A sugárterápia szerepe a onko-hematológiai betegségek ellátásában

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Klinikai hematológia – OFTEX továbbképző tanfolyam

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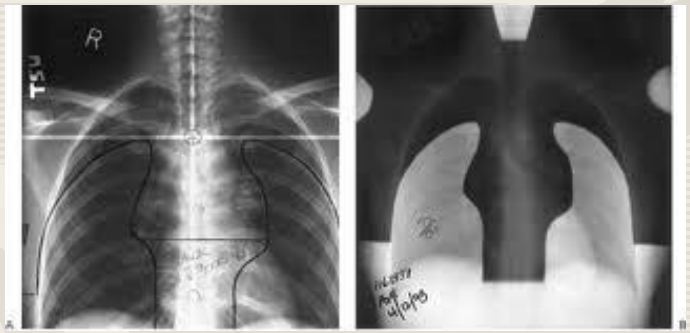
Az onko-hematológiai kórképek és a sugárkezelés: összefoglalás I.

- A szinte mindenhol növekvő sugárterápiás esetszámok (egy-egy prosztata-, emlő-, tüdődaganatos páciensnél a betegséglezajlás során számtalan besugárzási kurzus, a reirradiáció és a műtéti ellátás alternatívájaként szereplő SBRT kezelések mindennapos rutin kezeléssé válása miatt) ellenére az elmúlt 1-2 évtizedben az onko-heamatológiai indikációjú sugárkezelések száma egyértelműen csökkent
- A sugárterápia szerepe a hematológiában egyre inkább másodlagos, de a mai napig definitív irradiáció is lehet a terápiás döntés, korai esetekben és/vagy idősebb betegeknél a sugárterápia alkalmazása lehet a megoldás, illetve ez a modalitás sokszor a legkézenfekvőbb palliatív terápiás megoldás
- A sugárterápiás technológia az elmúlt 15-20 évben igen látványosan fejlődött (IMRT, IGRT, IMAT, SBRT stb.), és az elmúlt 10 évben az is igazolódott, hogy ennek a gyógyulási eredmények szempontjából is van jelentősége, mind az életminőség, mind a túlélési eredmények szempontjából (ld. prosztatarák, méhnyak-rák, fej-nyaki tumorok stb.), de talán mindezen technológiai fejlődésnek az onkohematológiai betegségek esetében „kisebb” a jelentősége
-

Az onko-hematológiai kórképek és a sugárkezelés: összefoglalás II.

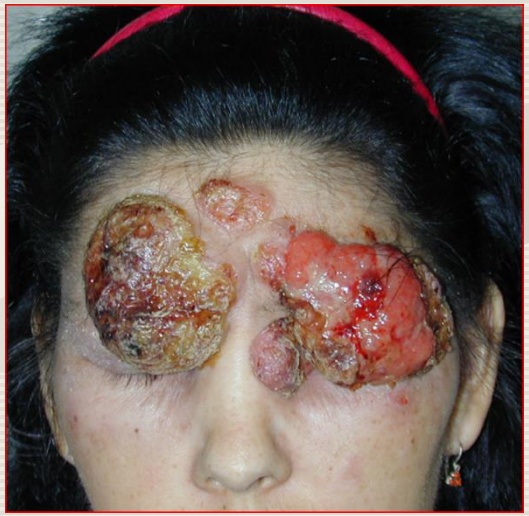
- Az onkohematológiai kórképek esetében többnyire közismerten sugár-érzékeny kórképekről van szó, és általában „fele-harmada-negyede” sugárterápiás dózisokat alkalmazunk (alkalmaztunk)
- A fenti alaptétel mellett is az elmúlt 2 évtizedben fokozatos dóziscsökkentés történt sok hematológiai indikációban
- Hagyományos nagymezős besugárzások (ld. pl. HL) háttérbe szorultak, az érintett mezős ellátások kerültek előtérbe

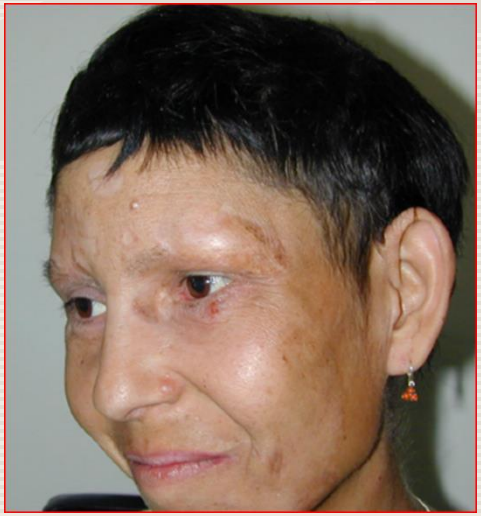


- Persze éppen a „mezőszűkítés” miatt egyre inkább szükséges-kötelező kihasználni a modern besugárzási technológiát, de természetesen hatásosak lehetnek a legegyszerűbb tervezési/kezelési módszerek is

A sugárkezelés és az onko-hematológiai kórképek : összefoglalás III.

- A diagnosztikus algoritmusok közül a PET-CT növekvő szerepe a céltérfogat meghatározásnál
- A mellékhatások, szövődmények elkerülése egyre fontosabb cél, illetve a hosszútávú következményekkel azonban továbbra is mindig számolni kell
- Terápiás döntés: mindig „onkoteam” megbeszélés alapján
- A fentiek összegzése, kihangsúlyozása mellett is a sugárterápia sokszor látványos hatású lehet egy-egy hematológiai eredetű körkép ellátása során

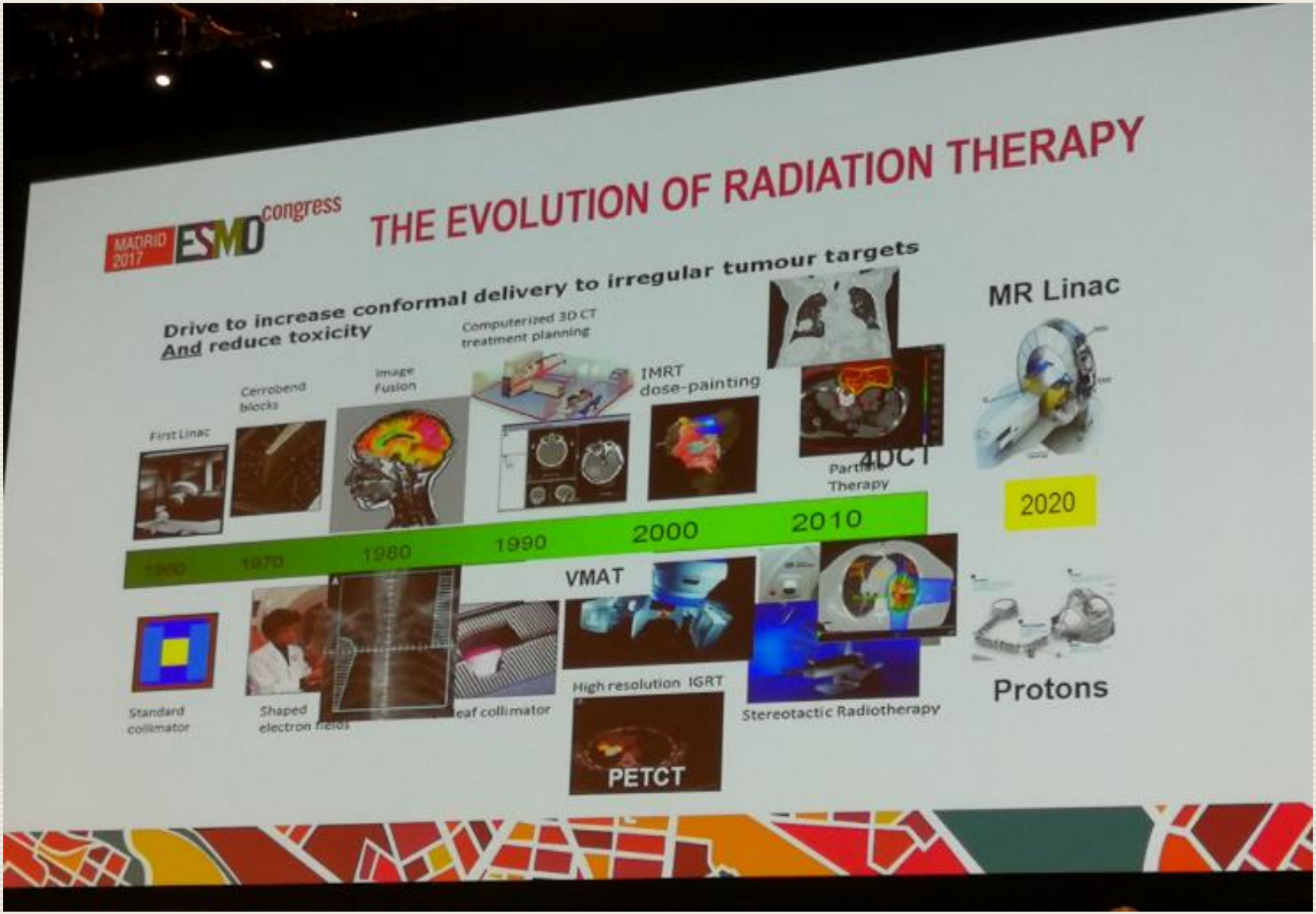


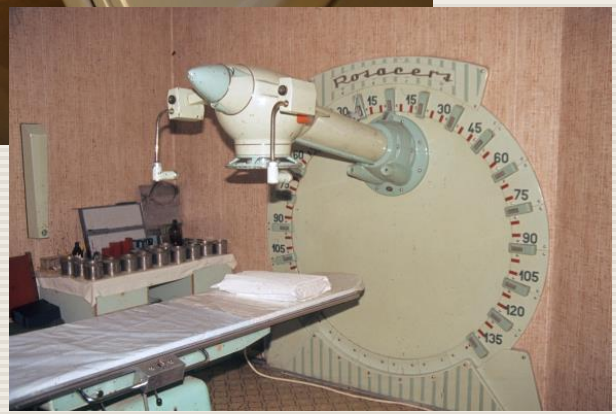


Akkor amiről beszélni szeretnék
(az összegző bevezetést követően):

- A sugárterápia fejlődése, és helye, szerepe, jelentősége a daganatos betegek ellátásában
- A sugárkezelések biológiai hatása
- „Új” sugárterápiás technikák
  - IMRT, IGRT, IMAT, sztereotaxiás sugárterápia
- Besugárzási technikák és indikációk onko-hematológiai kórképekben
  - Hodkgin kór
  - NHL, cután limfómák
  - Plasmocytoma, myeloma multiplex
  - Agyi limfómák
  - Egyéb indikációk

A sugárterápiás technológia drámai módon megváltozott az elmúlt 2 évtizedben




Poiacers

Röviden a sugárterápiás kezelésekről és azok indikációjáról

- **Lokális terápiás modalitás**, a sebészeti beavatkozások alternatívája és/vagy kiegészítője, a kuratív ellátások kb. 30%-a sugárterápiára épül, és a betegek kb. **felénél-kétharmadánál** alkalmazzuk valamikor a betegség lezajlása során

- **Definitív sugárterápia** elsősorban azon betegségeknél, ahol a lokális vagy loko-regionális kontroll a legfontosabb a gyógyulás szempontjából (és ahol viszonylag sugárérzékeny szövettanról van szó), ld. fej-nyaki laphám karcinoma, agydaganatok, méhnyak-daganat, nyelőcsőrák

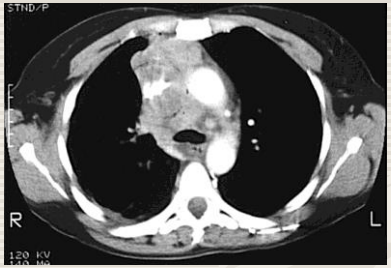
- Szisztémás onkológiai betegség állapot esetén is lehet a sugárkezelés az elsődleges, ha a gyógyszeres kezelés effektusa kérdéses (ld. szervezeti tartalékok, ill. várhatóan minimális terápiás hatékonyság), hiszen **általában az életminőséget kevéssé rontja** (pl. nagyméretű, „bulky" áttétek ellátása)

- Az **oligometasztatikus teória** elterjedésével a sugárterápia szerepe egyértelműen felértékelődött áttétes daganatok esetében is

- **Csont- ill. agyi áttétek** esetén a mai napig általában szintén az első terápiás választás

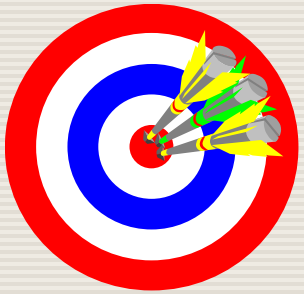
Röviden a sugárterápiás kezelésekről és azok indikációjáról II.

- **Sürgősségi esetekben** általában az első modalitás a sugárterápia, a gyorsabban jelentkező effektus miatt (ld. VCS szindróma, gerincvelő kompresszió)



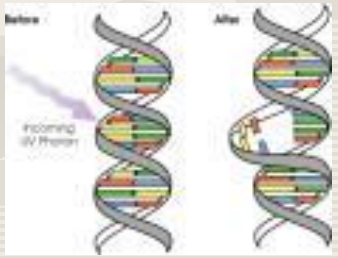
- A sugárterápia elmúlt 10-20 éves fejlődésének a legfontosabb összegzése: mind pontosabb céltérfogat meghatározás, mind „konformálisabb" sugártervezés és pontosabb kezelési kivitelezés, illetve állandó képi ellenőrzés lehetősége. Mindezek birtokában elérhető:
  - **Fokozott normál szöveti védelem**
  - **Magasabb dózisok kiszolgáltatásának lehetősége (dóziseszkaláció)**
  - **Radiokemoterápia rutinszerű alkalmazása**

- **Radiokemoterápia (RKT):** lokális kezelési modalitás, ahol a szimultán (és általában csökkentett dózisú) kemoterápia (esetleg bioterápia) a sugárkezelés effektusát növeli (és csak másodlagosan várható a távoli áttétek kialakulási esélyének csökkenése). Az RKT alkalmazása ma már szinte rutinszerű a legtöbb definitív sugárkezelést igénylő kórkép esetében. A RKT nem sugárterápia és kemoterápia együtt, és azon betegségekben ahol mindkét kezelési modalitás ugyanolyan fontos (ld. rektum tumorok - TNT), ott a radiokemoterápiát citosztatikus (szisztémás) kezelés követi (vagy előzi meg). RKT nem indikálható metasztatikus betegségben vagy palliatív céllal, ill. elesett állapotú betegeknél

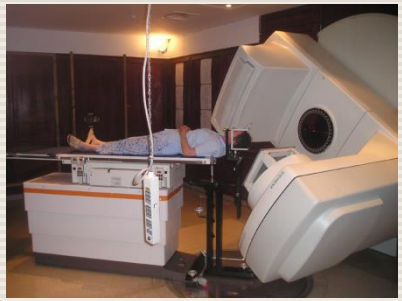


A besugárzás hatása

- A besugárzás biológiai célpontjai: 1.DNS 2. membránok, egyéb sejtalkotók 3. erek 4. fehérvérsejt elemek
- Fizikai, kémiai és biológiai fázis
- Komplex intra- és extracellularis történések, kaszkádszerű folyamatok, másodlagos reaktív mechanizmusok, „repair” és „az oxidatív stressz” szerepe
- Apoptózis indukálása, osztódás-gátlás, nekrózis kialakulása



- Nem csak a daganatos sejtek károsodnak!
- Sugaras mellékhatásokat illetően becslőskálák
  - A kezelés elviselését nehezítő akut mellékhatások
  - Előfordulhatnak irreverzibilis, életminőséget jelentősen rontó késői mellékhatások, ld. radionekrózis



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A review on lymphocyte radiosensitivity and its impact on radiotherapy

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It is well known that radiation therapy causes lymphopenia in patients and that this is correlated with a negative outcome. The mechanism is not well understood because radiation can have both immunostimulatory and immunosuppressive effects. How tumor dose conformation, dose fractionation, and selective lymph node irradiation in radiation therapy does affect lymphopenia and immune response is an active area of research. In addition, understanding the impact of radiation on the immune system is important for the design and interpretation of clinical trials combining radiation with immune checkpoint inhibitors, both in terms of radiation dose and treatment schedules. Although only a few percent of the total lymphocyte population are circulating, it has been speculated that their increased radiosensitivity may contribute to, or even be the primary cause of, lymphopenia. This review summarizes published data on lymphocyte radiosensitivity based on human, small animal, and *in vitro* studies. The data indicate differences in radiosensitivity among lymphocyte subpopulations that affect their relative contribution and thus the dynamics of the immune response. In general, B cells appear to be more radiosensitive than T cells and NK cells appear to be the most resistant. However, the reported dose-response data suggest that in the context of lymphopenia in patients, aspects other than cell death must also be considered. Not only absolute lymphocyte counts, but also lymphocyte diversity and activity are likely to be affected by radiation. Taken together, the reviewed data suggest that it is unlikely that radiation-induced cell death in lymphocytes is the sole factor in radiation-induced lymphopenia.

