Brachytherapy in the treatment of Cervical Cancers : An Essential Component for tumor control

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&

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ESTRO

European Society for Therapeutic Radiology and Oncology

IAEA

International Atomic Energy Agency

Atoms for Peace

Objectives

- To understand the role of BT in cervical cancer
- To learn the results and outcome
- To understand the need for BT in modern era for cervical cancers

Cervical Cancer and Intracavitary BT

- Tolerance doses of the target organs (cervix & vagina)
- Potential to spare normal structures due to the peculiar anatomy of the female genital tract
- High conformal dose distribution
- Shortening of the overall treatment time

EFFECT OF ICBT ON SURVIVAL

Treatment		5years Survival
1.	Ext. RT alone	36%
2.	Ext. RT + ICBT	67%
3.	Single ICBT	60%
4.	2 or more ICBT	73%
5.	Dose at point A >65 Gy	68%
6.	Dose at point A <65 Gy	42%

FRACTIONATED BT & DOSE ESCALATION IMPROVES OUTCOME

Patterns of Care Outcome Studies

Results of the National Practice in Cancer of the Cervix

GERALD E. HANKS, MD,* DAVID F. HERRING, PHD,† AND SIMON KRAMER, MD‡

This report summarizes the national data collected by the Patterns of Care Study in the process and outcome of care in the treatment of carcinoma of the cervix. Substantial variation was found from a consensus of best current management, although training facilities tended to score higher than non-training on a compliance measure. Four year national averages for control of cervical cancer are: Stage I, 87%, Stage II, 66%, Stage III, 28%. Factors relating to recurrences include failure to use intracavitary irradiation, the type of equipment, the central dose, and Karnofsky Score. The presence of complications is associated with daily dose, lateral dose and central dose, among other factors, and was shown to be unacceptably high in Stage I.

Cancer **51:959–967, 1983.**

The importance of central dose is shown in that when it was lower than the PCS recommendation, a substantial rise in failure rate was observed.

Intracavitary radiation proved extremely important in treating cervix cancer; when intracavitary irradiation was not used, the failure rate increased by a factor of 4.

TABLE 4. Effect of Intracavitary Radiation on Recurrence in Stage IIIB

	Regular survey		Extended survey	
	No. of patients	Recurrence†	No. of patients	Recurrence
Total	88	63 (72%)	59	25 (42%)
IC* Not Used	31	27 (87%)	7	6 (86%)
IC Used	57	36 (63%)	52	19 (37%)

* IC: Intracavitary irradiation.

† Lost patients counted as recurrences, four patients in the regular survey, two patients in the extended survey

PRETREATMENT AND TREATMENT FACTORS ASSOCIATED WITH IMPROVED OUTCOME IN SQUAMOUS CELL CARCINOMA OF THE UTERINE CERVIX: A FINAL REPORT OF THE 1973 AND 1978 PATTERNS OF CARE STUDIES

RACHELLE M. LANCIANO, M.D.,[1] MINHEE WON, M.A.,[2] LAWRENCE R. COIA, M.D.[1] AND GERALD E. HANKS, M.D.[1]

[1]Department of Radiation Oncology, Fox Chase Cancer Center, University of Pennsylvania; and
[2]American College of Radiology, Philadelphia, PA

IJROBP 1990

Table 2. 1973 and 1978 PCS cervix surveys combined: univariate analysis

	Dead/total	Survival 4 yr rate (% alive)	Failure/total	Infield failure (1st) 4 yr rate (% infield failure)
Stage				
I	110/618	81	45/618	8
II	211/632	65	115/632	19
III	172/289	40	125/289	47
	Mantel-Haenszel p (stratified) < .01		Mantel-Haenszel p (stratified) = <.001	
Age				
≤50 years	156/584	72	110/584	19
>50 years	340/958	64	180/958	20
	Mantel-Haenszel p (stratified) = .001		Mantel-Haenszel p (stratified) = NS	
Karnofsky performance status				
≤80	176/346	49	104/346	33
90–100	323/1201	72	183/1201	16
	Mantel-Haenszel p (stratified) < .001		Mantel-Haenszel p (stratified) < .001	
Use of intracavitary radiation (IC)				
No IC	95/156	37	70/156	47
IC	407/1402	70	221/1402	17
	Mantel-Haenszel p (stratified) < .001		Mantel-Haenszel p (stratified) < .001	

Trends in the Utilization of Brachytherapy in Cervical Cancer in the United States

Kathy Han, MD,* Michael Milosevic, MD,* Anthony Fyles, MD,* Melania Pintilie, MSc,† and Akila N. Viswanathan, MD, MPH‡

International Journal of Radiation Oncology biology • physics
www.redjournal.org

Int J Radiation Oncol Biol Phys, Vol. 87, No. 1, pp. 111–119, 2013

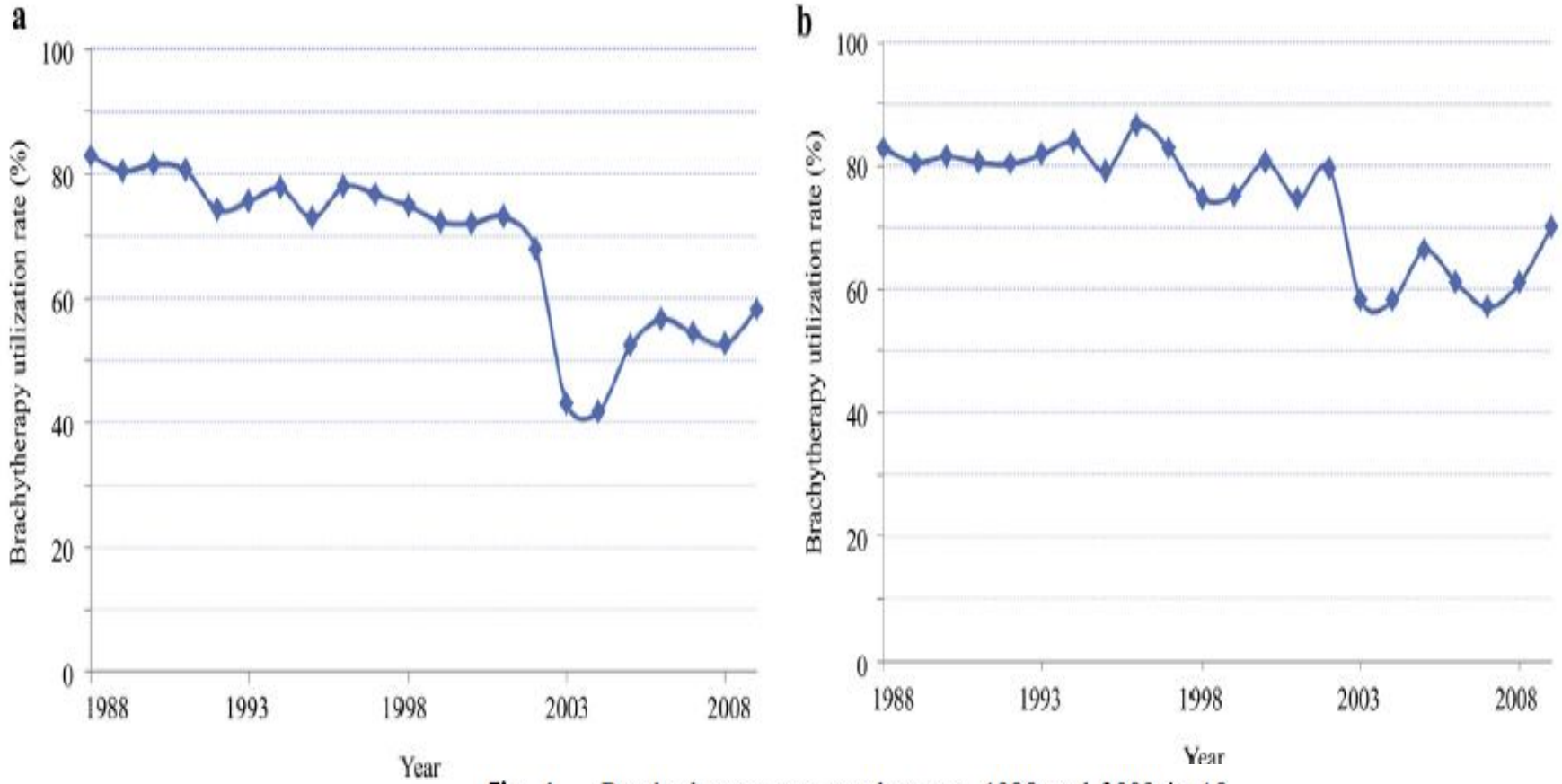

Fig. 1. Brachytherapy use rate between 1988 and 2009 in 18 (a) and the original 9 (b) SEER registries.

Brachytherapy in Gyn cancer in USA

Decrease of Cancer specific survival

4-year CSS 64.3% vs 51.5%, P<.001

Decrease of Overall Survival

58.2% Vs 46.2%,

P<.001

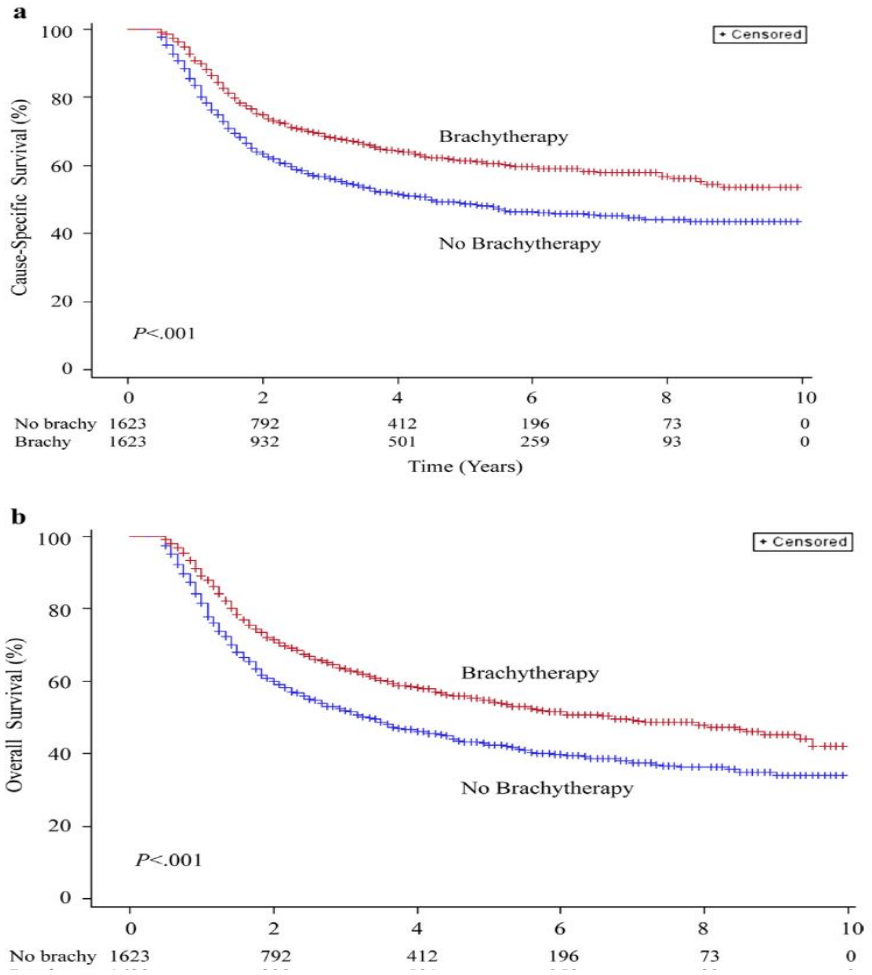

Fig. 2. Survival by brachytherapy use for matched cohort between 2000 and 2009. (a) Cause-specific survival; (b) overall survival, and (c) non-cancer-related survival.

Han et al., Int J Radiat Oncol Biol Phys. 2013;87

Evidence for dose needed to control primary tumor

Primary GYN tumors need dose (EBRT + BT)

- Local control depends on applied dose
- For cervix brachy contribution essential & vital

Radiotherapy and Oncology 93 (2009) 311–315

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journal homepage: www.thegreenjournal.com

Cervix cancer brachytherapy

Dose–effect relationship for local control of cervical cancer by magnetic resonance image-guided brachytherapy

Johannes C.A. Dimopoulos [a,*], Richard Pötter [a], Stefan Lang [a], Elena Fidarova [a], Petra Georg [a], Wolfgang Dörr [b], Christian Kirisits [a]

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Target
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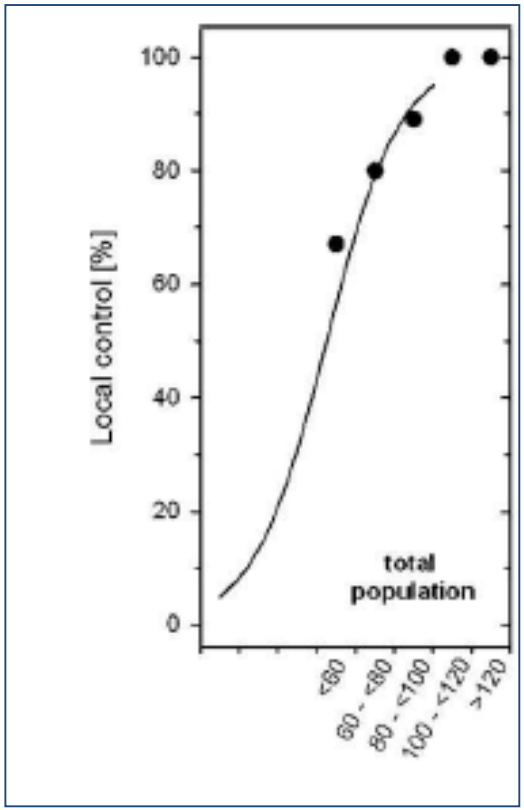
Dose–response

ABSTRACT

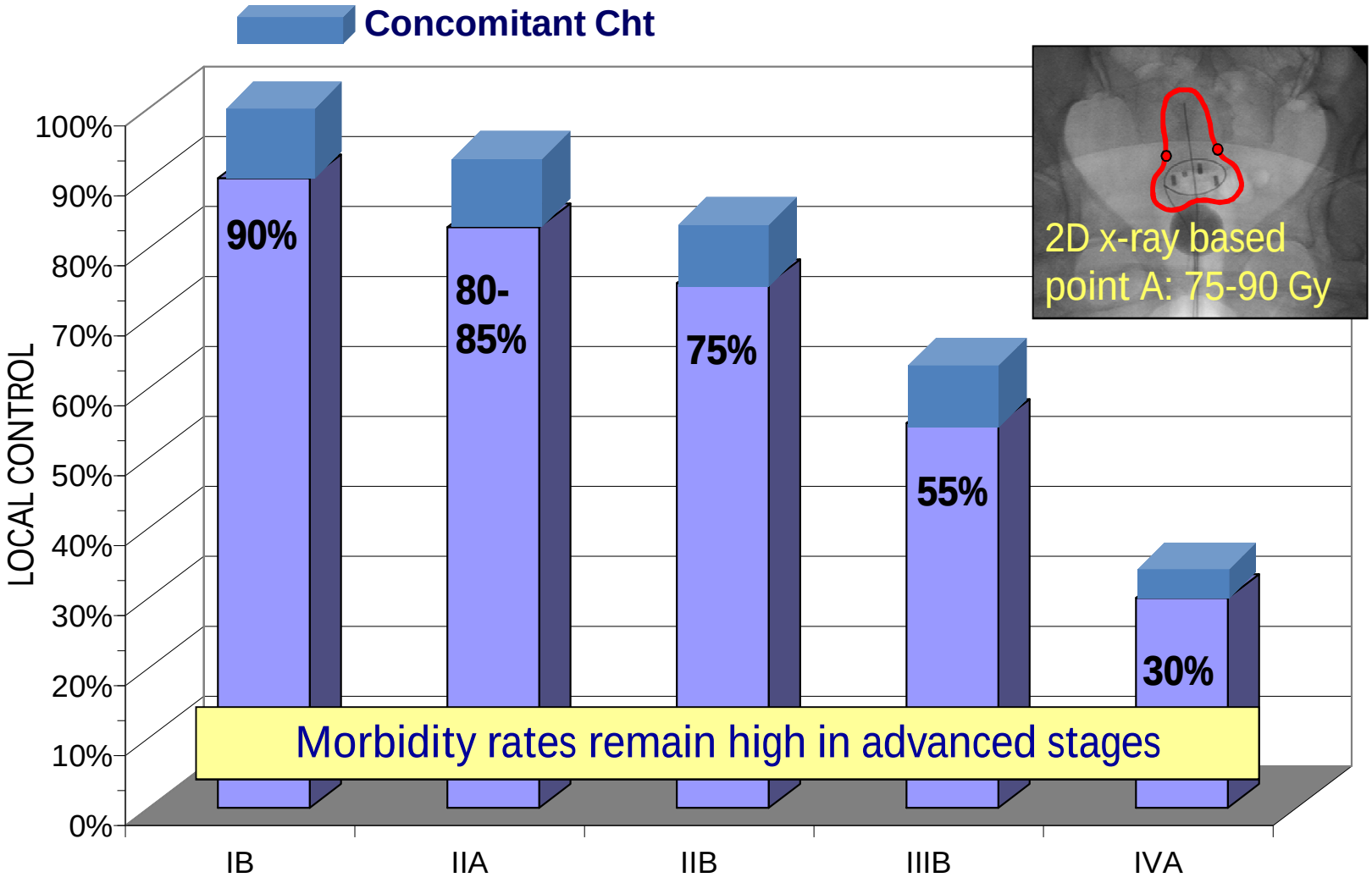
Background and purpose: To analyse dose–response relationships for local control of cervical cancer after MR image-guided brachytherapy (IGBT) based on dose–volume histogram parameters.
Methods and materials: The analysis includes 141 patients with cervix cancer (stages IB–IVA) treated with 45–50.4 Gy EBRT ± cisplatin plus 4 × 7 Gy IGBT. Gross tumour volume (GTV), high risk clinical target volume (HR CTV) and intermediate risk CTV (IR CTV) were delineated and DVH parameters (D90, D100) were assessed. Doses were converted to the equivalent dose in 2 Gy (EQD2) using linear-quadratic model ($\alpha/\beta = 10$ Gy). Groups of patients were formed according to tumour size at diagnosis (GTV_D) of 2–5 cm (group 1) or >5 cm (2), with subgroups of the latter for HR CTV size at first IGBT 2–5 cm (2a) or >5 cm (2b). Dose–response dependence for local recurrence was evaluated by logit analysis.
Results: Eighteen local recurrences in the true pelvis were observed. Dose–response analyses revealed a significant effect of HR CTV D100 ($p = 0.02$) and D90 ($p = 0.005$). The ED50-values for tumour control were 33 ± 15 Gy (D100) and 45 ± 19 Gy (D90). ED90-values were 67 Gy (95% confidence interval [50; 104]) and 86 Gy [77; 113], respectively.
Conclusions: A significant dependence of local control on D100 and D90 for HR CTV was found. Tumour control rates of >90% can be expected at doses >67 Gy and 86 Gy, respectively.



Dimopoulos ET AL; RAD. ONCOL. 2009

Cervix cancer Conventional (2D) Brachytherapy

Concomitant ChT improves results



Courtesy P Petric

Claire Vale et al. JCO 2008
Cochrane collaboration 2010

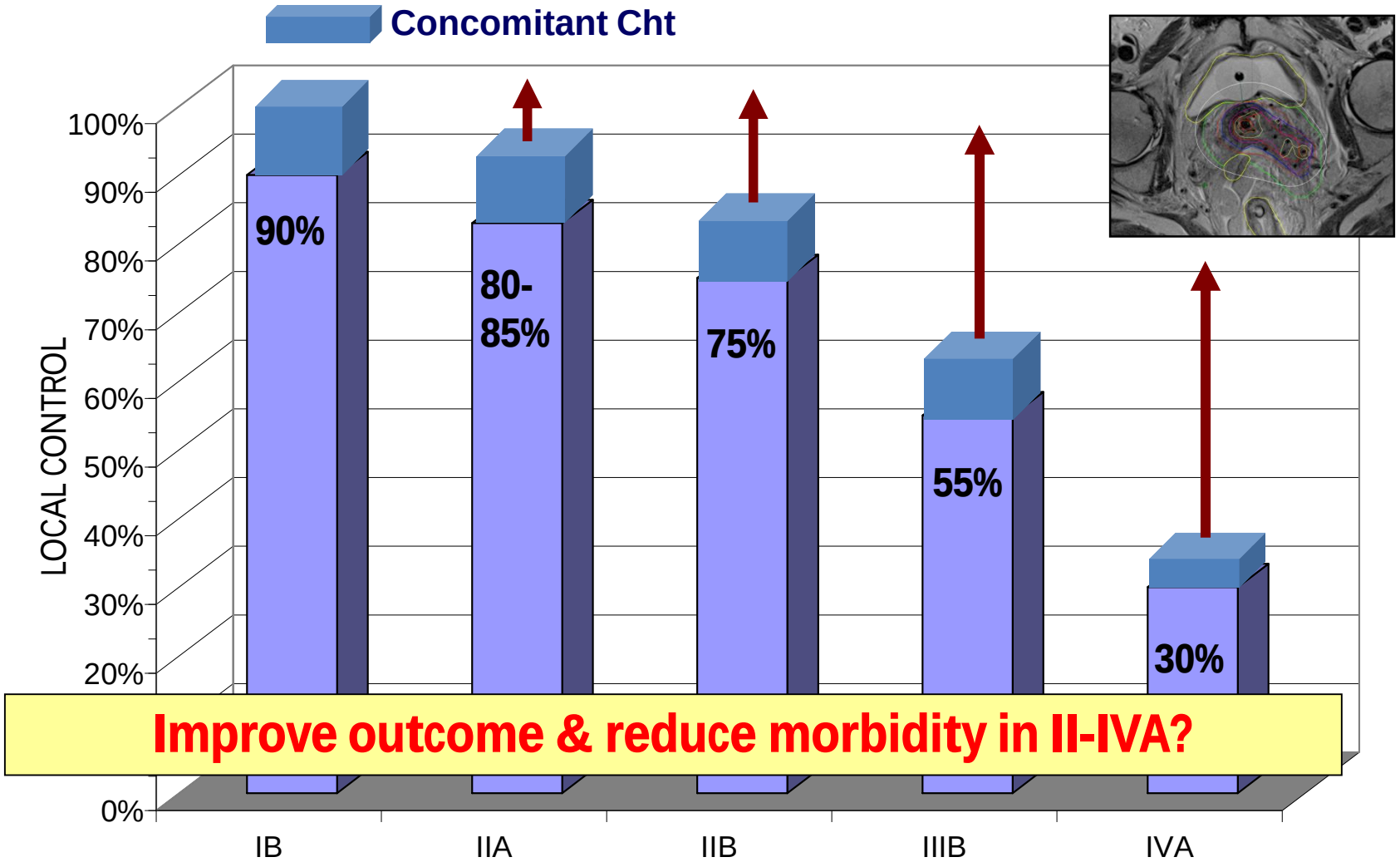
Green et al. Lancet 2001
The GEC ESTRO Handbook of Brachytherapy.

