



LIGA
CONTRA
O CÂNCER
O MELHOR. SEMPRE.

A evolução da radioterapia em próstata: dos tratamentos 2D a SBRT

SUMÁRIO

Radioterapia 2D – características e requisitos.

Radioterapia 3D - características e requisitos.

Radioterapia Estereotactica Corporea - características e requisitos.

RADIOTERAPIA 2D

- Dose no ponto
- Calculo manual de unidades monitoras.
- Campos típicos da ordem de 9 cm x 9 cm.

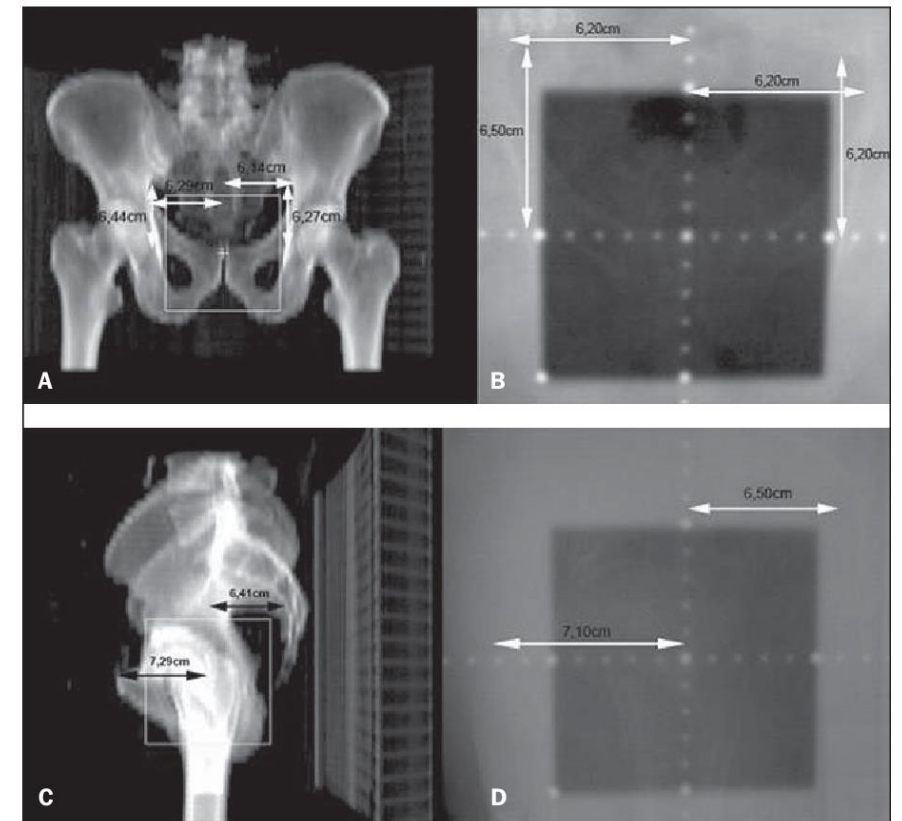
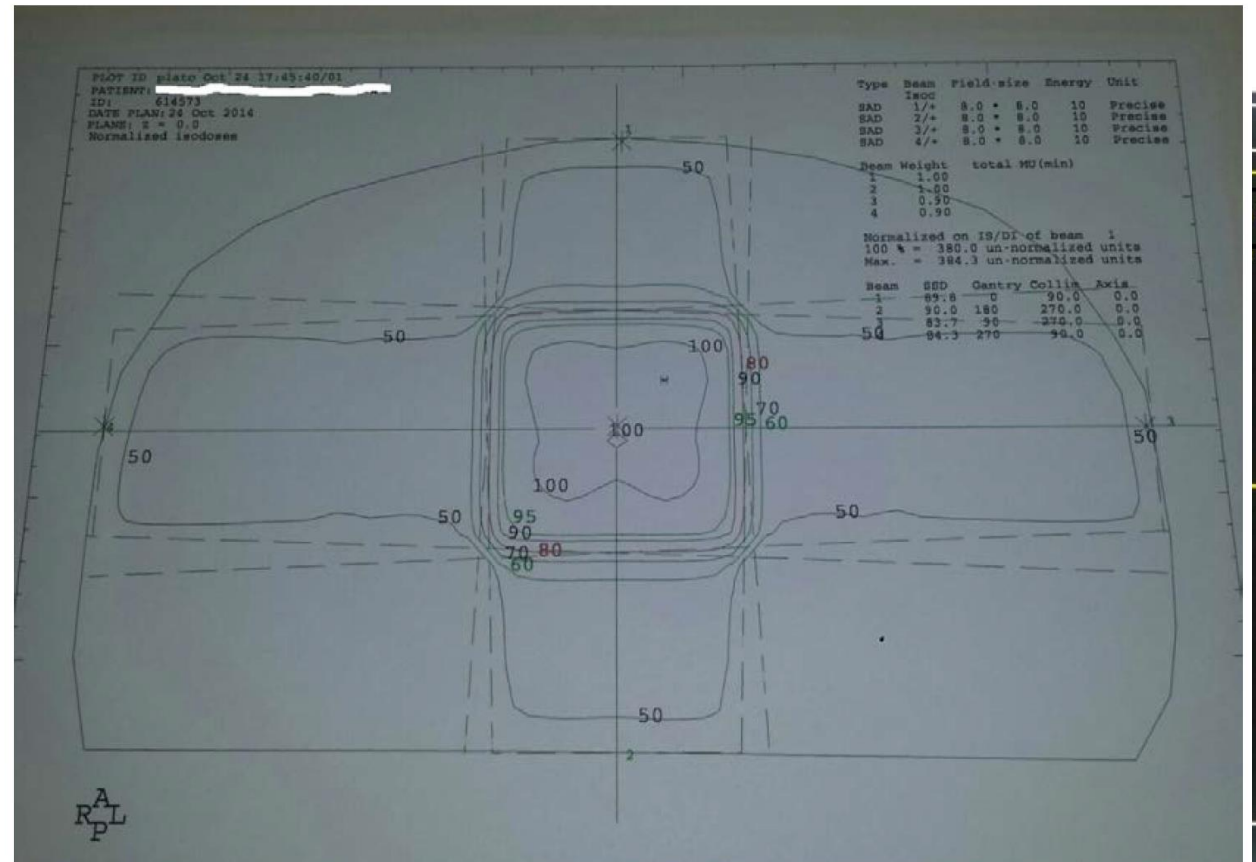