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Intercellular Communication of Tumor Cells and Immune Cells after Exposure to Different Ionizing Radiation Qualities

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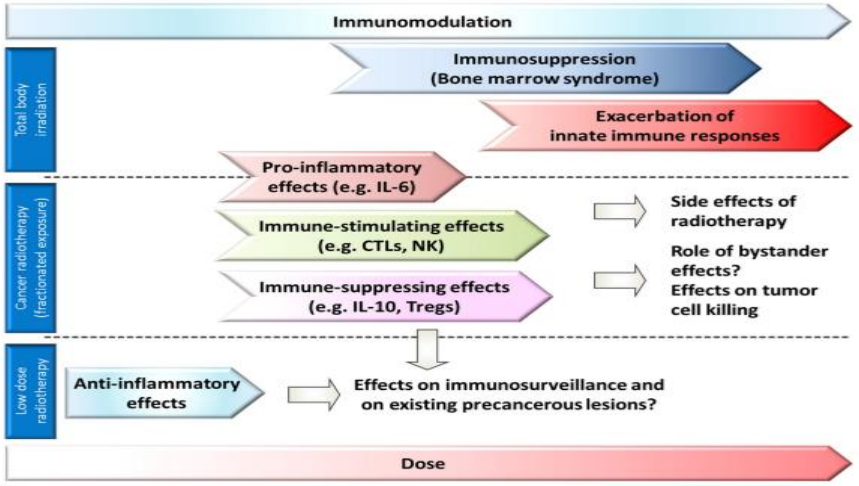


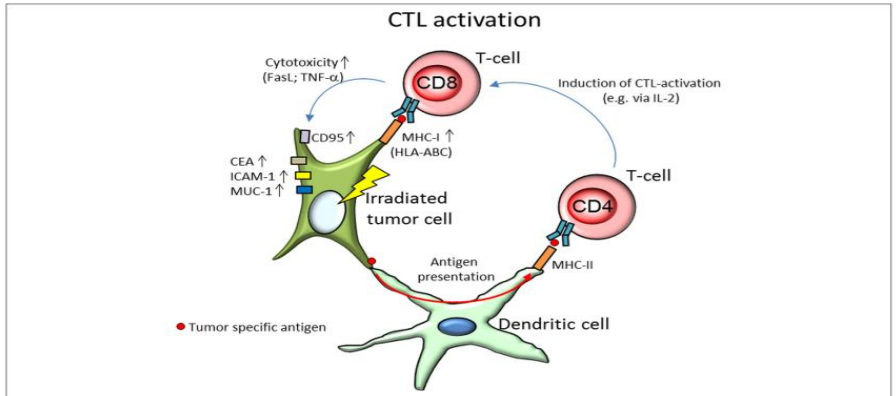
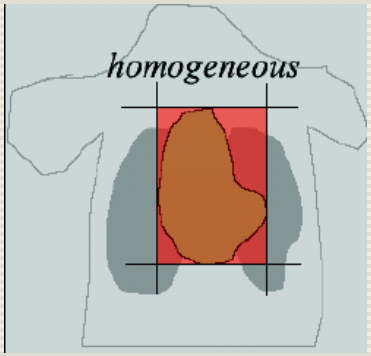
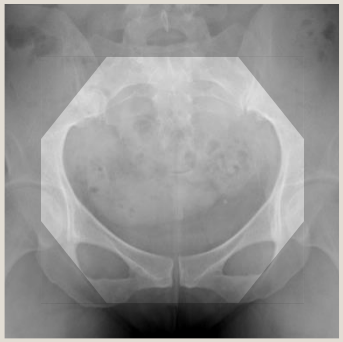


FIGURE 2 | Activation of CD8+ cytotoxic T-cells (CTL) by tumor specific antigens presented by the irradiated tumor cell and dendritic cells (DCs). After irradiation, the tumor cell shows an increased expression of surface markers CD95 (Fas), carcinoembryonic antigen (CEA), intercellular adhesion molecule 1 (ICAM-1), and mucin-1 (MUC-1), as well as upregulated expression of major histocompatibility complex class I (MHC-I; HLA-ABC, human leukocyte antigen A, B, and C). While increased expression of CEA, ICAM-1, and MUC-1 are found to enhance cytolytic T-cell activity, CD95, and MHC-I are responsible for the activation of the T-cell. Increased expression of either has been associated with elevated activation of CTL. By binding with surface bound Fas-ligand (FasL) to the tumors' CD95, T-cells can initiate tumor cell death *via* apoptosis. MHC-I molecules on the other hand present tumor specific antigens to the T-cell *via* the T-cell receptor and initiate degranulation of tumor necrosis factor α (TNF-α), perforines, and granzymes, thereby lysing the target tumor cell. After irradiation, tumor cells were found to produce unique antigen peptides, leading to increased tumor recognition. DCs, in their role as antigen-presenting cells, enable radiation-induced CTL lysis. DC take up tumor specific antigens and present them *via* MHC-II molecules to T-helper cells (CD4+), which prime and activate CTL, e.g., *via* secretion of interleukin-2 (IL-2).

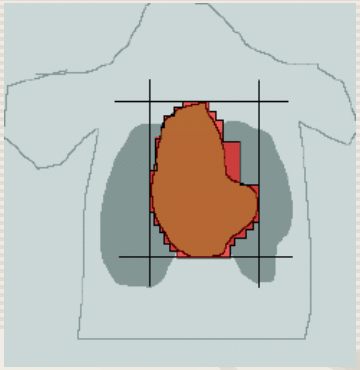
Besugárzás - teleterápia

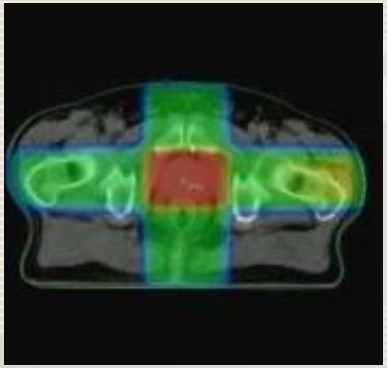
konvencionális
(1D)

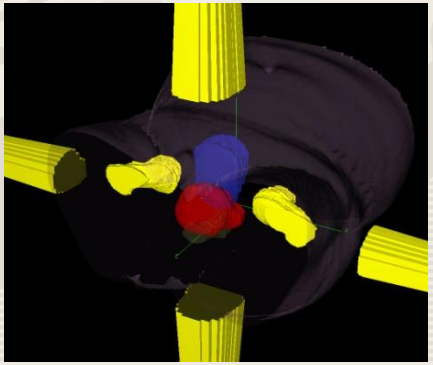




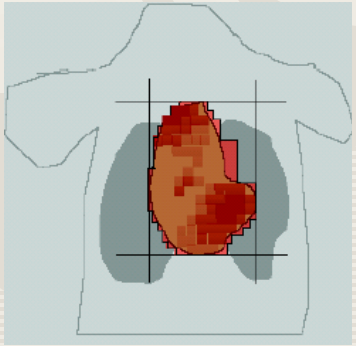
konformális
(3D)

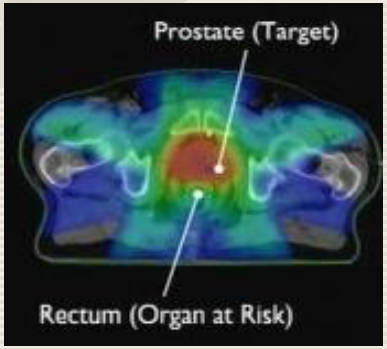


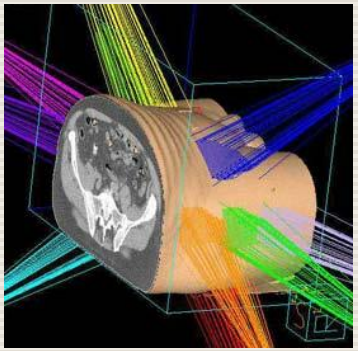




inzenzitás-modulált
(IMRT)
(3D)

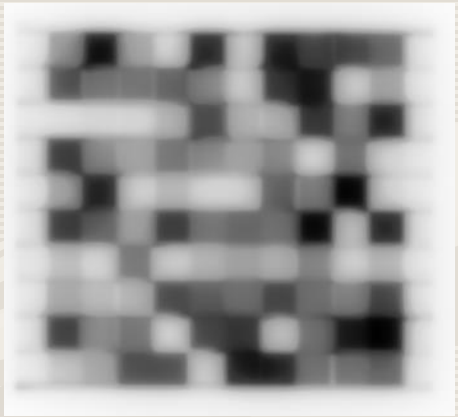


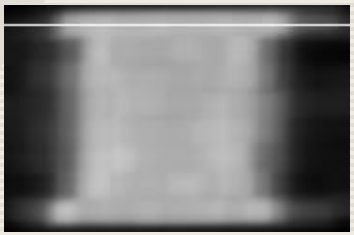


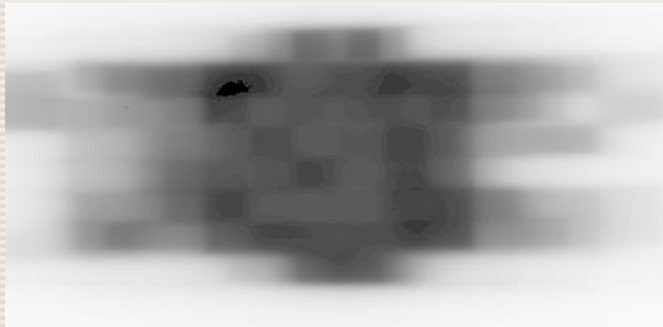


Intenzitás modulált sugárterápia (IMRT)

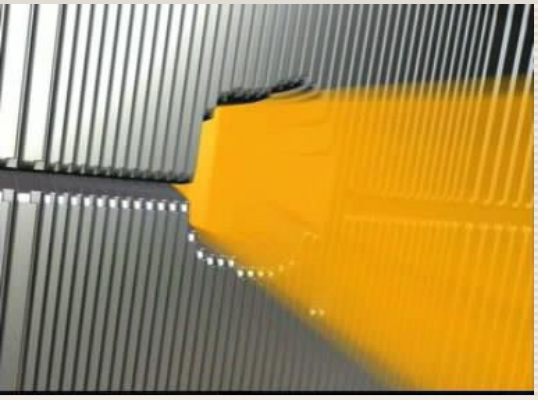
- MLC tizedmilliméter pontossága nélkülözhetetlen
- A sugármezők moduláltak (változóak)
- A célterület homogénebben ellátható
- Rizikószervek dózisa csökkenthető
- Magasabb dózis adható le, ➡ jobb lehet a tumor kontroll
- Nem minden esetben jár klinikai előnnyel
- Idő és eszközigényes

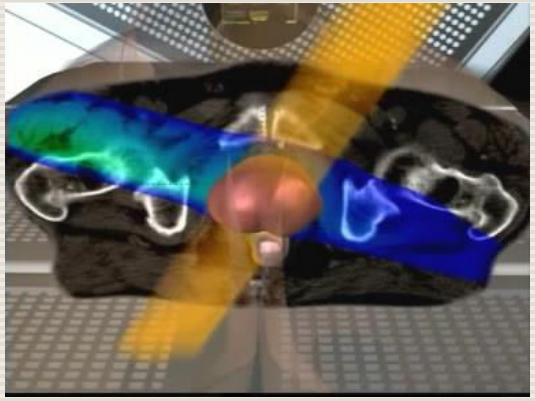


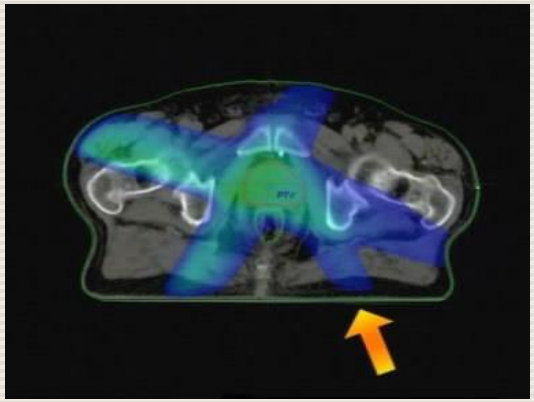


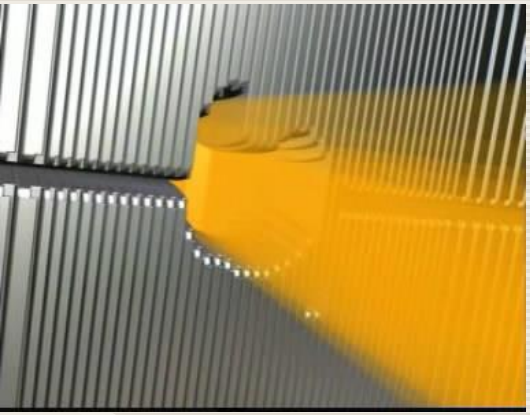


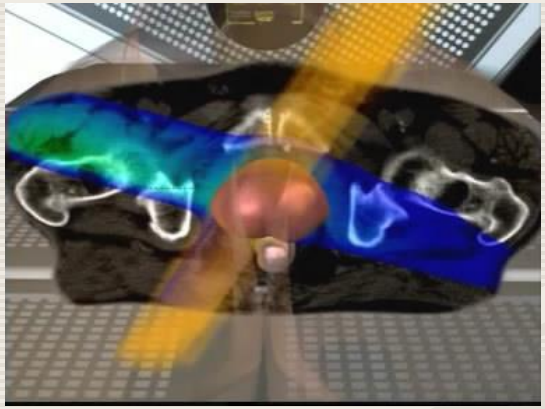
IMRT

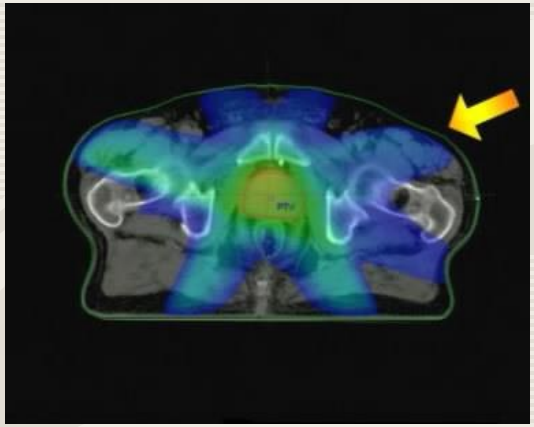


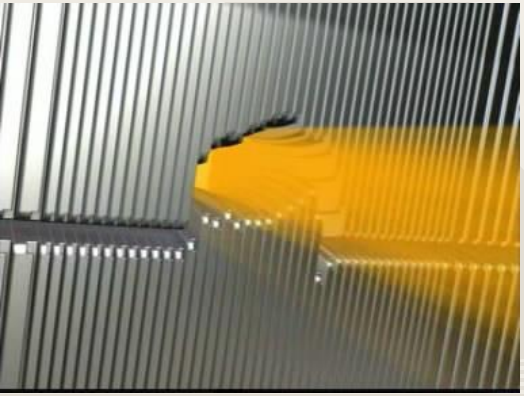


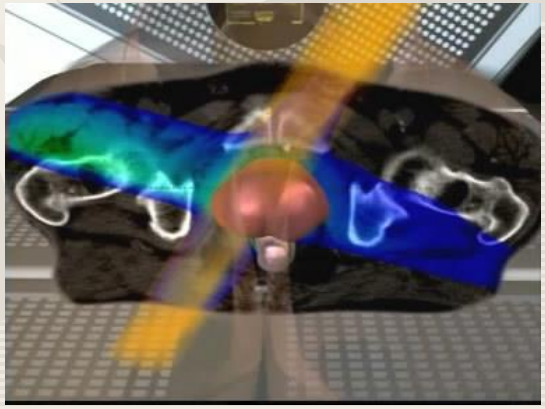


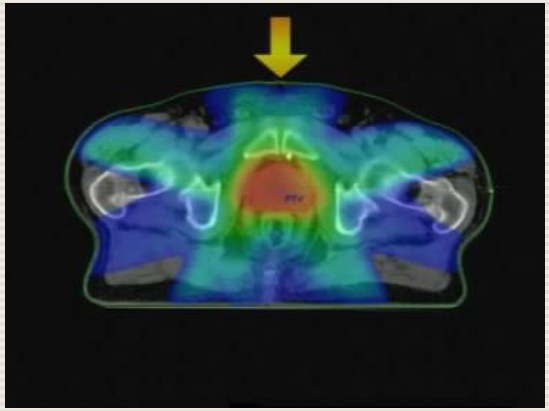






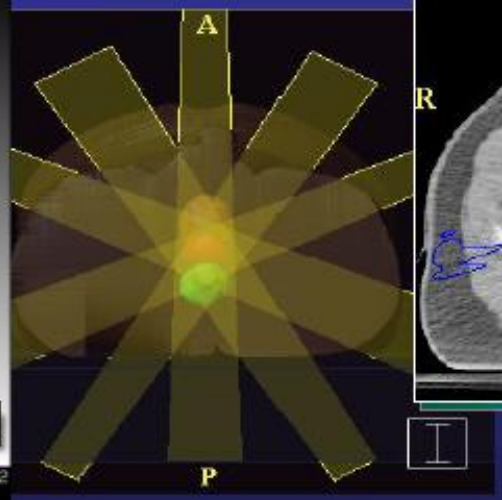




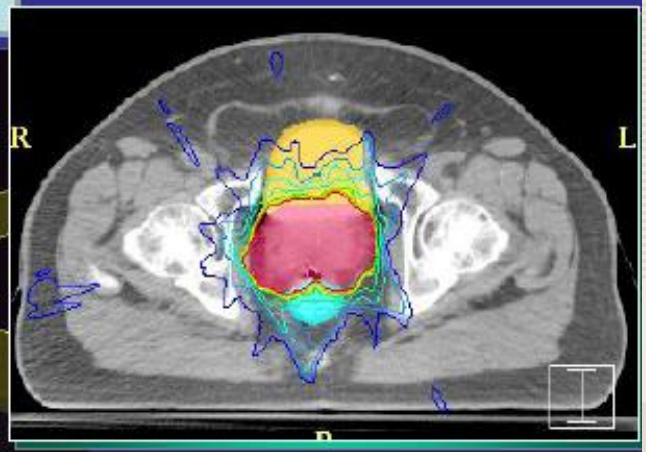


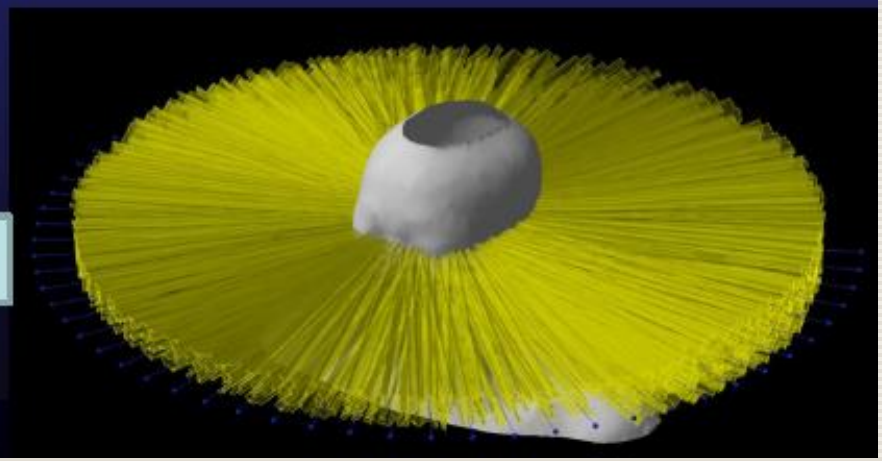
Evolution Towards RapidArc

1990's



2000's



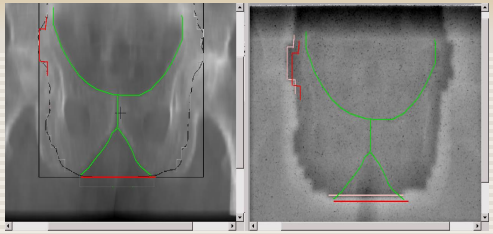


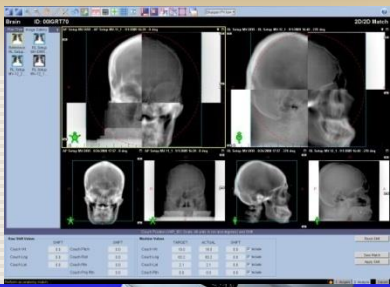
2010-present

IGRT- Novalis TX

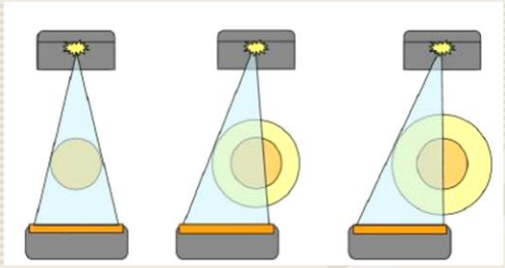
Képalkotási lehetőségek

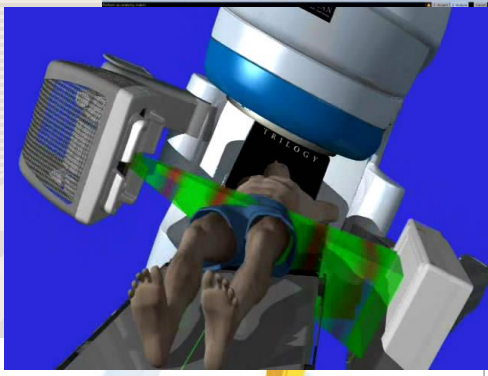
- MV röntgen (terápiás sugár)
  - Kezelés közben



