

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

Preface.....	1
Abstract	3
Acknowledgements	5
1. Introduction.....	7
1.1 Developments in Epidemiology and Treatment of Cervical Cancer.....	7
1.2 Outline of Report.....	8
1.2.1 Prevention, Diagnosis, Prognosis, Treatment, and Outcome	8
1.2.2 Brachytherapy Techniques and Systems	8
1.2.3 Brachytherapy Imaging for Treatment Planning.....	8
1.2.4 Tumor and Target Volumes and Adaptive Radiotherapy	9
1.2.5 OAR- and Morbidity-Related Concepts and Volumes.....	10
1.2.6 Radiobiological Considerations.....	10
1.2.7 Dose and Volume Parameters.....	10
1.2.8 Physics Aspects of Three-Dimensional Volumetric Dose Assessment.....	10
1.2.9 Radiographic Localization of Absorbed-Dose Points	10
1.2.10 Sources and Dose Calculation	11
1.2.11 Treatment Planning.....	11
1.2.12 Summary of the Recommendations.....	11
1.2.13 Clinical Examples.....	12
1.2.14 Electronic Spreadsheet	12
1.2.15 Report Organization: Summaries, Recommendations, and Key Messages ..	12
2. Prevention, Diagnosis, Prognosis, Treatment, and Outcome.....	13
2.1 Etiology and Screening	13
2.2 Patterns of Spread.....	13
2.3 FIGO Staging and TNM Classification.....	13
2.4 Tumor and Lymph-Node Imaging.....	13
2.4.1 Tumor Assessment	14
2.4.2 Nodal Assessments by Imaging	14
2.5 Invasive Lymph-Node Assessment	15
2.5.1 Extra-Peritoneal Laparoscopic Para-Aortic Node Staging.....	15
2.5.2 Sentinel Lymph-Node Mapping in Early-Stage Cervical Cancer.....	15
2.5.3 Bulky Lymph Nodes.....	15
2.6 Prognostic Factors	15
2.7 Stage- and Risk-Adapted Multidisciplinary Treatment	16
2.7.1 FIGO Stage IA1	16
2.7.2 FIGO Stage IA2	16
2.7.3 FIGO Stage IB1	16
2.7.4 FIGO Stage IB2-IVA	17

2.8 Radiation Therapy	17	4.6 Radiography.....	41
2.9 Treatment Results	18	4.7 Imaging in Treatment Planning	43
2.9.1 Stage IA	18	4.7.1 Imaging in external-beam radiotherapy	43
2.9.2 Stages IB1 and Limited IIA	18	4.7.2 Imaging in brachytherapy	43
2.9.3 Stage IB2, Extensive IIA, IIB, III, and IVA.....	18	4.8 Summary.....	45
2.10 Conclusion	19	4.9 Key Messages	46
2.11 Summary.....	19		
2.12 Key Messages	19		
3. Brachytherapy Techniques and Systems.....	21	5. Tumor and Target Volumes and Adaptive Radiotherapy	49
3.1 The Evolution of Brachytherapy Systems, Techniques, and Absorbed-Dose Rates Applied to Cervical Center	21	5.1 Introduction and Overview	49
3.2 Historical Radium Systems	22	5.2 Volume Definitions in Adaptive (Gynecological) Radiotherapy	49
3.2.1 The Stockholm System	22	5.2.1 Tumor and Target Volume Definitions for the Primary Tumor	50
3.2.2 The Paris Method.....	22	5.2.1.1 GTV for the Primary Tumor (GTV-T)	50
3.2.3 The Manchester System	22	5.2.1.2 CTV for the Primary Tumor (CTV-T)	50
3.2.4 The Fletcher (M.D. Anderson) System	24	5.2.1.3 Residual GTV-T (GTV-T _{res})	50
3.3 From Radium to Man-Made Radionuclides	25	5.2.1.4 Adaptive CTV-T (CTV-T _{adapt})	50
3.4 Contemporary Techniques and the Decline of the Radium Systems	26	5.2.1.5 High-Risk CTV-T (CTV-T _{HR})	50
3.4.1 Tandem and Ring Techniques (Modified Stockholm Technique).....	26	5.2.1.6 Intermediate-Risk CTV-T (CTV-T _{IR})	50