Figure 2. On **A** and **B** anterior views of DRR and radiography are observed, and on **C** and **D** the lateral

RADIOTERAPIA 2D e 1/2

- Contorno do paciente
- Dose calculada no raio central
- 4 campos
- 70 Gy em 35 frações



RADIOTERAPIA 2D e ½

QA_ing

- Clinac QA
- Checagem independente de MU



RADIOTERAPIA 2D e ½

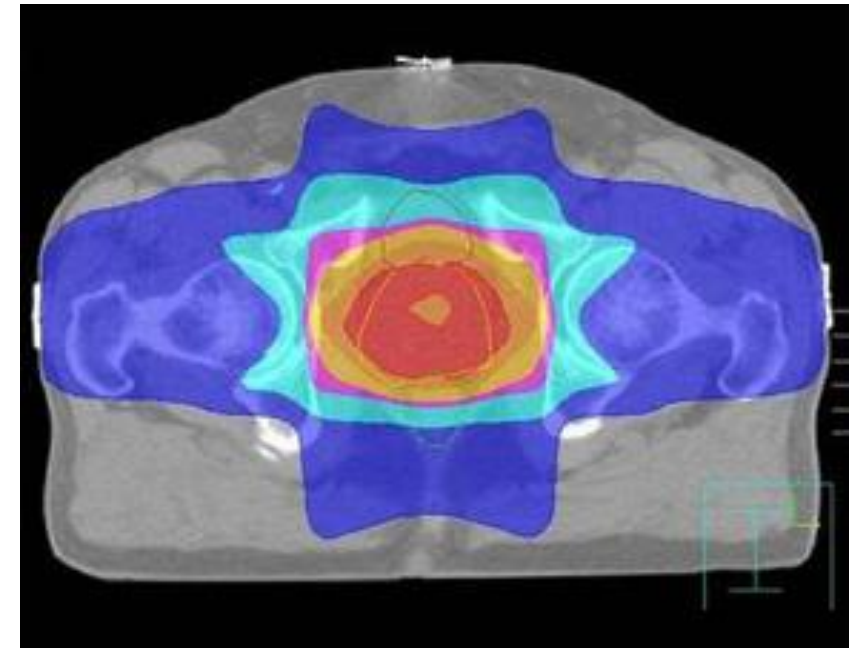
Recursos humanos e educação

- Físico com domínio das quatro operações básicas.
- Médico com bom conhecimento em anatomia ossea



RADIOTERAPIA 3D

- Cálculo de dose volumétrico
- Sistema de planejamento complexo.
- Possibilitou o escalonamento da dose.
- Adicionou um aumento considerável na complexidade dos tratamentos.



RADIOTERAPIA 3D

	Level 1 Basic CRT	Level 2 3-D CRT	Level 3 Advanced 3-D CRT
1. Patient data acquisition			
Immobilization	Desirable	Customized to the patient	Customized to the patient
Imaging system	Localization films, few CT slices optional	Thin adjacent CT slices, MR optional	Co-registered CT with MR or PET
Anatomical data			
Reference marks for setup	Height above table and skin marks	External markers or frame	Implanted markers or frame
Critical organs	Contour individual slices	3-D segmentation	3-D segmentation
Inhomogeneities	Optional	Contouring every slice or voxel based correction	Voxel based correction
Gross tumour volume (GTV)	May not be formally defined	Contouring every slice	3-D segmentation
Clinical target volume (CTV)	May not be formally defined	Grown from GTV using auto-margin growing	Margin growing from GTV + functional imaging
Internal target volume (ITV)	May not be formally defined	Based on standard decision rules	4-D CT data to define ITV customized to patient

RADIOTERAPIA 3D

2. Beam definition

Accounting for beam setting uncertainty	Margins are not customized	3-D margins based on audit of setup errors	Image guidance
Type of radiation and beam modifiers	Photons or electrons $\pm$ wedge filters	Photons, wedges, field in field, compensators	Photons + IMRT
Beam incidence	Coplanar beams	Several (including non-coplanar) beams	Multiple non-coplanar beams or arcs
Isocentre	SSD or SAD technique	SAD technique (auto centred on target)	SAD technique (auto centred on target)
Beam limiting device	Non-customized shielding blocks	Customized blocks or MLC	MLC or mini MLC
PTV – CTV margin	Shape drawn on simulation films	Protocol margins based on audit	Individual margin based on e.g. 4-D CT

RADIOTERAPIA 3D

3. Dose calculation and optimization

Calculation model	1-D or 2-D (slice) $\pm$ inhomogeneity	2-D or 3-D with inhomogeneity	3-D or 4-D with inhomogeneity
Evaluation of treatment plans	Isodoses on central slice or several slices	Isodoses viewed in 3-D on computer + DVH	3-D isodose surface + DVH, TCP, NTCP
Treatment plan optimization	Successive trials + visual appreciation	Successive trials + simple optimisation	Inverse planning

4. Treatment verification and execution

Verification simulation	Normal practice	Useful	Replaced by IGRT on treatment machine
Immobilization (see above)	Desirable	Customized to the patient	Individual cast or stereotactic frame
Aids for positioning	Lasers + light field	Isocentre lasers	Lasers or frameless stereotaxy
Patient positioning	Height above couch + skin marks	Move from anatomical reference or stereotaxy	Daily image guidance
Verification reference image	Simulation film	DRR	CT data compared to cone beam CT
Record and verify system	Desirable	Essential but network is optional	Essential including network transfer
In vivo measurements	Desirable	TLD or diodes recommended	TLD or diodes or EPID transit dosimetry

RADIOTERAPIA 3D

O que é necessário?