Limitations in Conventional 2D Brachytherapy Planning

- Limitations of Point A Based Dosimetry: Small & large tumors
- OAR Dose Assessment: Relative and Indirect
- Several Studies: No correlation with toxicities
- Tumor related Target Volume Assessment : Not possible
- Delineation of Target and Organs at Risk
  - Residual tumor at brachytherapy
  - Rectum, bladder, sigmoid,
  - Small intestine, vagina etc....
- Advances in Brachytherapy : Although slow

Cervix cancer Brachytherapy

3D Image Guidance and adaptation of application



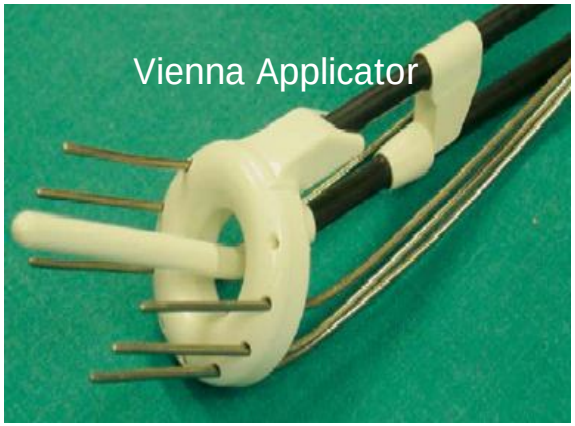
Review: Gerbaulet A, Pötter R, Haie-Meder C. Cervix Carcinoma. In: Gerbaulet A, Pötter R, Mazeron JJ, Meertens H, Van Limbergen E, eds. (2002) The GEC ESTRO Handbook of Brachytherapy. Brussels:ESTRO

Courtesy P Petric

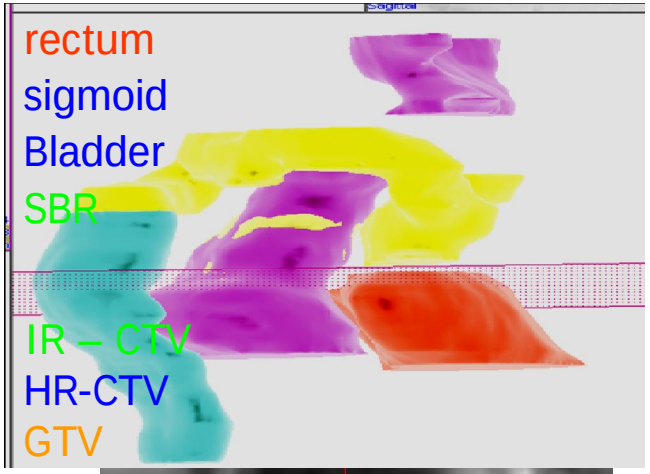
Benefit of Image Based BT Approach
Application – Imaging – Optimization

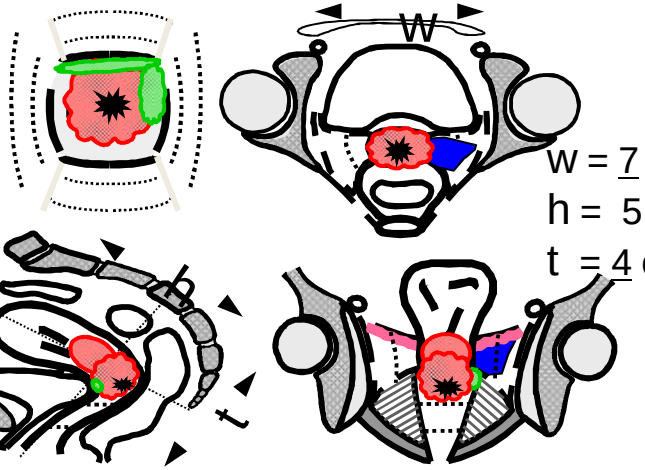
	Small tumours < 32cc		Large tumours ≥ 32cc	
	STANDARD	OPTIMISED	STANDARD	OPTIMISED
Target covered	**93%**	**93%**	**14%**	**71%**
OAR respected	**24%**	**90%**	**64%**	**93%**

K Tanderup et al, Radiother Oncol 2010



- **Applicators**
- **Imaging**
- **Planning systems**

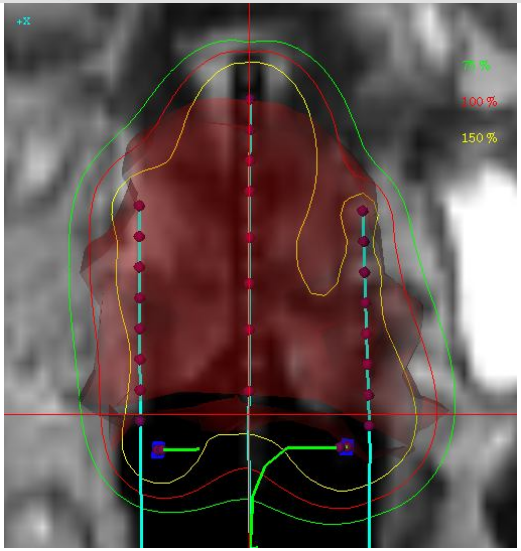




w = 7 cm
h = 5 cm
t = 4 cm

“GOLD STANDARD”

Clinical drawing
&
MR Imaging



Clinical Evidence in IGABT Cervix Cancer
dose point and dose volume effects (dve)

Upcoming Evidence

- Mono-instititutional cohorts (ongoing, publicat. since 2007)
- Multi-center cohorts with retrospective evaluation
  RetroEMBRACE (publications since 2016)
- Prospective Trials
  STIC: comparative 2D vs. 3D (published 2012)
  EMBRACE I: observational, 08/2008 - 12/2015
  EMBRACE II: interventional, from 03/2016

IGABT cervix cancer
Mono-institutional results

Author	Pt nb	image modal.	BT modal.	Total EQD2 D90 HR-CTV	Local control
Haie-Meder 2010	84	MRI	LDR	79	90%
Beriwal 2011	44	Hybrid	HDR	83	88%
Potter 2011	156	MRI	HDR	93	97%
Mahantshetty 2012	24	MRI	HDR	71	21/24
Lindegaard 2013	140	MRI	PDR	91	90%
Mazeron 2013	163	MRI	PDR	78	95%
Nomden 2013	46	MRI	PDR/HDR	84	93%
Refaat 2013	40	MRI/CT	PDR	±80	90%
Tharavichitkul 2013	47	MRI	HDR	93	98%
Rikjmans 2014	83	MRI	HDR	81	93%
Castelnau 2015	225	MRI	PDR	80	86%
Ribeiro 2016	170	MRI	PDR	85	96%

Local control and FIGO Stage (RetroEMBRACE)

Sturdza et al. R O 2016

Loc failure (Retro 3-5y)

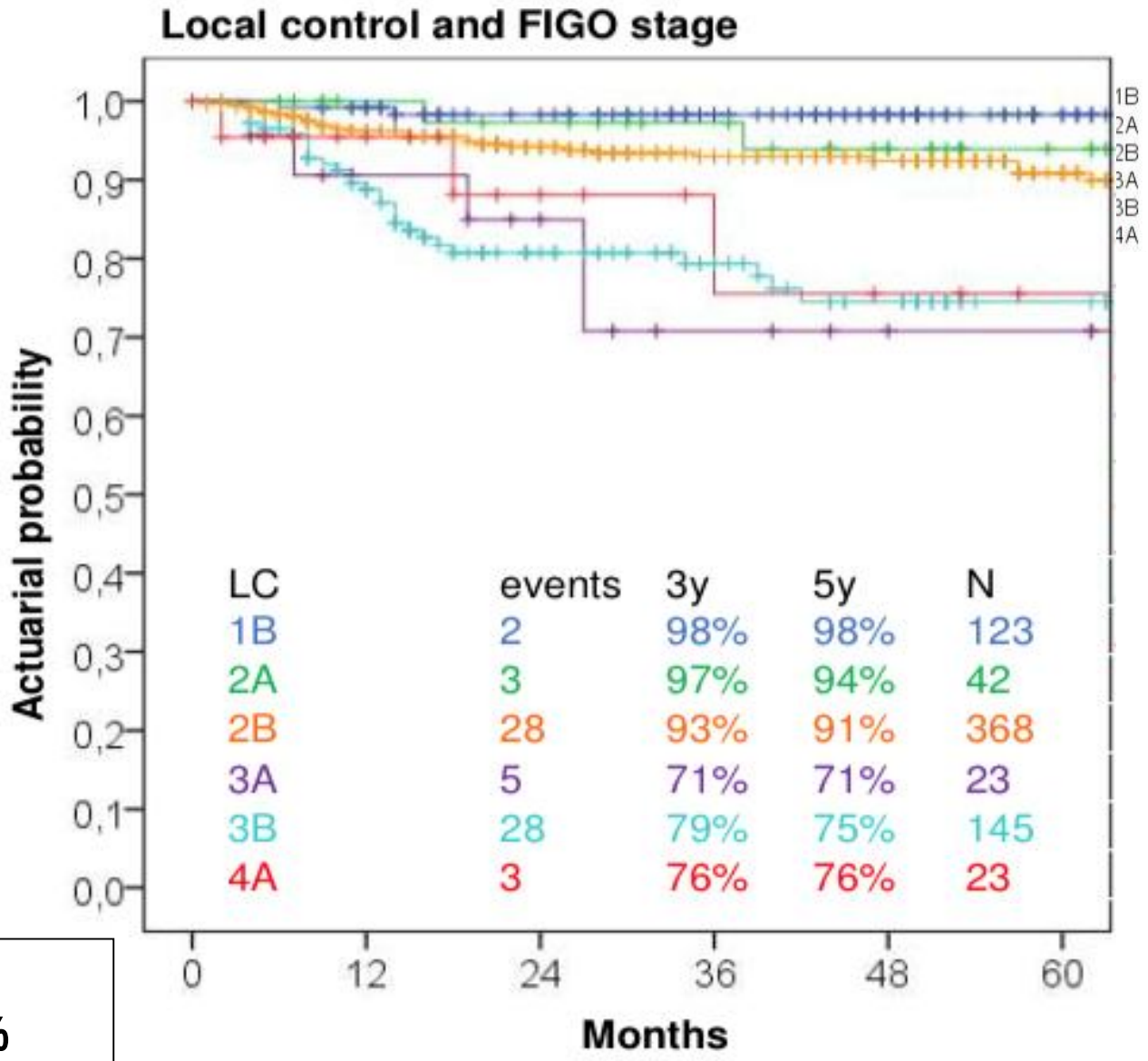
IB 2%
IIB 7-9%
IIIB 21-25%
IVA 24%

RetroEMBRACE 3y:

IB: 98%*
IIB 93%
IIIB 79%

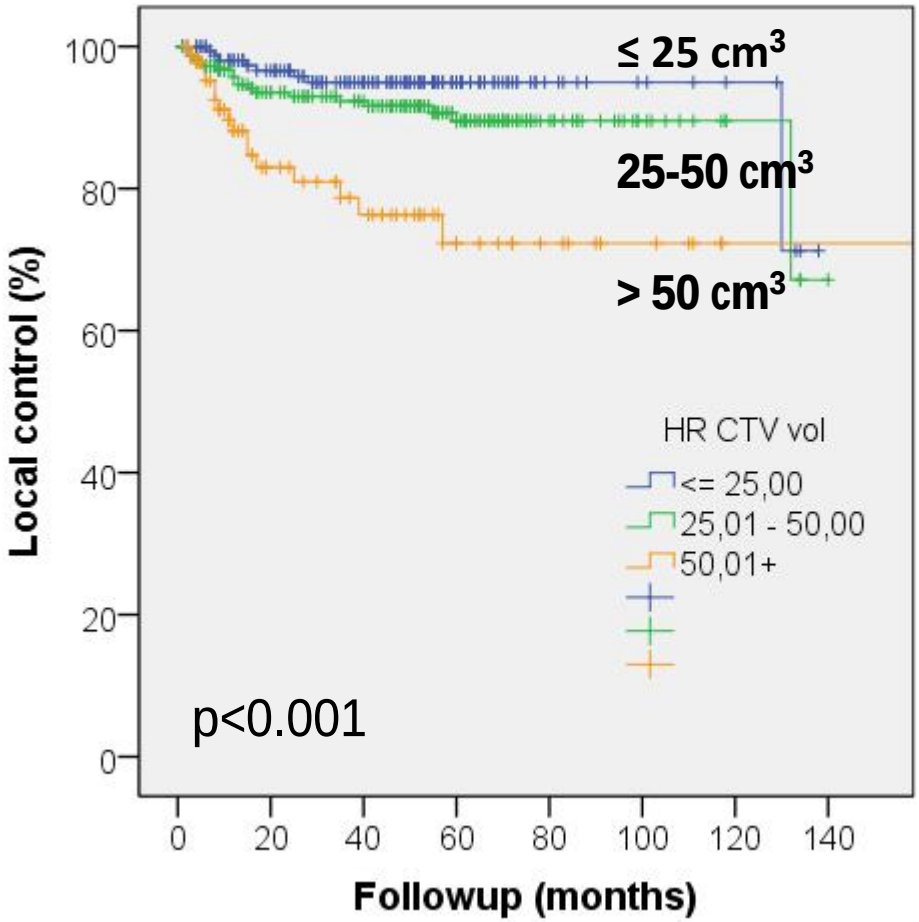
***2 events in IB2**

RetroEMBRACE (2016) 3y:
Overall local control 91%

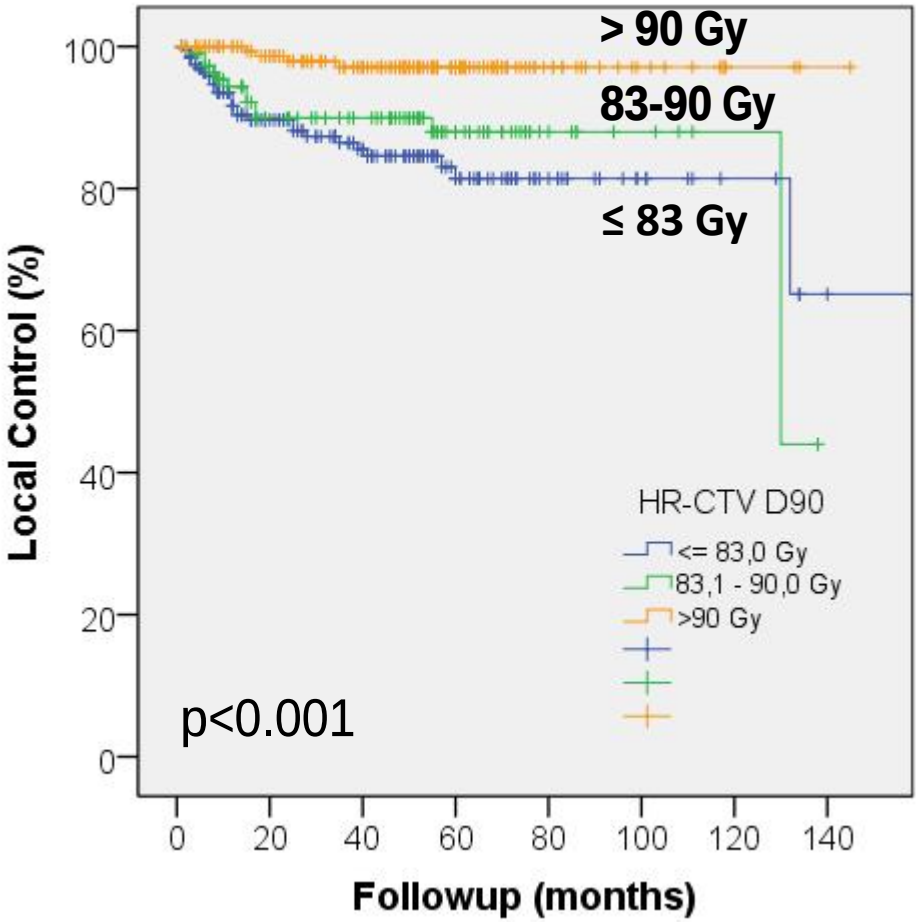


Actuarial local control: univariate analysis separate for HR CTV volume and dose

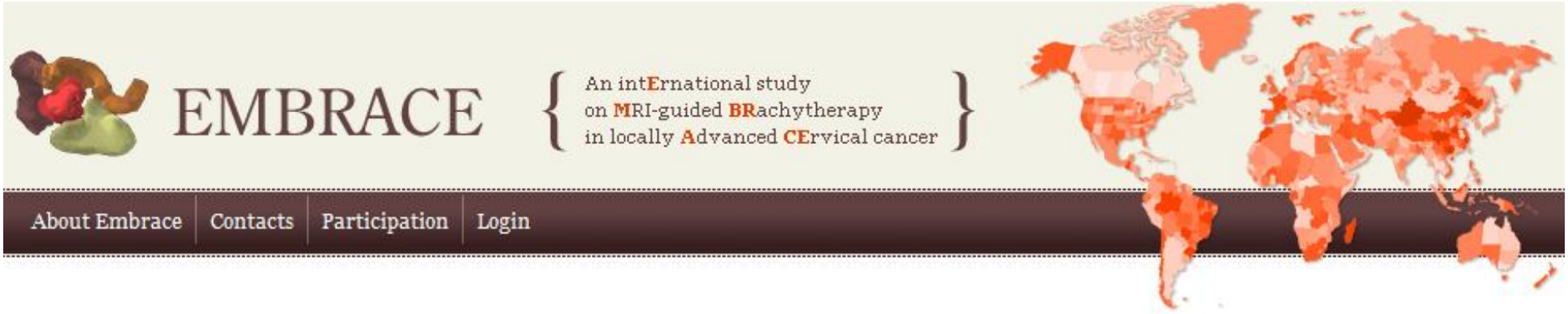
CTV_{HR} volume



CTV_{HR} dose



Tanderup et al R O 2015



- EMBRACE - International study on MRI-based 3D brachytherapy in locally advanced cervical cancer

- A prospective observational multi-centre trial

- Major endpoint: local control; multiple other endpoints
- multiple hypthese on dose volume effects

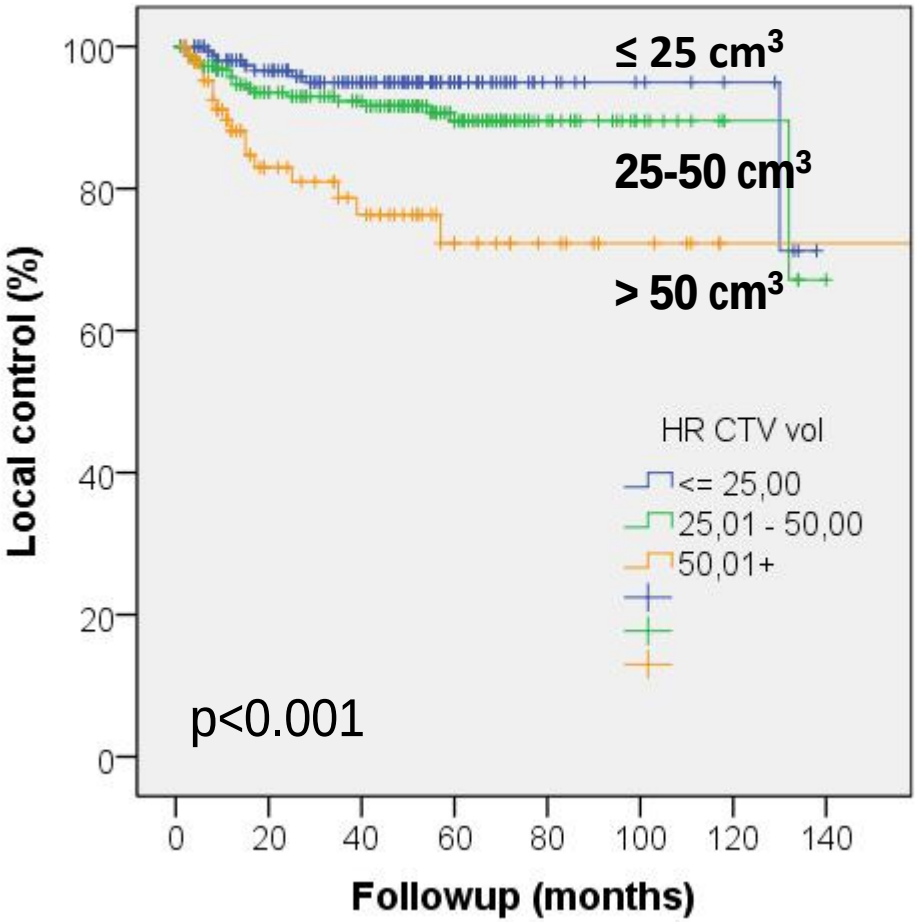
- Enrollment of patients 7/2008-12/2015, 1416 pts accrued

