GYN GEC-ESTRO/ICRU 89
Target Concept

Richard Pötter
Medical University Vienna
GYN GEC ESTRO RECOMMENDATIONS-BACKGROUND
From 2D to 3D/4D

Historical difficulties in communicating results of cervical BT due to different traditions (60 Gy reference volume, point A..., midline block)

• CTV according to GTV at diagnosis?
• CTV according to GTV at BT?

Building the tower of Babel (confusion of languages)
Brueghel, 16th century (1563)
Vienna, Museum of Fine Arts

We need a common language!
Gyn GEC ESTRO Recommendations 2005
PREScribing, Recording, AND REPORTING BRACHyThERAPY FOR CANCER OF THE CERVIX

Report Committee

R. Pötter (Co-Chairman), Medical University of Vienna, Vienna, Austria
C. Kirisits (Co-Chairman), Medical University of Vienna, Vienna, Austria
B. Erickson, Medical College of Wisconsin, Milwaukee, USA
C. Haie-Meder, Gustave Roussy Cancer Campus, Villejuif, France
E. Van Limbergen, University Hospital Gasthuisberg, Leuven, Belgium
J. C. Lindegaard, Aarhus University Hospital, Aarhus, Denmark
J. Rownd, Medical College of Wisconsin, Milwaukee, USA
K. Tanderup, Aarhus University Hospital, Aarhus, Denmark
B. R. Thomadsen, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

Commission Sponsors

P. M. DeLuca, Jr., University of Wisconsin, Madison, WI, USA
A. Wambersie, Universite Catholique de Louvain, Brussels, Belgium
S. Bentzen, John Hopkins, Baltimore, MD, USA
R. A. Gahbauer, Ohio State University, Columbus, OH, USA
D. T. L. Jones, Cape Scientific Concepts, Cape Town, South Africa
G. F. Whitmore, Ontario Cancer Institute, Toronto, Canada

Consultants to the Report Committee

W. Dörr, Medical University of Vienna, Vienna, Austria
U. Mahantshetty, Tata Memorial Hospital, Mumbai, India
P. Petrič, National Center for Cancer Care and Research, Doha, Qatar
E. Rosenblatt, International Atomic Energy Agency, Vienna, Austria
A. N. Viswanathan, Harvard Medical School, Boston, MA, USA
Purpose of the ICRU/GEC ESTRO Report 89

To provide common concepts and terms for

* volumes, in particular initial/residual GTV
  initial/adaptive CTV and OAR (3D/4D)
* radiobiological variations (equi-effective dose)
* dose volume parameters (3D/4D)
* the process from planning aims to prescription
* dose point parameters (2D)
* different levels of clinical practice (level 1, 2, 3)
ICRU report 89 (258 pages)

Prescribing, Recording, and Reporting Brachytherapy for Cancer of the Cervix

Sections 1-12
Summary (end of each section)
Key messages (1-4, 9, 12)
Recommendations (5-8, 10-11)

Chapter (1) – Introduction
Chapter (2) – Prevention, Diagnosis, Prognosis, Treatment and Outcome
Chapter (3) – Brachytherapy Techniques and Systems
Chapter (4) – Brachytherapy Imaging for Treatment Planning

Chapter (5) – Tumor and Target Volumes and Adaptive Radiotherapy
Chapter (6) – Organs At Risk and Morbidity-Related Concepts and Volumes
Chapter (7) – Radiobiological considerations
Chapter (8) – Dose and Volume Parameters for Prescribing, Recording, and Reporting Brachytherapy, Alone or combined with External Beam Therapy

Chapter (9) – Volumetric Dose Assessment
Chapter (10) – Radiographic Dose Assessment
Chapter (11) – Sources and Absorbed-Dose Calculation
Chapter (12) – Treatment planning

Chapter (13) – Summary of The Recommendations

Appendix A: 9 Comprehensive Clinical Examples (various clinical/technical scenarios)
CTV for the primary tumor (CTV-T)

- GTV and assumed sub-clinical malignant disease
- CTV-T encompasses the microscopic tumor spread at the boundary of the primary tumor GTV
CTVs concepts

Cancer cell density in 3 different target volumes

Pelvic wall region
Potential microscopic tumour spread
Macroscopic tumour load
Significant microscopic disease
Potential microscopic tumour spread

Pelvic wall region

Cervix
Tumor and target volume definitions for the primary tumor
Gyn GEC ESTRO, ICRU 89, EMBRACE II

- initial GTV for the primary tumor (GTV-T_{init})
- initial CTV for the primary tumor (CTV-T_{init})
- Residual GTV-T (GTV-T_{res})
- Adaptive CTV-T (CTV-T_{adapt})
- High-Risk CTV-T (CTV-T_{HR})
- Intermediate-Risk CTV-T (CTV-T_{IR})
- Low-Risk CTV-T (CTV-T_{LR}) (init/res)
- Planning Target Volume (PTV-T)
Various patterns of tumor response and adaptive CTV