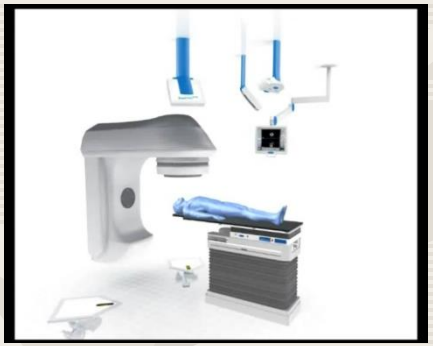


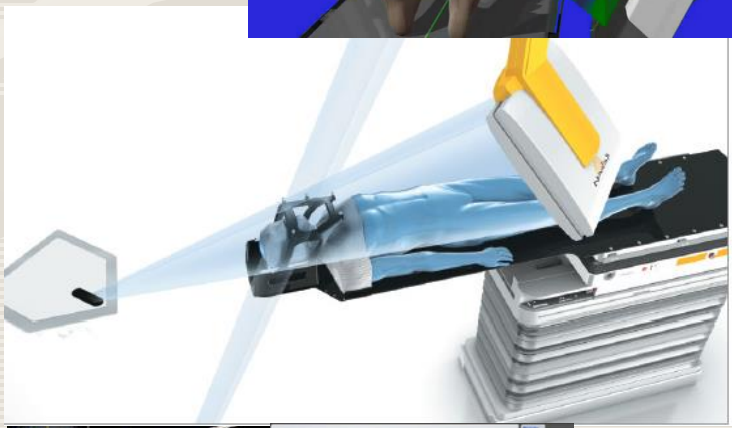
- kV-os CT (CBCT)
  - Kezelés előtt/után



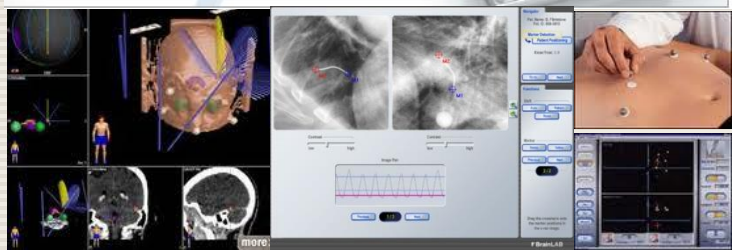


- kV-os PadlóRtg
  - Kezelés előtt/közben

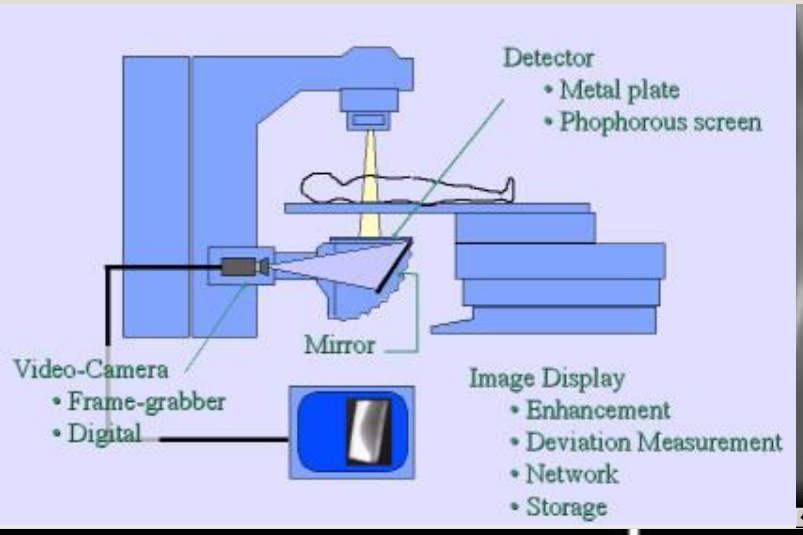


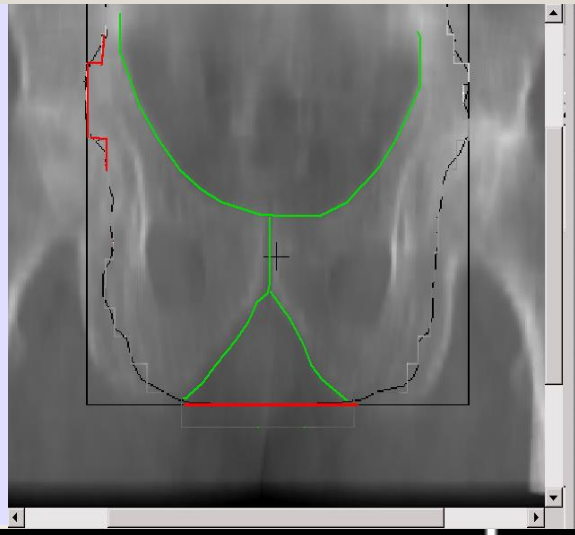


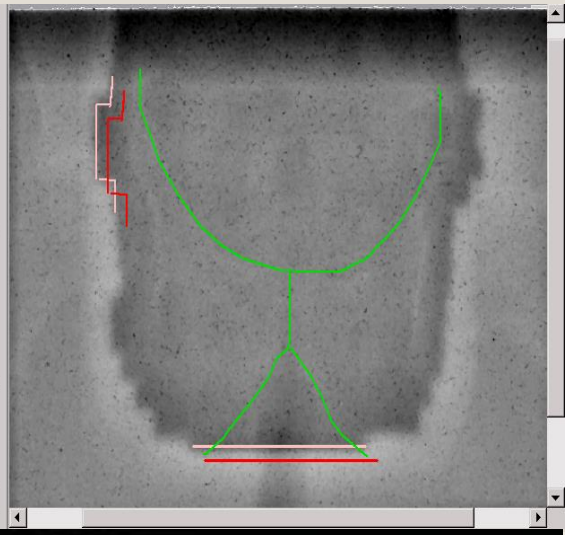
- Infravörös kamera (ExacTrac)
  - Kezelés előtt/közben

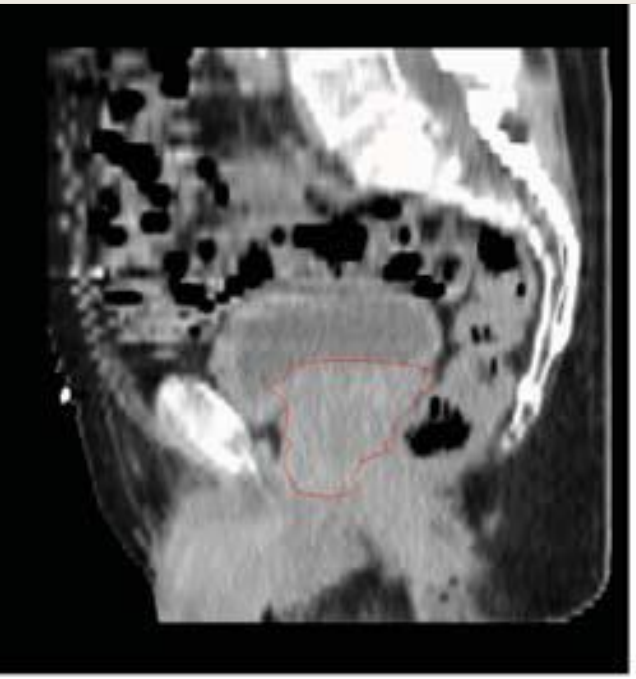


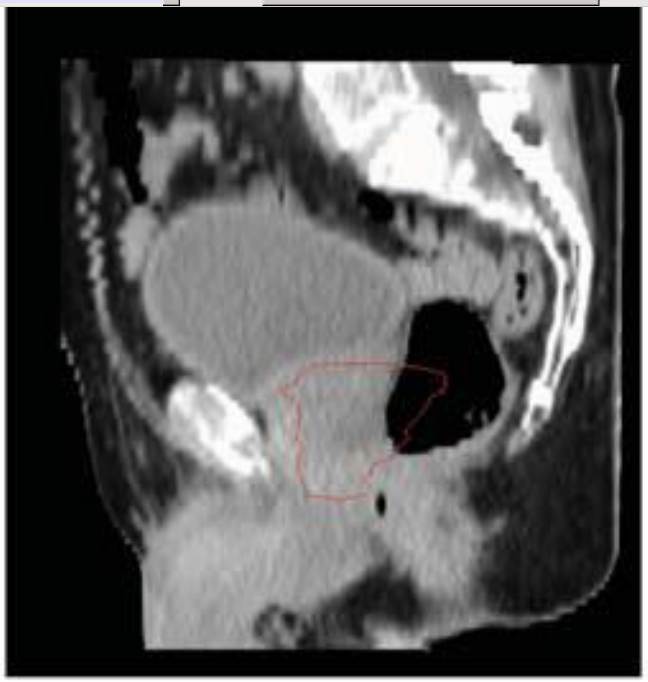
IGRT

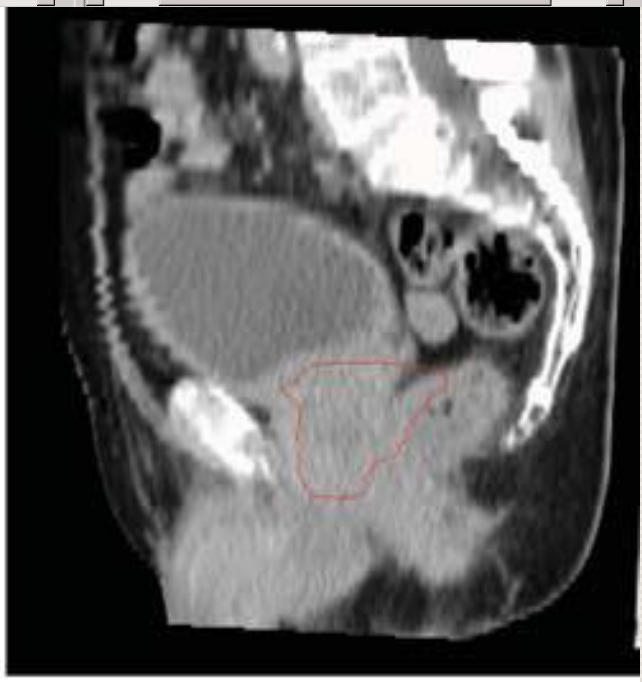

Detector
• Metal plate
• Phophorous screen
Mirror
Video-Camera
• Frame-grabber
• Digital
Image Display
• Enhancement
• Deviation Measurement
• Network
• Storage









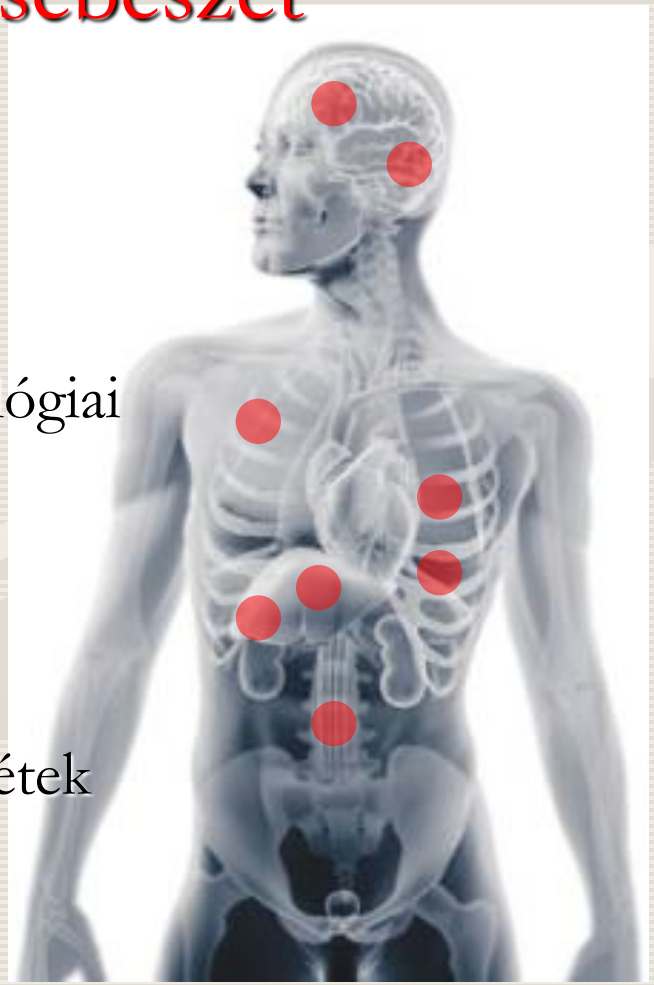


SBRT – Sztereotaxiás testbesugárzás vagy extrakraniális sugársebészet

- Ötvözi és felhasználja a sugársebészet

  és az IGRT előnyeit

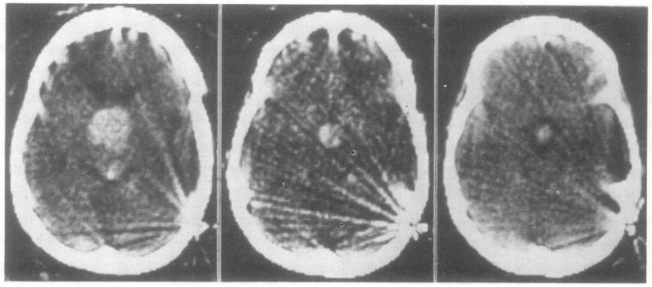
- Hypofrakcionált kezelések, magasabb biológiai hatékonyság
- Kezelés pontossága, gyorsasága fontos
- Alkalmazási területe: elsősorban távoli áttétek
- Új TNM?
  - M1: 1 met., M2: 2-4 met., M3: >5 met



Journal of Neurology, Neurosurgery, and Psychiatry 1983;**46**:797–803

Occasional review

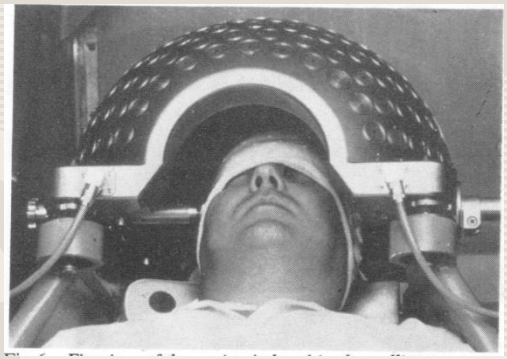
Stereotactic radiosurgery

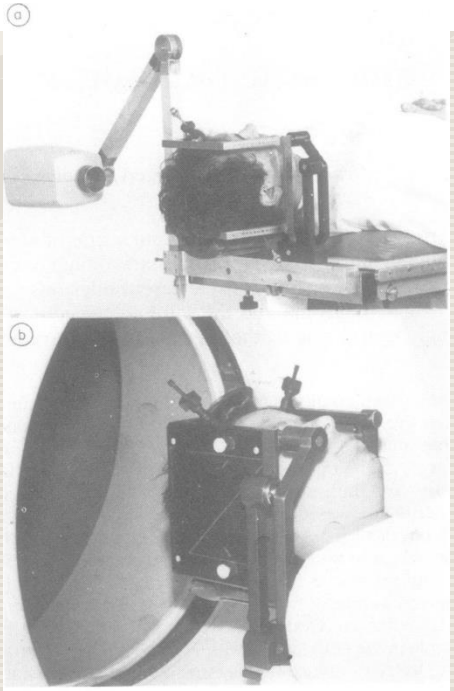


LARS LEKSELL

From the Department of Neurosurgery, Karolinska Sjukhuset, Stockholm, Sweden

SUMMARY The development and scope of stereotactic radiosurgery is described. The technique, which combines well with the latest diagnostic methods, has already proved a safe and effective way of treating inaccessible cerebral lesions and in particular small arteriovenous malformations, acoustic neuroma and the solid component of craniopharyngioma, as well as playing an increasingly useful role in the therapy of pituitary adenoma.