VARIAN medical systems | A partner for life

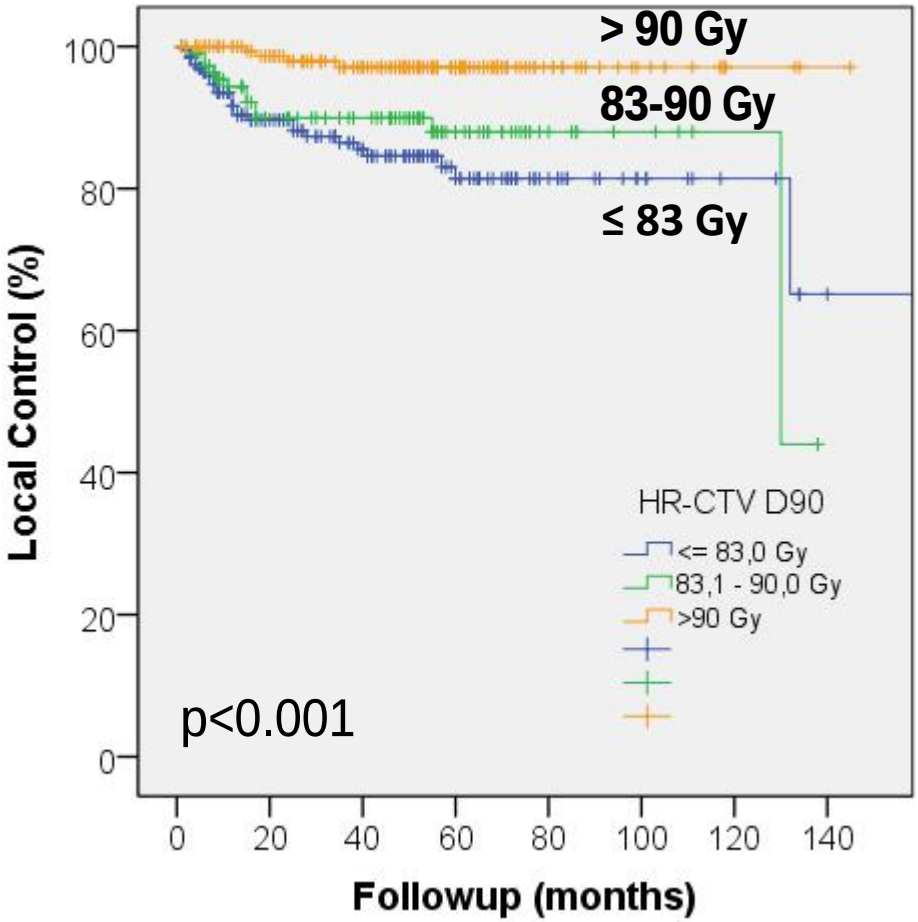
Nucletron Improving patient care

EMBRACE DATA: 931 Pts
Actuarial local control Rates

CTV_{HR} volume



CTV_{HR} dose



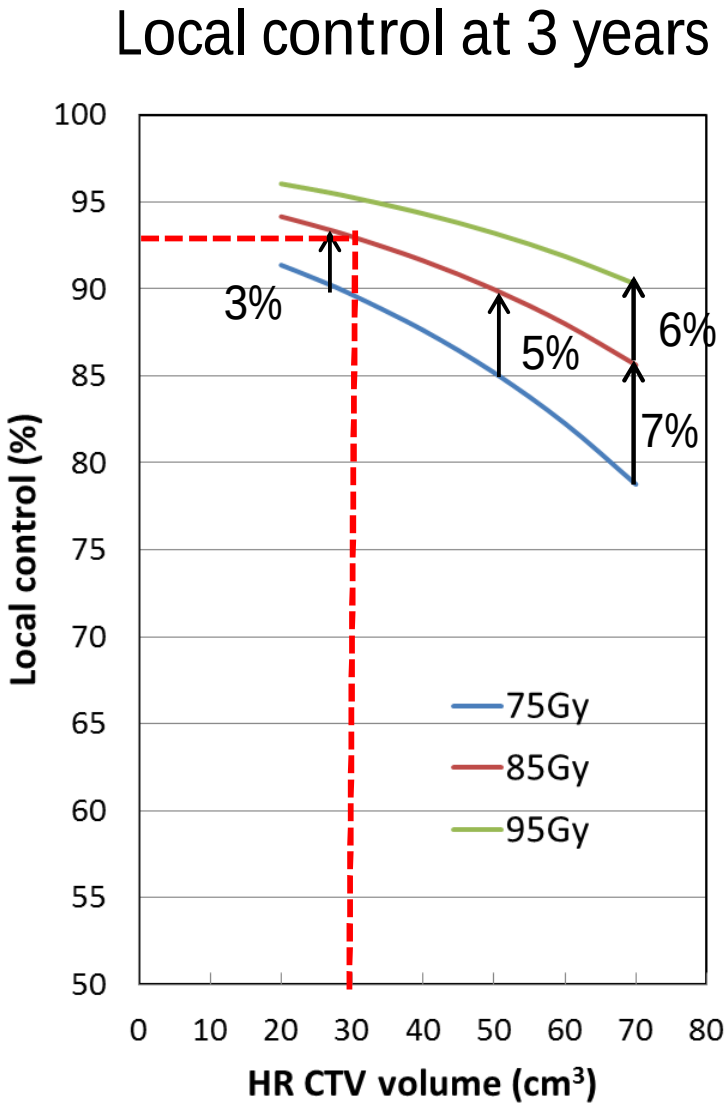
Tanderup et al 20

Dose, volume, and time effect

Effect of dose, volume and time:

Dose: **10Gy → 5% LC**
Time: **7 days ~ 5Gy**
Volume **10cm^3 ~ 5Gy**

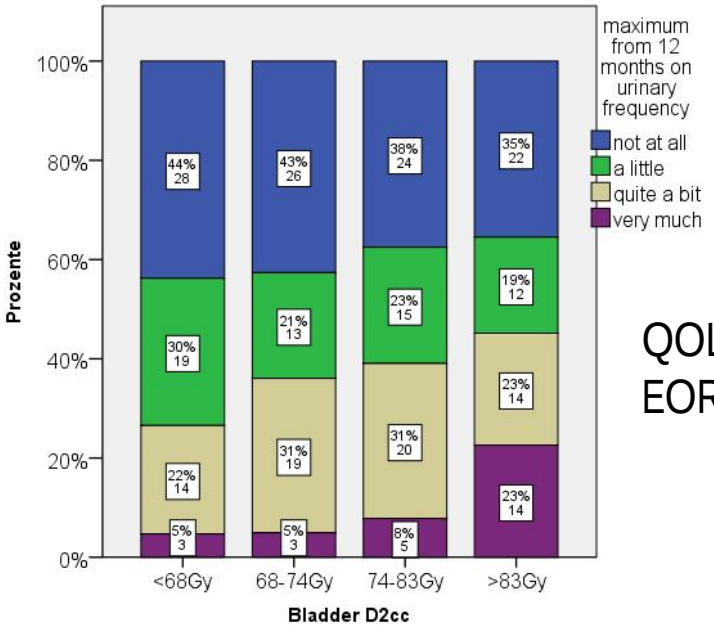
85Gy for 30cm^3 CTV$_{HR}$:
93% LC



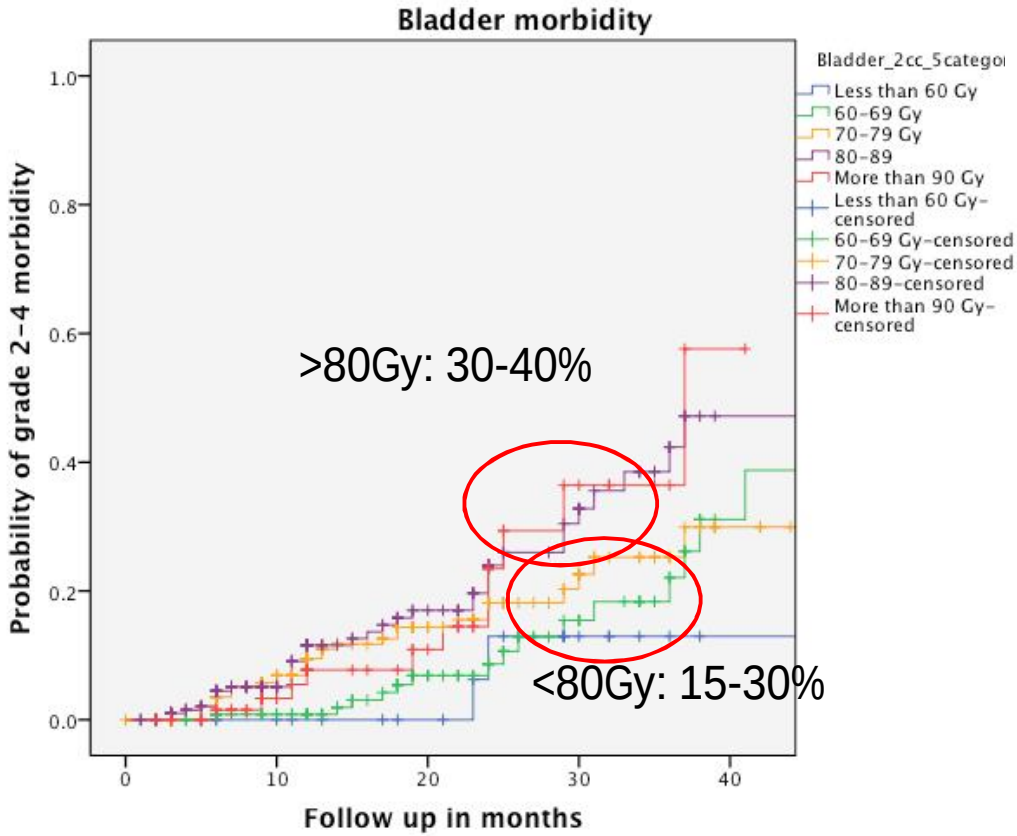
Tanderup et al, RO in press 2016

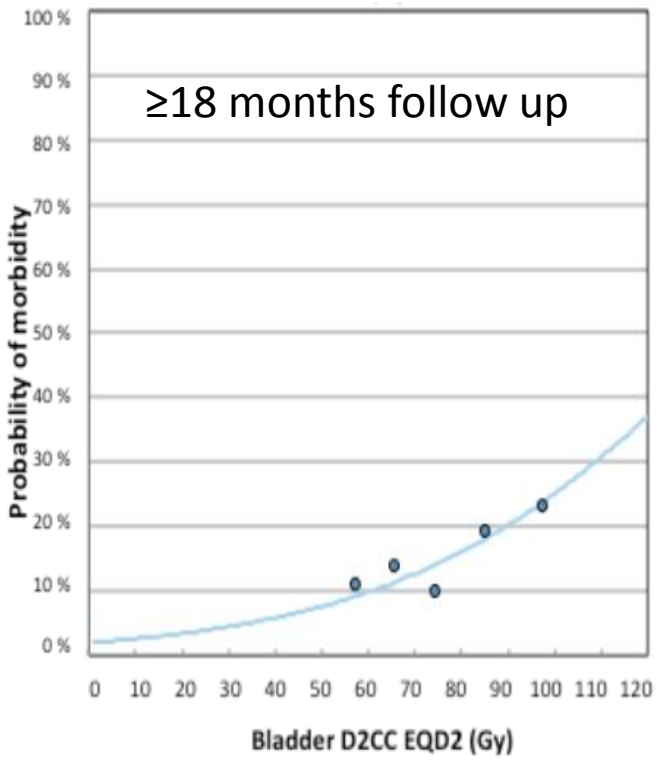
Bladder

- EMBRACE CTCAE
- All endpoints except ureter stenosis G≥2



QOL EORTC



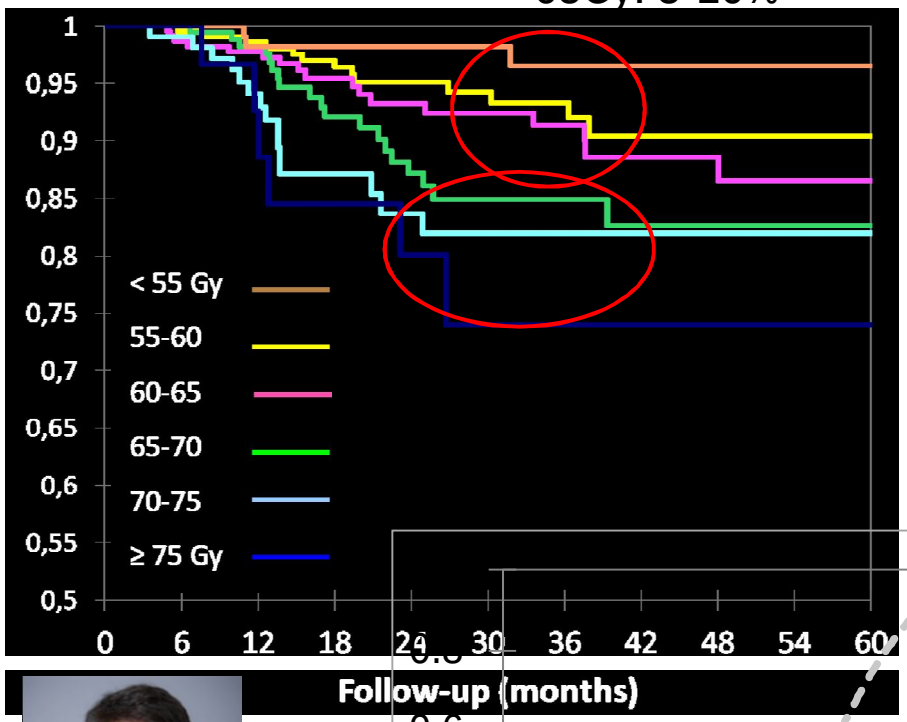


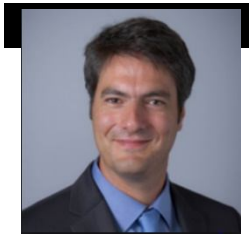
Fokdal et al 2015

Rectal dose volume effects ($2cm^3$)

≥G2 rectal morbidity
(EMBRACE cohort, n=960)

<65Gy: 5-10%





Mazeron et al.,
RadOnc 2016

≥G2 rectal morbidity (bleeding)
(Vienna cohort, n=145)

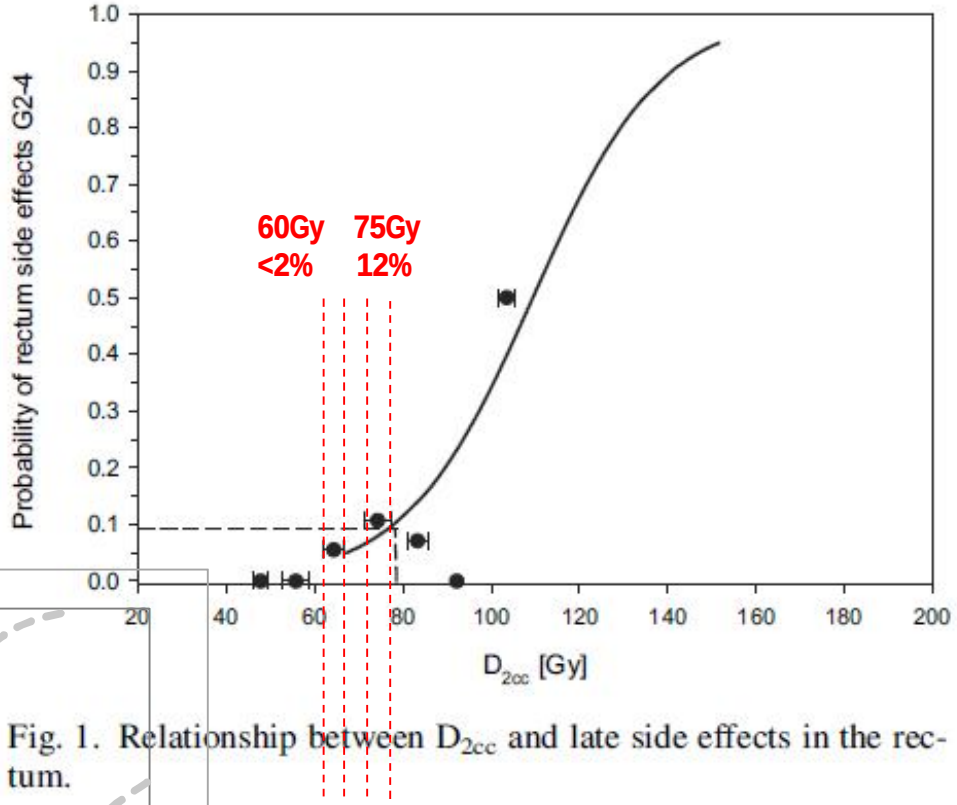
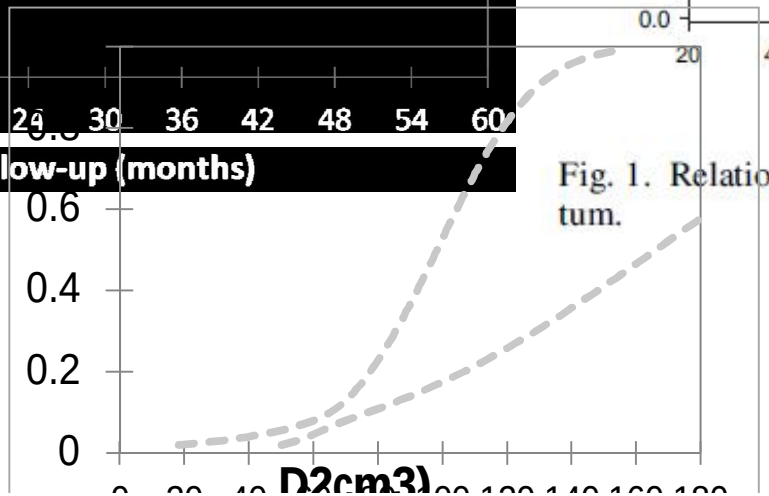
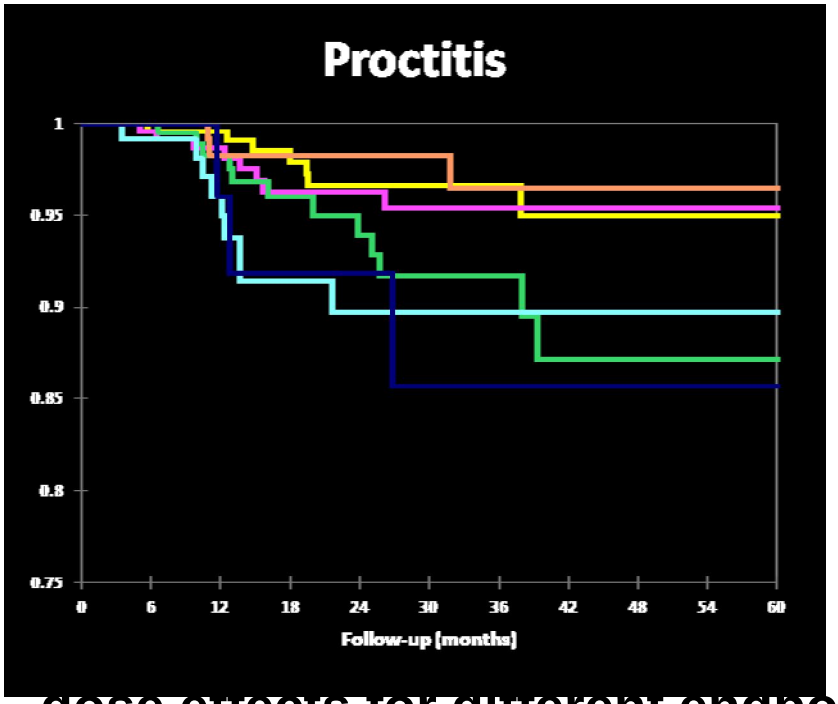
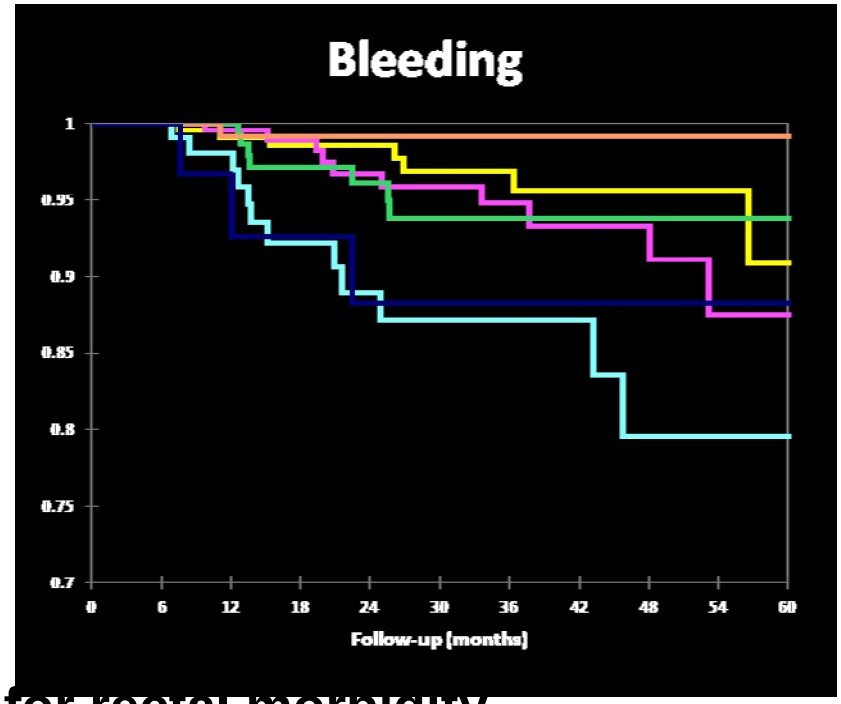


Fig. 1. Relationship between D_{2cc} and late side effects in the rectum.