3.4.2 Tandem and Ovoid Techniques (Modified Manchester Technique).....	26	5.2.1.7 Low-Risk CTV-T (CTV-T _{LR})	50
3.4.3 Tandem and Ovoid Techniques (Modified Fletcher Technique).....	27	5.2.1.8 Planning Target Volume (PTV-T)	50
3.4.4 The Tandem and Cylinder Technique.....	27	5.2.1.9 Initial Treatment Based on Different CTV-Ts	51
3.4.5 The Tandem and Mold Technique	28	5.2.2 Target Volume Definitions for Nodal and Metastatic Disease	51
3.5 Limitations of Historical and Current Brachytherapy Systems, Techniques, and Prescriptions	28	5.3 Clinical Aspects of Selecting and Contouring the Initial (GTV-T _{init}) and Residual (GTV-T _{res}) GTV-T	51
3.5.1 Applications Based on Amount of Radium	28	5.3.1 Concept of the GTV	51
3.5.2 Application Based on Dose Points (Point A, Point B, Lymph Nodes, Bony Structures, Organs at Risk)	28	5.3.2 GTV-T Selection and Delineation	51
3.5.2.1 Ovoid Surface Visibility on Radiographs	29	5.3.2.1 GTV-T Selection and Investigation Technique	51
3.5.2.2 Steep Absorbed-Dose Gradient	29	5.3.2.2 Identification of Sub-GTV-T(s)	52
3.5.2.3 Point A and Tumor Absorbed Dose (According to the Definition Given in this Report).....	29	5.3.2.3 The Composite GTV: The GTV-T	54
3.5.2.4 Point B and Lymph-Node Absorbed Dose	29	5.3.3 Change of Primary Tumors during Treatment: The Initial GTV-T (GTV-T _{init}) and the Residual GTV-T (GTV-T _{res})	54
3.5.3 Further Developments Based on TRAK, Points, and Volumes	29	5.3.4 Initial GTV-T (GTV-T _{init}) and Residual GTV-T (GTV-T _{res}) in Cervical Cancer Radiotherapy (at the Time of Brachytherapy)	54
3.5.4 Developments in regard to New Absorbed-Dose Rates	30	5.3.4.1 Initial GTV (GTV-T _{init})	55
3.6 Modern Applications in the Volume-Based Imaging Era with HDR and PDR Brachytherapy	30	5.3.4.2 Residual GTV (GTV-T _{res})	55
3.6.1 Quality of an Application	31	5.3.5 Uncertainties in GTV-T Selection and Contouring	56
3.6.2 Tandem and Ovoids	31	5.4 CTV and Adaptive CTV	58
3.6.3 Tandem and Ring	31	5.4.1 Concept of CTV	58
3.6.4 Tandem and Mold	31	5.4.2 CTV-T Selection and Delineation	58
3.6.5 Tandem and Cylinder	31	5.4.3 Change of Primary Tumor CTV-T during Treatment: The Adaptive CTV	59
3.6.6 Interstitial Applicators with and without a Tandem and Colpostats	32	5.4.4 Initial CTV-T and Adaptive CTV-T in Stage-Related Treatment of Cervical Cancer	60
3.6.7 Insertion and Planning Techniques based on Volumetric Imaging	33	5.4.4.1 Uterine Cervix: The Primary CTV-T for any Invasive Cervical Cancer	61
3.7 External-Beam Radiotherapy	34	5.4.4.2 Peri-Cervical Areas at Risk in Tumors with an Intact Cervix (Stage IB)	61
3.8 Concluding Remarks.....	34	5.4.4.3 Peri-Cervical Areas at Risk in Tumors Infiltrating beyond the Cervix (Stage II-IVA)	64
3.9 Summary.....	34	5.4.4.4 Regional Lymph Nodes Involved and at Risk	64
3.10 Key Messages	35	5.4.5 High-Risk CTV (CTV _{HR}), Intermediate-Risk CTV (CTV _{IR}), Low-Risk CTV (CTV _{LR}) in Combined Radiotherapy of Cervical Cancer	65
4. Brachytherapy Imaging for Treatment Planning	37	5.4.5.1 The High-Risk CTV-T: The Adaptive CTV-T for Cervical Cancer Brachytherapy	67