Radiation Oncology

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Stereotactic, single-dose irradiation of stage I non-small cell lung cancer and lung metastases

Peter Fritz*[1], Hans-Jörg Kraus[1], Werner Mühlnickel[1], Udo Hammer[2], Wolfram Dölken[2], Walburga Engel-Riedel[3], Assad Chemaissani[3] and Erich Stoelben[3]

Address: [1]St. Marien-Krankenhaus, (Medical Education Hospital of the University of Marburg), Department of Radiotherapy, D-57072 Siegen, Germany, [2]St. Marien-Krankenhaus, (Medical Education Hospital of the University of Marburg), Department of Radiology, D-57072 Siegen, Germany and [3]Cologne Metropolitan General Hospital, Clinic for Thoracic Disease, D-51109 Köln, Germany

Email: Peter Fritz* - P.H.Fritz@t-online.de; Hans-Jörg Kraus - j.kraus@marienkrankenhaus.com; Werner Mühlnickel - w.mühlnickel@marienkrankenhaus.com; Udo Hammer - u.hammer@marienkrankenhaus.com; Wolfram Dölken - w.dölken@marienkrankenhaus.com; Walburga Engel-Riedel - engel-riedelw@kliniken-koeln.de; Assad Chemaissani - chemaissania@kliniken-koeln.de; Erich Stoelben - stoelbene@kliniken-koeln.de

* Corresponding author

Published: 20 August 2006

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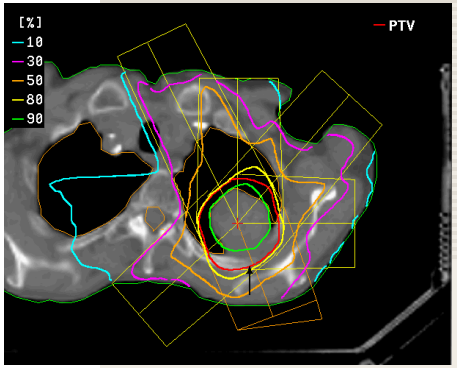

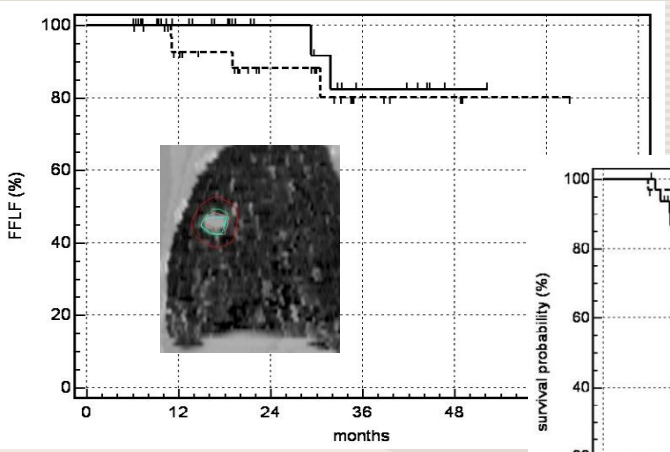

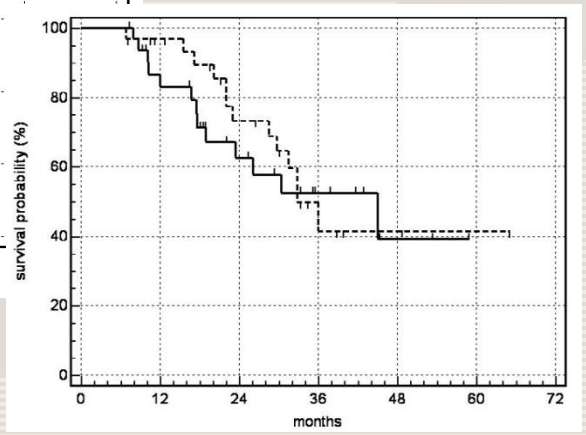

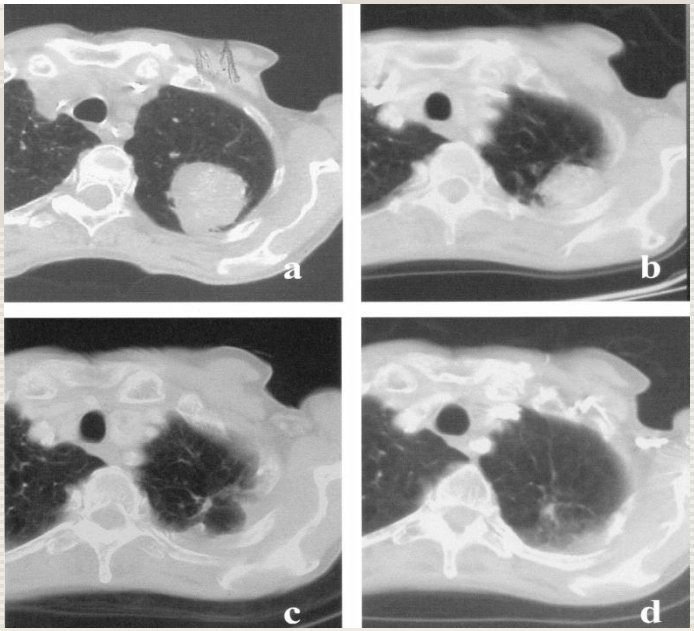

ASTRO Model Policies

STEREOTACTIC BODY RADIATION THERAPY (SBRT)

DIAGNOSIS	ICD-10 CODE(S)
PRIMARY TUMORS	
Lung cancer	C34.00 – C34.92
Prostate cancer	C61
Pancreatic cancer	C25.0 – C25.9
Renal cancer	C64.1 – C65.9
Liver or bile duct cancer	C22.0 – C22.9
Adrenal gland cancer	C74.00 – C74.92
Benign spinal cord tumor	D33.4
Primary spinal cancer	C41.2
Benign spinal tumor	D16.6
Bone tumors	C40.00 – C41.9
METASTATIC TUMORS	
Lung metastasis	C78.00 – C78.02
Liver metastasis	C78.7
Renal metastasis	C79.00 – C79.02
Adrenal gland metastasis	C79.70 – C79.72
Bone metastasis	C79.51, C79.52
Abdominal lymph nodes metastasis	C77.2
Pelvic lymph node metastasis	C77.5
Spine Cord metastasis	C72.0. C72.1
Spinal Meninges metastasis	C70.1
RECURRENT TUMORS AFTER PRIOR RT	
Thoracic lymph nodes metastasis	C77.1
Abdominal and pelvic cancer	C76.2, C76.3
Gynecologic cancer	C51.0-C57.9
Rectal and anal cancer	C19-C21.8
Head and neck cancer	C00.0-C10.8 C11.0- C14.8 C30.0-C32.9, C76.0
Lymph node metastasis	C77.0-C77.9
Prior radiotherapy, any site	Z92.3, T66.XXXA*

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ClinicalTrials.gov

Find Studies ▾ About Studies ▾ Submit Studies ▾ Resources ▾

Home > Search Results

Modify Search Start Over

1017 Studies found for: **SBRT**

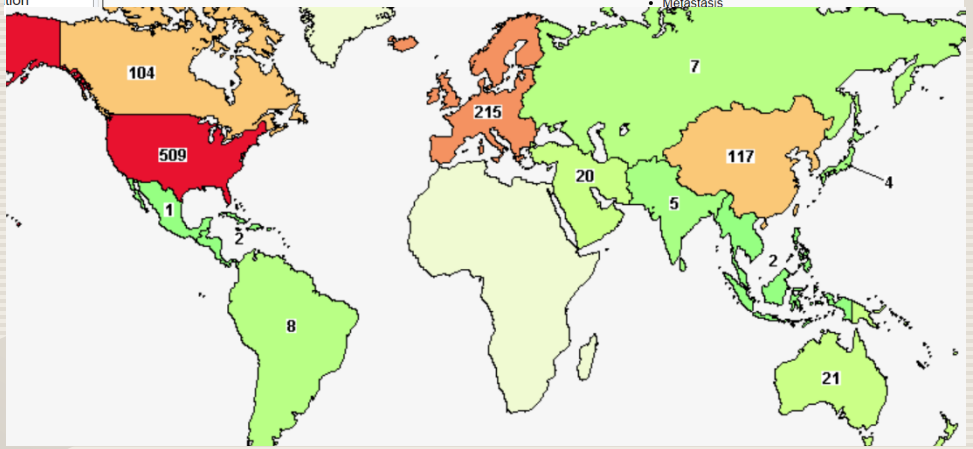
Also searched for **Stereotactic body radiation therapy**, **Stereotactic Radiotherapy** and **Stereotactic radiation therapy**. See

On Map Search Details

Showing: 1-10 of **1,017** studies 10 studies per page

Clear

Row	Saved	Status	Study Title	Conditions	Interventions
1	☐	Recruiting	**Stereotactic Body Radiation Therapy (SBRT)** for Invasive Breast Cancer Patients Not Undergoing Definitive Surgery	• Breast Cancer	• Radiation: **Stereotactic Body Radiation Therapy (SBRT)**
2	☐	Recruiting	Integrated Boost to the Dominant Intraprostatic Nodule Based on Ga-68 PSMA PET/MR Study of **SBRT** With Prostate Cancer	• Treatment	• Radiation: **Stereotactic Body Radiation Therapy (SBRT)**
3	☐	Not yet recruiting	**SBRT** for Oligo-metastatic Lesions After Systemic Treatment of Primary Metastatic Nasopharyngeal Carcinoma	• Nasopharyngeal Carcinoma • Metastasis	• Radiation: **SBRT**



When you might have stereotactic radiotherapy

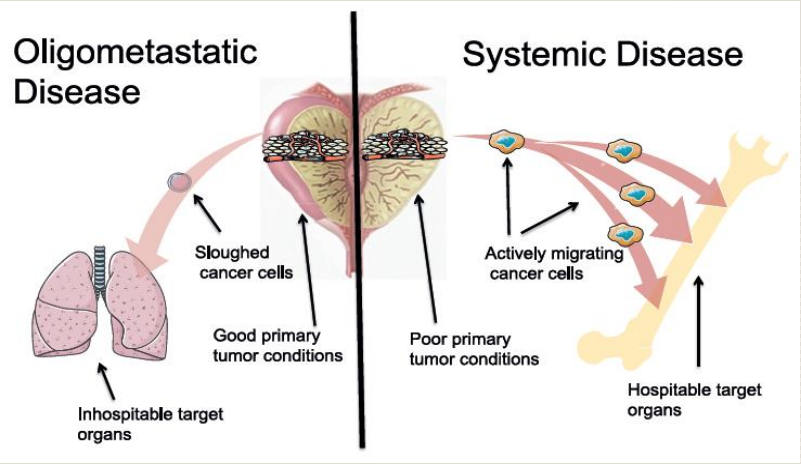
This type of radiotherapy is mainly used to treat very small cancers, including:

- cancer in the lung
- cancer that started in the liver or cancer that has spread to the liver
- cancers in the lymph nodes
- spinal cord tumours
- cancer spread in the brain

CANCER RESEARCH UK

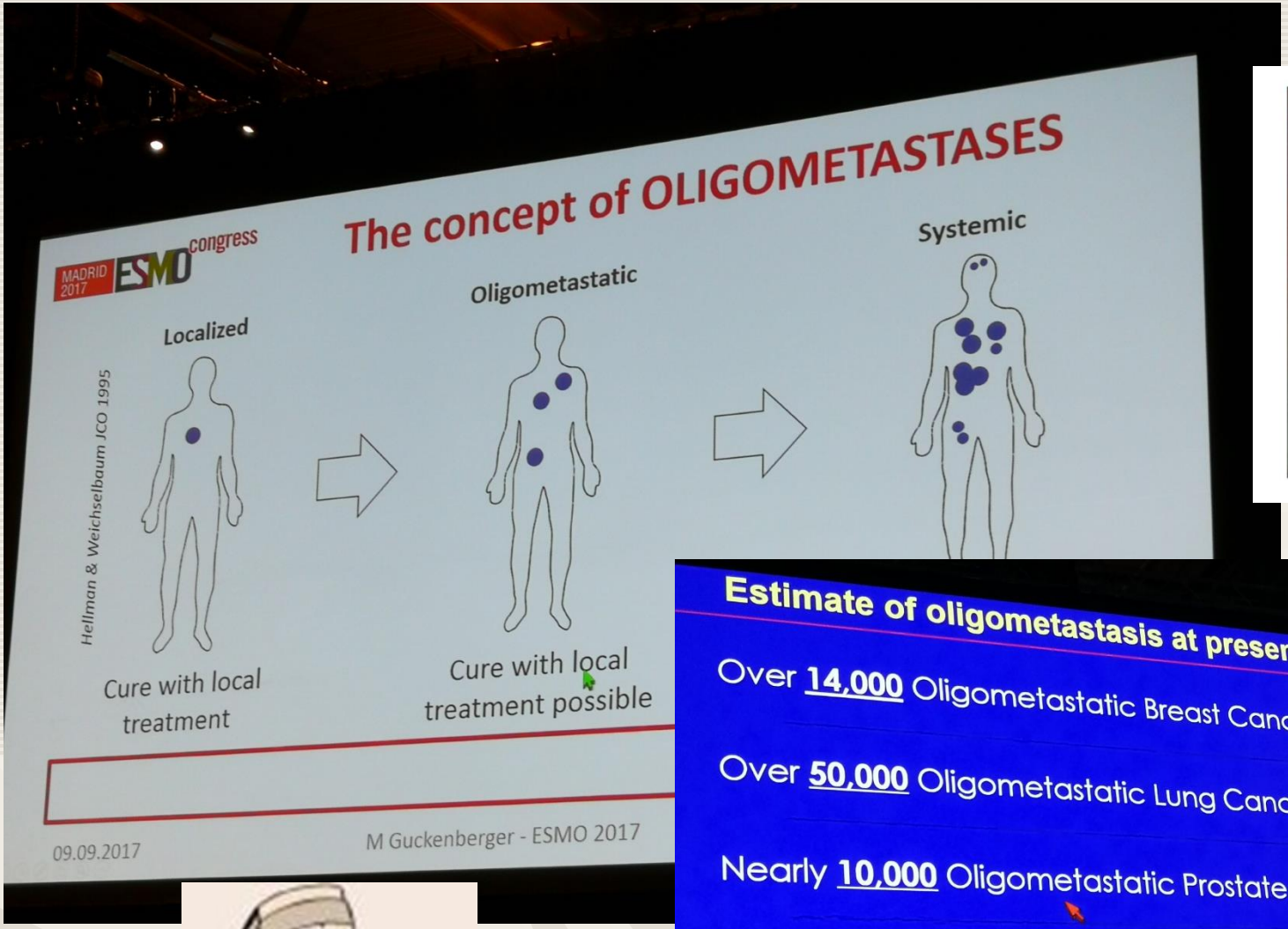
Az áttétképződés elméletei

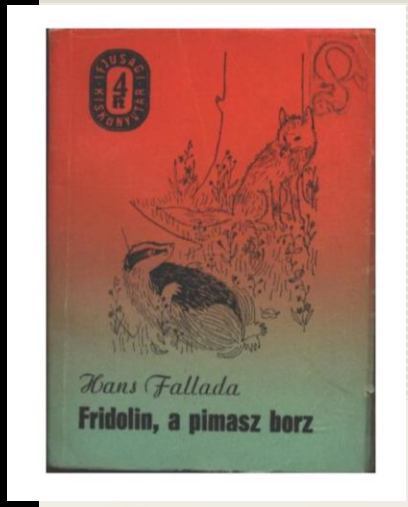
- Paget (1889): „seed and soil theory”
- Halstead (1894): direkt terjedés, progrediáló folyamatos szórás
- Ewing (1928): az áttétek ott nőnek, ahova a vér- vagy nyirokáram sodorja őket
- Keynes (1956), Fisher (1980): „systemic disease theory” : pl. nyirokcsomó áttét csak marker
- Hellman (1994): „spectrum theory” : különböző klónokból indolens betegség vagy éppen agresszív áttétképződés alakul ki, függően a sejteken levo mutációktól, az elsődleges tumor sajátosságaitól és a gazdaszövet tulajdonságaitól
- Weichselbaum and Hellman (1995) : oligo-metasztázis fogalom megalkotása: a primer tumor sejtjeinek korlátozott a képessége áttétképződésre
- Hanahan and Weinberg (2000, 2011): „hallmarks of cancer theory” ; 6 lépcsős sejtbiológiai transzformáció szükséges az áttétképződés elindulásához

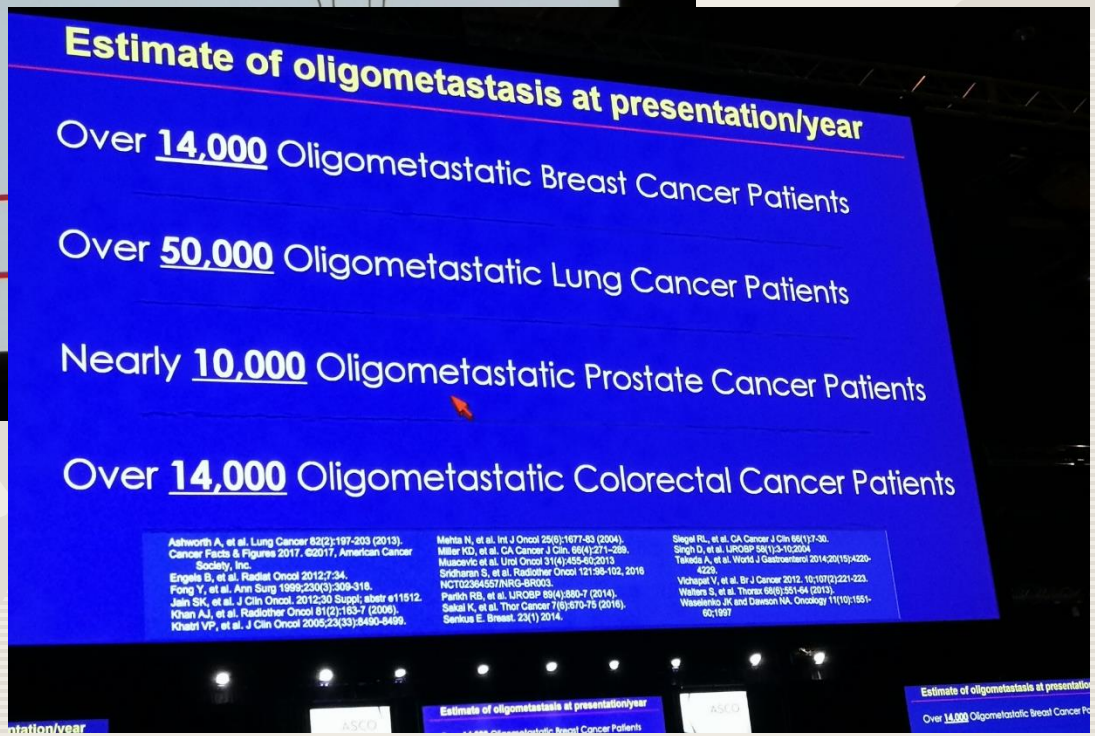


DK Reyes, KJ Pienta: The biology and reatment of oligometastatic cancer Oncotarget, 2015

