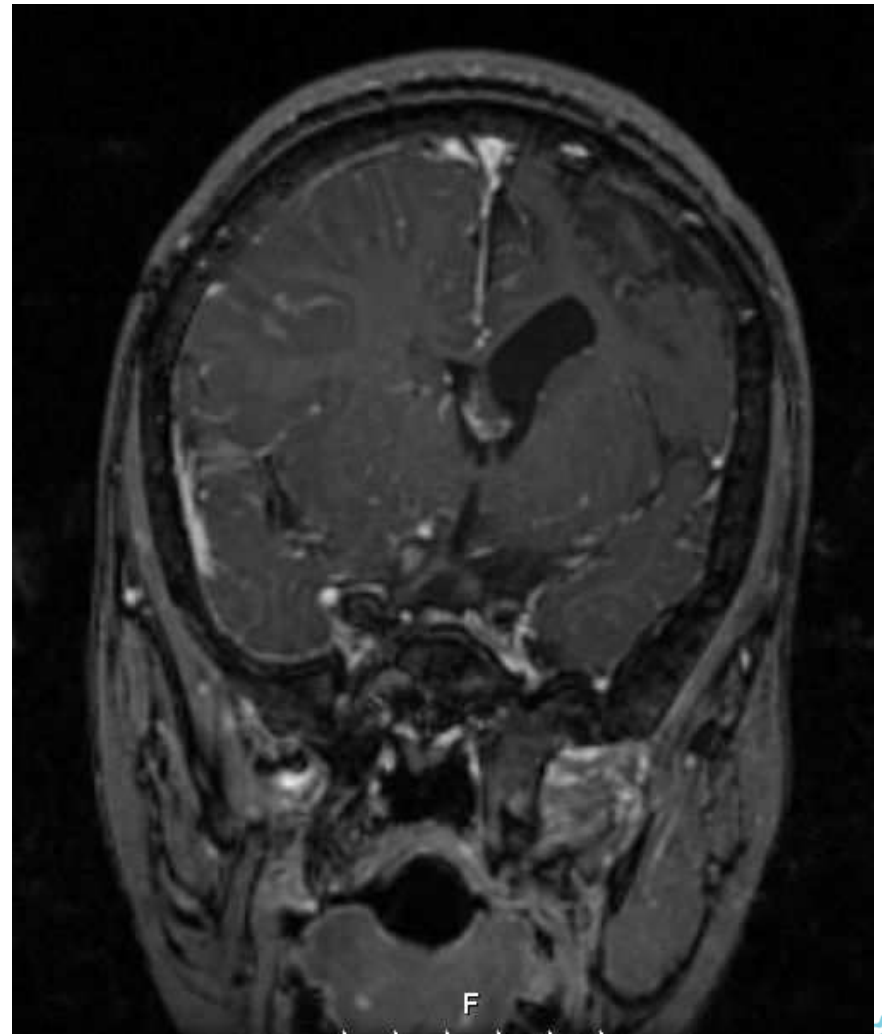
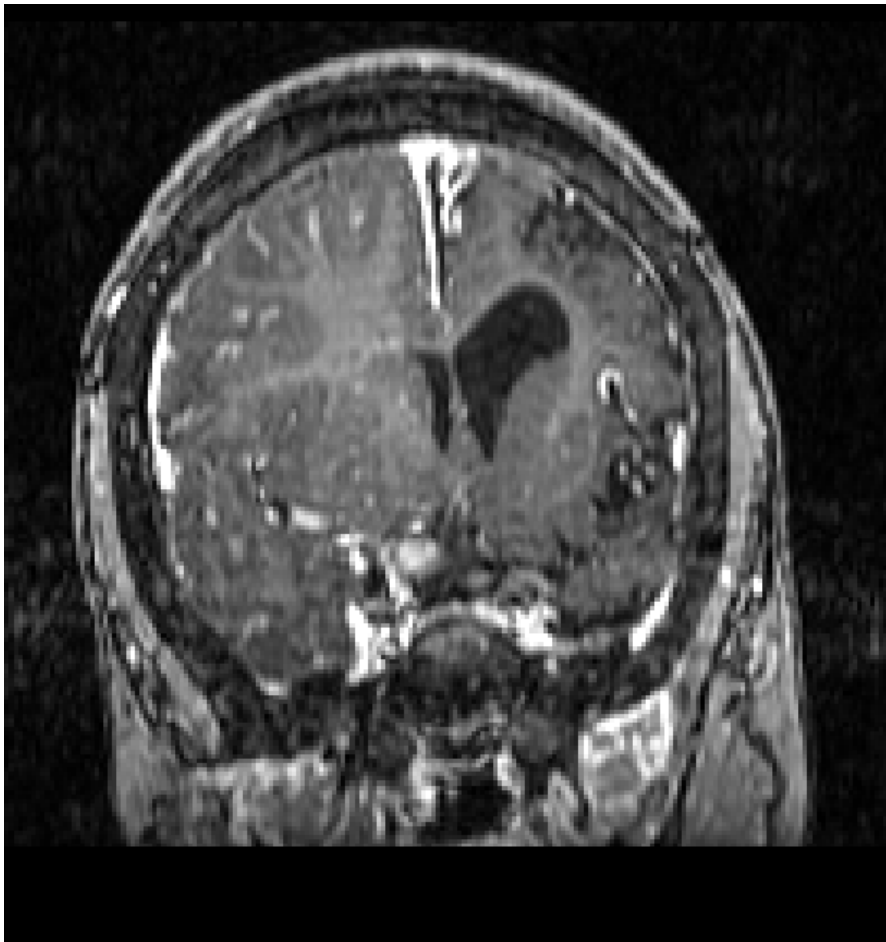
Recidief Craniopharyngioom