P. Georg et al.,
IJROBP 2011

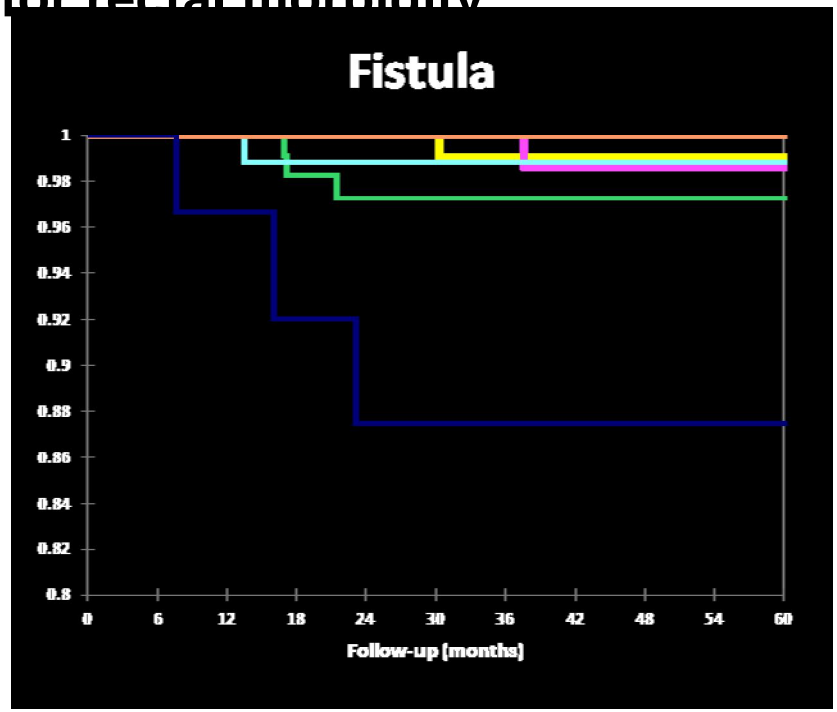






dose effects for different endpoints for rectal morbidity
EMBRACE (n=960)

< 55 Gy
55-60
60-65
65-70
70-75
≥ 75 Gy



Mazeron et al, RadiothOncol 2016

Retrospective and feasibility study : Dec 2006 - May 2008 (N = 24)

Conventional Treatment Planning

Prescription to Point 'A'

MR Protocol Standardization and Understand the Volume Concepts

Retrospective contouring and evaluation of DVH parameters

International Journal of Gynecological Cancer:
August 2011 - Volume 21 - Issue 6 - pp 1110-1116
doi: 10.1097/IGC.0b013e31821caa55
Radiation Therapy

Reporting and Validation of Gynaecological Groupe Euopeen de Curietherapie European Society for Therapeutic Radiology and Oncology (ESTRO) Brachytherapy Recommendations for MR Image-Based Dose Volume Parameters and Clinical Outcome With High Dose-Rate Brachytherapy in Cervical Cancers: A Single-Institution Initial Experience

Mahantshetty, Umesh MD, DNBR, DMRT*; Swamidas, Jamema MSc, DRP*; Khanna, Nehal MD*; Engineer, Reena DNBR*; Merchant, Nikhil H. MD†; Deshpande, Deepak D. DRP, PhD*; Shrivastava, Shyamkishore MD, DNBR*

	Vienna IC IJROBP2005	Vienna IC/IS IJROBP2005	Brabandere RO 2008	Lindegaard IJROBP2008	Chargari IJROBP 2008	TMH study IJGC 2011
HRCTV						
Vol in cc	34 +/- 17	44 +/- 27	48+/-19	34+/- 12	36.3 ± 35	**45.2 ± 15.8**
D100	66 +/- 7	70 +/- 6	64+/-6	76 +/- 7	61.66 ± 7	**53.9 ± 6.5**
D90	87 +/-10	96 +/- 12	79+/-7	91 +/- 10	74.85 ± 10	**70.3 ± 10.6**
Avg. Pt A	89 +/- 8	93 +/- 9	79+/-5	92 +/- 9	71.4 ± 6	**73.4 ± 4.5**
Bladder						
Vol in cc	--	--		--		**80.3 (20.3-235)**
ICRU Bmax	75 +/-16	73 +/- 19	74+/-15	67 +/- 31	63.7 ± 9	**80.4 ± 34.4**
D0.1cc						**136.0 ± 54.7**
D2cc						**91.4 ± 24.6**
Rectum						
Vol cc						**33.4 (11-64.6)**
ICRU Rmax						**63.5 ± 8.1**
D0.1cc						**67.2 ± 9.9**
D2cc						**57.9 ± 7.7**
Sigmoid						
Vol cc	--	--		--		**49.0 (14.5-97.5)**
D0.1cc	79 +/- 12	84 +/- 14	82+/-13	79 +/- 13	72.7 ± 18	**101.9 ± 45.2**
D2cc	63 +/- 7	67 +/- 7	68+/-7	69 +/- 9	60.6 ± 6	**74.4 ± 19.6**

LESSONS LEARNT

Retrospective Data: 24 patients

Tumor Volumes larger: Advanced Stages

Bladder and Sigmoid Doses Higher

Mahantshetty et al, IJGC Aug. 2011

CLINICAL OUTCOME

TMH Retrospective Data (Dec 2006 - May 2008) (N = 24)

Median Follow-up : 18 (12 - 40) months

	Stage			
	I B2 / IIA N=2	IIB N=10	IIIB N=12	Total N=24
Local	--	2*	1#	3
Pelvic Node	--	--	1	1
Dist. metastasis	--		1	1
Total	--	2	3	5

*** Point A: 79 Gy and HR-CTV D90 doses : 56.5, 67 Gy;**

 # Point A: 70 Gy and HR-CTV D90 doses : 65Gy;

Late sequelae: 1 pt with protco-sigmoiditis

(0.1 and 2cc : R 46 & 64; S: 260 & 140 Gy)

Mahantshetty et al, Clin. Oncol. 2011 ; IJGC Aug. 2011

TMH - AKH Vienna Collaboration: 2008 – 2009

Bilateral Exchange Program

Tata Memorial Hospital Participation in International Multicentric Studies

- Refine treatment standards

- GYN GEC-ESTRO Research Network

A European study on MRI-guided brachytherapy
in locally advanced cervical cancer

EMBRACE

(ENDORSED BY GEC ESTRO)

2009 ONWARDS

TATA HOSPITAL CONTRIBUTION TO EMBRACE

100 patients (IIB-IVA)

TMH EMBRACE Data
Prospective MR Based Brachytherapy (N = 94 patients)
Dec 2009 – March 2014

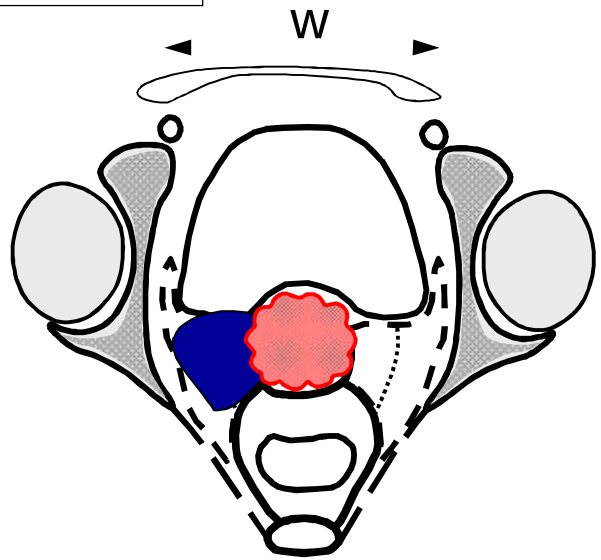
Total no of patients	**94 patients**
Median Age (range)	**49(42 - 65) years**
Histology	
Squamous Carcinoma	**81**
Adenocarcinoma	**09**
AdenoSquamous	**04**
FIGO Stage (n)	**94**
IIB	**31**
IIIB	**55**
IVA (Bladder mucosa invasion)	**08**
Intracavitary Brachytherapy (HDR)	**4 fractions of 7 Gy to HRCTV**
Median follow-Up (IQR)	**39 (26-50) months**

w = 60 mm
h = 50 mm
t = 50 mm

Vagina Involvement = 4 cm (Post)

A Clinical Example

At Diagnosis



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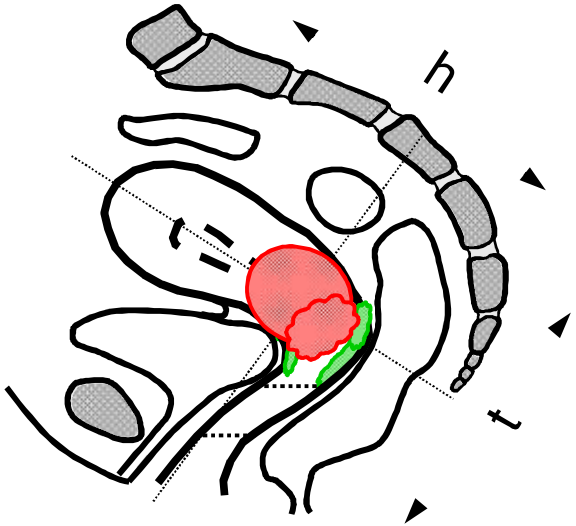
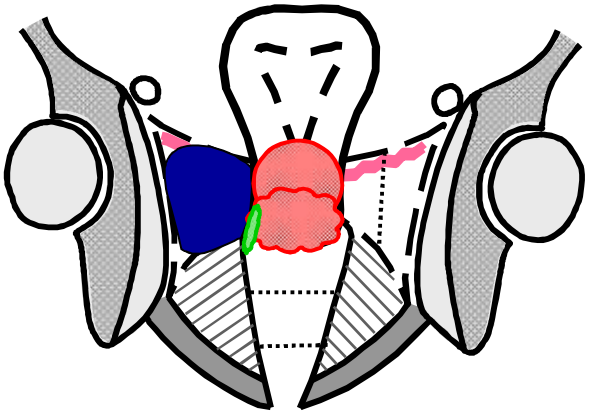


Sag



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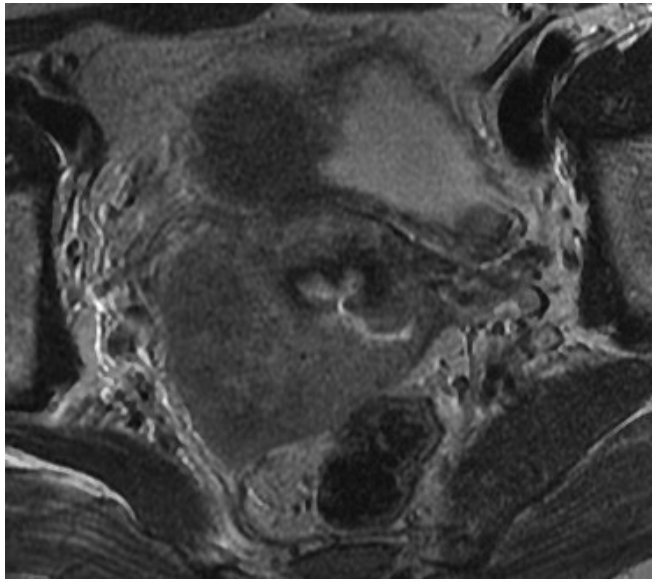
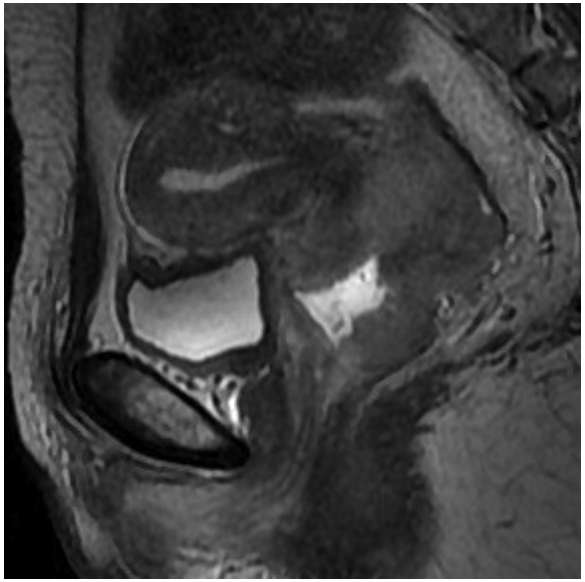
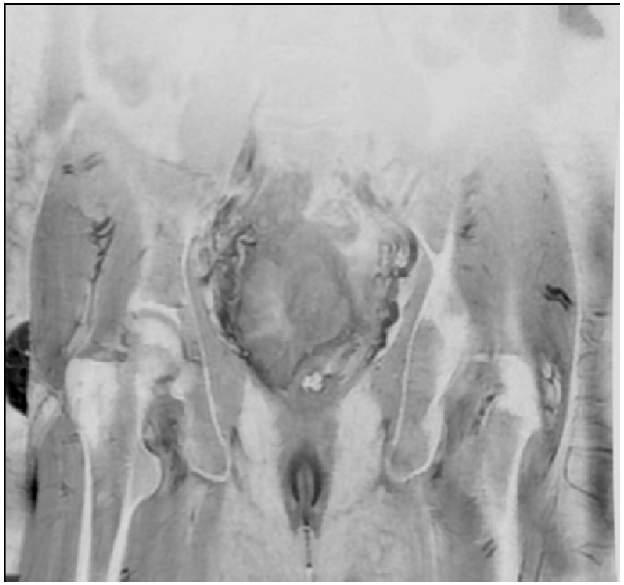




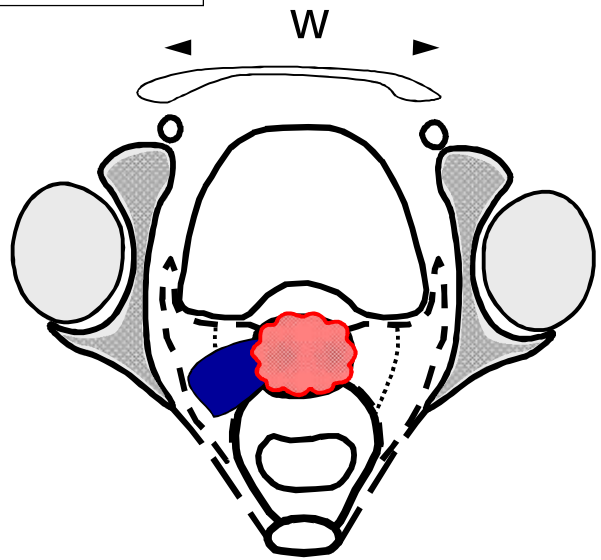


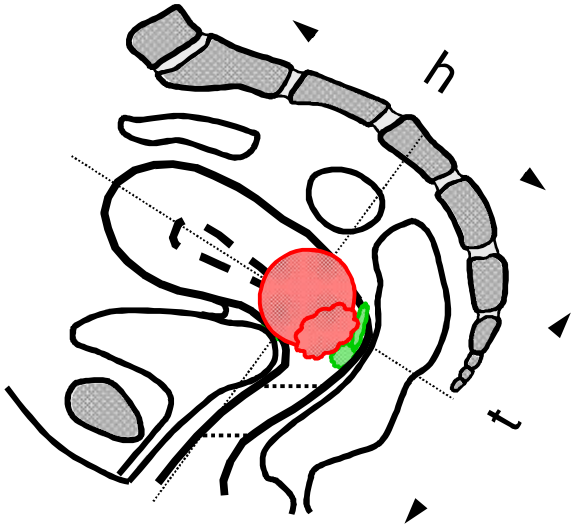
w = 60_ mm
h = 40_mm
t = 30_ mm

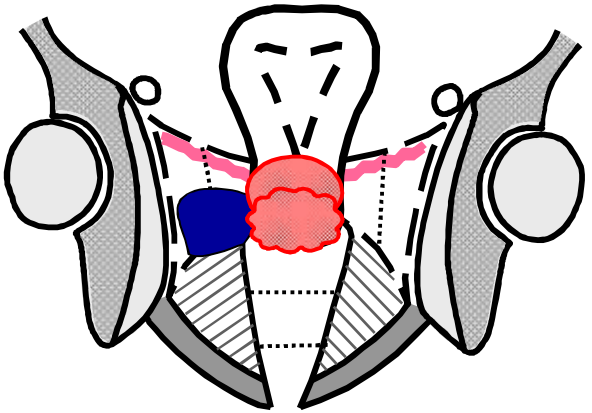
Vagina Involvement
= 20mm (Post)