- Serviço de imagem com pelo menos uma TC para planejamento.
- Treinamento acadêmico do staff médico, físico médico e técnicos em radioterapia
- Treinamento prático do staff médico, físico médico e técnicos em radioterapia
- Comissionamento do sistema de planejamento 3D
- Programa da garantia da qualidade
- Protocolos clínicos

IAEA-TECDOC-1588

***Transition from 2-D Radiotherapy to
3-D Conformal and Intensity
Modulated Radiotherapy***

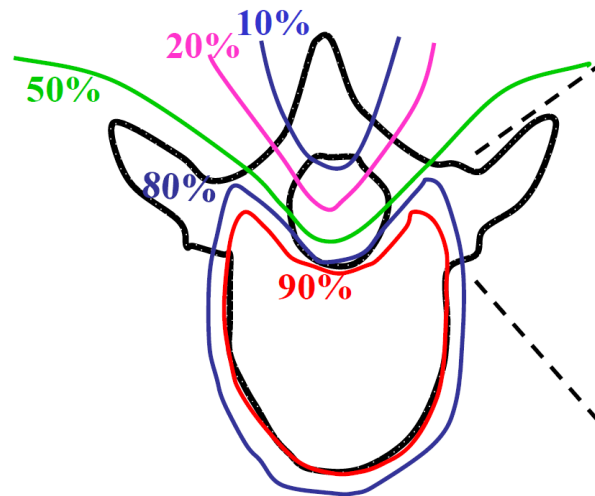


IAEA
International Atomic Energy Agency

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Radio estereotactica corporea

I want to hit a moving target
with high dose while sparing
all the healthy tissue around
it!



STEREOTACTIC BODY RADIATION THERAPY

Required equipment

Devices for accurate determination of target coordinates

Immobilization system

External beam delivery unit

Image guidance system

STEREOTACTIC BODY RADIATION THERAPY

Required equipment

- Devices for accurate determination of target coordinates

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STEREOTACTIC BODY RADIATION THERAPY

Required equipment

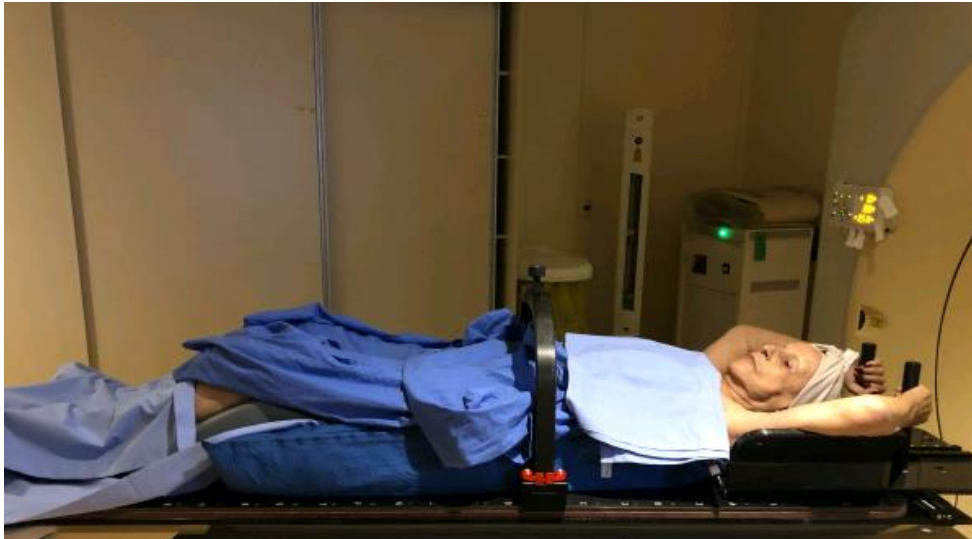
Devices for accurate determination of target coordinates.