16 x 2.8 Gy @ 80%; 4x / week



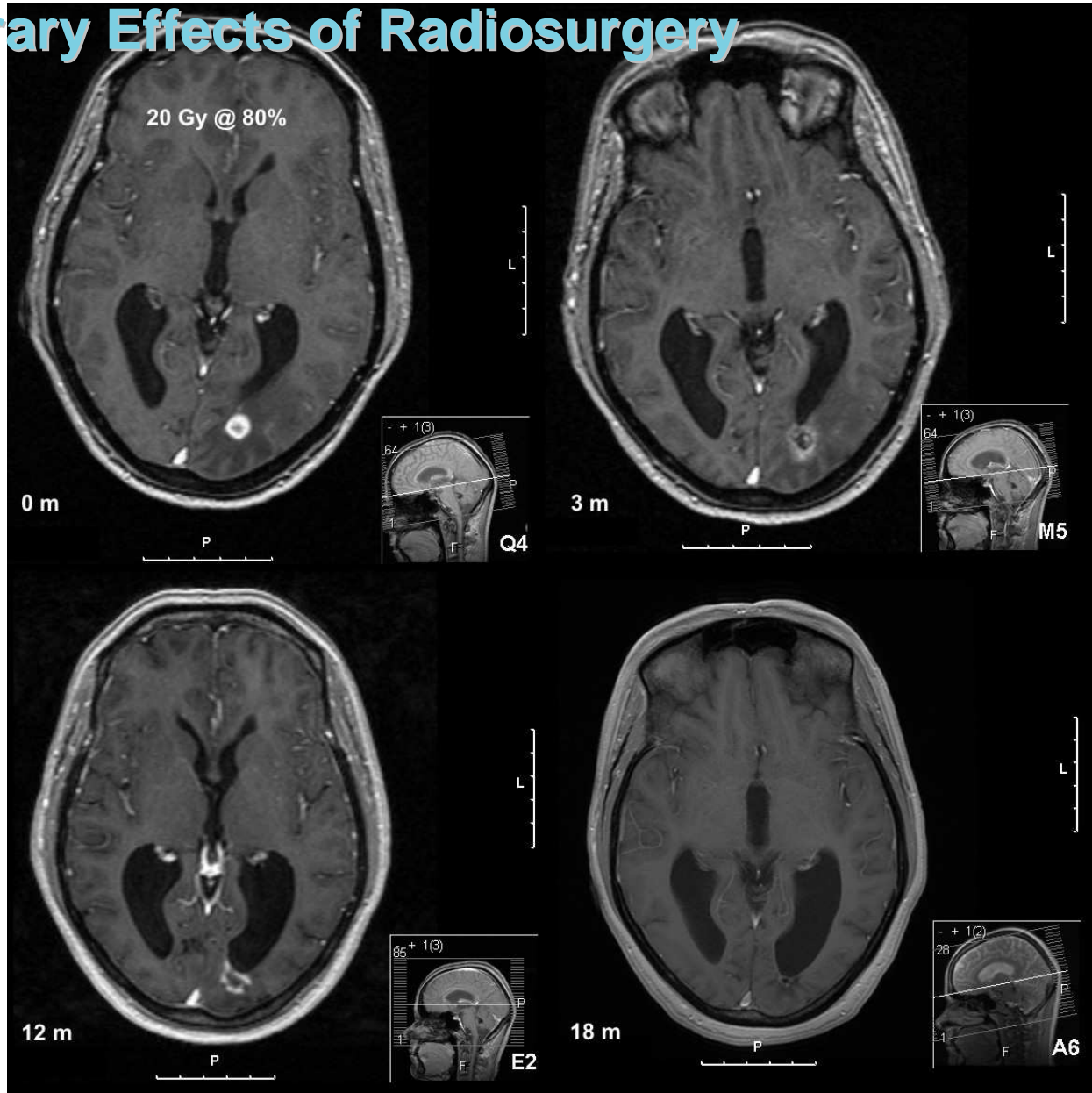
FU 4 maanden



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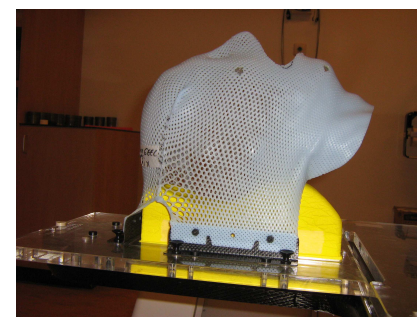
Temporary Effects of Radiosurgery



SRT met Cyberknife



- Toestel alleen geschikt voor SRT
- Intra- en extracraniele tumoren
- 6 MV
- Cone (Ø 5-60mm)
- Robot, continue tracking + correctie
- Fixatie m.b.v vacuummatras of cast



CYBERKNIFE



Conventionele Linac versus Cyberknife



	<u>Linac</u>	<u>Cyberknife (huidige)</u>
Toepassing	Intracraniaal en KNO	Intra-en extracraniaal
Fixatie	Invasief en niet invasief frame	Frameless, cast of vac. matras
Marge	2mm	0 - 2mm
Fractionering	Hyperfractioneren mogelijk (1-33 fracties)	Hyperfractioneren niet goed mogelijk (1-6 fracties)
Dosis (kinderen)	...-... gy	10-24 gy
Fieldshaping	mMLC + cones	Cones (painting)
Dosisverdeling	kleiner lage dosis gebied	kleiner hoge dosis gebied
Precisie ligging	frame, gekoppeld aan een 3D coördinaten systeem	Online afbeelden en automatische correctie op veranderingen
Extra dosis ivm afbeelden	geen	Beperkt (+/- 0,5 cGy/fr)
Bestralingstijd	Vrij kort (15-45 min)	Soms lang (20–110 min)
Anesthesie	mogelijk	niet mogelijk

Overweging arts SRT op linac of Cyberknife (1)



Eerste keus voor SRT bij kinderen: Linac

- hyperfractioneren vaak wenselijk i.v.m. herstel van gezond weefsel
- In lage dosis gebied kunnen nieuwe tumoren ontstaan
- Anesthesie is mogelijk

Overweging arts SRT linac of Cyberknife (2)



Cyberknife gunstig bij:

Extracraniele leasies

Boost (hypofractioneren + < marges)

Reïrradiatie (hoge dosis gebied conformer + < marges)