Clinical Drawing

At Brachytherapy



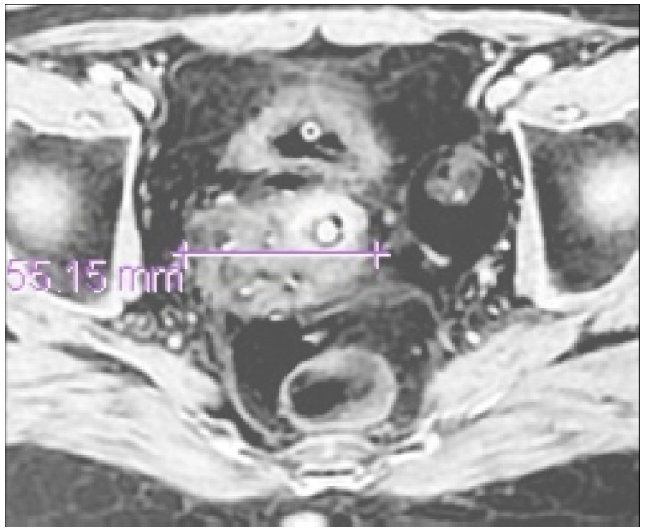


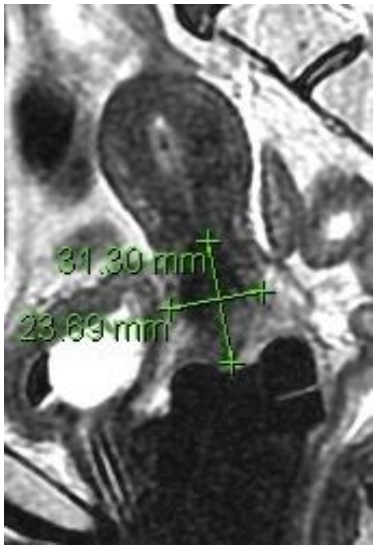


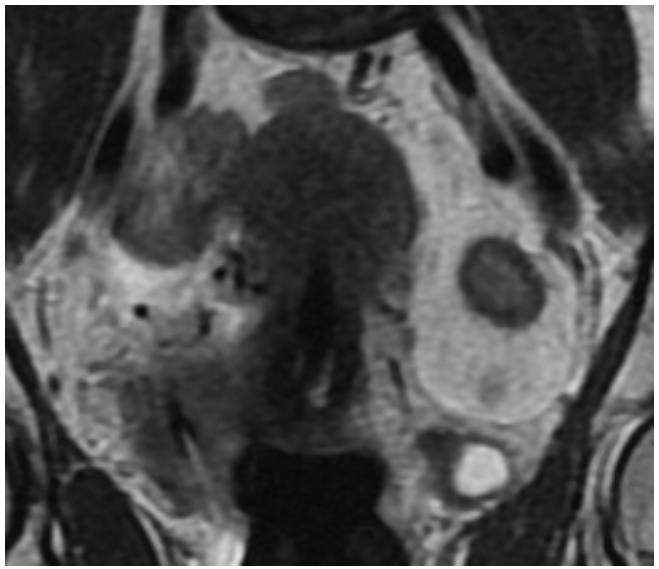
Axial

Sag

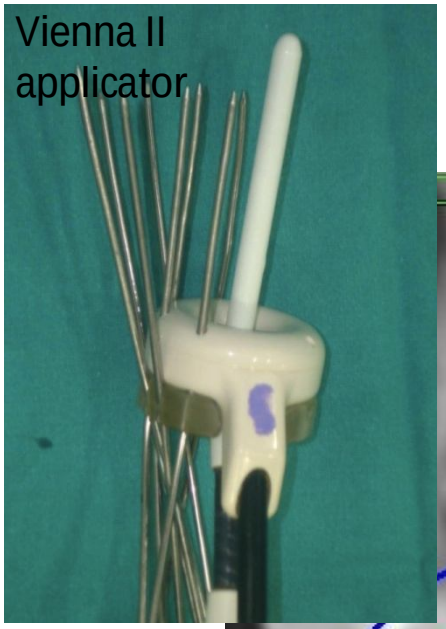
Coronal

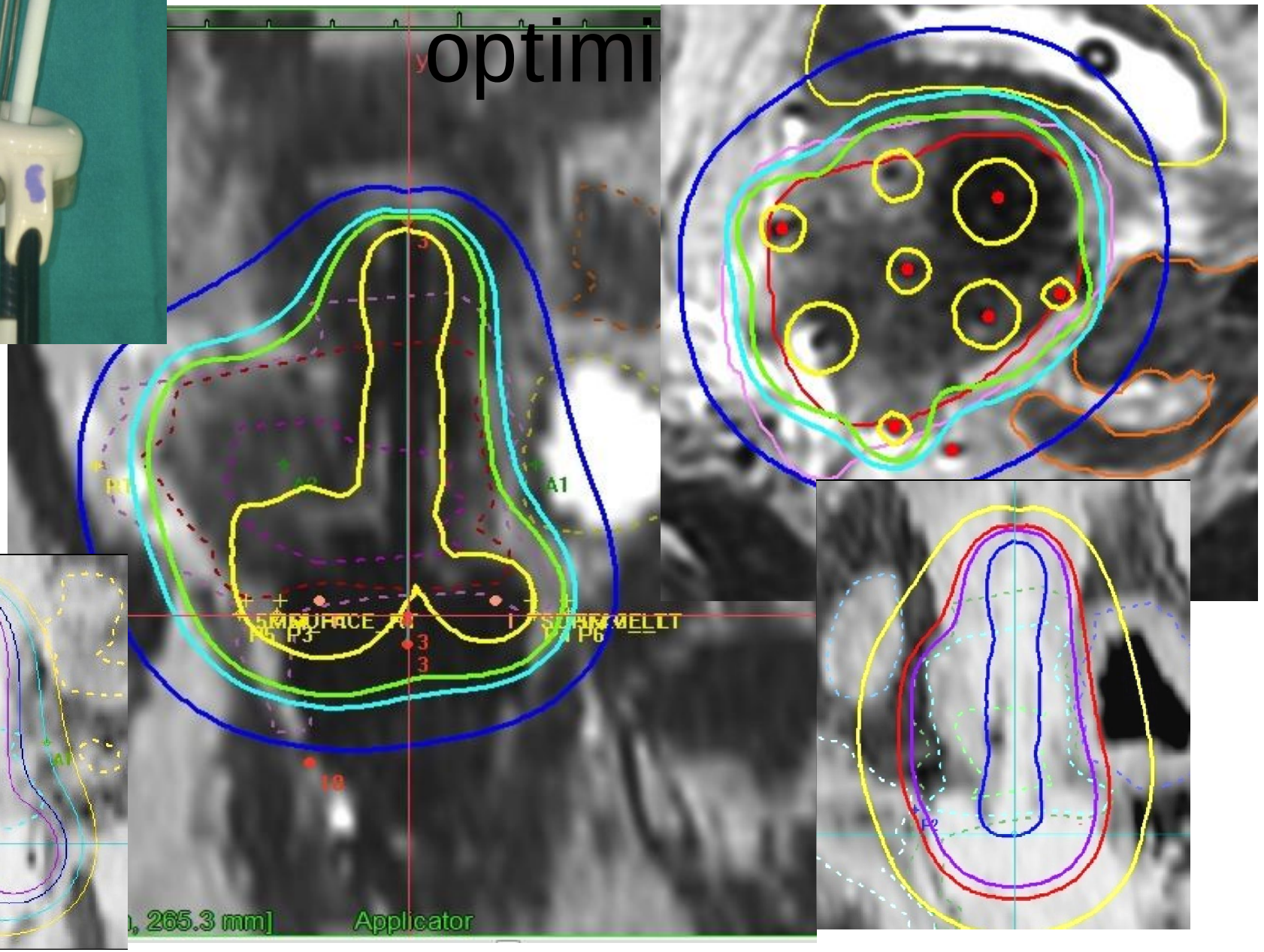






Treatment planning / optimi





	Dosimetric comparison for 1 #			Cumulative RT Doses (4# of BT)	
DVH Parameters	**Ring STD ICA Only**	**Vienna with one set of needles**	**Vienna with additional needles**	**Planning aim**	**Prescribed dose**
HRCTV D90 (Gy)	4.38	6.2	8.3	≥ 85 Gy	96.2 Gy
HRCTV D98 (Gy)	3.45	4.5	7.0		
SIGMOID 2 CC	4.6	4.5	4.1	≤ 70 Gy	67.4 Gy
SIGMOID 0.1 CC	6.1	5.8	5.2		
BLADDER 2 CC	7.9	6.5	5.5	≤ 90 Gy	82.9 Gy
BLADDER 0.1 CC	10.2	8.5	6.5		
RECTUM 2 CC	3.9	3.8	4.2	≤ 70 Gy	68.3 Gy
RECTUM 0.1 CC	5.4	5.3	5.6		

Post Rx 3months follow-up

Clinico - MR Complete Response

with RT para fibrosis

Post Rx 12 months follow-up

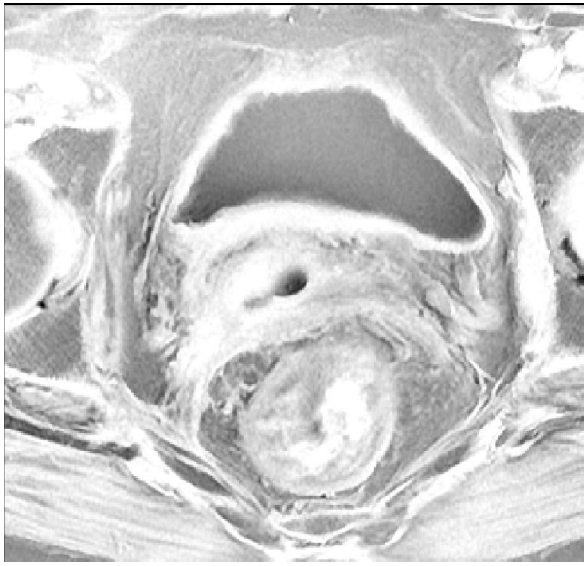
Clinico - MR Controlled

with RT para fibrosis

Post Rx 4 years follow-up

Clinico – radiologically Controlled

with RT para fibrosis



DOSIMETRIC COMPARISON: Retrospective Vs Prospective Data Vs Literature

	Vienna (IC)	VIE (IC/IS)	Brabandere	TMH: RD (24 pts)	TMH: Embrace data (94 pts)
HRCTV					
Vol in cc	34 +/- 17	44 +/- 27	48+/-19	45.2 ± 15.8	46.9+24.6
D100	66 +/- 7	70 +/- 6	64+/-6	54.1 ± 6.5	65.7±4.6
D90	87 +/-10	96 +/- 12	79+/-7	70.9 ± 10.6	88.3+4.4
Avg. Pt A	82 +/- 9	--	79+/-5	73.4 ± 4.5	93.1 ±24.8
I				34.4	76.4 ±15.5
				± 54.7	109.6 ±19.7
				± 24.6	85.7+9.8
I				± 8.1	68 ±7.9
				9.9	71.5 ±7.5
				± 7.7	65.5+7.2
Sigmoid					
D0.1cc	79 +/- 12	85 +/- 14	82+/-13	109.4 ± 45.2	74 ±8.6
D2cc	63 +/- 7	67 +/- 7	68+/-7	74.6 ± 19.6	67+8.8

LESSONS LEARNT

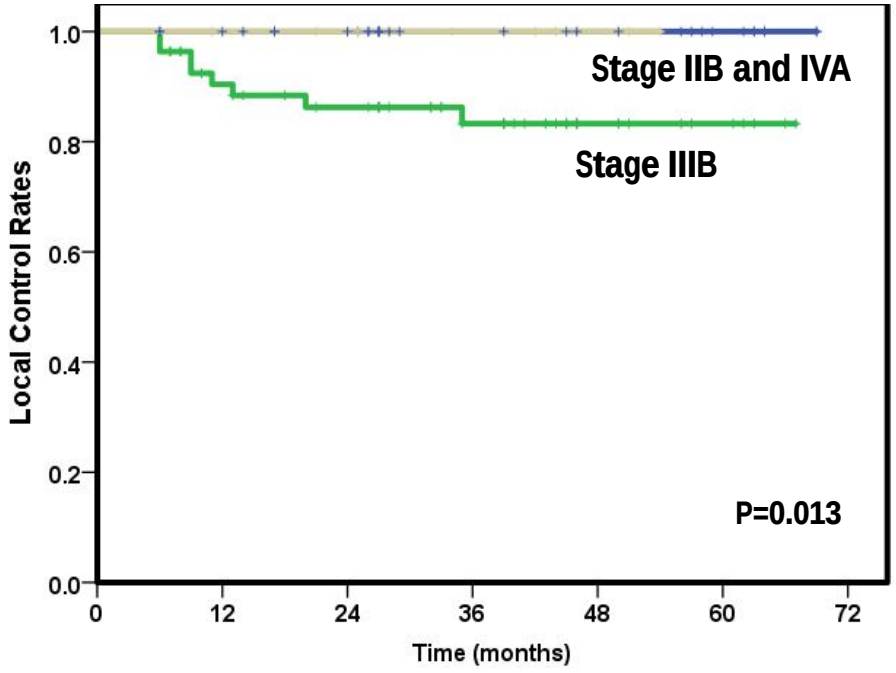
Prospective Data: 94 patients

HR-CTV Volumes larger: Advanced Stages

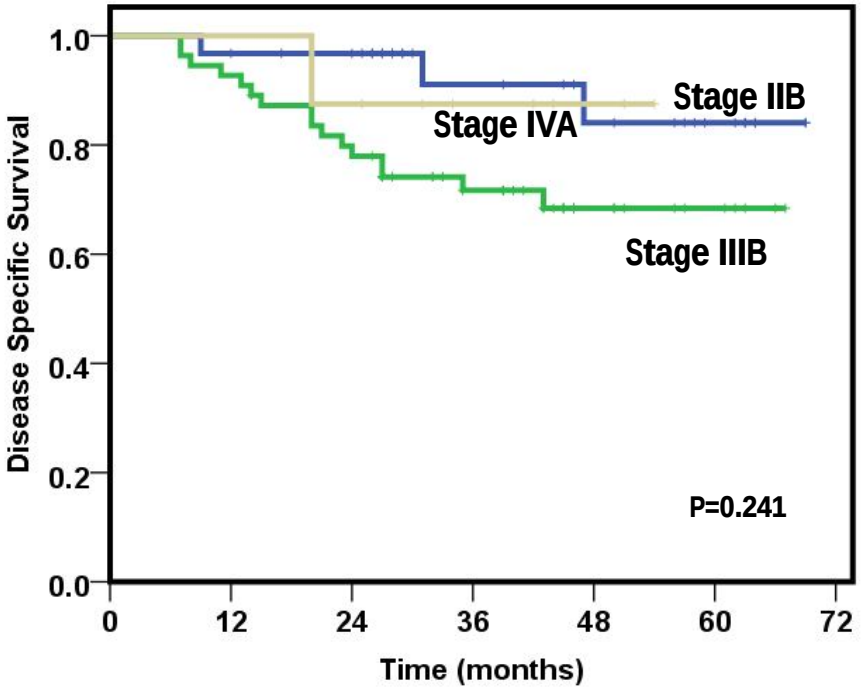
Higher doses to HR-CTV

Bladder and Sigmoid Doses Better

MR IMAGE BASED BRACHYTHERAPY
EMBRACE STUDY : 1400 PATIENTS
TMH ACCRUAL: 94 PATIENTS



IIB	31	28	24	15	12	07	01
IIIB	55	45	39	27	10	05	01
IVA	08	07	06	04	02	00	00

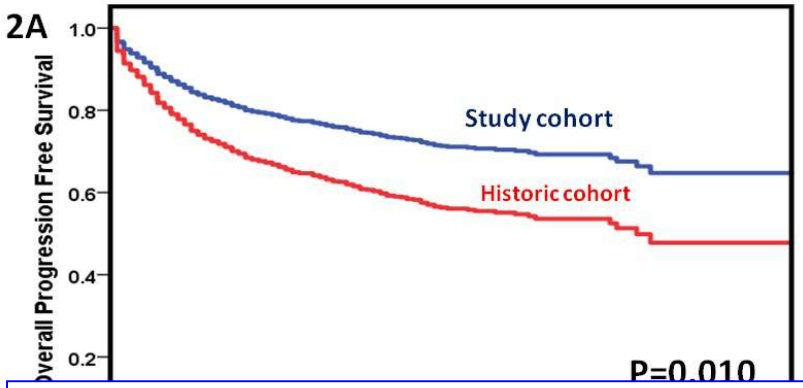


IIB	31	29	26	16	12	07	01
IIIB	55	51	43	28	10	05	01
IVA	08	08	07	04	02	00	00

EXCELLENT LOCAL CONTROL RATES FOR ALL STAGES

Mahantshetty et al, IJROBP 2017

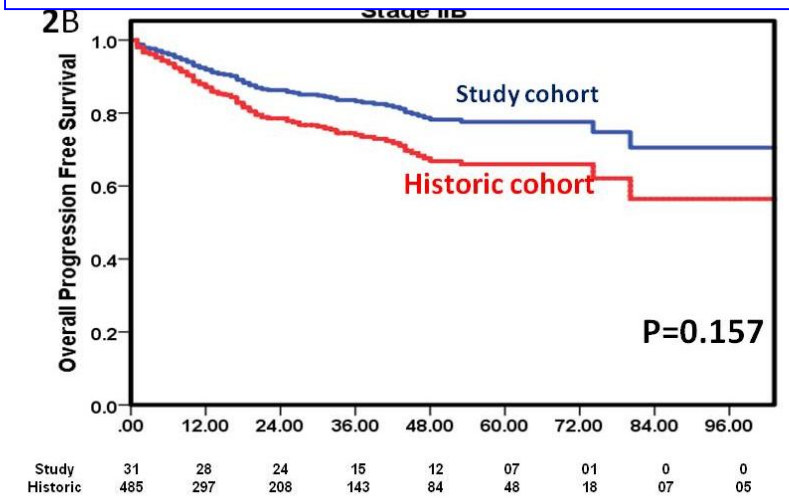
COMAPRISON OF HISTORICAL CONTROLS Vs MR BT EXPERIENCE: TMH



HISTORIC COHORT B: CONVENTIONAL BT SERIES (1979-94)

STUDY COHORT : MR IGABT APPROACH

MR IMAGE BASED BRACHYTHERAPY BENEFICIAL
LOGISTICS : Availability, Cost & Implementation Issues



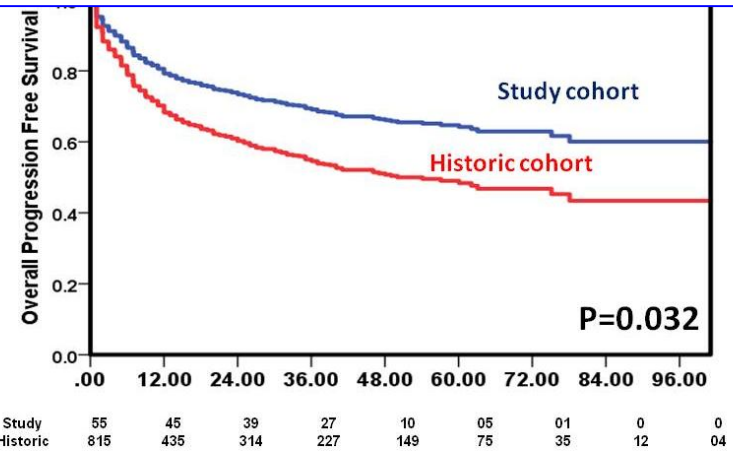


Figure 2: Comparison of overall progression free survival using log rank test for study cohort and historic cohort [21] for, all patients (A), stage IIB (B), and stage IIIB (C).

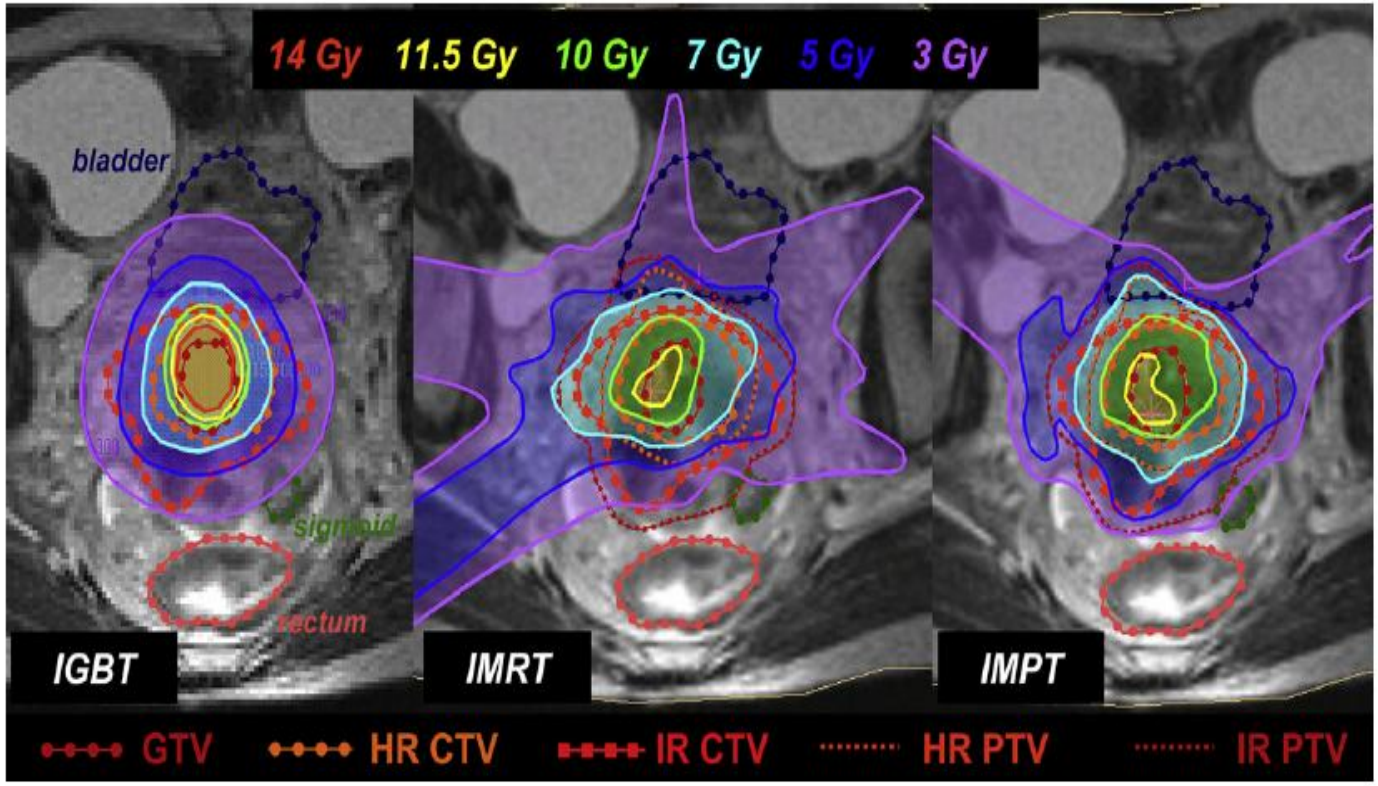
Mahantshetty et al, IJROBP 2017

IMAGE-GUIDED RADIOTHERAPY FOR CERVIX CANCER: HIGH-TECH EXTERNAL BEAM THERAPY VERSUS HIGH-TECH BRACHYTHERAPY

DIETMAR GEORG, PH.D., CHRISTIAN KIRISITS, PH.D., MARTIN HILLBRAND, M.SC., JOHANNES DIMOPOULOS, M.D., AND RICHARD PÖTTER, M.D., PH.D.

Department of Radiotherapy, Medical University Vienna, Vienna, Austria

Int. J. Radiation Oncology Biol. Phys., Vol. 71, No. 4, pp. 1272–1278, 2008



Conclusion: For benchmarking high-tech EBT, high-tech BT techniques have to be used. For cervix cancer boost treatments, both IMRT and IMPT seem to be inferior to advanced BT.

EVIDENCE

Can High Tech XRT replace BT?