4.1 Clinical Gynecologic Examination and Clinical Diagrams	37	5.4.5.1.1 Alternative Imaging Modalities for Selection of CTV _{HR}	67
4.2 Magnetic Resonance Imaging	37	5.4.5.2 The Intermediate-Risk CTV-T (CTV-T _{IR})	68
4.3 Computed Tomography	38		
4.4 Positron-Emission Tomography (PET-CT)	39		
4.5 Ultrasound	40		

5.4.5.2.1 Selection of the CTV-T _{IR} for Various Patterns of Tumor Response after EBRT ± Chemotherapy	69	7.6.2 Mathematical Modeling of the Effects of Dose Rate and Dose per Fraction, Recovery Capacity, and Half-Time of Recovery	94
5.4.6 Uncertainties in Target Selection and Contouring	70	7.6.2.1 HDR Irradiation	94
5.5 Planning Target Volume (PTV-T)	73	7.6.2.2 LDR Irradiation	95
5.5.1 Concept of PTV-T	73	7.6.2.3 PDR Irradiation	96
5.5.2 Geometric Uncertainties in EBRT and Brachytherapy	73	7.6.3 The Equieffective Absorbed Dose Concept, EQDX	96
5.5.3 Geometric Uncertainties and PTV Margins in Brachytherapy	73	7.6.4 Equieffective Dose and EQD2	99
5.5.4 Internal Margin and the ITV	74	7.6.5 Combination of EBRT and brachytherapy	100
5.5.4.1 External Beam Radiotherapy	74	7.7 Recommended Common Terminology for Reporting Dose-Time Parameters of Combined EBRT and ICBT	100
5.5.4.2 Brachytherapy	74	7.8 Uncertainties Related to the Dose-Time Modeling	102
5.5.5 Set-up Margin (External Margin)	74	7.9 Equivalent Uniform Dose, EUD	102
5.5.5.1 External Beam Radiotherapy	75	7.10 Recommendations for Reporting Dose-Time Parameters	103
5.5.5.2 Brachytherapy	75	7.11 Summary	103
5.5.6 Preimplantation PTV	75		
5.6 Recommendations	76		
5.7 Summary	77		
6. Organs At Risk and Morbidity-Related Concepts and Volumes	79	8. Dose and Volume Parameters for Prescribing, Recording, and Reporting Brachytherapy, Alone and Combined with External-Beam Radiotherapy	105
6.1 Treatment-Related Morbidity and Health-Related Quality of Life	79	8.1 Brief Historical Survey of Dose Effects and Reporting	105
6.2 Radiation-Related Morbidity Endpoints	80	8.2 Dose Distribution and DVH for Targets and OARs	105
6.3 Volume Selection and Contouring Uncertainties for the OAR in Brachytherapy	82	8.3 Point Doses and Dose-Volume Parameters for the Target	108
6.4 Geometrical Uncertainties in OAR Assessment	85	8.3.1 TRAK and Dose to Point A	108
6.5 Remaining Volumes at Risk	86	8.3.2 CTV _{HR} and CTV _{IR} (D _{98 %} , D _{90 %} , D _{50 %})	108
6.6 Recommendations on Morbidity-Related Volumes and Points	87	8.3.3 GTV _{res} at Time of Brachytherapy (D _{98 %})	109
6.7 Summary	87	8.3.4 PTV for Brachytherapy	109
7. Radiobiological Considerations	89	8.3.5 Lymph Nodes (D _{98 %})	110
7.1 Introduction	89	8.4 OAR: Dose-Point and Dose-Volume Parameters	110
7.1.1 Dose Distributions	89	8.4.1 Bladder, Rectum, Sigmoid, and Bowel: High Dose Regions, Points, and Small Volumes (D _{0.1 cm³} , D _{2 cm³})	111
7.1.2 Time-Dose Patterns	89	8.4.2 Bladder, Rectum, Sigmoid, and Bowel: Intermediate- and Low-Dose and Non-Small Volumes	113
7.2 Time-Dose Patterns: Definitions	90	8.4.3 Vagina High-, Intermediate-, and Low-Dose Regions, Points, Small and Large Volumes	115