Proton Beam Therapy



Massachusetts General Hospital



PROTONEN BEHANDELING DE FEITEN



Customized Shaping



Massachusetts General Hospital

PROTONEN BEHANDELING DE FEITEN

Geïoniseerde deeltjes die schade veroorzaken aan het DNA

Vanwege hun grote massa verspreiden protonen zich minder door het weefsel

Alle protonen met een bepaalde energie hebben een beperkt bereik

Daarbij wordt de dosis over een paar millimeter afgegeven: Bragg Peak

PROTONEN BEHANDELING DE FEITEN

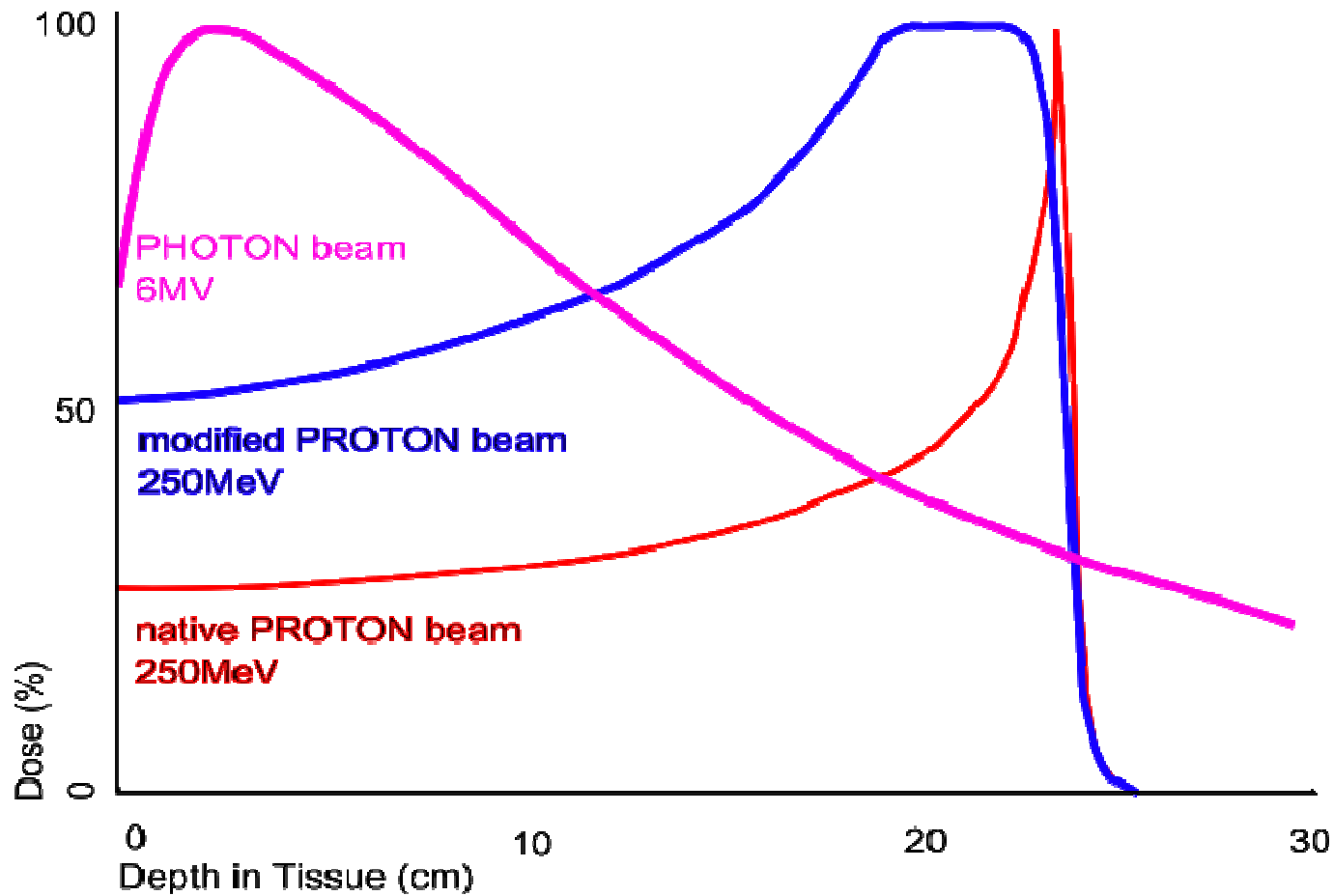
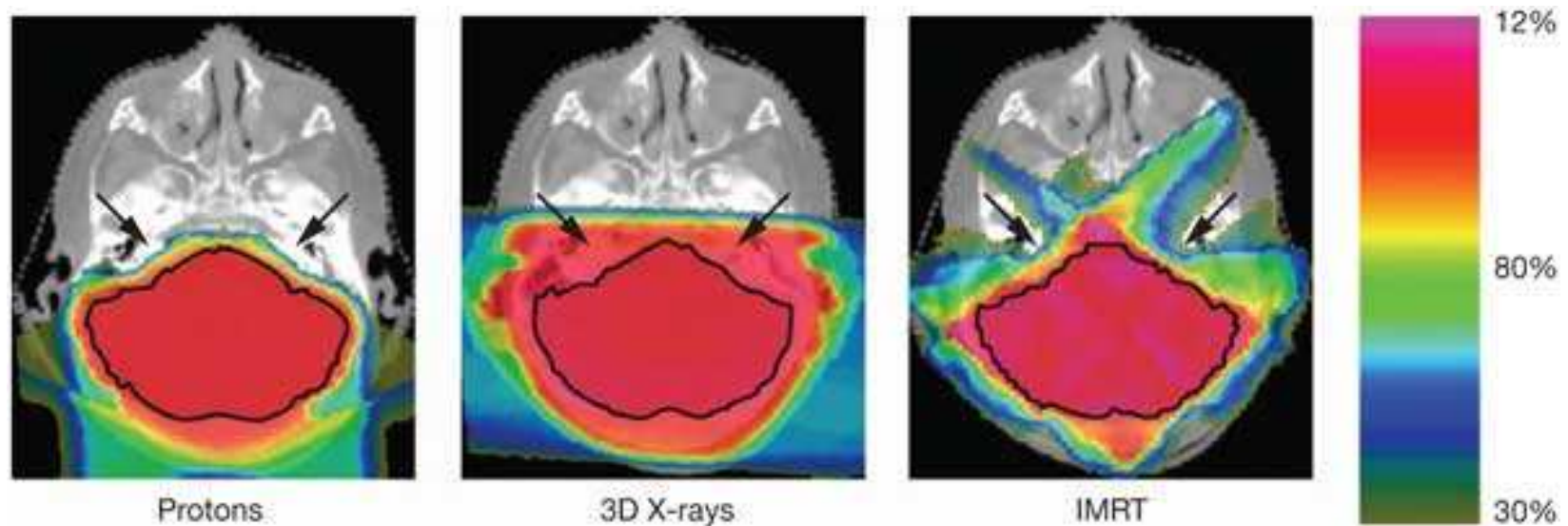
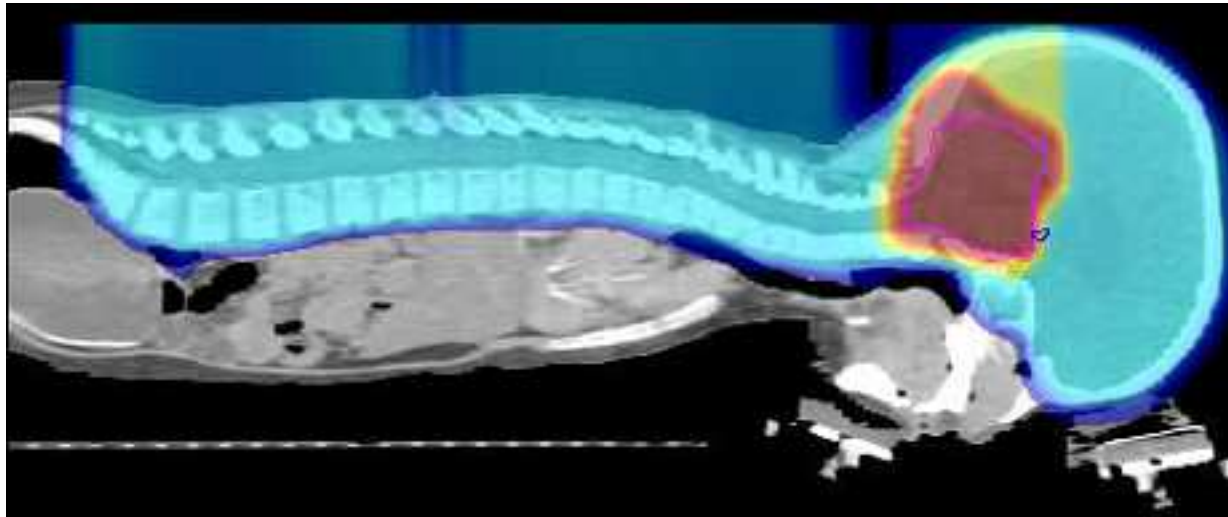