High Tech XRT

Vs

BT (Conventional)

Clinical Investigation

National Cancer Data Base Analysis of Radiation Therapy Consolidation Modality for Cervical Cancer: The Impact of New Technological Advancements

Beant S. Gill, MD,* Jeff F. Lin, MD,† Thomas C. Krivak, MD,‡ Paniti Sukumvanich, MD,† Robin A. Laskey, MD,† Malcolm S. Ross, MD,† Jamie L. Lesnock, MD,† and Sushil Beriwal, MD*

*Departments of *Radiation Oncology and †Gynecologic Oncology, Magee-Womens Hospital of University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania; and ‡Department of Gynecologic Oncology, Western Pennsylvania Hospital, Pittsburgh, Pennsylvania*

Int J Radiation Oncol Biol Phys, Vol. 90, No. 5, pp. 1083–1090, 2014

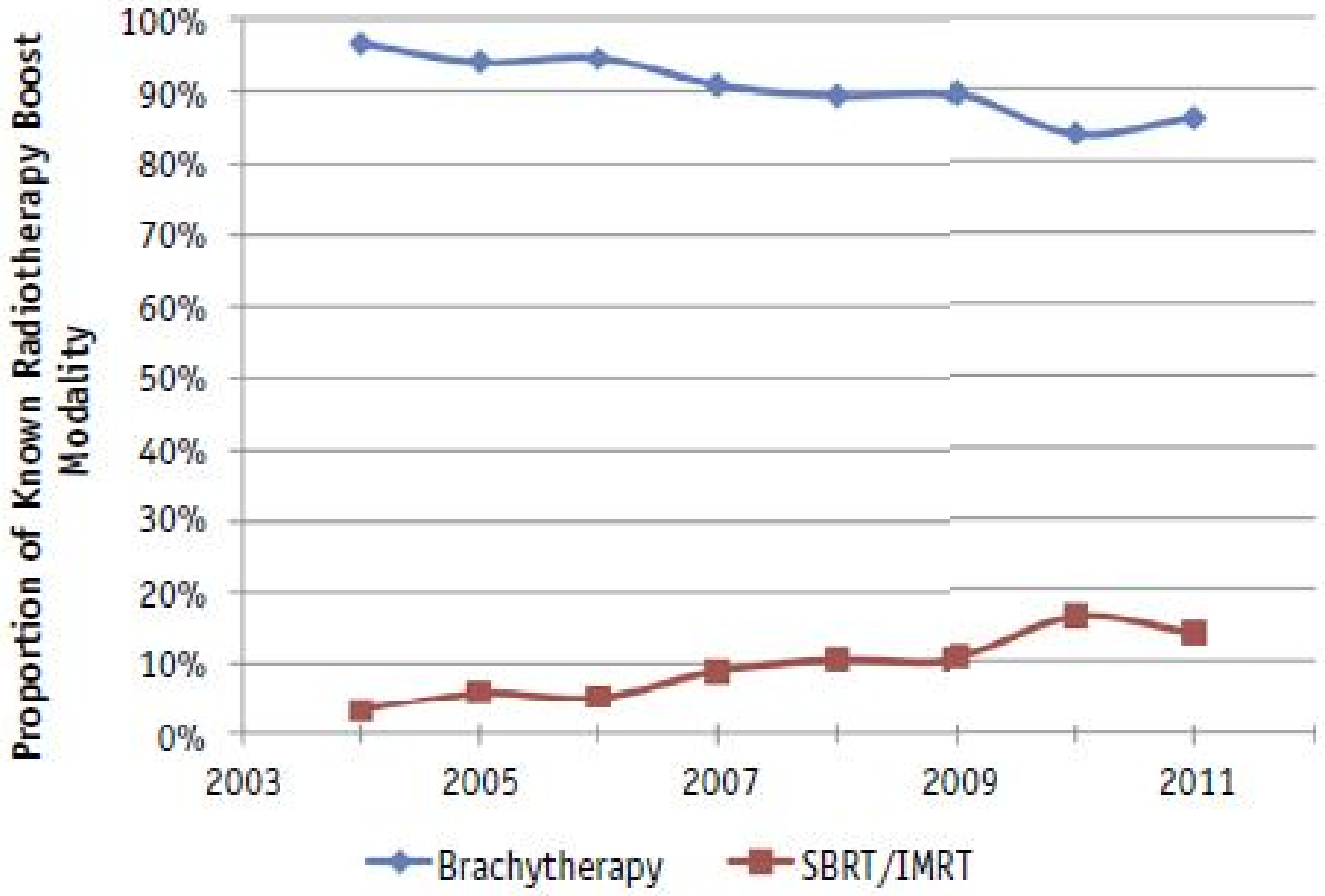


Fig. 1. Changes in radiation therapy boost modality utilization over time from 2004 to 2011. IMRT = intensity modulated radiation therapy; SBRT = stereotactic body radiation therapy.

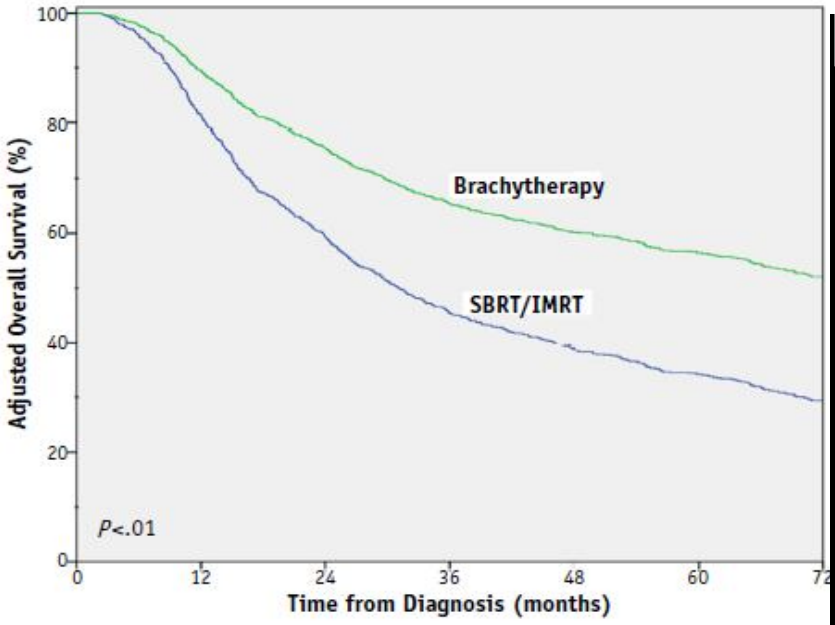
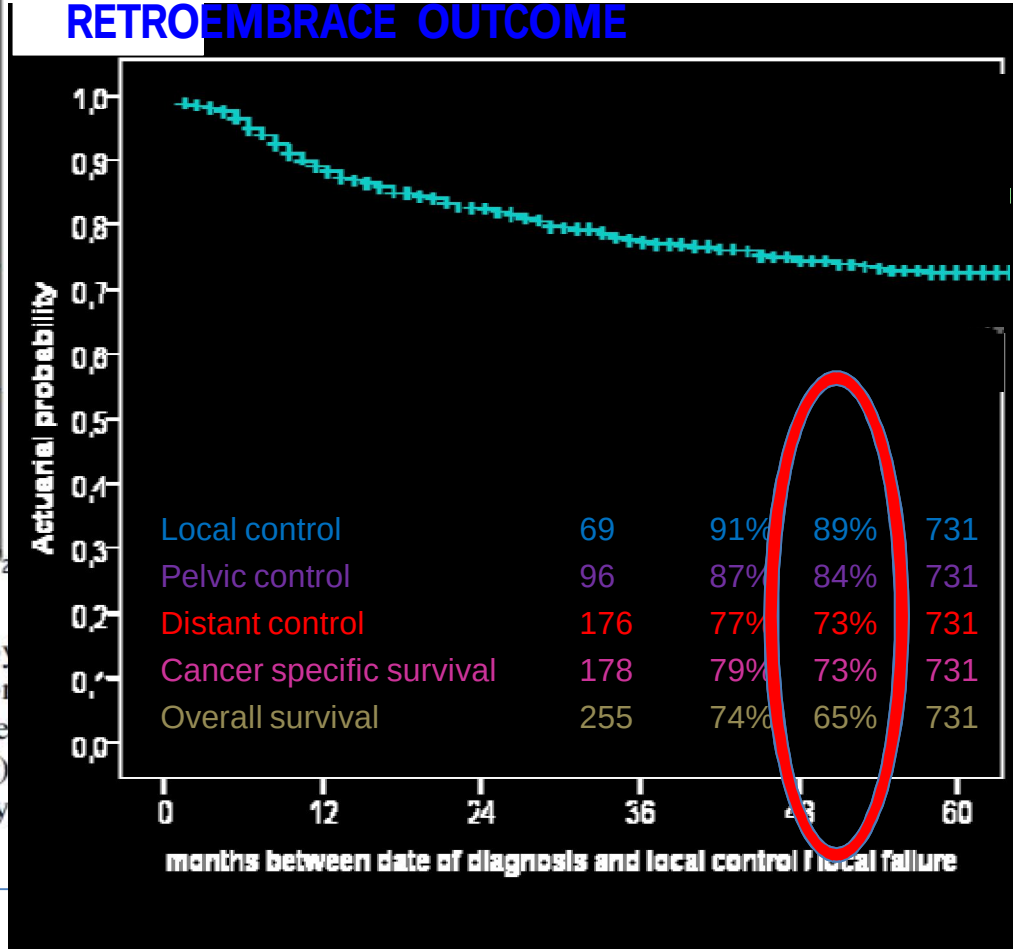


Fig. 3. Adjusted overall survival estimate, stratified by boost modality and corrected for significant variables or multivariable Cox proportional hazard model analysis (age Charlson/Deyo score, stage, and chemotherapy utilization) IMRT = intensity modulated radiation therapy SBRT = stereotactic body radiation therapy.

RETROEMBRACE OUTCOME



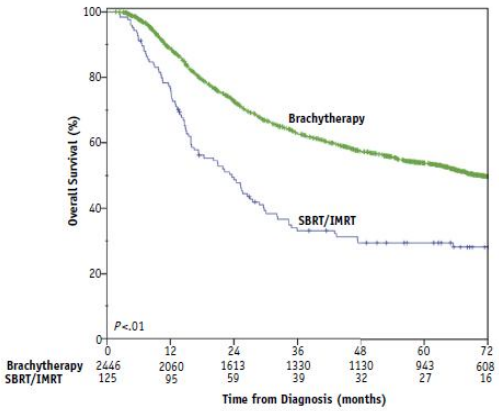


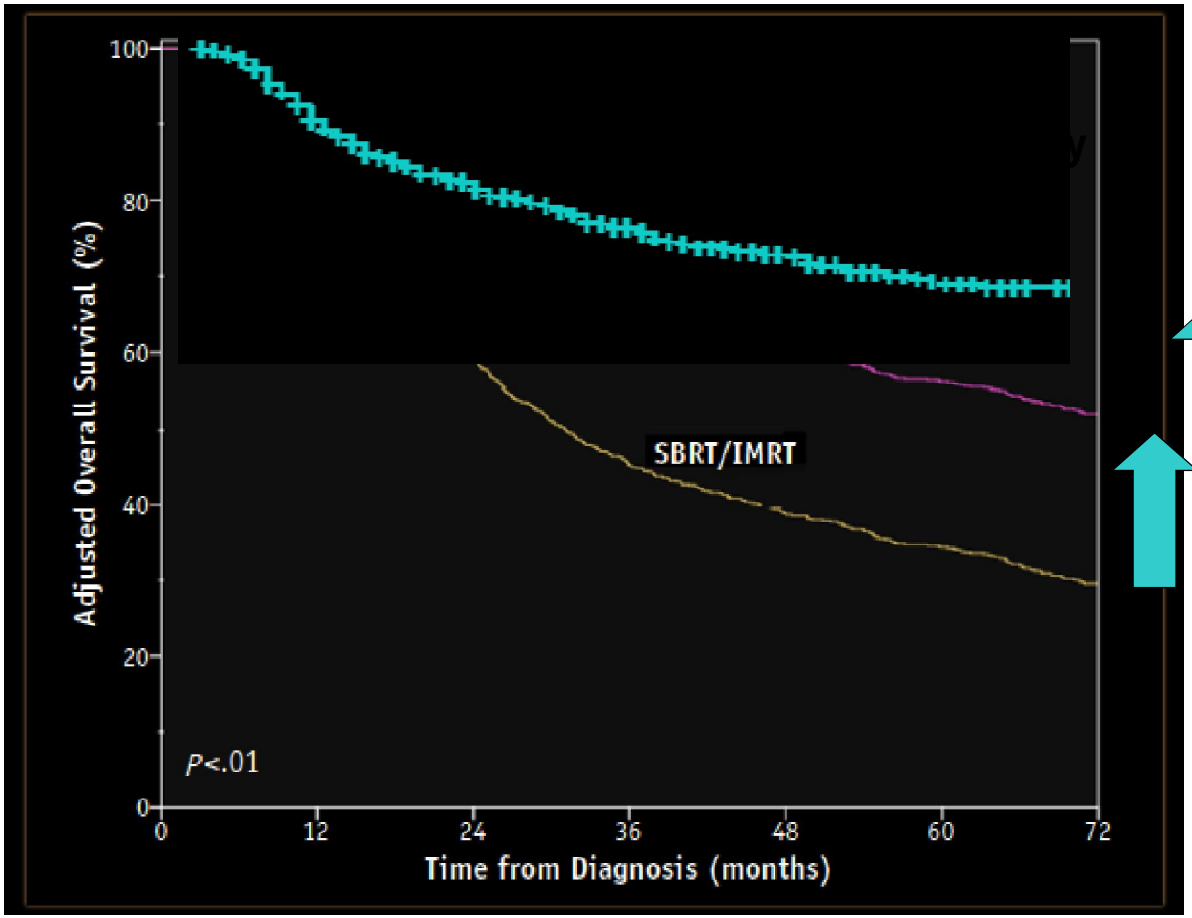
Fig. 2. Kaplan-Meier overall survival estimate stratified by boost modality. IMRT = intensity modulated radiation therapy; SBRT = stereotactic body radiation therapy.

Overall Survival locally advanced cervical cancer

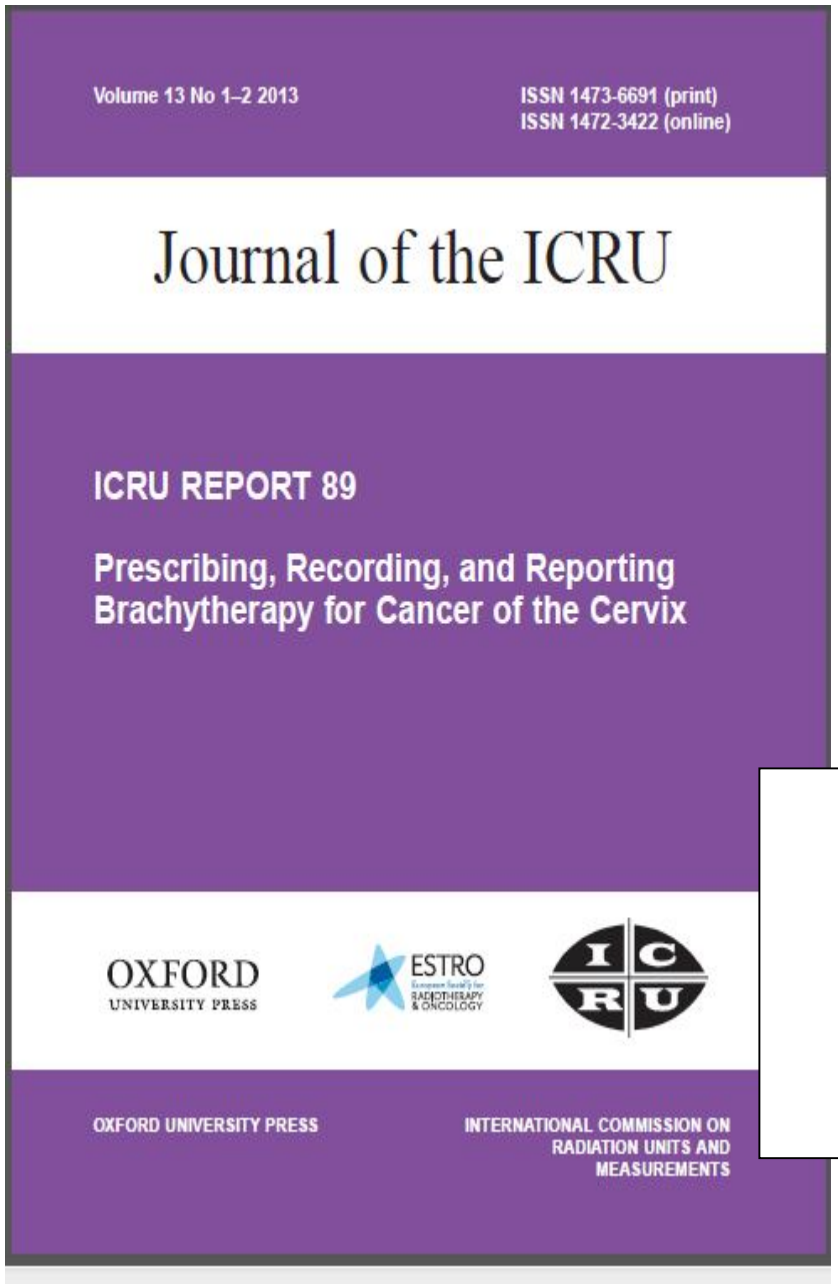
SBRT/IMRT boost vs. 2D BT vs. 4D IGABT

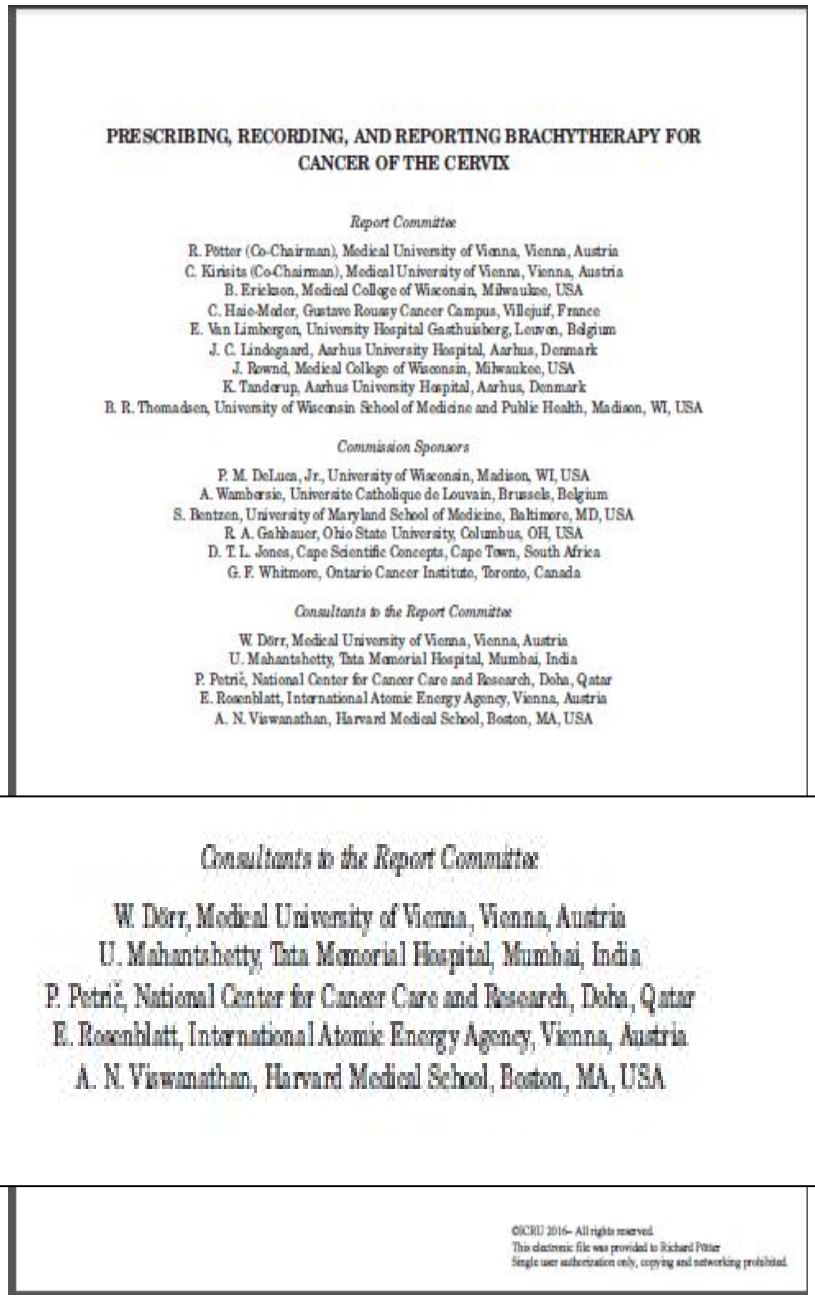
total
25% Increase in
Overall Survival

4D IGABT
Versus
SBRT/IMRT



Gill B et al. Int J Radiat Oncol Biol Phys 2014;90:1083
Sturdza et al. Improved local control and survival in LACC through Image guided adaptive brachytherapy, submitted





PRESCRIBING, RECORDING, AND REPORTING BRACHYTHERAPY FOR CANCER OF THE CERVIX

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Published in June 2016

ICRU report 89 (258 pages)

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

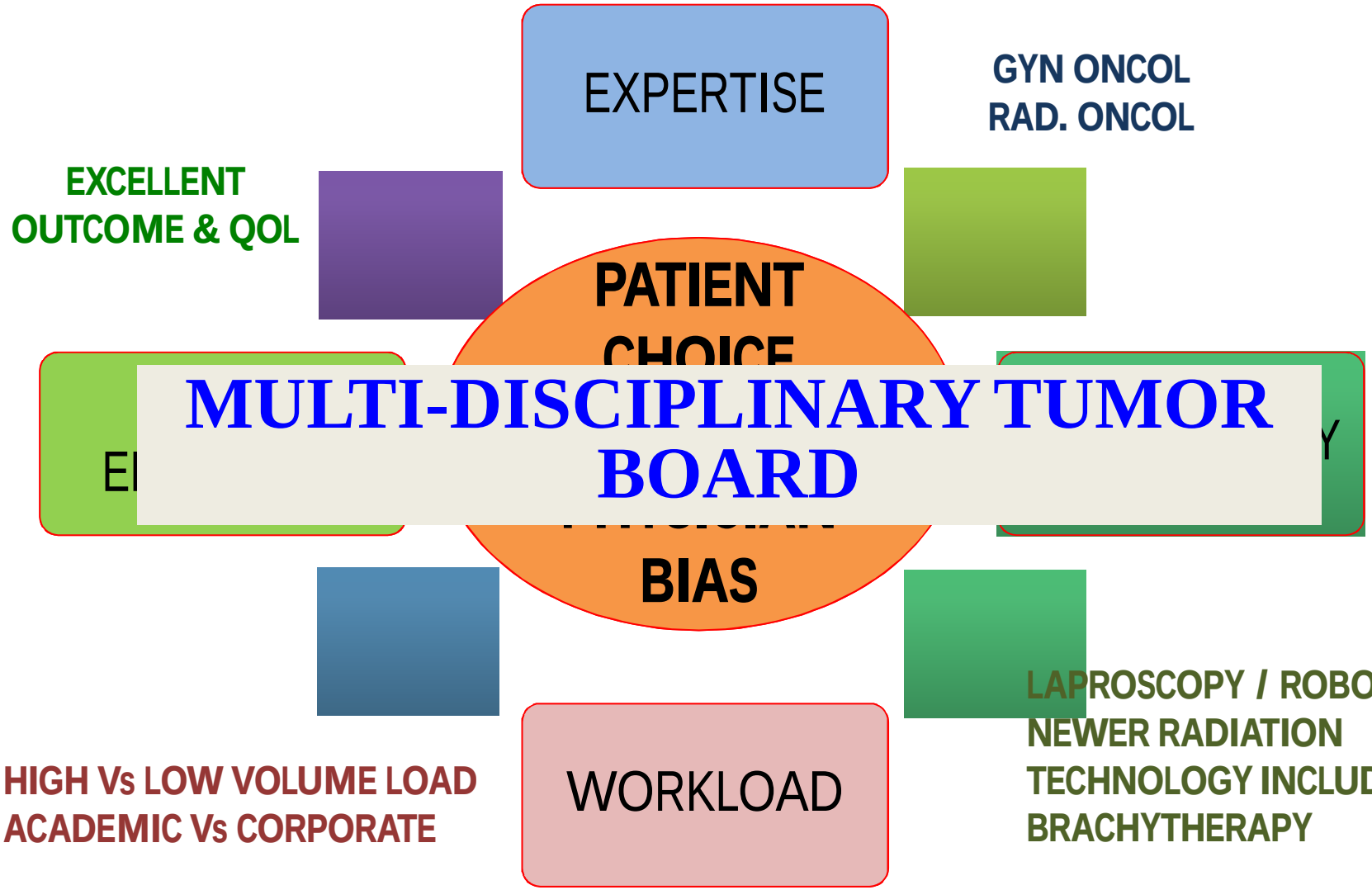
Sections 1-12
Summary (end of each section)
Key messages (1-4, 9, 12)
Recommendations (5-8,10-11)