7.2.1 Application	90	8.4.4 Other OAR	116
7.2.2 Fraction	90	8.5 Specific Issues in Dose-Volume Reporting for the Combination of EBRT and Brachytherapy	116
7.2.3 Fractionated Irradiation	90	8.6 From Planning Aims to Prescription	119
7.2.4 Pulse	90	8.6.1 Traditional Terms for Dose Prescription	119
7.2.5 Hypofractionation	90	8.6.2 Concepts and Terms: From Planning Aim to Dose Prescription	119
7.2.6 Hyperfractionation	90	8.7 Isodose Surface Volume	120
7.2.7 Accelerated Fractionation	91	8.8 Recommendations for Reporting	120
7.2.8 Fractionated HDR Irradiation	91	8.9 Summary	121
7.2.9 PDR Irradiation	91		
7.2.10 Continuous LDR Irradiation	91		
7.2.11 Non-Continuous LDR	91		
7.2.12 Overall Treatment Time	91	9. Volumetric Dose Assessment	123
7.2.13 Mean Dose Rate	91	9.1 Applicator Reconstruction	123
7.3 Dose-Rate Effects on Recovery	91	9.2 Definition of Reference Points in 3D Images	124
7.3.1 Low-Dose-Rate Brachytherapy	91	9.3 Registration and Fusion of Images	125
7.3.2 Medium-Dose-Rate Brachytherapy	92	9.3.1 Registration According to the Brachytherapy Applicator	125
7.3.3 High-Dose-Rate Brachytherapy	92	9.3.2 Image Fusion for Reconstruction Purposes	126
7.4 Other Time-Dose Pattern-Related Radiobiological Processes	92	9.3.3 Fusion of Pre-EBRT and Brachytherapy Planning Images	126
7.4.1 Repopulation	92	9.3.4 Fusion of Target Contours between Image Series at the Time of Brachytherapy	127
7.4.2 Reoxygenation	93	9.4 Volume Reconstruction, Voxel Size, and DVH Calculation	127
7.4.3 Redistribution	93	9.5 Intra-Fraction, Inter-Fraction, and Inter-Application Variations	128
7.5 Dose-Time Patterns and Dose Rates	93	9.5.1 Intra- and Inter-Fraction Variations	129
7.6 Radiobiological Consequences of Different Dose-Time Patterns	93	9.5.2 Inter-Application Uncertainties	129
7.6.1 From Absorbed Dose to Biologically Equieffective Dose	93		

9.5.3 Summation of Dose Across Treatment Applications	129	12.4.3 Inverse planning	158
9.6 Key Messages	130	12.4.4 Optimization by changing absorbed-dose rate in LDR and PDR treatments or fraction size in HDR brachytherapy	159
9.7 Summary.....	130	12.5 Key Messages	159
10. Radiographic Dose Assessment	133	12.6 Summary.....	159
10.1 Target Points	133	13. Summary of the Recommendations	161
10.1.1 Location of Point A	133	Level 1 - Minimum standard for reporting	161
10.1.2 Relationship between point A dose and the CTV_{HR} $D_{90\%}$	134	Level 2 - Advanced standard for reporting	161
10.1.3 Isodose-surface volumes and dimensions	134	Level 3 - Research-oriented reporting	162
10.1.4 Target dose approximation	134		
10.1.5 Lymph-node and Pelvic-wall points	135		
10.1.5.1 Pelvic wall reference points	137		
10.1.5.2 Lymphatic trapezoid.....	137		
10.2 Reference Points for Upper, Mid, and Low Vagina	137		
10.3 Reference Points for Rectum and Bladder	138		
10.3.1 Recto-vaginal reference point	138		
10.3.2 Bladder reference point	139		
10.3.3 Clinical relevance of the bladder and rectal reference points.....	139		
10.3.4 Sigmoid reference point	140		
10.4 Uncertainties with Radiographic Localization	140		