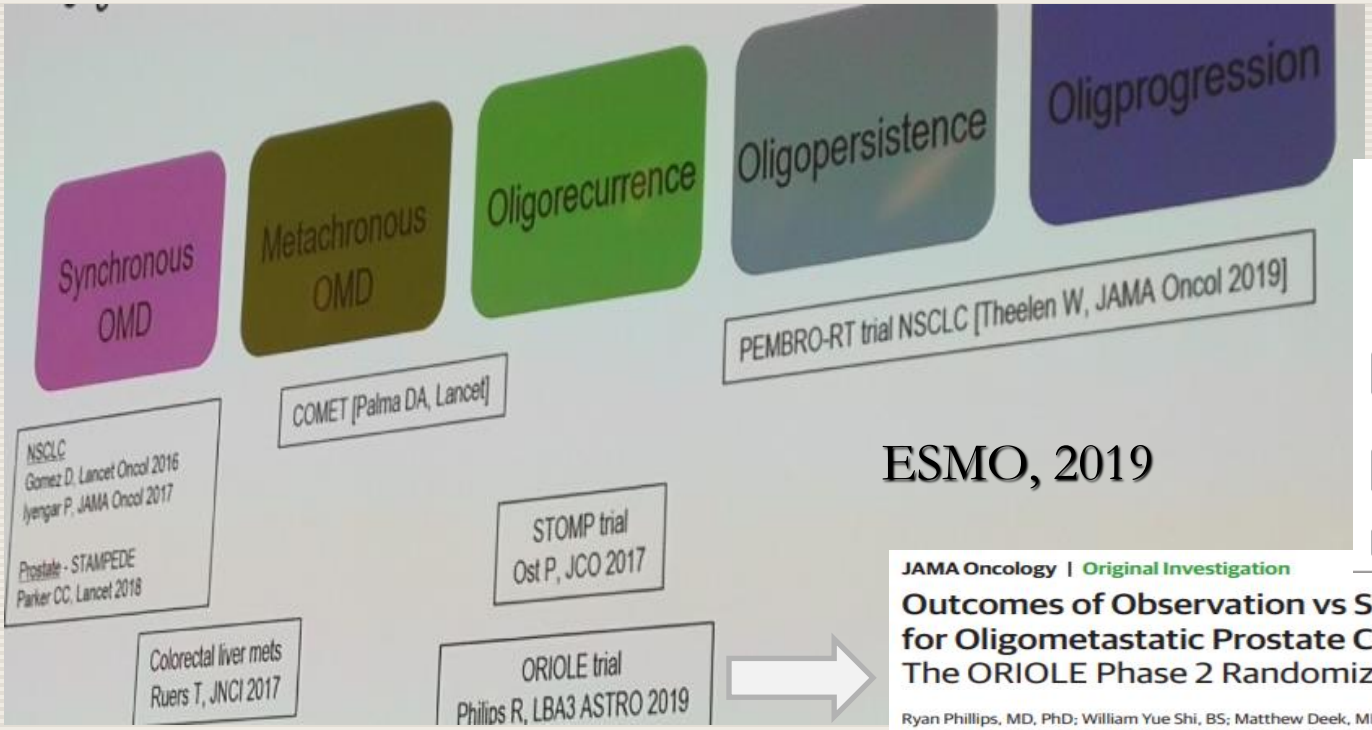
i


The concept of OLIGOMETASTASES
MADRID 2017 ESMO congress
Localized
Oligometastatic
Systemic
Hellman & Weichselbaum JCO 1995
Cure with local treatment
Cure with local treatment possible
09.09.2017
M Guckenberger - ESMO 2017

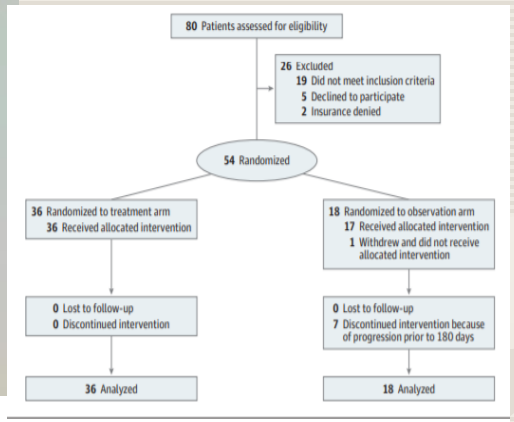

Hans Fallada
Fridolin, a pimasz borz

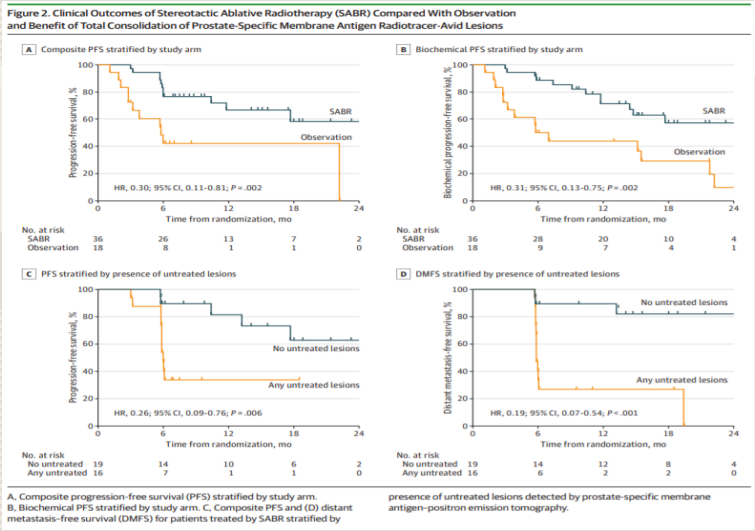

Estimate of oligometastasis at presentation/year
Over 14,000 Oligometastatic Breast Cancer Patients
Over 50,000 Oligometastatic Lung Cancer Patients
Nearly 10,000 Oligometastatic Prostate Cancer Patients
Over 14,000 Oligometastatic Colorectal Cancer Patients

Oligometasztatikus betegség állapotok és klinikai vizsgálati eredmények



ESMO, 2019





A, Composite progression-free survival (PFS) stratified by study arm. B, Biochemical PFS stratified by study arm. C, Composite PFS and (D) distant metastasis-free survival (DMFS) for patients treated by SABR stratified by presence of untreated lesions detected by prostate-specific membrane antigen–positron emission tomography.

JAMA Oncology | Original Investigation

Outcomes of Observation vs Stereotactic Ablative Radiation for Oligometastatic Prostate Cancer
The ORIOLE Phase 2 Randomized Clinical Trial

Ryan Phillips, MD, PhD; William Yue Shi, BS; Matthew Deek, MD; Noura Radwan, MD; Su Jin Lim, ScM; Emmanuel S. Antonarakis, MD; Steven P. Rowe, MD, PhD; Ashley E. Ross, MD, PhD; Michael A. Gorin, MD; Curtiland Deville, MD; Stephen C. Greco, MD; Hailun Wang, PhD; Samuel R. Denmeade, MD; Channing J. Paller, MD; Shirl Dipasquale, MS, RN; Theodore L. DeWeese, MD; Daniel Y. Song, MD; Hao Wang, PhD; Michael A. Carducci, MD; Kenneth J. Pienta, MD; Martin G. Pomper, MD, PhD; Adam P. Dicker, MD, PhD; Mario A. Eisenberger, MD; Ash A. Alizadeh, MD, PhD; Maximilian Diehn, MD, PhD; Phuoc T. Tran, MD, PhD

RESULTS In the 54 men randomized, the median (range) age was 68 (61-70) years for patients allocated to SABR and 68 (64-76) years for those allocated to observation. Progression at 6 months occurred in 7 of 36 patients (19%) receiving SABR and 11 of 18 patients (61%) undergoing observation ($P = .005$). Treatment with SABR improved median progression-free survival (not reached vs 5.8 months; hazard ratio, 0.30; 95% CI, 0.11-0.81; $P = .002$). Total consolidation of PSMA radiotracer-avid disease decreased the risk of new lesions at 6 months (16% vs 63%; $P = .006$). No toxic effects of grade 3 or greater were observed. T-cell receptor sequencing identified significant increased clonotypic expansion following SABR and correlation between baseline clonality and progression with SABR only (0.082085 vs 0.026051; $P = .03$).

CONCLUSIONS AND RELEVANCE Treatment with SABR for oligometastatic prostate cancer improved outcomes and was enhanced by total consolidation of disease identified by PSMA-targeted positron emission tomography. SABR induced a systemic immune response, and baseline immune phenotype and tumor mutation status may predict the benefit from SABR. These results underline the importance of prospective randomized investigation of the oligometastatic state with integrated imaging and biological correlates.

Table 1. Summary of Surgical Metastasectomy and SBRT for Metastasis Therapy to Multiple Sites

Surgical Series	Year	No. of Patients	5-Year Survival (%)	10-Year Survival (%)	Site
Rees et al (colorectal cancer)	2008	929	36[a]	23[a]	Liver
Fong et al (colorectal cancer)	1999	1,001	37	22	Liver
Pawlik et al (colorectal cancer)	2005	557	58	No 10-year follow-up	Liver
Carpizo et al (colorectal cancer)	2009	1,369		No 10-year follow-up	
Liver only		1,242	49		Liver
Limited EHD		127	26		Liver and EHD[b]
De Haas et al (colorectal cancer)	2008				Liver
R0 resection		234	61	43	
R1 resection		202	57	37	
Elias et al (colorectal cancer)	1998	269	24.7	No 10-year follow-up	Liver
Elias et al (noncolorectal only)	1998	147	36	No 10-year follow-up	Liver
Scheele et al (colorectal cancer)	1995	350	39.3	23.6	Liver
de Jong et al (colorectal cancer)	2009	1,669	47.3	No 10-year follow-up	Liver
Pastorino et al (many primary tumors)[c]	1997	4,572	36	26	Lung
Choong et al (soft tissue sarcoma)	1995	274	40	No 10-year follow-up	Lung
Casiraghi et al (many primary tumors)[d]	2011	575	46	No 10-year follow-up	Lung
Pfannschmidt et al (renal cell carcinoma)	2002	191	39.6	No 10-year follow-up	Lung
Pfannschmidt et al (colorectal cancer)	2003	167	32.4	10-year follow-up	Lung
Kanemitsu et al (colorectal cancer)	2003	313	38.3	No 10-year follow-up	Lung
Petersen et al (melanoma)	2007				Lung
Complete resection					
Incomplete resection					
Saito et al (colorectal cancer)	2002				Lung
Kim et al (multiple primary tumors)[e]	1998	37	24	No 10-year follow-up	Adrenal
Porte et al (NSCLC)	2001	43	11[f]	No 10-year follow-up	Adrenal
Mercier et al (NSCLC)	2006	23	23	No 10-year follow-up	Adrenal
Burt et al (NSCLC)	1992	185	13	7	Brain
Bonnette et al (NSCLC)	2001	103	11	No 10-year follow-up	Brain

CLINICALLY LIMITED METASTASES MAY BE INCREASINGLY IDENTIFIED

Radiation Series	Year	No. Patients	No. Lesions	Local Control (%)	Survival (%)	Site
Blomgren et al	1995	31	42	80	Not reported	Liver, lung, and retroperitoneum
Wulf et al	2004	41	51	80	33[g]	Lung
Hoyer et al (colorectal cancer)	2006	64	141	86[g]	38[g], 13[h]	Lung, liver, and adrenal
Hof et al	2007	61	71	63[i]	47.8[i]	Lung
Rusthoven et al	2009	47	63	92[g]	30[g]	Liver
Rusthoven et al	2009	38	63	96[g]	39[g]	Lung
Kang et al (colorectal cancer)	2010	59	78	66[j]	49[j]	Multiple
Okunieff et al	2006	49	125	83[j]	25[j]	Lung
Katz et al	2007	69	174	57[k]	24[l,m]	Liver
Lee et al	2009	70	143	71[m]	47[n]	Liver
Milano et al	2011	121				Multiple[p]
Breast cancer				87[o]	74[g], 47[o]	
All others				65[o]	39[g], 9[o]	
Salama et al	2011	61	111	66.7[g,q]	56.7[g]	Multiple
Bae et al (colorectal cancer)	2012	41	50	64[i], 57[h]	64[i], 38[h]	Lung, liver, and lymph node
Norihisa et al	2008	34		90[g]	84.3[g]	Lung

SHIFT IN PARADIGM

- Extracranial Oligometastases: A Subset of Metastases Curable With Stereotactic Radiotherapy; Kimberly S. Corbin, Samuel Hellman, and Ralph R. Weichselbaum, *University of Chicago Medical Center, Chicago, IL; JCO 2013*

NCCN Guidelines Version 1.2021
Kidney Cancer

RELAPSE OR STAGE IV

TREATMENT

Clear cell histology →
- Clinical trial
- or
- See First-Line Therapy (KID-C, 1 of 2)
- or
- Metastasectomy or stereotactic body RT (SBRT) or ablative techniques for oligometastatic disease
- and
- Best supportive care[h]

→ **Follow-up** See KID-B

NCCN Guidelines Version 3.2019
Metastatic Spine Tumors

NCCN Guide
Table

PRESENTATION		TREATMENT	ADJUVANT TREATMENT
No tumor		Evaluate for other causes of pain and/or neurologic symptoms[j]	
Spinal cord compression[g]	Steroids[h]	Surgery[k,l,m] ± stabilization followed by RT[n] (category 1) or Primary RT[n] or In the absence of clinical myelopathy, primary chemotherapy[f] if chemosensitive tumor (eg, lymphoma, germ cell tumor, myeloma)	
No spinal cord compression[g]	Fracture or spinal instability[i]	Surgical stabilization or Vertebral augmentation[o]	Followed by RT[n]
	No fracture or spinal instability	RT[n] (preferred) or Chemotherapy[f] (if chemosensitive tumor) or Surgery[m] (selective cases) followed by RT	Consider surgery[m] or SRS[n] if: • Deterioration during RT • Intractable pain • Tumor progression

NCCN Guidelines Version 2.2021
Colon Cancer

PRINCIPLES OF RADIATION AND CHEMORADIATION THERAPY

- **Consider SBRT for patients with oligometastatic disease.**

NCCN Guidelines Version 2.2021
Non-Small Cell Lung Cancer

NCCN

THERAPY FOR RECURRENCE AND METASTASIS

Locoregional recurrence or symptomatic local disease
- Endobronchial obstruction → Any combination of the following: • Laser/stent/other surgery[k] • External-beam RT or brachytherapy[l] • Photodynamic therapy
- Resectable recurrence → • Reresection (preferred)[k] • External-beam RT or SABR[l,m]
- Mediastinal lymph node recurrence → No prior RT → Concurrent chemoradiation[l,t]; Prior RT → Systemic therapy (NSCL-18)
- Superior vena cava (SVC) obstruction → • Concurrent chemoradiation[l,t] (if not previously given) ± SVC stent • External-beam RT[l] ± SVC stent • SVC stent
- Severe hemoptysis → Any combination of the following: • External-beam RT or brachytherapy[l] • Laser or photodynamic therapy or embolization • Surgery

→ • Chest CT with contrast • Brain MRI with contrast[o] • PET/CT
- → No evidence of disseminated disease
- → Evidence of disseminated disease

Distant metastases
- Localized symptoms → Palliative external-beam RT[l]
- Diffuse brain metastases → Palliative external-beam RT[l,gg]
- Bone metastasis → • If risk of fracture, orthopedic stabilization + palliative external-beam RT[l] • Consider bisphosphonate therapy or denosumab
- Limited metastasis → See pathway for Stage IV, M1b (NSCL-14)
- Disseminated metastases → See Systemic Therapy for Metastatic Disease (NSCL-18)

NCCN Guidelines Version 3.2021
Head and Neck Cancers

PRINCIPLES OF RADIATION TECHNIQUES[a]

- **Reirradiation with 3D Conformal RT, SBRT, PBT, or IMRT[40-51]**

NCCN Guidelines Version 5.2020
Anaplastic Gliomas[a]/Glioblastoma

RECURRENCE				TREATMENT[y]
Recurrent disease[p,z] for: • Anaplastic oligodendroglioma • Anaplastic oligoastrocytoma, NOS[j] • Anaplastic astrocytoma • Anaplastic gliomas • Glioblastoma	Diffuse or multiple			Consider clinical trials (preferred for eligible patients) or Systemic chemotherapy[n,aa] or Surgery for symptomatic, large lesion or Consider alternating electric field therapy for glioblastoma (category 2B) or Palliative/best supportive care if poor performance status
	Local	Resectable	Consider clinical trial or Resection[x] → Brain MRI[b,i]	Consider clinical trials (preferred for eligible patients) or Systemic chemotherapy[n,aa] or Consider reirradiation (category 2B)[l,bb] or Consider alternating electric field therapy for glioblastoma (category 2B) or Palliative/best supportive care if poor performance status
		Unresectable or resection not recommended/ elected		

ÚJ SZÉCHENYI TERV

17. számú melléklet

TIOP 2.2.6/12/A/1 - Struktúraváltás támogatása az onkológia centrumok fejlesztésével dmű kiírás

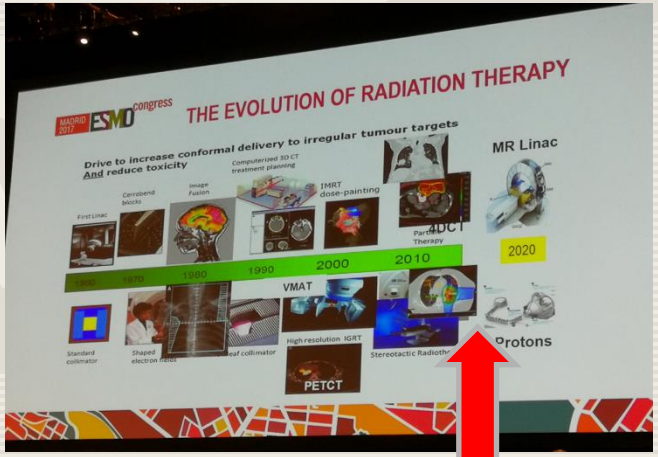
A kiírás esetében az egyes pályázó intézmények szintjén a támogatható tevékenységekre fordítható összegek és azok forrásallokációja az alábbi:

Regionális Onkológiai Centrumok (millió forintban):

	Eszközök	Építés	Egyéb (informatika, menedzsment, általános költség, nyilvánosság, közbeszerzés, stb.)	**Maximálisan igényelhető támogatási összeg (Mft)**
Markusovszky Kórház Zrt.	1005	105	230	**1330**
Pécsi Tudományegyetem (Klinikai Központ)	600	1100	300	**2000**
Szegedi Tudományegyetem	510	350	250	**1110**
Debreceni Egyetem (Orvos- és Egészségtudományi Centrum)	855	-	185	**1040**

Térségi Onkológia és Sugárterápiás Centrumok (millió forintban):

	Eszközök	Építés	Egyéb (informatika, menedzsment, általános költség, nyilvánosság, közbeszerzés, stb.)	**Maximálisan igényelhető támogatási összeg (Mft)**
Petz Aladár Megyei Oktató Kórház	920	-	280	**1200**
Kaposi Mór Oktató Kórház vagy/és (konzorcium esetében) Kaposvári Egyetem	700	-	155	**855**
Kecskeméti Megyei Kórház	1020	15	110	**1245**
Jósa András Oktatókórház	420	-	75	**495**
Békés Megyei Pándy Kálmán Kórház	385	-	85	**470**



Cancer/Radiothérapie 28 (2024) 119–130

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Clinical practice guidelines

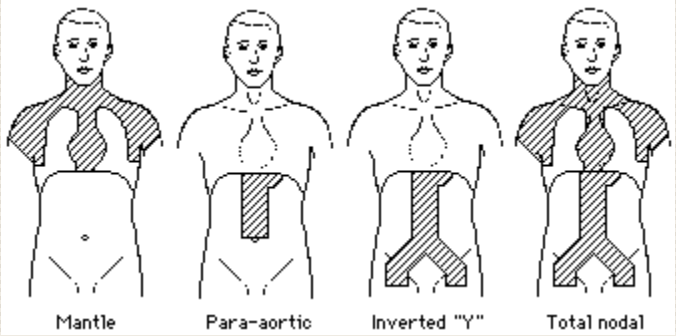
Is oligometastatic disease an applicable and useful concept in haematologic malignancies? A narrative review of radiation therapy standards, modern techniques, and innovations

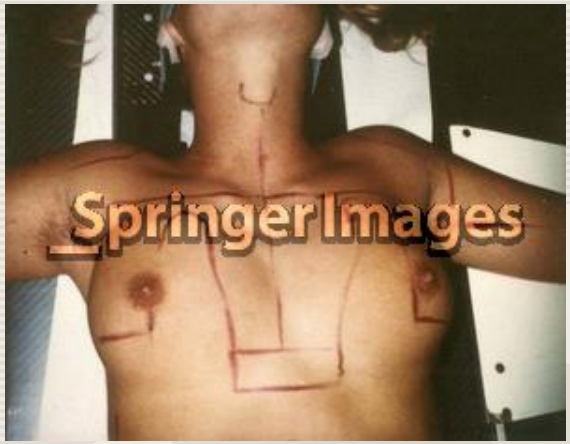
Table 1
Recommendations for curative-intent radiation therapy for haematologic malignancies.

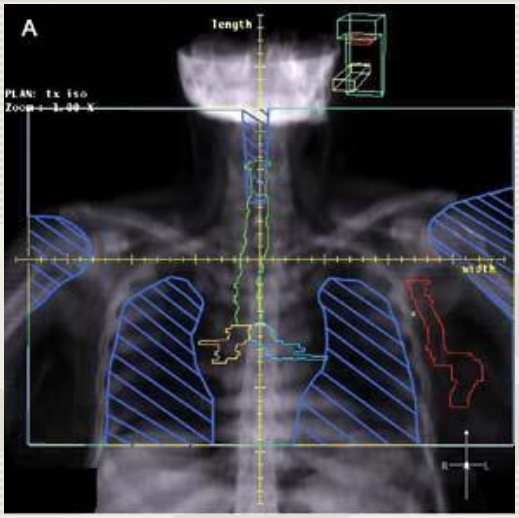
Indication	Dose	Volume	Studies and groups	References
Hodgkin lymphoma				
Early stage favourable	20–30 Gy	Involved-site radiation therapy	H10, HD16	[4,87]
Early stage unfavourable	30 Gy	Involved-site radiation therapy	H10, HD17	[2,4]
Advanced stage	30 Gy	Residual PET CT+	HD15	[88]
Non-Hodgkin lymphoma				
Indolent	24–30 Gy	Involved-site radiation therapy	UK, ILROG	[16,19,32]
Aggressive	Complete response: 30–36 Gy Partial response: 40–50 Gy	Involved-site radiation therapy Residual PET CT+	UNFOLDER, ILROG	[19,27,32]
Solitary plasmocytoma	40–50 Gy	GTV + 0.5–1 cm	ILROG	[89]
Prehaematopoietic stem cell transplantation total body irradiation	Myeloablative conditioning: 12 Gy Non myeloablative conditioning: 2–4 Gy	Total body irradiation	ILROG	[90]

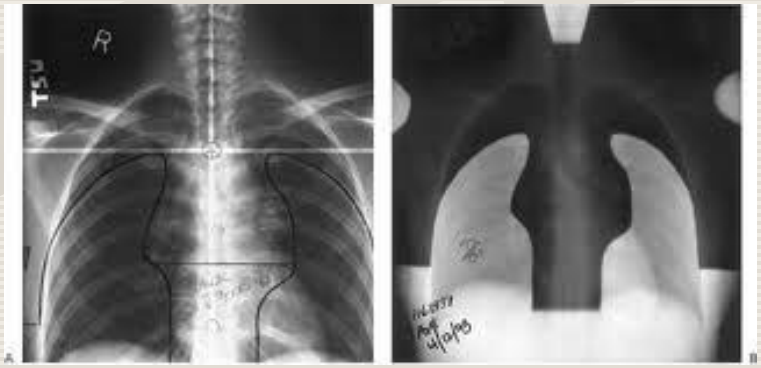
GTV: growth tumour volume; ILROG: International Lymphoma Radiation Oncology Group; PET–CT: positron-emission tomography–computed tomography.

Mantel és fordított Y besugárzás

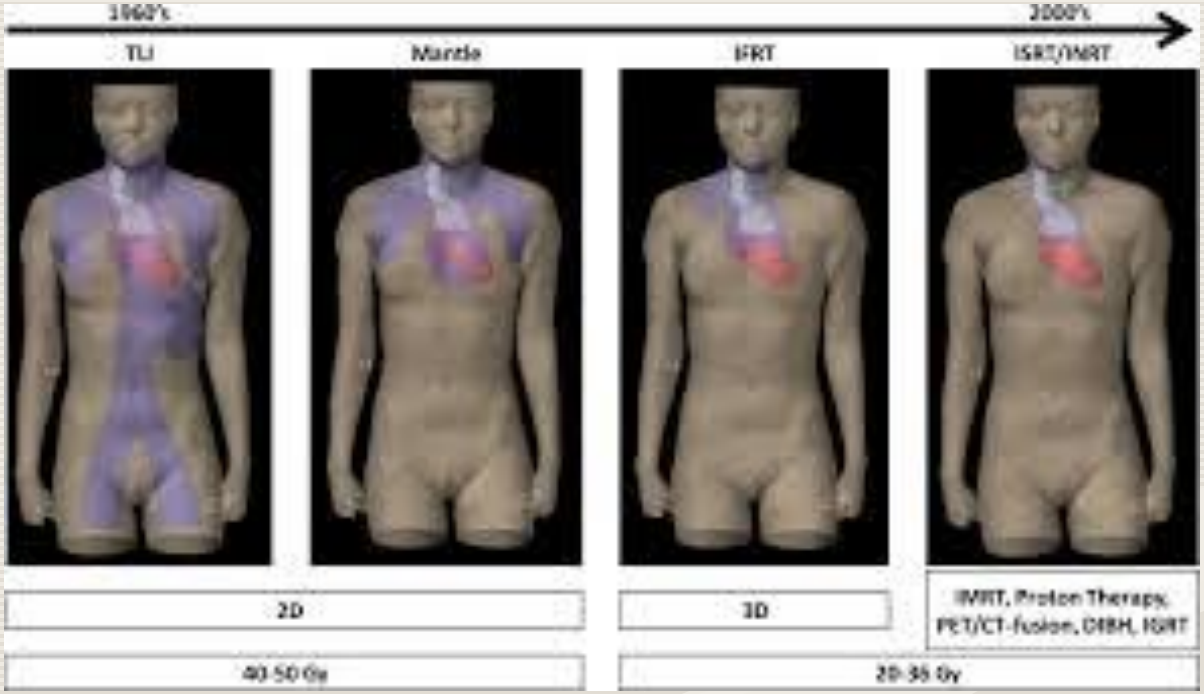








Hodgkin kór - sugárterápiás szemléleti és technológiai fejlődés



RT Fields	Years	Dose (Gy)	Technique	Planning Methods	Machines
EFRT	1960-1990	40-44	2D RT	2D planning	Cobalt Units; first LINACS
IFRT	1995-2005	30-36	3D-CRT	3D Planning	
			Static-IMRT	Forward/Inverse planning	LINAC with Multileaf Collimator
ISRT/INRT	2005-present	20-30	Static IMRT	Inverse Planning	LINAC with Multileaf Collimator
			Arc-therapy	Biologic Optimization	LINAC with Dinamic MLC and Image-Guidance
			Tomotherapy	Multimodality Imaging	Volumetric Modulated Arc Therapy
				Dose Painting	Helical Tomotherapy
				Image-Guided Radiotherapy	

Hodgkin kór - sugárterápia

- IFRT – involved field radiotherapy , ISRT – involved site radiotherapy, INRT – involved node radiotherapy -vs.- EFRT – extended field radiotherapy
- GTV (gross tumor volume: makroszkópos daganat) – CTV (clinical target volume: mikroszkópos ill. potenciális terjedés) – PTV (plannning target volume: beállítási bizonytalanságok)
- Tervezésnél: lehetőleg MRI és/vagy PET információ (ld. Deauville kritériumok)
- Önálló sugárkezelés esetén nagyobb CTV
- 3D konformális irrad. V. IMRT, frakcionálás: 2 Gy/die
- Dózisok: non-bulky disease: 20-30 Gy, bulky disease: 30-36 Gy
  - 20 Gy elégséges StI-IIA esetén, ha nincs extra-limfatikus terjedés, és max. 2 régió érintett
- Önálló sugárterápia esetén, érintett régió: 30-36 Gy, nem érintett régió: 25-30 Gy
- Alkalmazás: önállóan, elsővonalbeli kezelés után, refrakter esetben másodvonalbeli kemoterápia után, ill. relapszus esetén

EORTC/LYSA/FIL classification scheme

Risk factors/Stage	IA	IA/B, IIA	IIB	IIIA/B	IVA/B
Nodular lymphocyte predominant Hodgkin lymphoma (NLPHL)	**NLPHL IA:** RT 30 Gy ISRT	**Early stage favourable:** (H10F [3]) **ABVD ×2 and FDG-PET/CT** **FDG-PET/CT–:** ABVD ×1 + RT 20 Gy ISRT **FDG-PET/CT+:** BEACOPPEesc ×2 + RT 30 Gy ISRT		**Advanced stage:** (AHL 2011 [4]) **BEACOPP ×2 and FDG-PET/CT** **FDG-PET/CT–:** ABVD ×4 **FDG-PET/CT+:** BEACOPP ×4	
No risk factor					
≥ 4 nodal areas [a]	**Early stage unfavourable:** (H10U [3]) **ABVD ×2 and FDG-PET/CT** **FDG-PET/CT–:** ABVD ×2 + RT 30 Gy ISRT/INRT **FDG-PET/CT+:** BEACOPPesc ×2 + RT 30 Gy ISRT/INRT				
A: ESR ≥ 50 B symptoms: ESR ≥ 30					
Mediastinal mass MTR > 0.35					
Age ≥ 50					

Involved-site Radiation Therapy (ISRT)

Dose:

- **Combined Modality Therapy**
  - **Non-bulky disease (stage I-II): 20*–30 Gy (if treated with ABVD), 30 Gy (if treated with Stanford V); 1.5–2.0 Gy per fraction**
  - **Non-bulky disease (stage IB-IIB): 30 Gy; 1.5–2.0 Gy per fraction**
  - **Bulky disease sites (all stages): 30–36 Gy; 1.5–2.0 Gy per fraction**
  - **Sites of partial response to chemotherapy: 36–45 Gy**
- **ISRT Alone (uncommon, except for NLPHL):**
  - **Involved regions: 30–36 Gy (the dose of 30 Gy is mainly used for NLPHL); 1.5–2.0 Gy per fraction**
  - **Uninvolved regions: 25–30 Gy; 1.5–2.0 Gy per fraction. ISRT for NLPHL includes extension to initially uninvolved nodes.**
- **Palliative RT: 4–30 Gy**

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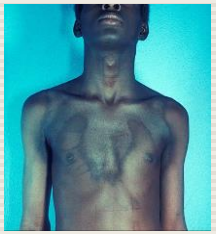
Sugárterápiás késői szövődmények:

- kardiovaszkuláris mellékhatások (5-10 év után, kardiológiai követés szükséges, egyéb rizikófaktorok szerepe)
- pajzsmirigy hypofunkció (nyaki besugárzás után, hosszú távú túlélők 50%-ánál)
- másodlagos daganatok (10 év után, magasabb dózisú sugárkezelés nagyobb rizikó, de mezőkiterjesztés önmagában nem)
- DÓZISKORLÁTOK kiemelt szerepe



PRINCIPLES OF RADIATION THERAPY

RT DOSE CONSTRAINT GUIDELINES FOR LYMPHOMA[b]

OAR		Dose Recommendation (1.5–2 Gy/fraction)	Toxicity
Head and Neck	Parotid glands[c]	Ipsilateral: Mean <11 Gy (recommended); <24 Gy (acceptable) Contralateral: as low as reasonably achievable (ALARA)	Xerostomia[15,16]
	Submandibular glands[c]	Ipsilateral: Mean <11 Gy (recommended); <24 Gy (acceptable) Contralateral: ALARA	Xerostomia[17]
	Oral cavity (surrogate for minor salivary glands)	Mean <11 Gy	Xerostomia, dysgeusia, oral mucositis[17]
	Thyroid	V25 Gy <63.5% Minimize V30 Gy	Hypothyroidism[18]
	Lacrimal glands	V20 Gy <80%	Dry eye syndrome[19]
	Larynx/Pharyngeal constrictors	Mean <25 Gy	Laryngeal edema, dysphagia[20]
	Carotids	Ipsilateral: Avoid hotspots Contralateral: ALARA	Carotid artery atherosclerosis

OAR		Dose Recommendation (1.5–2 Gy/fraction)	Toxicity
Thorax	Heart[d]	Mean <8 Gy (recommended) Mean <15 Gy (acceptable); ALARA given increased risk with even lower doses	Major adverse cardiac events[21-24]
	Aortic and mitral valves	Dmax <25 Gy	Valvular heart disease[22,25,26]
	Pulmonic valve	Dmax <30 Gy	
	Tricuspid valve	Mean <5 Gy (recommended); Dmax < 30 Gy (acceptable)	Valvular heart disease[27]
	Left ventricle	Mean <8 Gy (recommended) Mean <15 Gy (acceptable)	Heart failure[22,28] Coronary artery disease[27]
	Right ventricle	Mean <5 Gy	Valvular heart disease[27]
	Coronary vessels (total)	Mean <7 Gy Minimize the maximum dose to individual coronary arteries	
	Left anterior descending (LAD) artery	V15 Gy <10%[d]	Major adverse cardiac events[29,30]
	Left circumflex artery	V15 Gy <14%	Major adverse cardiac events
	Right coronary artery	Mean <5 Gy	Coronary artery disease[27]
	Lungs	Mean <13.5 Gy V20 <20% (recommended); <30 Gy (acceptable) V5 <55%	Pneumonitis[31-33]

OAR		Dose Recommendation (1.5–2 Gy/fraction)		Toxicity
Abdomen	Liver	Mean <15 Gy V20 <30% V30 <20%		Hepatic toxicity[37,38]
	Stomach	Dmax <45 Gy		Ulceration[39]
	Spleen	Mean <10 Gy V5 ≤30% V15 ≤20%		Late infections[40] Lymphopenia[41]
	Pancreas	Mean <21 Gy		Diabetes[42-45]
	Small bowel	V15 <120 cc Dmax <45 Gy		Diarrhea[35] Obstruction, ulceration, fistula[35]
	Kidney	Single organ Mean <5 Gy (recommended); <8 Gy (acceptable) V10 <30% V20 <15% (recommended); <25% (acceptable)	Bilateral V5 <58%	Renal insufficiency[46-48]
Other	Bone marrow[e]	V5: ALARA V10 <50% V25 <25%		Acute cytopenias[49-50] Chronic cytopenias[51]
	Long bone	V40 <64%		Fracture[52]