Residual GTV
Residual pathologic tissue

Adaptive CTV

ICRU/GEC ESTRO report 89
Fig. 5.4
Overview of adaptive target concept in cervix cancer

ICRU/GEC ESTRO report 89
Fig. 5.9-11
Target volume concepts

**High Risk CTV:**
GTV at time of brachytherapy
In all cases includes:
- GTV + whole cervix
- Presumed tumour extension in adjacent tissues
  - Clinical assessment
  - Residual grey zones on MRI

**Intermediate Risk CTV:**
GTV at time of diagnosis
In all cases includes:
- HR-CTV
- Integrates initial GTV

**SAFETY MARGINS:**
- 1-1.5 cm cranially
- 0.5 cm antero-posteriorly
- 1 cm laterally

NO SAFETY MARGINS
Overview

- Stage IB1
- Stage IB2
- Stage IIB
- Stage IIIB

- Limited disease
- Extensive disease, sufficient response
- Extensive disease, insufficient response
Target volume concepts

**High Risk CTV (IB1):**

GTV at time of brachytherapy

In all cases includes:

- Whole cervix
- MRI and clinical assessment

NO SAFETY MARGINS
Stage IB1
Stage IB1
1. Limited disease (tumour size <4cm)

Definition of GTV

Clinical Examination:
macroscopic tumour

MRI Findings:
- High signal intensity zone in cervix
1. Limited disease (tumour size <4cm)

**Definition of HR-CTV:**

GTV + whole cervix

![Diagram](image-url)
1. Limited disease (tumour size < 4 cm)

**Definition of HR-CTV:**

GTV + whole cervix
1. Limited disease (tumour size $< 4$cm)

**Definition of IR-CTV**

HR CTV + safety margin
(area of adjacent significant microscopic tumour load)

5 mm anterior – posterior
10 mm into parametria
1. Limited disease (tumour size < 4cm)

Definition of IR-CTV

HR CTV + safety margin (area of potential adjacent significant microscopic tumour load)

- 5 mm anterior – posterior
- 10 mm into parametria

HR CTV

GTV

IR CTV

+/- additional 5 mm

10 mm into the corpus
10 mm into the vagina
Adaptive MRI based planning concept

Dimopoulos et al. IJROBP 2006
Findings at time of diagnosis

Dimensions (cm):
- Width: 7
- Thickness: >5
- Height: >5
- Vaginal inv.: 0.5
  (right fornix)

Findings at time of brachytherapy

Dimensions (cm):
- Width: 3.5
- Thickness: 2
- Height: 2
- Vaginal inv.: 0

Fig.5.1
Various patterns of tumor response and adaptive CTV

Residual GTV
Residual pathologic tissue

Adaptive CTV

ICRU/GEC ESTRO report 89
Fig. 5.4
Overview of adaptive target concept in cervix cancer

ICRU/GEC ESTRO report 89
Fig. 5.9-11
Initial GTV, Residual GTV, Residual Pathologic Tissue

- Infiltrative outer half
  → grey and bright zones

- Expansive with spiculae + infiltrative part
  → grey zones in the PM

- Expansive with spiculae
  → no pathologic tissue in the PM
Target volume concepts

**High Risk CTV (IB2):**

Residual GTV at time of brachytherapy (bright (MRI))

In all cases includes:

- Whole cervix
- (intra-uterine GTV extension)

NO SAFETY MARGINS
Stage IB2
Stage IB2
Stage IB2: initial clinical examination

**Infiltrating**  **Exophytic**

- Cervix
- Vagina
- Parametrium
- Rectum or Bladder

**Dimensions (cm):**
- Width: 6
- Thickness: 5
- Height: 5
Stage IB2: initial MRI

- 6 cm
- 5 cm
- 6 cm
Stage IB2: at the time of brachytherapy

**Dimensions (cm):**
- Width: 2.5
- Thickness: 2
- Height: 2.5
Stage IB2: at the time of brachytherapy
Stage IB2
Stage IB2
Stage IB2
Stage IB2
Target volume concepts

**High Risk CTV (IIB):**

- Residual GTV at time of brachytherapy
- Residual pathologic tissue at time of brachytherapy

In all cases includes:
- Whole cervix
- Residual GTV (clinical and MRI)
- Residual pathologic tissue (clinical and MRI (grey zones)) located within the initial GTV

**NO SAFETY MARGINS**
Overview of adaptive target concept in cervix cancer

ICRU/GEC ESTRO report 89
Fig. 5.9-11
Stage IIB: initial clinical examination

**Dimensions (cm):**
- Width: 5
- Thickness: 5
- Height: 5
- Fornix involv 1

**Infiltrating**  
- Cervix
- Vagina
- Parametrium
- Rectum or Bladder

**Exophytic**
Stage IIB: initial MRI
Stage IIB: at the time of brachytherapy

Infiltrating  Exophytic

Cervix
Vagina
Parametrium
Rectum or Bladder

Dimensions (cm):
Largeur : 3
Epaisseur : 3
Hauteur : 3
Env. vaginal : 1
Stage IIB : MRI at the time of brachytherapy
Stage IIB

GTV

Tumor at time of diagnosis.