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)

Message : 1

TREATMENT DECISION



At Diagnosis ☐

Message : 2

Clinical Examination & Drawings Documentation

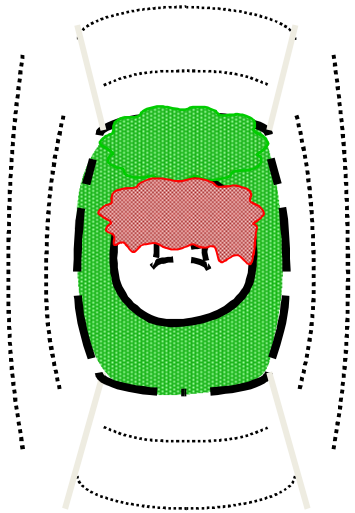
At Brachytherapy [X]

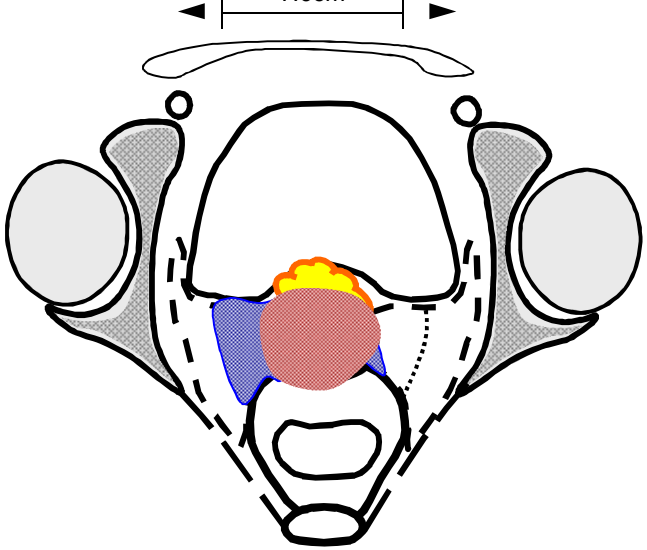
Dose of EBRT 45 Gy

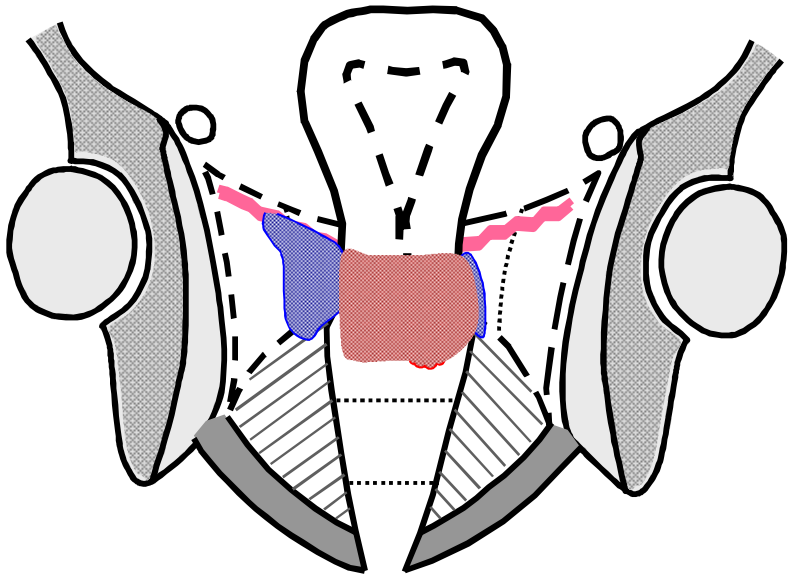
IVA - Bladder

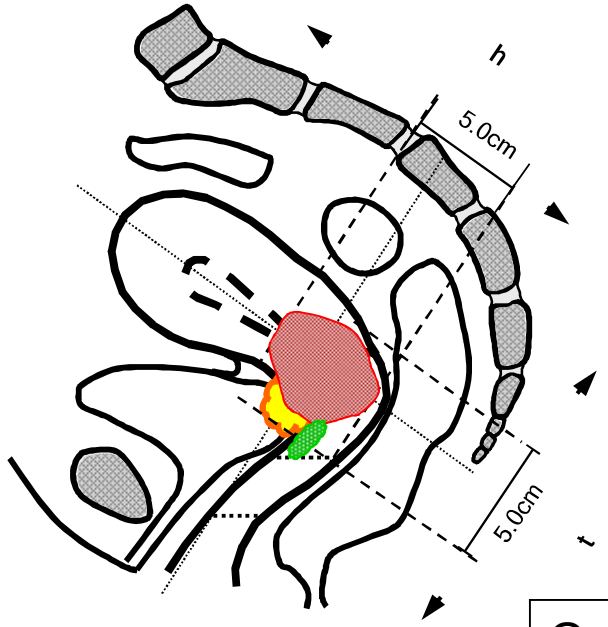
w = 7.0 cm
h = 5.0 cm
t = 5.0 cm

Vagina: 2.5 cm







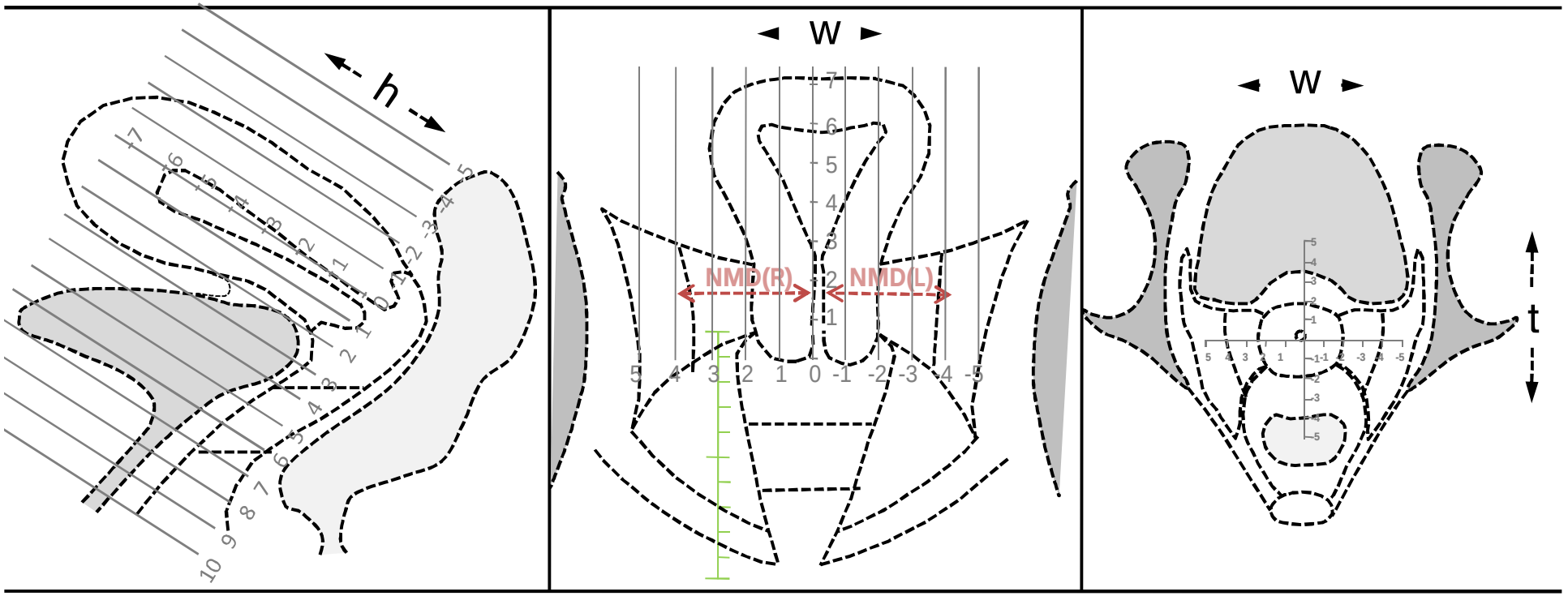


dd/mm/yy
__/__/__

Signature

Case V

At Diagnosis □ / **At Brachytherapy** □
[Brachytherapy fraction no. __]

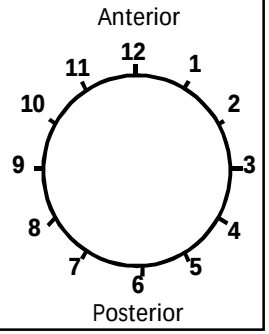


h = ____ cm **t = ____ cm** **w = ____ cm** **NMD (R) =____cm** **NMD (L) =____cm**

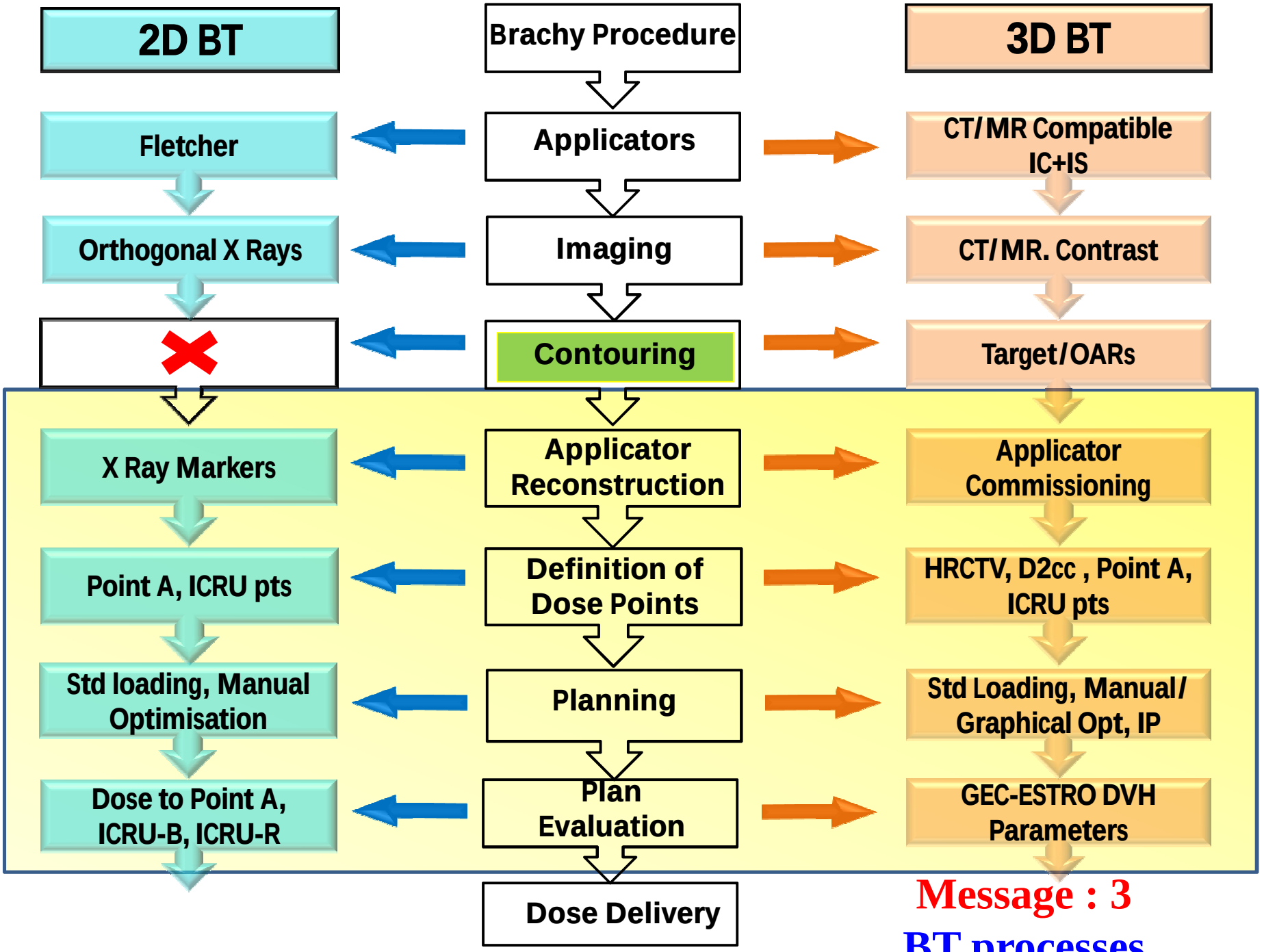
[NMD-Near Minimum Distance with respect to central canal]

Vaginal Disease

Ant : ___ cm
Post :___ cm
Rt Lat: ___cm
Lt Lat: ___cm



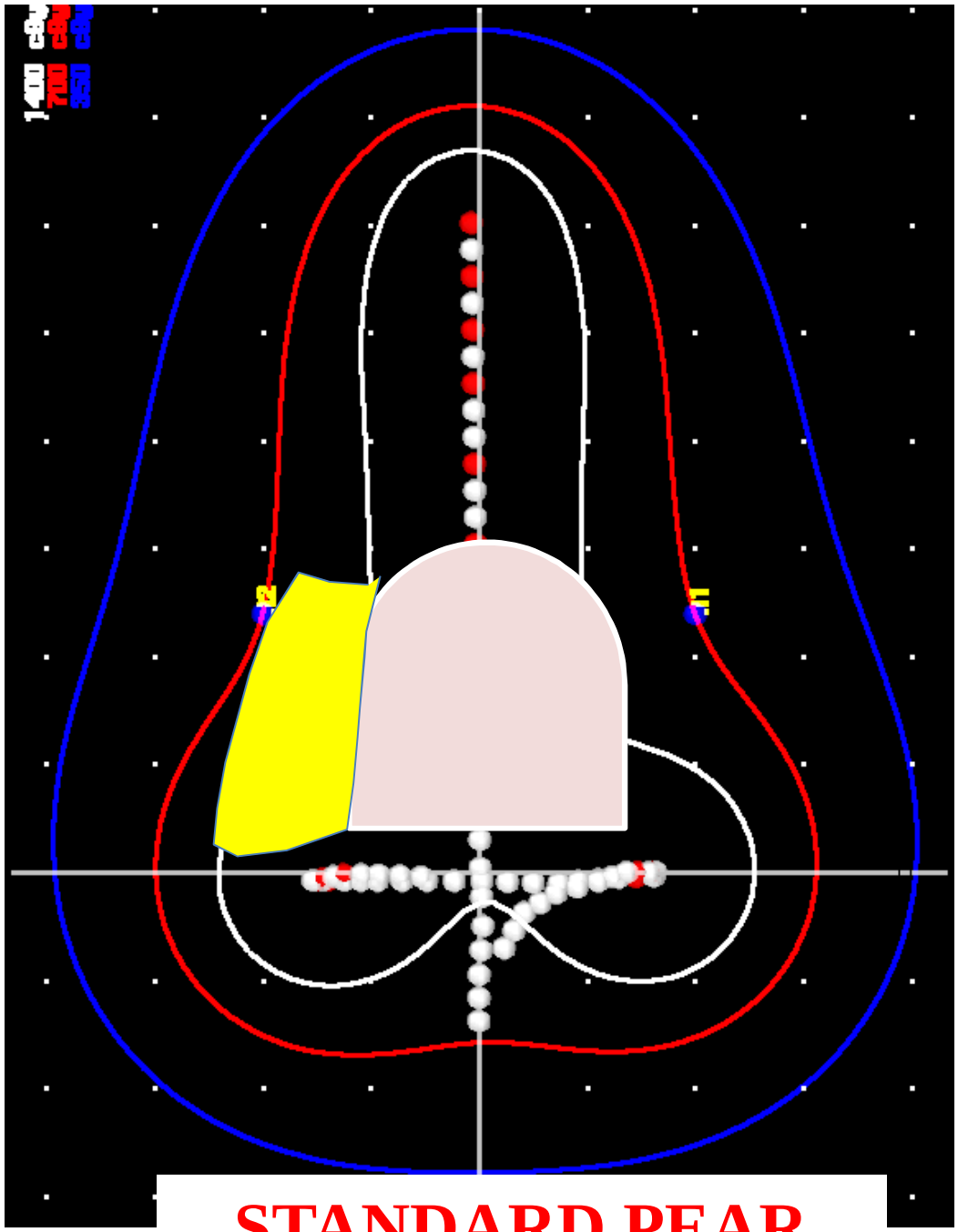
	Infiltrative	Exophytic
Cervix		
Vagina		
Parametria		
Rectum or Bladder		