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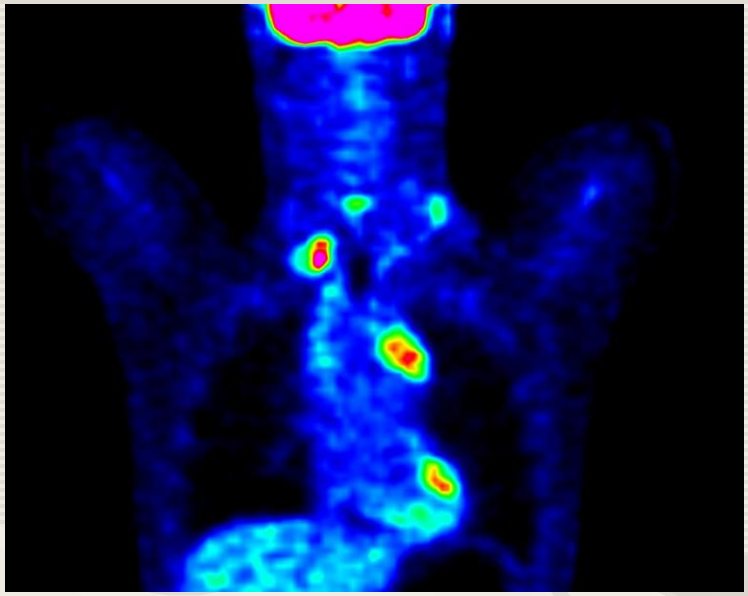
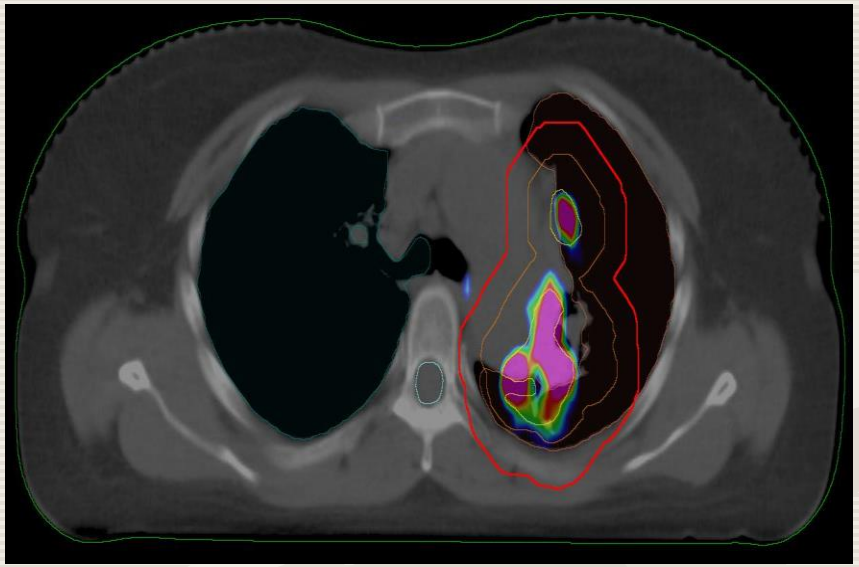
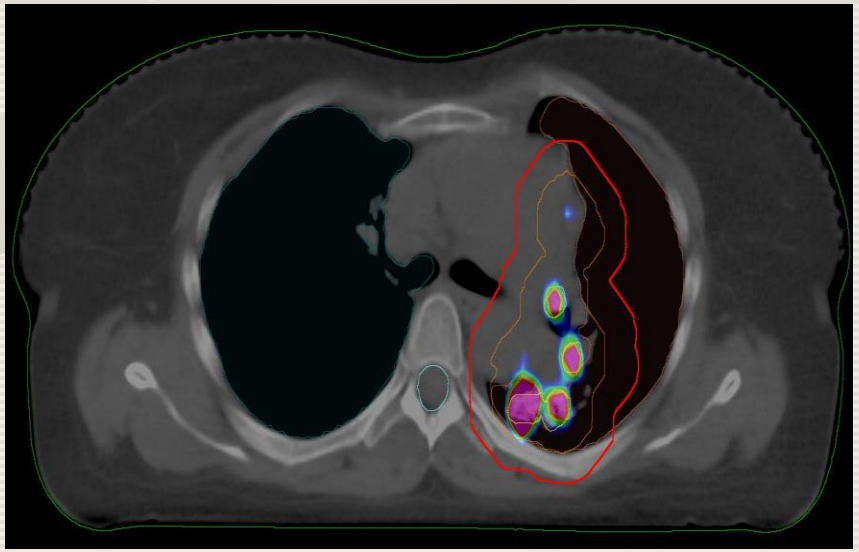
SECONDARY MALIGNANCIES[f]

OAR	Dose Recommendation (1.8–2 Gy/fraction)	Secondary Malignancy
Breast	Minimize volume >4 Gy (ideally <10%)	Breast cancer (adenocarcinoma)[56]
Colon	Minimize volume >10 Gy	Colon cancer[57]
Lung	Minimize volume >9 Gy	Lung cancer[58]
Esophagus	Minimize volume >30 Gy	Esophageal cancer[59]
Stomach	Minimize volume >25 Gy	Gastric cancer[60]
Pancreas	Minimize volume >5–10 Gy	Pancreatic cancer[61]

PET-CT szerepe a céltérfogat meghatározás során







Myeloma multiplex 2018

National Comprehensive Cancer Network®

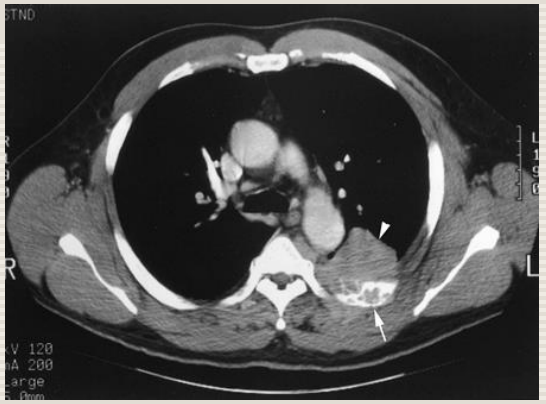
NCCN Guidelines Version 4.2018
Multiple Myeloma

NCCN Guidelines Index
Table of Contents
Discussion

CLINICAL PRESENTATION	PRIMARY TREATMENT	FOLLOW-UP/SURVEILLANCE
Solitary Osseous	RT (40–50 Gy in 1.8–2.0 Gy/fraction) to involved field ± surgery[d]	Follow-up interval, every 3–6 mo:[e] • CBC, differential, platelet count • Serum chemistry for creatinine, albumin, corrected calcium • Serum quantitative immunoglobulins, SPEP, with SIFE as needed • 24-h urine for total protein and UPEP with UIFE as needed • Serum FLC assay as clinically indicated • Serum LDH and beta-2 microglobulin as clinically indicated • Bone marrow aspirate and biopsy as clinically indicated • Skeletal survey as clinically indicated or annually • Whole body MRI or low-dose CT or PET/CT scan as clinically indicated
Solitary Extraosseous	RT (40–50 Gy in 1.8–2.0 Gy/fraction) to involved field ± surgery[d]	

Primary progressive[f] or Response followed by progression[f] → Restage with myeloma workup → See Active (symptomatic) (MYEL-3)

- Palliáció, pl. erős fájdalmak esetén 10-30 Gy, 1-10 frakcióban
- Modern technika javasolható, de palliáció esetén megfelelhet egyszerűbb technológia, pl. telekobalt kezelés is

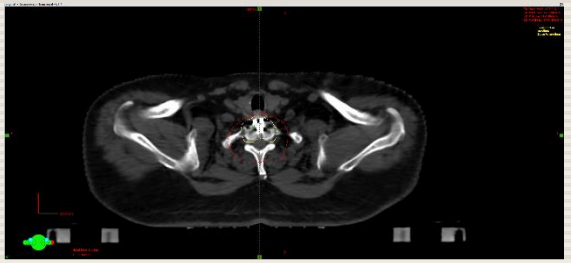


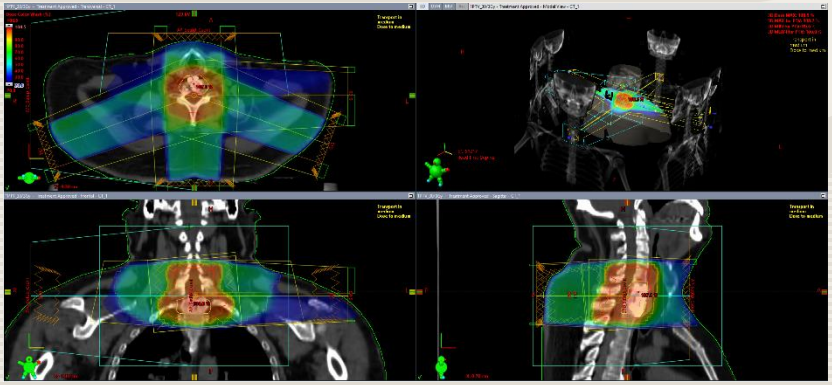
Myeloma multiplex 2025

National Comprehensive Cancer Network®

NCCN Guidelines Version 1.2025
Multiple Myeloma

CLINICAL FINDINGS	PRIMARY TREATMENT	FOLLOW-UP/SURVEILLANCE
Solitary plasmacytoma or Solitary plasmacytoma with minimal marrow involvement[i,j]	→ RT[k] ± surgery[l,m] or Consider clinical trial →	Follow-up interval, every 3–6 mo[n]: • CBC, differential, and platelet count • Serum chemistry for creatinine and corrected calcium • Tests as needed: ▸ Serum quantitative immunoglobulins, SPEP, with SIFE ▸ 24-h urine for total protein and UPEP with UIFE ▸ Serum FLC assay ▸ Bone marrow aspirate and biopsy as indicated ▸ All plasmacytomas should be imaged yearly, preferably with the same technique used at diagnosis, for at least 5 years[d,o]





Treatment Information/Dosing:

- Solitary plasmacytoma (MYEL-2)
  - RT (40–50 Gy in 1.8–2.0 Gy fractions [20–25 total fractions]) to involved site.
  - Treatment with 35–40 Gy is an acceptable alternative for solitary plasmacytomas <5 cm in size, due to the high rates of local control reported for smaller tumors.

Palliative RT Dosing for MM:

- Low-dose RT (8 Gy x 1 fraction) or 20–30 Gy in 5–15 total fractions can be used as palliative treatment for indications such as uncontrolled pain, for impending pathologic fracture, or for impending cord compression. Moderately fractionated courses of 20–25 Gy in 8–10 fractions are generally preferred over higher doses (30 Gy) absent extenuating circumstances (eg, severe symptomatic cord compression) to limit toxicity risk and reduce future toxicity risk in the event additional irradiation is needed to adjacent or overlapping sites (e.g. overlapping sites in the spine/spinal cord.
- Limited involved sites should be used to limit the impact of irradiation on hematopoietic stem cell harvest or impact on potential future treatments.
- For RT dose constraint suggestions regarding bone marrow and other organs at risk (OARs), see NCCN Guidelines for Hodgkin Lymphoma.

NHL - sugárkezelés

- Itt is érintett mezős besugárzás
- PET-MRI képi információ és modern technológia használata javasolt
- Extranodális betegségben is hasonlóak a sugárterápiás szabályok
- MALT limfóma, lokalizált cután limfómák: irrad. mint elsővonalbeli kezelési lehetőség

General Dose Guidelines:

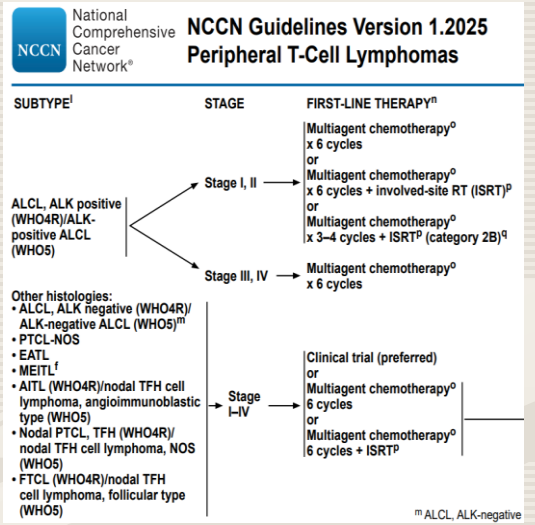
- Localized CLL/SLL: 24-30 Gy
- Follicular lymphoma: 24-30 Gy
- Marginal zone lymphoma:
  - Gastric: 30 Gy
  - Other extranodal sites: 24-30 Gy
  - Nodal MZL: 24-30 Gy
- Early-stage mantle cell lymphoma: 30-36 Gy
- Mini-dose RT (2 Gy x 2 may be repeated) for palliation/local control of SLL, FL, MZL, MCL
- Diffuse large cell lymphoma or PTCL
  - Consolidation after chemotherapy CR: 30-36 Gy
  - Complimentary after PR: 40-50 Gy
  - RT as primary treatment for refractory or noncandidates for chemotherapy: 45-55 Gy
  - Salvage pre- or post-stem cell transplantation: 30-40 Gy
- Primary cutaneous anaplastic large cell lymphoma: 30-36 Gy

PRINCIPLES OF RADIATION THERAPY[a]

Target Volumes:

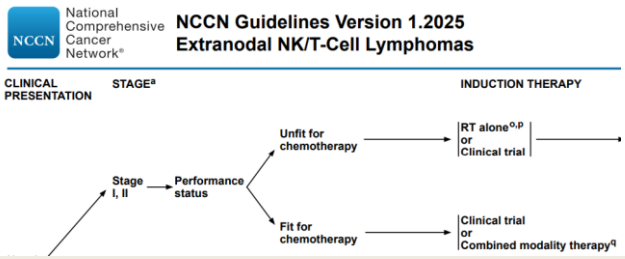
- **ISRT for nodal disease**
  - ISRT is recommended as the appropriate field for non-Hodgkin lymphoma. Planning for ISRT requires modern CT-based simulation and planning capabilities. Incorporating other modern imaging such as PET and MRI often enhances treatment volume determination.
  - ISRT targets the site of the originally involved lymph node(s). The volume encompasses the original suspicious volume prior to chemotherapy or surgery. Yet, it spares adjacent uninvolved organs (eg, lungs, bone, muscle, kidney) when lymphadenopathy regresses following chemotherapy.
  - The pre-chemotherapy or pre-biopsy gross tumor volume (GTV) provides the basis for determining the clinical target volume (CTV). Concerns for questionable subclinical disease and uncertainties in original imaging accuracy or localization may lead to expansion of the CTV and are determined individually using clinical judgment.
  - Possible movement of the target by respiration as determined by 4D-CT or fluoroscopy (internal target volume [ITV]) should also influence the final CTV.
  - The planning target volume (PTV) is an additional expansion of the CTV that accounts only for setup variations (see International Commission on Radiation Units and Measurements [ICRU] definitions).
  - The OARs should be outlined for optimizing treatment plan decisions.
  - The treatment plan is designed using conventional, 3-D conformal, or IMRT techniques using clinical treatment planning considerations of coverage and dose reductions for OARs.

- **ISRT for extranodal disease (excluding ENKL)**
  - Similar principles as for ISRT nodal sites (see above).
  - For certain organs (eg, stomach, salivary gland, thyroid), the whole organ comprises the CTV. For other organs, including orbit, breast, lung, bone, localized skin, and well-localized salivary gland, partial organ RT may be appropriate.
  - Prophylactic irradiation is not required for uninvolved lymph nodes.



General Dose Guidelines: (RT in conventional fraction sizes)

- **PTCL**
  - Consolidation after chemotherapy CR: 30–36 Gy; PR: 40–50 Gy
  - RT as primary treatment for refractory or non-candidates for chemotherapy: 40–55 Gy
  - In combination with HCT: 20–36 Gy, depending on sites of disease and prior RT exposure
- **BIA-ALCL: 24–36 Gy for local residual disease**



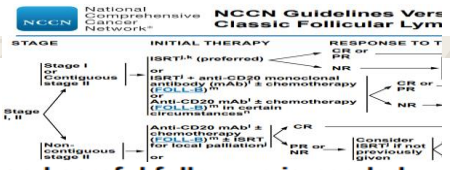
- **ENKL**
  - RT alone as primary treatment (if unfit for chemotherapy): 50–55 Gy
  - RT in combination with chemotherapy: 45–56 Gy
  - Combined modality therapy (non–asparaginase-based):
    - ◊ CCRT:
      - – 50 Gy in combination with DeVIC (dexamethasone, etoposide, ifosfamide, and carboplatin)
      - – 50–54 Gy in combination with cisplatin followed by VIPD (etoposide, ifosfamide, cisplatin, and dexamethasone)
    - ◊ Sequential chemoradiation:
      - – Modified SMILE regimen followed by RT 45–50.4 Gy for stage I–II disease
      - – DDGP regimen followed by RT 50 Gy for stage I–II disease
    - ◊ Sandwich chemoradiation:
      - – P-GEMOX (2 cycles) followed by RT 56 Gy followed by P-GEMOX (2–4 cycles)
      - – GELAD (2 cycles) followed by RT 50–56 Gy followed by GELAD (2 cycles)
- **Palliative RT: 20–36 Gy in 5–18 fractions**

PRINCIPLES OF RADIATION THERAPY[a]

Volumes

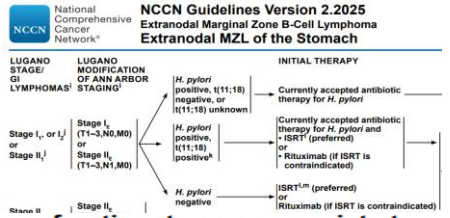
- ISRT for nodal disease[17]
  - ISRT is the recommended approach for volume definition and treatment planning for NHL. Planning for ISRT requires CT-based treatment planning and incorporates volume determinations including gross tumor volume (GTV), clinical target volume (CTV), and planning target volume (PTV). Incorporating other imaging tests such as PET and MRI often enhances treatment volume determination.
  - The pre-chemotherapy or pre-biopsy GTV provides the basis for determining the CTV. Concerns for questionable subclinical disease and uncertainties in original imaging accuracy or localization may lead to expansion of the CTV and are determined individually using clinical judgment. Further, adjacent uninvolved organs (eg, lungs, bone, muscle, kidney) are excluded from the CTV when disease regresses following chemotherapy.
  - For early-stage indolent NHL treated with RT alone, larger treatment volumes should be considered to encompass potential microscopic disease in adjacent lymph nodes or the immediate vicinity. For example, the CTV definition for treating FL with RT alone will be greater than that used for DLBCL with similar disease distribution, as the latter is treated with combined modality therapy.
  - Motion of the target caused by respiration as determined by 4D-CT or fluoroscopy (internal target volume [ITV]) should also influence the final CTV.
  - The PTV is an additional expansion of the CTV that accounts only for setup variations and potential target motion not previously accounted for in the CTV (see International Commission on Radiation Units and Measurements [ICRU] definitions). Proton RT planning does not generally use a PTV, but rather robustness evaluation to ensure coverage of the CTV.
  - OARs should be outlined for dose-volume analysis and optimizing treatment planning decisions.
  - The treatment plan can be designed with conventional, 3D conformal, IMRT/VMAT, or proton therapy techniques using clinical treatment planning considerations of target coverage and normal tissue avoidance.

- ISRT for extranodal disease[18]
  - Similar principles as for ISRT nodal sites (see above).
  - For EMZL, the CTV generally consists of the entire affected organ (eg, stomach, salivary gland, thyroid). Partial organ ISRT may be appropriate if the disease is well localized on imaging (eg, orbit and breast).
  - For most NHL subtypes, uninvolved lymph nodes should not be targeted.