STEREOTACTIC BODY RADIATION THERAPY

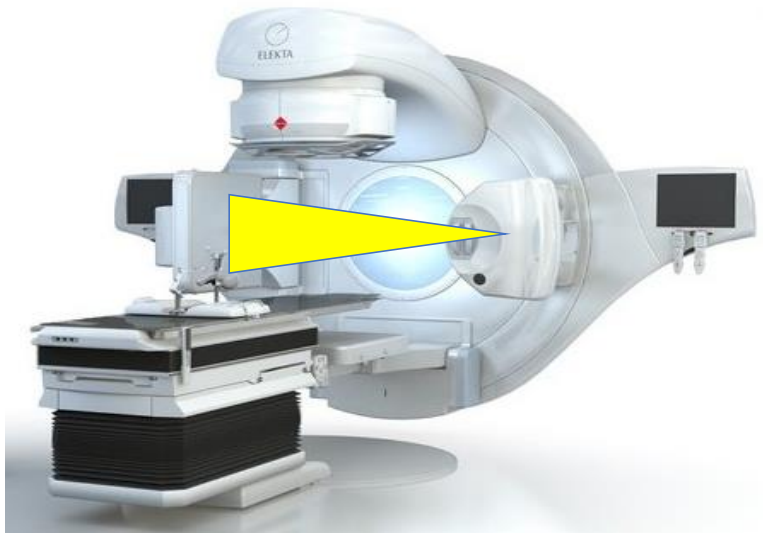
Immobilization system

Immobilization system



STEREOTACTIC BODY RADIATION THERAPY

External beam delivery unit



Required equipment

Image guidance system





A rigid quality
assurance system is
needed



“QA measures are imperative to reduce the likelihood of accidents and errors and increase the probability that the errors will be recognized and rectified if they do occur.” (WHO, 2006)

QA for SBRT

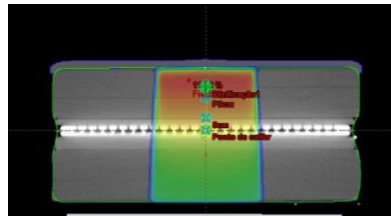
Task Group 142 report: Quality assurance of medical accelerators'

Stereotactic body radiation therapy: The report of AAPM Task Group 101

A SBRT/SRS QA program should be divided in two

Patient Related

Machine Related



QA for SBRT

Machine Related QA - frequency

Daily



To verify the basic functionality and safe operation of the delivery and imaging equipment.

Monthly



To detect trends in performance away from baseline and are focused on the imaging and delivery devices most likely to affect patient treatment.

Annually



E2E tests

QA for SBRT

Daily QA

Daily Tests

Mechanical

Laser localization	1 mm
Distance indicator (at isocenter)	2 mm
Collimator size indicator : both jaws and MLC	1 mm

Safety

Stereotactic interlocks (lockout): cone size, backup jaws	Functional
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In addition to tests listed above (ASTRO)

Winston-Lutz test	≤ 0.75 mm average
IGRT positioning/repositioning	≤ 1 mm
Imaging subsystem interlocks	Functional

QA for SBRT

Monthly QA

Monthly Tests

Dosimetry

Typical dose rate ^a output constancy	2 % (at SRS/SBRT dose rate, MU)
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Mechanical

Treatment couch position indicators ^b	1 mm/0.5°
Localizing lasers	≤1 mm

In addition to tests listed above (ASTRO)

Winston-Lutz test: both cones and MLC, covering complete range of gantry, couch, collimator positions	≤0.75 mm average, ≤1 mm maximum
Hidden target test using SRS frame and/or IGRT system	≤1 mm

Conclusions

Know your machine.

Follow the published guidelines

Know your limitations by evaluating your uncertainties.

Evaluate the need your QA results trends.



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