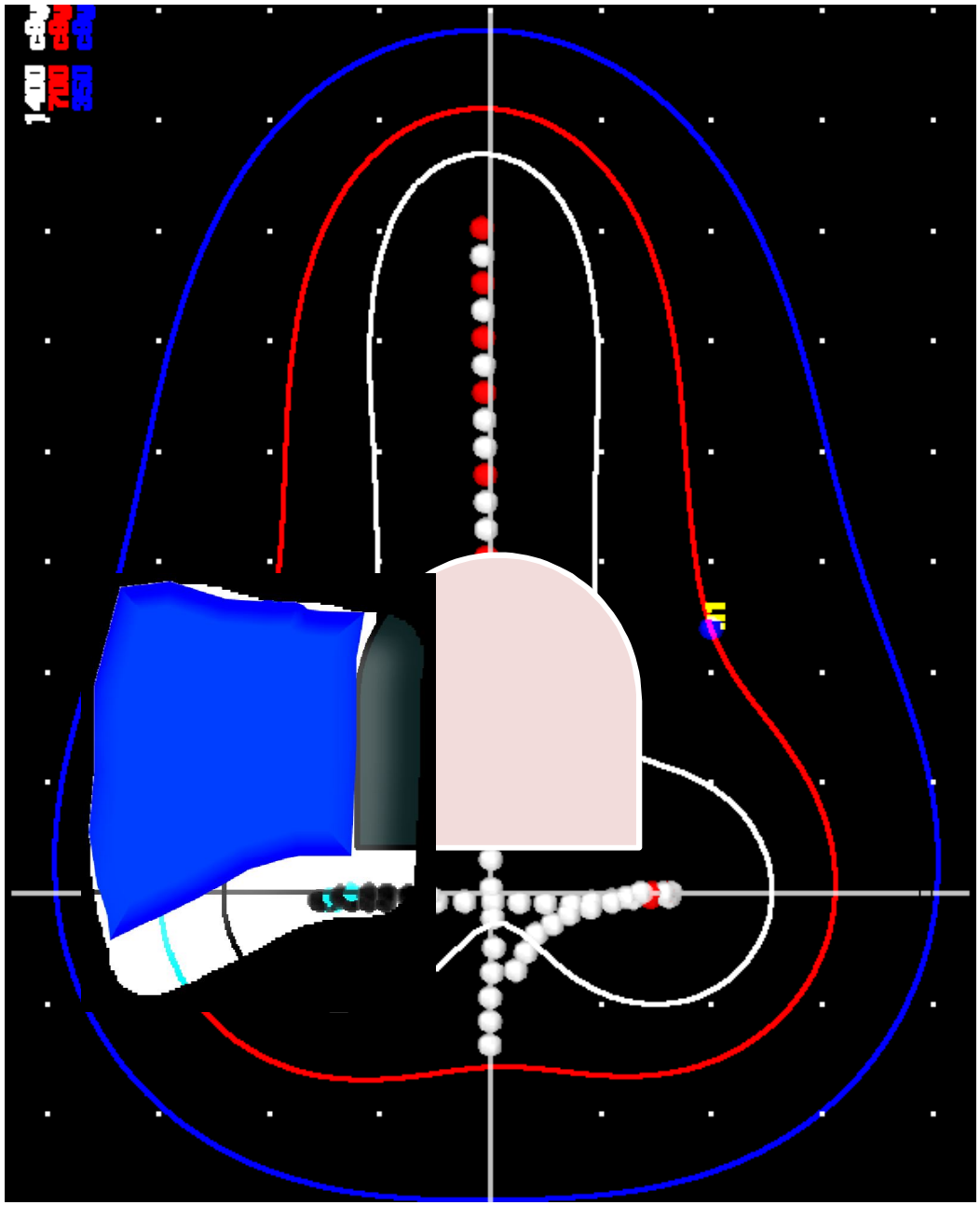
Message : 3

BT processes

Message : 4

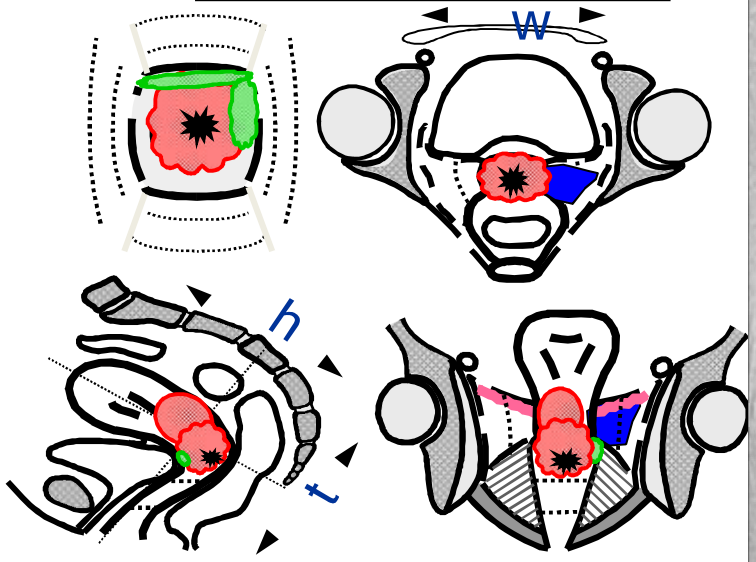


STANDARD PEAR

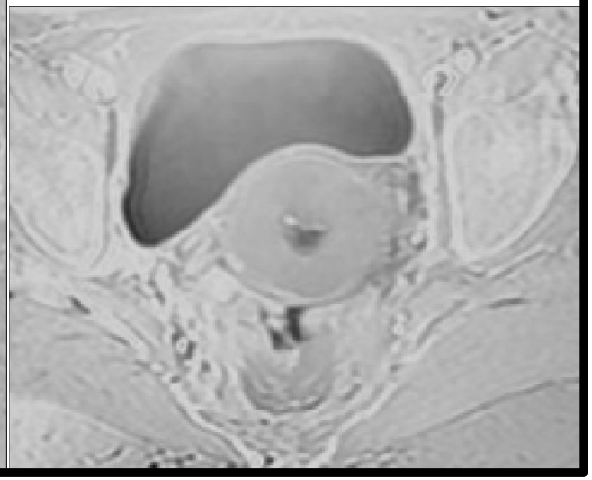


LIMITATION OF STANDARD PEAR

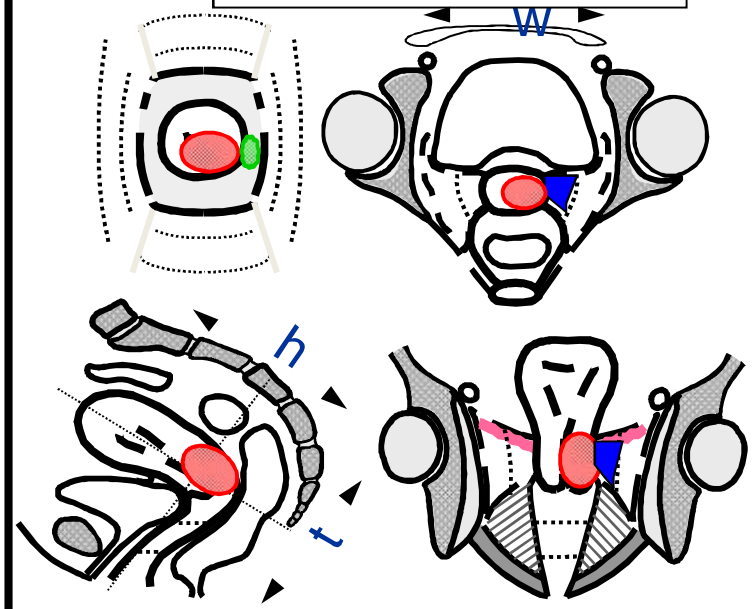
Clinical Drawing

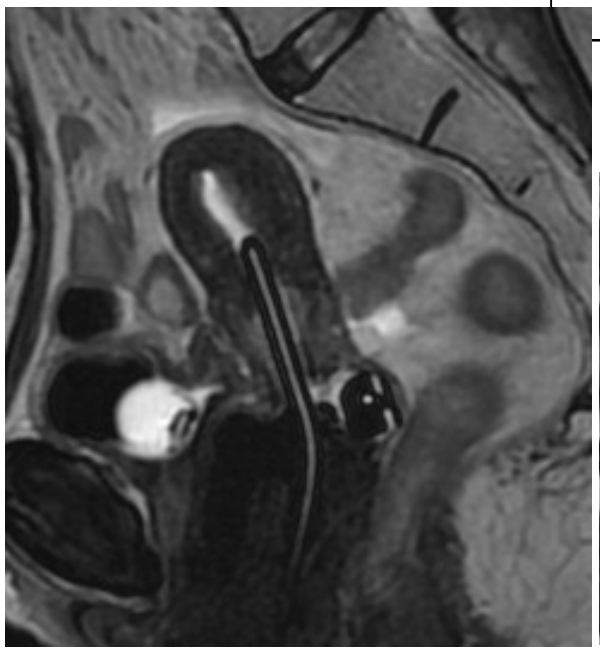


MR at Diagnosis

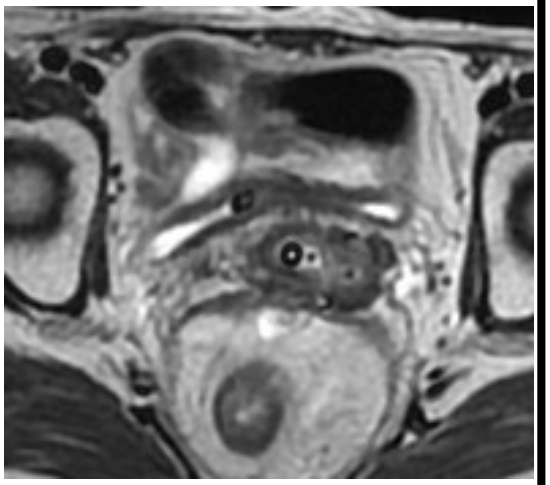


Clinical Drawing



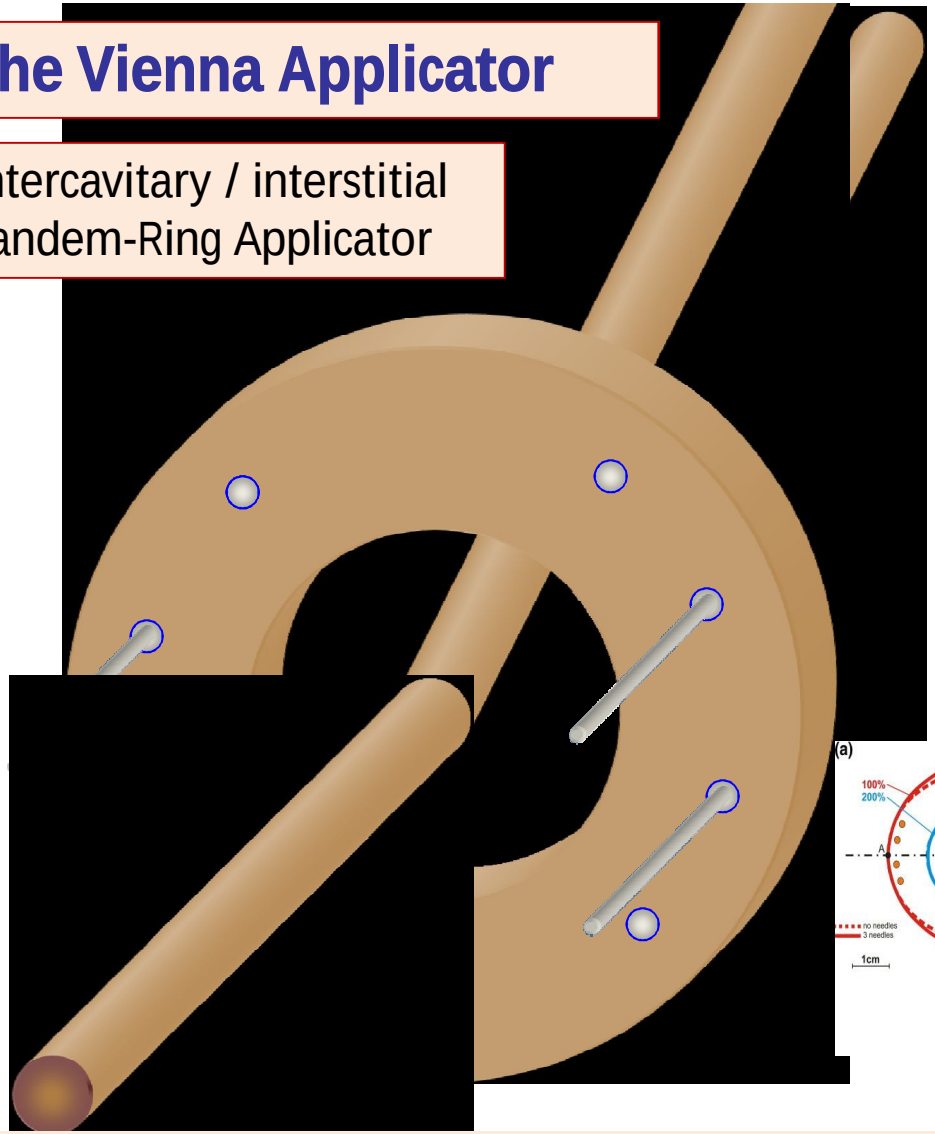


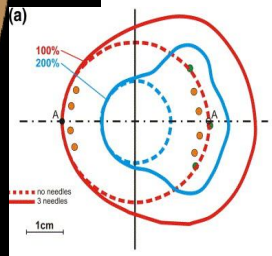
MR at Brachytherapy

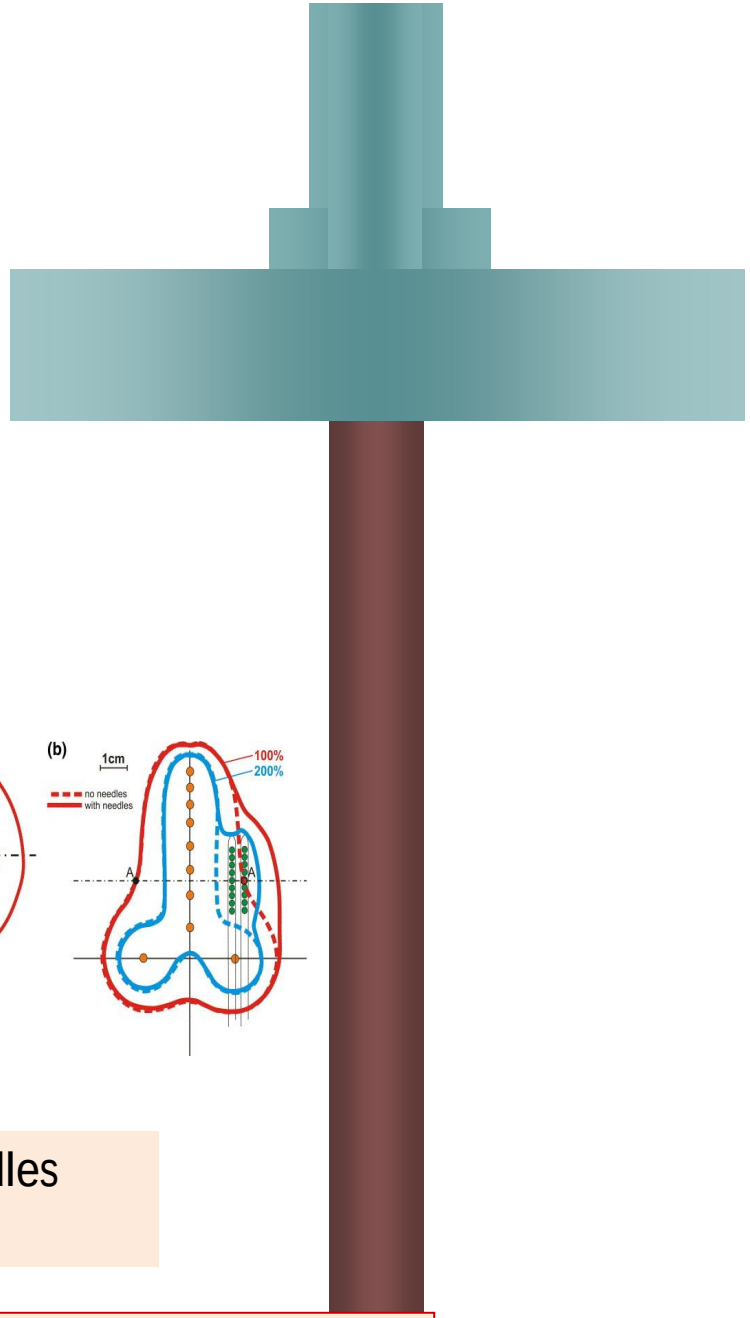


The Vienna Applicator

Intercavitary / interstitial
Tandem-Ring Applicator



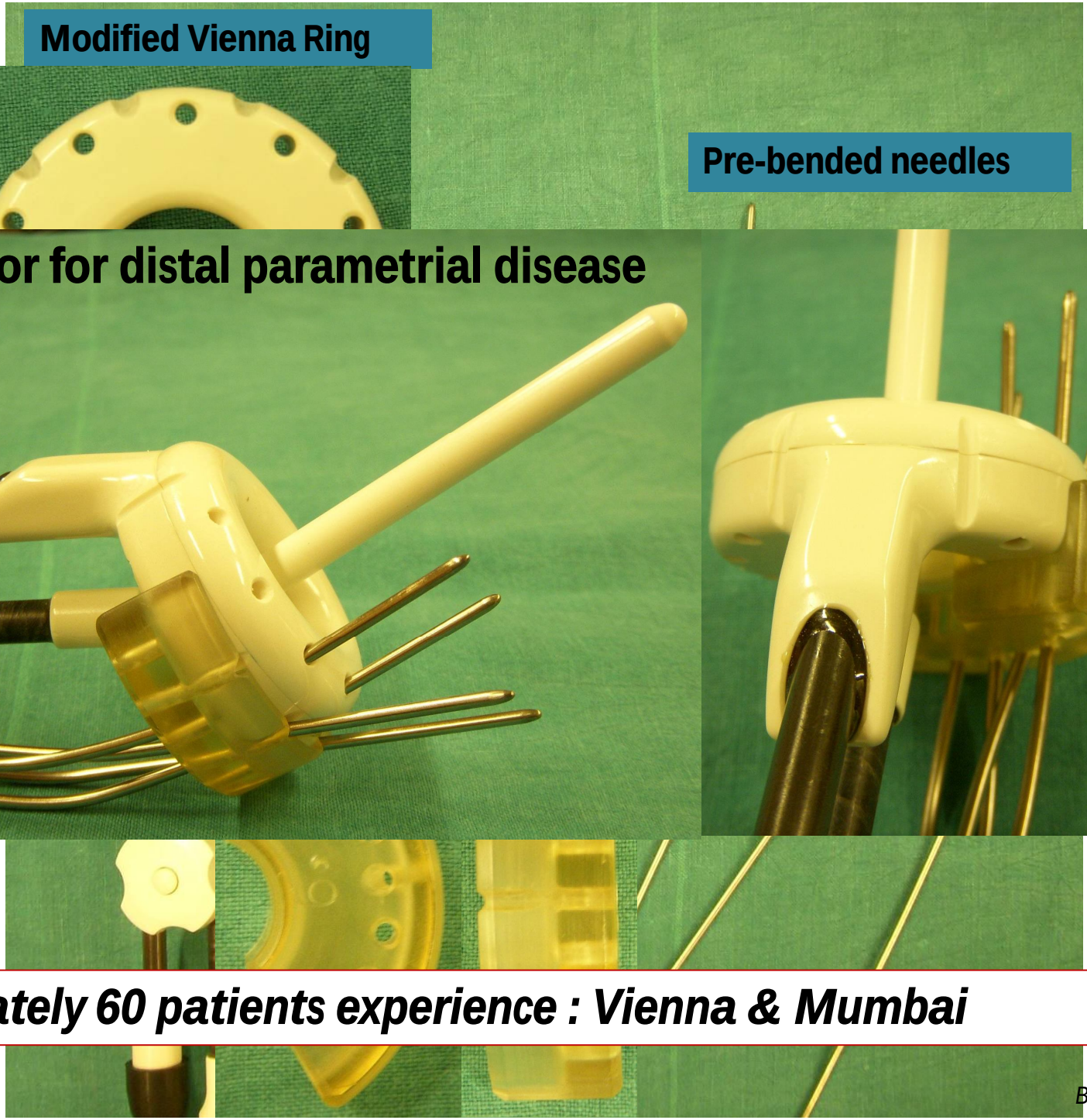




Modified Applicator: drilled holes into ring to insert needles parallel to the Tandem

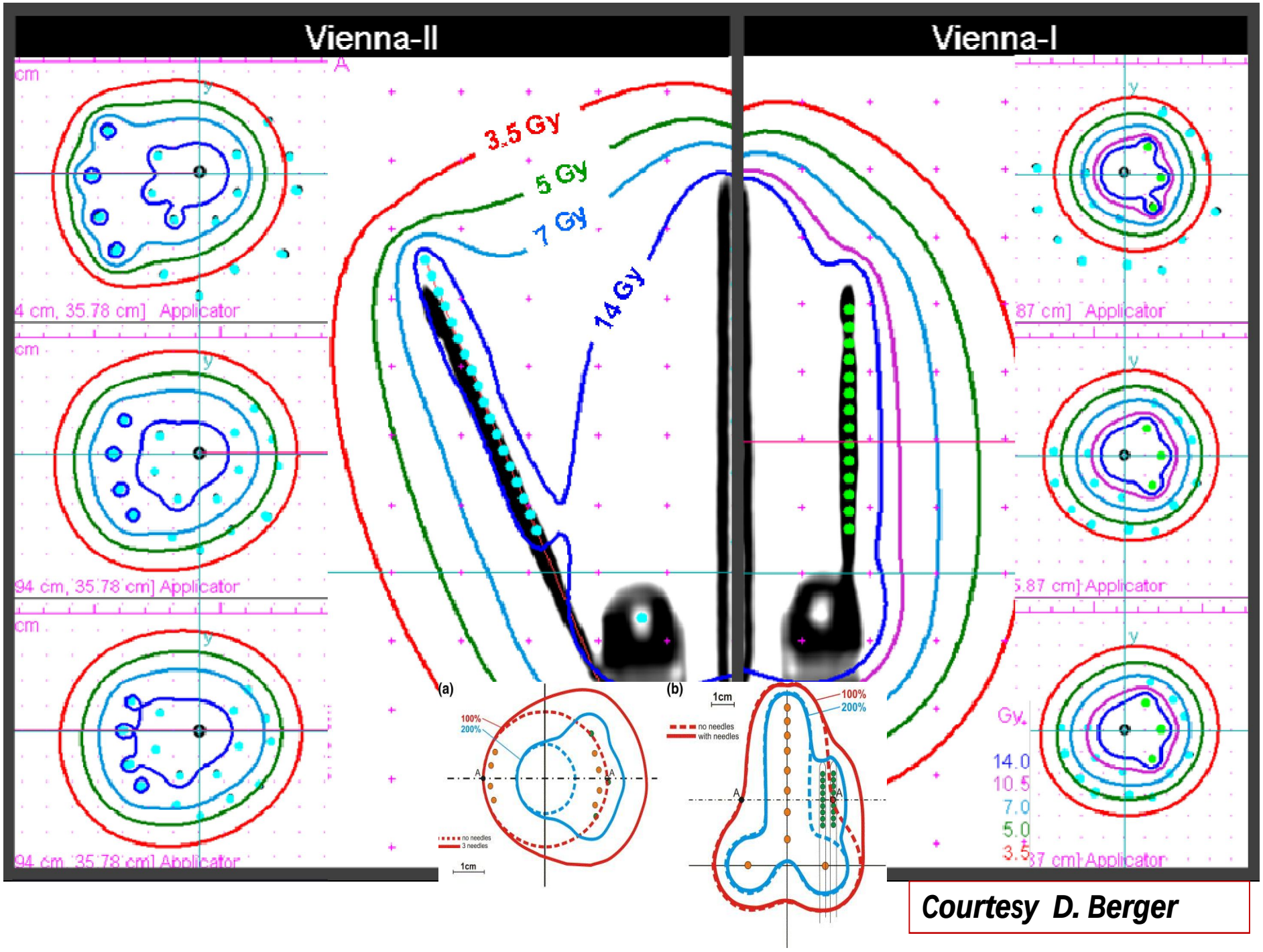
Kirisits et al. IJROBP 2006 (technical note)

Dimopoulos et al. IJROBP 2006 (clinical results)



Approximately 60 patients experience : Vienna & Mumbai

Berger et al.



Courtesy D. Berger

"Man often becomes what he believes himself to be.

If I keep on saying to myself that I cannot do a certain thing, it is possible that I may end by really becoming incapable of doing it. On the contrary, if I have the belief that I can do it, I shall surely acquire the capacity to do it even if I may not have it at the beginning." — Mahatma Gandhi

Brachytherapy Skills?

Work hard to Strengthen your skills – technology will follow you !!