Figure 2 Differences in dose conformity using protons, conventional 3D planned photons and IMRT



Yock TI and Tarbell NJ (2004) Technology Insight: proton beam radiotherapy for treatment in pediatric brain tumors. *Nat Clin Pract Oncol* 1: 97–103 doi:10.1038/ncponc0090

Proton Beam en Medulloblastoom



Proton Beam Therapy. Leven et al., British Journal of Cancer, 2005, 93(8), 849–54

PROTONEN

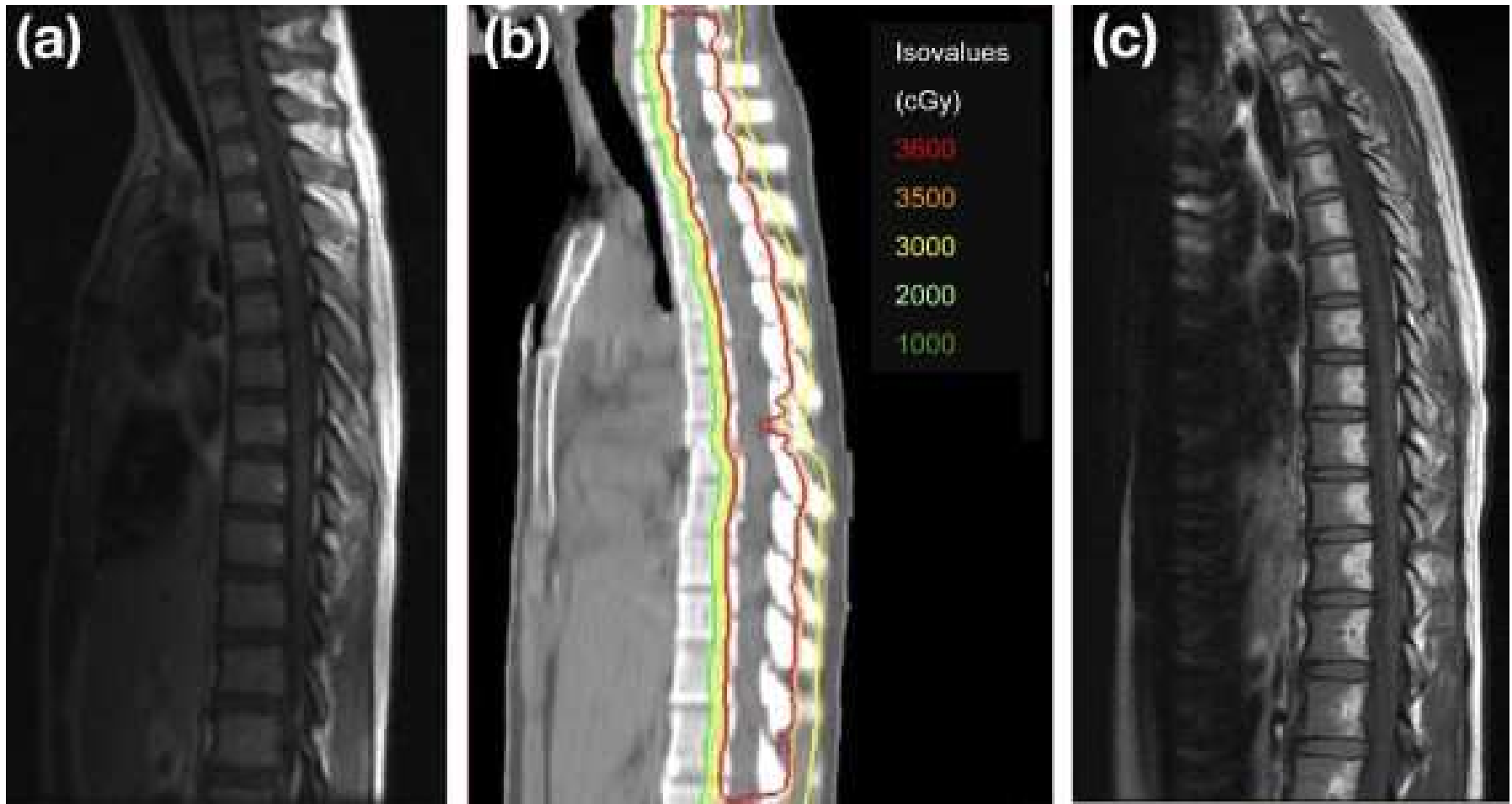


Fig. 1. A 14-year-old girl with supratentorial primitive neuroectodermal tumor: craniospinal irradiation prescribed to the thecal sac and exiting nerve roots only. (a) T1-weighted magnetic resonance image 1 week before radiation treatment. (b) Computed tomography–proton radiotherapy treatment plan. (c) T1-weighted magnetic resonance image showing hyperintense fatty changes in posterior aspect of vertebral bodies 1 month after

completion of proton radiotherapy

Krejkarec et al 2007

CONCLUSIE

PROGNOSE VAN KINDEREN VERBETERD

LATE TOXICITEIT FORS

DOEL STEREOTAXIE BEHOUDEN OF VERBETEREN LOCALE
CONTROLE → VERMINDEREN TOXICITEIT