10.5 Recommendations for Reporting	141		
10.6 Summary.....	141		
11. Sources and Absorbed-Dose Calculation.....	143		
11.1 Radionuclides.....	143		
11.2 Source-Strength Specification.....	143		
11.2.1 Reference Air-Kerma Rate	143		
11.2.1.1 Definition of RAKR	143		
11.2.1.2 Analogs	143		
11.2.1.3 Measurement	143		
11.2.1.4 The Energy Cutoff, δ	144		
11.2.1.5 Standards Work in Progress	145		
11.2.2 Survey of Previously Used Source-Strength Descriptors	145		
11.2.2.1 Radium Mass	145		
11.2.2.2 The Milligram-Radium Equivalent.....	145		
11.2.2.3 Contained, Apparent, and Equivalent Activity	145		
11.2.2.4 Exposure Rate at 1 m	145		
11.2.3 Advantages of RAKR	146		
11.2.4 The Air-Kerma-Rate Constant, Γ_8	146		
11.3 Total Reference Air Kerma.....	146		
11.4 Absorbed-Dose Calculation	147		
11.4.1 Absorbed-dose-calculation formalism	147		
11.4.2 Inhomogeneity Correction and Applicator Influences on the Absorbed Dose..	148		
11.5 Recommendations for Reporting	149		
11.6 Summary.....	149		
12. Treatment Planning	151		
12.1 Combining EBRT and Brachytherapy: Dose and Fractionation Strategies	152		
12.2 Implant Geometry.....	154		
12.2.1 Applicator type.....	154		
12.2.2 Pre-planning of the implant.....	155		
12.3 Loading Pattern and 3D Absorbed-Dose Distribution without Reference to Targets.....	155		
12.4 Optimization of the Dose Distribution	157		
12.4.1 General aspects of dose optimization.....	157		
12.4.2 Forward planning	158		
		A.1 Case 1: Small Cervical Cancer Stage IB1, with Positive Nodes,Treated with 3D Conformal EBRT and Concomitant Chemotherapy Plus Conformal Boost and MRI-Based PDR Brachytherapy with Mould Technique	165
		A.1.1 General Patient Information.....	165
		A.1.2 Tumor Extension at Diagnosis	165
		A.1.2.1 Gynecological Examination (Figure A.1.1, Table A.1.1)	165
		A.1.2.2 MRI of the pelvic and Para-Aortic Area (Figure A.1.1, Table A.1.1)	165
		A.1.2.3 Other Findings	165
		A.1.2.4 Conclusion	165
		A.1.3 Treatment Intention	165
		A.1.4 External Beam Radiotherapy.....	166
		A.1.5 Brachytherapy	167
		A.1.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.1.4)	167
		A.1.5.2 MRI of the Lower Pelvic Area at First Brachytherapy (Figure A.1.4)	168
		A.1.5.3 Treatment Planning Aim	168
		A.1.5.4 Treatment Delivery	168
		A.1.5.5 Equipment Used for Brachytherapy (Figure A.1.5)	168
		A.1.6 Treatment Planning and Reporting Brachytherapy and EBRT	170
		A.1.6.1 Example of Dose Distribution	170
		A.1.7 Current Patient Status	170
		A.2 Case 2: Large Cervical Cancer Stage IB2, Intracavitary, No Nodes, Treated with 3D Conformal Box EBRT and Parametrial Boost, with Concomitant Chemotherapy, and MRI-Based Intracavitary Tandem/Ring and Tandem/Ovoid HDR Brachytherapy	171
		A.2.1 General Patient Information	171
		A.2.2 Tumor Extension at Diagnosis	171
		A.2.2.1 Gynecological Examination (Figure A.2.1, Table A.2.1)	171
		A.2.2.2 MRI of the Lower Pelvic Area (Figure A.2.1, Table A.2.1)	171
		A.2.2.3 Other Findings	171
		A.2.2.4 Conclusion	171
		A.2.3 Treatment Intention	171
		A.2.4 External Beam Radiotherapy	171
		A.2.5 Brachytherapy	173