General Dose Guidelines:

- Definitive RT (1.5–2.0 Gy daily fractions)
  - FL: 24–30 Gy[19,20]
  - Marginal zone lymphoma (MZL): 24 Gy
    - EMZL of the stomach: 24 Gy in 16 fractions (1.5 Gy/fractions) to minimize acute GI toxicity.[19] – 4 Gy in 2 fractions has been used.[21] However, additional 20 Gy is needed for some patients and careful follow-up is needed.
    - Orbital and salivary gland MZL: 4 Gy in 2 fractions may be considered as an alternative to 24 Gy. Careful regular follow-up (physical exam and imaging as appropriate) with radiation oncologist and ophthalmologist is essential when using this very-low-dose regimen. Definitive doses are recommended for incomplete response or relapsed disease.[22,23]
  - MCL:
    - Primary treatment (without chemoimmunotherapy) - 36 Gy
    - Consolidation after chemoimmunotherapy
      - CR - 24–30 Gy
      - PR - 36 Gy
  - DLBCL/HGBL/PMBL/MGZL
    - Primary treatment (without chemoimmunotherapy): 40 Gy
    - Consolidation after chemoimmunotherapy
      - CR (5-PS 1–3) - 30–36 Gy
      - PR (5-PS 4) - 36–50 Gy
    - Refractory disease (5-PS 4–5) - 40–55 Gy
    - In combination with HCT: 20–36 Gy, depending on sites of disease and prior RT exposure[24]; hypofractionate as appropriate to expedite HCT procedure)
    - Prophylactic testicular irradiation (25–30 Gy)



- Palliative RT
  - FL/MZL/MCL/SLL: 2 Gy X 2 fractions or 4 Gy X 1 fraction (which may be repeated as needed); doses up to 30 Gy may be appropriate in select circumstances
  - DLBCL/HGBL/PMBL/MGZL and BL: (higher doses/fraction typically appropriate)
    - 20–30 Gy in 5–10 fractions. Standard hypofractionated palliative treatment schedules such as 20 Gy in 5 fractions and 30 Gy in 10 fractions are appropriate depending upon clinical scenario.
  - HIV-related B-cell lymphomas and PTLD: Treated based on underlying histologic subtype and treatment intent (curative vs. palliative)

- Bridging RT with CAR T-cell Therapy
  - Localized disease - 20–40 Gy (higher doses and comprehensive coverage preferred if feasible; hypofractionate as appropriate to expedite CAR T-cell procedure)
  - Extensive disease - 20–30 Gy (hypofractionate as outlined above)

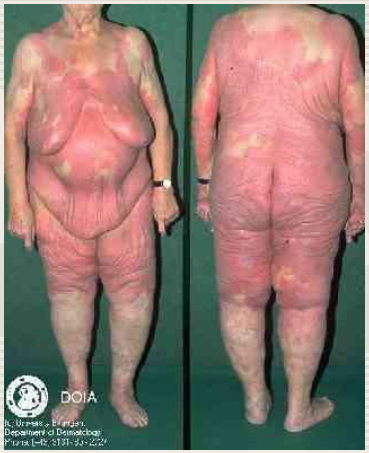
NHL – egésztest elektron besugárzás

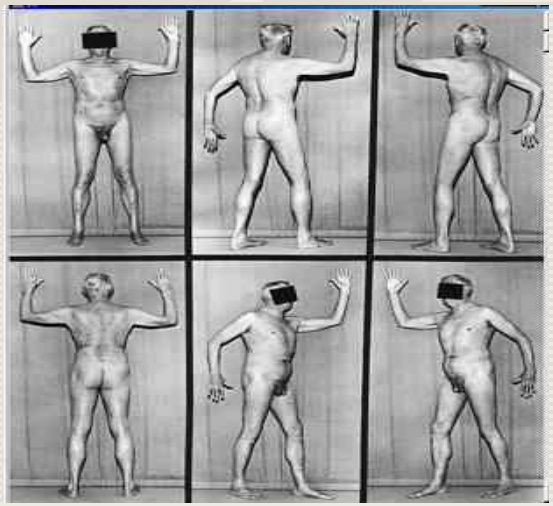
National Comprehensive Cancer Network®

NCCN Guidelines Version 2.2018
Mycosis Fungoides/Sezary Syndrome

NCCN Guidelines Index
Table of Contents
Discussion

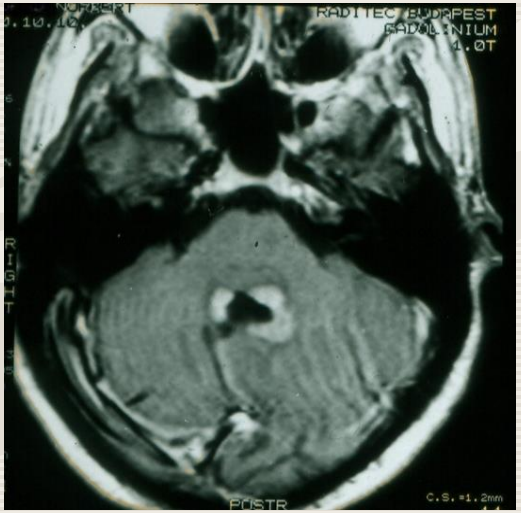
STAGE (MFSS-3 and MFSS-4)	PRIMARY TREATMENT[r]	RESPONSE TO THERAPY[s]	See Supportive Care for MF/SS (MFSS-B)
Stage IA[p,q]	Skin-directed therapies (may be alone or in combination with other skin-directed therapies): See Suggested Treatment Regimens "Skin-Directed Therapies (Skin-Limited/Local)" (MFSS-A) • If B1 blood involvement ▸ Consider primary treatment for Stage III, B1 MFSS-8 (category 2B)	CR/PR[t] or inadequate response	Relapse with or persistent T1 skin disease
		Refractory disease to multiple previous therapies or progression to >stage IA on skin-directed therapies	Systemic therapy ± skin-directed therapy (see Stage IB on MFSS-6) or Total skin electron beam therapy (TSEBT)[u] or Clinical trial



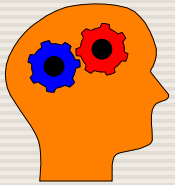


Primer agyi limfómák sugárkezelése

- Általában gyorsan kialakuló tünettan, koponyaűri nyomásfokozódásra utaló jelek
- Natív CT-n is sejthető hyperdenzitás, gyakori kamrák körüli lokalizáció
- Szteroid adása kivizsgálás során nem szerencsés
- Régen sürgősségi besugárzás indikációja volt a diagnózis felállítása
- Jelenleg irradiáció reziduum, relapszus, a szisztémás kezeléssel kapcsolatos rezisztencia ill. szisztémás kezelés kontraindikációja esetén jön szóba
- Továbbra is a nagymezős besugárzás javasolt
- Dózistartomány: 24-36 Gy, ill. boost kieg. 45 Gy-ig önálló irrad. vagy rezisztencia esetén
- Mentális károsodás esélye viszonylag magas



A besugárzás hatása a mentális teljesítményre, neuro-pszichológiai kutatások:



- A besugárzás után romlik a memória, a figyelem, a tanulási képesség és a gondolkodásbeli flexibilitás (Armstrong 1993, Archibald 1994, Fleckenstein 2008)
- Magasabb dózisok után alacsonyabb funkcionalitás, fáradékonyság, inszomnia, érzelmi instabilitás, szexuális diszfunkció (Kiebert 1998)
- Súlyos esetek magas dózisú hypofrakcionált kezeléseknél, kemoterápia ill. előzetes idegrendszeri érintettség esetén (DeAngelis 1989)
- RT után hetekkel valóban vannak pszichés elváltozások, azonban ezek 1-2 év múlva már nem észlelhetők (Vigliani 1996)
- Maga az idegrendszeri betegség okozza a pszichés tüneteket, a szellemi hanyatlást, és a depressziót **(Taphoorn 1994)**
- **A betegség az alapvető ok**, de a radioterápia dózis, frakció és mezőméret függvényében közrejátszhat a szellemi hanyatlásban (Klein 2002, Taaphorn 2004, Laack 2004)
- Recidivák jelentős része neurológiai deficitet okoz, ua. **mentális funkciók szempontjából a loko-regionális kontroll a legfontosabb** (Regine 2002, Torres 2003, Aoyama 2007)
- Hosszan túlélő, recidíva mentes malignus gliomás betegek mentális képessége érdemben nem rossabb, mint az egészséges kontroll csoporté (Bosma 2008)
- Egyre nagyobb szerepet kap a hippocampus ill. elülső temporális régió védelme (Basina 2010, Hsu 2010)
- Irodalmi áttekintés: QOL javul a jobb prognózisú betegeknél (Wong, 2008)
- **Kombinált kezelésben részesülő agyi limfómás betegek mentális teljesítménye egyértelműen romlik (Doolittle, 2013)**

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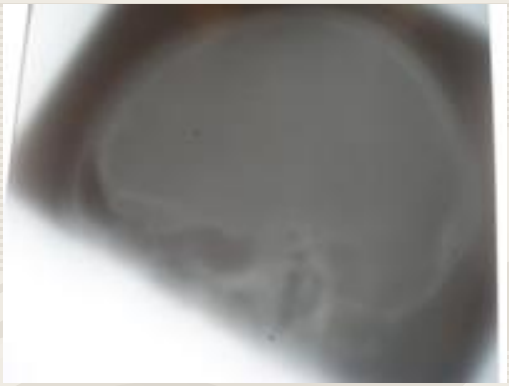
NCCN Guidelines Version 5.2017
Acute Lymphoblastic Leukemia

National Comprehensive Cancer Network®

NCCN Guidelines Version 3.2024
Acute Lymphoblastic Leukemia

CNS Prophylaxis and Treatment

The goal of CNS prophylaxis and/or treatment is to prevent CNS disease or relapse by clearing leukemic cells within sites that cannot be readily accessed with systemic chemotherapy because of the blood-brain barrier. CNS-directed therapy may include cranial irradiation, intrathecal chemotherapy (eg, methotrexate, cytarabine, corticosteroids), and/or high-dose systemic chemotherapy (eg, methotrexate, cytarabine, 6-mercaptopurine (6-MP), L-asparaginase).[1,42,108] CNS prophylaxis is typically given to all patients throughout the entire course of ALL therapy, from induction, to consolidation, to the maintenance phases of treatment.



ALL-B

- **First bullet removed: Given the risks of neurotoxicity associated with central nervous system (CNS)-directed therapy, baseline and post-treatment comprehensive neuropsychological testing may be useful.**
- **Bullet 6 and 9: cytarabine clarified as intermediate or high dose**
- **Bullet 7 modified: CNS leukemia (CNS-3 and/or cranial nerve involvement) at diagnosis typically warrants treatment with cranial irradiation of ≥18 Gy *in 1.8 to 2.0 Gy/fraction*. The recommended dose of radiation, where given, is highly dependent on the intensity of systemic chemotherapy; thus, it is critical to adhere to a given treatment protocol in its entirety. The entire brain and posterior half of the globe should be included. The inferior border should ~~be below~~ *include* C2.**

- **CNS-directed therapy may include cranial irradiation, IT therapy (eg, methotrexate, cytarabine, corticosteroid), and/or systemic chemotherapy (eg, high-dose methotrexate, intermediate or high-dose cytarabine, pegaspargase [PEG]). Generally, IT therapy should start during the induction phase.**
- **CNS leukemia (CNS-3 and/or cranial nerve involvement) at diagnosis, or persisting after induction, may warrant treatment with cranial irradiation of 18 Gy in 1.8–2.0 Gy/fraction. The recommended dose of radiation, where given, is highly dependent on the intensity of systemic chemotherapy; thus, it is critical to adhere to a given treatment protocol in its entirety. The entire brain and posterior half of the globe should be included. The inferior border should include C2.**

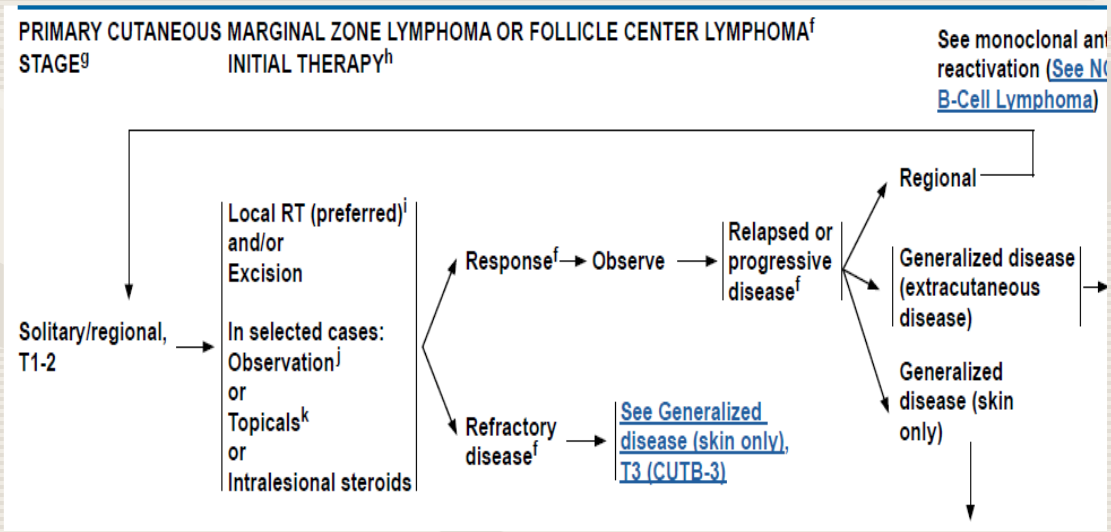
National Comprehensive Cancer Network®

NCCN Guidelines Version 2.2018
Primary Cutaneous B-Cell Lymphomas

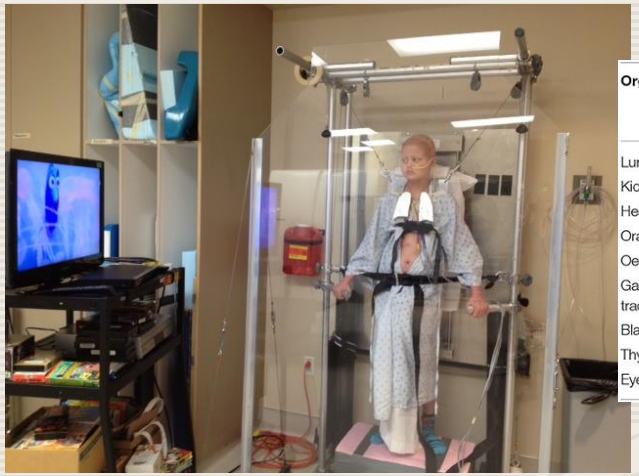
PRINCIPLES OF RADIATION THERAPY

PCMZL and PCFCL

- Optimal initial management for solitary/regional PCMZL and PCFCL is with external beam RT, 24-30 Gy.
- For relapsed/refractory disease, 4 Gy external beam RT may be adequate
- Surface margins beyond area of clinically evident disease will vary depending on lesion size and body site and must take into account dosimetry of the beam being used. Surface margins of 1.0-1.5 cm are generally adequate.
- Margins in depth should include the volume at risk for involvement.
- Generally, treatment with 6-9 MeV electrons (with surface bolus) provides an adequate depth of treatment. Alternatively, low energy x-rays (~100 Kv) may be used.



Egyéb sugárterápiás indikációk: egésztest-besugárzás csontvelő transzplantáció előtt



Organ	TBI 12 Gy with lung blocks	TMLI 12 Gy (bone, lymph nodes, spleen, liver, and brain)
Lungs	8.2	4.7
Kidneys	12.0	6.1
Heart	11.1	4.6
Oral Cavity	11.9	2.9
Oesophagus	12.4	3.8
Gasto-Intestinal tract	12.1	3.7
Bladder	12.0	6.4
Thyroid	12.2	3.9
Eyes	11.2	6.2

J Radiat Res. 2017 Mar 1;58(2):210-216. doi: 10.1093/jrr/rrw115.

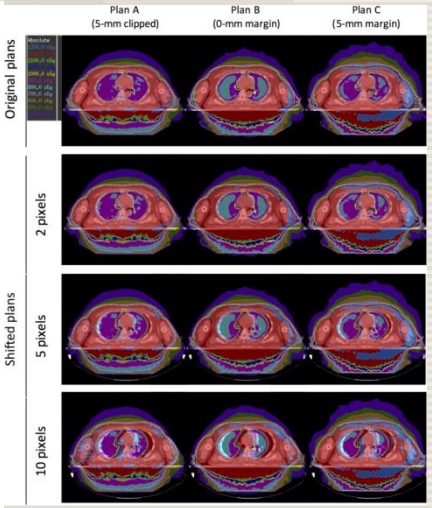
Adequate target volume in total-body irradiation by intensity-modulated radiation therapy using helical tomotherapy: a simulation study.

Takenaka R[1], Haga A[1], Yamashita H[1], Nakagawa K[1].

Author information

Abstract

Recently, intensity-modulated radiation therapy (IMRT) has been used for total-body irradiation (TBI). Since the planning target volume (PTV) for TBI includes the surrounding air, a dose prescription to the PTV provides high fluence to the body surface. Thus with just a small set-up error, the body might be exposed to a high-fluence beam. This study aims to assess which target volume should be prescribed the dose, such as a clinical target volume (CTV) with a margin, or a CTV that excludes the surface area of the skin. Three treatment plans were created for each patient: the 5-mm clipped plan (Plan A), the 0-mm margin plan (Plan B) and the 5-mm margin plan (Plan C). The CTV was the whole body. PTVs were the CTV with the exception of 5 mm from the skin surface in Plan A, equal to the CTV in Plan B, and the CTV with a 5 mm margin in Plan C. The prescribed dose was 12 Gy in six fractions. To assess the influence of the set-up error, dose distributions were simulated on computed tomography (CT) images shifted 2 pixels (= 4.296 mm), 5 pixels (= 10.74 mm) and 10 pixels (= 21.48 mm) in the lateral direction from the original CT. With a set-up error of 10.74 mm, V110% was 8.8%, 11.1% and 23.3% in Plans A, B and C, respectively. The prescription to the PTV containing the surrounding air can be paradoxically vulnerable to a high-dose as a consequence of a small set-up error.



Köszönöm a megtisztelő figyelmet és kollegáimnak a közreműködést!