HR CTV

CTV

IR CTV
Stage IIB
Stage IIB
Stage IIB
Target volume concepts

High Risk CTV (IIIB):

Residual GTV and Residual pathologic tissue at time of brachytherapy

In all cases includes:
- Whole cervix
- residual GTV (clinical and MRI)
- residual pathologic tissue (clinical and MRI (grey zones)) located within the initial GTV

NO SAFETY MARGINS
Overview of adaptive target concept in cervix cancer

ICRU/GEC ESTRO report 89
Fig. 5.9-11
Stage IIIB: initial clinical examination

Infiltrating Exophytic

Cervix

Vagina

Parametrium

Rectum or Bladder

**Dimensions (cm):**

Width: 6

Thickness: 4

Height: 4
Stage III B: initial MRI

40 mm

45 mm

62 mm
Stage III B: at the time of brachytherapy

**Dimensions (cm):**

- Width: 4.5
- Thickness: 3
- Height: 3
Stage IIIB: MRI at the time of brachytherapy
Stage III B
Stage III B
Stage III B
Stage IIIB
HR and IR-CTV
Extent at diagnosis and degree of remission

- Complete remission
- Good partial remission
- Poor partial remission
- No remission

Initial tumour extension
Residual disease
HR-CTV
IR-CTV

10 mm
cervix
10 mm
cervix
10 mm
cervix
10 mm
cervix
10 mm
cervix
Target volume concepts

**High Risk CTV:**
GTV at time of brachytherapy
In all cases includes:
- GTV + whole cervix
- Presumed tumour extension in adjacent tissues
  - Clinical assessment
  - Residual grey zones on MRI

**Intermediate Risk CTV:**
GTV at time of diagnosis
In all cases includes:
- HR-CTV
- Integrates initial GTV
**SAFETY MARGINS:**
1-1.5 cm cranially
0.5 cm antero-posteriorly
1 cm laterally

NO SAFETY MARGINS
Historical difficulties in communicating results of cervical BT due to different traditions (60 Gy reference volume, point A…, midline block)

- CTV according to GTV at diagnosis: IR CTV
- CTV according to GTV at BT: HR CTV

We have a common language: GEC ESTRO/ICRU
We should apply as much as possible
Gyn GEC ESTRO Recommendations are applicable for Gyn BT in general (vagina, endometrium, vulva, recurrent tumours)

Clinical examples

1. Limited disease (tumour size < 4cm)
2. Large tumour, sufficient response
3. Large tumour, insufficient response
1. Limited disease (tumour size < 4cm)

Definition of GTV

Clinical Examination:
macroscopic tumour

MRI Findings:
- High signal intensity zone in cervix
1. Limited disease (tumour size < 4cm)

Definition of HR-CTV:

GTV + whole cervix

GTV

HR CTV

7 mm 11 mm

18 mm 18 mm

18 mm 18 mm

14 mm

24 mm

36 mm
1. Limited disease (tumour size < 4cm)

Definition of HR-CTV:

GTV + whole cervix
1. Limited disease (tumour size < 4cm)

**Definition of IR-CTV**

HR CTV + safety margin
(area of adjacent significant microscopic tumour load)

- 5 mm anterior – posterior
- 10 mm into parametria
1. Limited disease (tumour size < 4cm)

**Definition of IR-CTV**

HR CTV + safety margin
(area of potential adjacent significant microscopic tumour load)

- 5 mm anterior–posterior
- 10 mm into parametria

GTV

HR CTV

IR CTV

+/- additional 5 mm

10 mm into the corpus
10 mm into the vagina
Clinical examples

1. Limited disease (tumour size < 4cm)
2. Large tumour, sufficient response
3. Large tumour, insufficient response
2. Large tumour - sufficient response

**INITIAL clinical findings:**
- St.p. Conisation, Cervix to the right
- Invasion of:
  - Right and dorsal fornix
  - Right PM to middle 1/3
- Left PM free

**Clinical findings at BT:**
- No macroscopic residuum in vagina
- Residuum in:
  - Right PM - inner third
Clinical examples

1. Limited disease (tumour size < 4cm)
2. Large tumour, sufficient response
3. Large tumour, insufficient response
Initial findings:
- No invasion of vagina
- Distal involvement of right parametrium (clinical)
- Proximal invasion of the left parametrium

Findings at brachytherapy:
- Residual disease right parametrium middle third
- No invasion of left parametrium
3. Large tumour-insufficient response
Gyn GEC ESTRO Recommendations are applicable for Gyn BT in general (vagina, endometrium, vulva, recurrent tumours)