		A.2.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.2.4)	173
		A.2.5.2 MRI of the Lower Pelvic Area at First Brachytherapy (Figure A.2.4)	174
		A.2.5.3 Treatment Planning Aim	174
		A.2.5.4 Treatment Delivery	175
		A.2.5.5 Equipment Used for Brachytherapy (Figure A.2.5)	175
		A.2.6 Treatment Planning and Reporting Brachytherapy and EBRT	175

A.2.6.1 Example of Absorbed Dose Distribution.....	177	A.5.4 External Beam Radiotherapy (Figure A.5.3, Table A.5.2).....	193
A.2.7 Current Patient Status.....	177	A.5.5 Brachytherapy.....	195
A.3 Case 3: Large Cervical Cancer Stage IIA2, No Nodes, Treated with 3D Conformal EBRT, with Concomitant Chemotherapy, and MRI-Based Intracavitary Tandem/Ovoid PDR Brachytherapy	179	A.5.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.5.4, Table A.5.1)	195
A.3.1 General Patient Information.....	179	A.5.5.2 MRI of the Lower Pelvic Area at First Brachytherapy (Figure A.5.4, Table A.5.1)	195
A.3.2 Tumor Extension at Diagnosis	179	A.5.5.3 Treatment Planning Aim	195
A.3.2.1 Gynecological Examination (Figure A.3.1, Table A.3.1)	179	A.5.5.4 Treatment Delivery.....	196
A.3.2.2 MRI of the Lower Pelvic Area (Figure A.3.1, Table A.3.1)	179	A.5.5.5 Equipment Used for Brachytherapy (Figure A.5.5)	196
A.3.2.3 Other Findings	179	A.5.6 Treatment Planning and Reporting Brachytherapy and EBRT	197
A.3.2.4 Conclusion	179	A.5.6.1 Example of Dose Distribution.....	199
A.3.2.5 Treatment Intention.....	179	A.5.7 Current patient status	199
A.3.3 External Beam Radiotherapy	179	A.6 Case 6: Large Cervical Cancer Stage IIIB with Pathological Pelvic Nodes Treated with IMRT, Concomitant Chemotherapy, and MRI Based Intracavitary and Interstitial Tandem/Ring Pulsed Dose Rate Brachytherapy with Needles.....	201
A.3.4 Brachytherapy.....	180	A.6.1 General Patient Information.....	201
A.3.4.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.3.4)	180	A.6.2 Tumor Extension at Diagnosis	201
A.3.4.2 MRI of the Lower Pelvic Area at First Brachytherapy (Figure A.3.5)	180	A.6.2.1 Gynecological Examination (Figure A.6.1, Table A.6.1)	201
A.3.4.3 Treatment Planning Aim	181	A.6.2.2 MRI of the Pelvis (Figure A.6.1, Table A.6.1)	201
A.3.4.4 Treatment Delivery.....	183	A.6.2.3 Other Findings	201
A.3.4.5 Equipment Used for Brachytherapy (Figure A.3.5)	183	A.6.2.4 Conclusion	201
A.3.4.6 Treatment Reporting	183	A.6.3 Treatment Intention and Overall Treatment Plan.....	201
A.3.4.7 Example of Dose Distribution.....	184	A.6.4 External Beam Radiotherapy (Figure A.6.3 and Table A.6.2)	201
A.3.5 Current Patient Status.....	184	A.6.5 Brachytherapy.....	205
A.4 Case 4: Cervical Cancer Stage IB1 Treated with 3D Conformal External Beam Irradiation, Concomitant Chemotherapy, and Radiograph-Based Intracavitary Tandem/Ovoid High Dose Rate Brachytherapy.....	185	A.6.5.1 Gynecological Examination at First Time of Brachytherapy (Figure A.6.4)	205
A.4.1 General Patient Information.....	185	A.6.5.2 MRI of the Pelvis at First Brachytherapy (Figure A.6.4 and Table A.6.1)	206
A.4.2 Tumor Extension at Diagnosis	185	A.6.5.3 Treatment Planning aim (Table A.6.3)	206
A.4.2.1 Gynecological examination (Figure A.4.1, Table A.4.1)	185	A.6.5.4 Treatment Delivery.....	206
A.4.2.2 MRI of the Pelvis (Figure A.4.1, Table A.4.1)	185	A.6.5.5 Equipment Used for Brachytherapy (Table A.6.4 and Figure A.6.5a and Figure A.6.5b and Figure A.6.5)	207
A.4.2.3 Other Findings	185	A.6.6 Treatment Planning and Reporting Brachytherapy and EBRT	207
A.4.2.4 Conclusion	185	A.6.6.1 Example of Dose Distribution (Figure A.6.6)	207
A.4.3 Treatment Intention	185	A.6.7 Current Status	207
A.4.4 External Beam Radiotherapy (Figures A.4.3 and Table A.4.2).....	185	A.7 Case 7: Large Cervical Cancer Stage IIB, with 3D Conformal EBRT with Concomitant Chemotherapy, and Radiograph-Based Intracavitary PDR Brachytherapy with Mould Technique	209
A.4.5 Brachytherapy.....	187	A.7.1 General Patient Information.....	209
A.4.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.4.4, Table A.4.1)	187	A.7.2 Tumor Extension at Diagnosis	209
A.4.5.2 Treatment Planning Aim	187	A.7.2.1 Gynecological Examination (Figure A.7.1 and Table A.7.1)	209
A.4.5.3 Treatment Delivery.....	188	A.7.2.2 MRI of the Lower Pelvic Area (Figure A.7.1, Table A.7.1)	209
A.4.5.4 Equipment Used for Brachytherapy (Table A.4.4, Figure A.4.5)	188	A.7.2.3 Other Findings	209
A.4.6 Treatment Planning and Reporting EBRT and Brachytherapy	190	A.7.2.4 Conclusion	209
A.4.6.1 Example of Dose Distribution (Figure A.4.6)	191	A.7.3 Treatment intention	209
A.4.7 Current Patient Status.....	191	A.7.4 External Beam Radiotherapy	209
A.5 Case 5: Large Cervical Cancer Stage IIB with Vaginal Involvement, No Nodes, Treated with 3D Conformal EBRT with Concomitant Chemotherapy, and MRI Based Intracavitary and Interstitial HDR Brachytherapy Using a Tandem/Ring Applicator with Needles	193	A.7.5 Brachytherapy	211
A.5.1 General Patient Information.....	193	A.7.5.1 Gynecological Examination at the First Time of Brachytherapy (Figure A.7.4)	211
A.5.2 Tumor Extension at Diagnosis	193	A.7.5.2 Treatment Planning Aim	212
A.5.2.1 Gynecological Examination (Figure A.5.1, Table A.5.1)	193	A.7.5.3 Treatment Delivery	212
A.5.2.2 MRI of the Lower Pelvic Area (Figure A.5.1, Table A.5.1)	193	A.7.5.4 Equipment Used for Brachytherapy (Figure A.7.5)	212
A.5.2.3 Other Findings	193	A.7.6 Treatment Planning and Reporting Brachytherapy and EBRT	213
A.5.2.4 Conclusion	193	A.7.6.1 Example of Dose Distribution.....	213
A.5.3 Treatment Intention	193	A.7.7 Current Patient Status	215

A.8 Case 8: Large Cervical Cancer Stage IIIB with No Nodes, Treated with 3D Conformal Box with Concomitant Chemotherapy and MRI-Based Intracavitary and Interstitial HDR Brachytherapy with Tandem/Ring Applicator and Needles	217
A.8.1 General Patient Information	217
A.8.2 Tumor Extension at Diagnosis	217
A.8.2.1 Gynecological Examination (Figure A.8.1, Table A.8.1)	217
A.8.2.2 MRI of the Pelvis (Figure A.8.1, Table A.8.1)	217
A.8.2.3 Other Findings	217
A.8.2.4 Conclusion	217
A.8.3 Treatment Intention	217
A.8.4 External Beam Radiotherapy	217
A.8.5 Brachytherapy	220
A.8.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.8.4)	220
A.8.5.2 MRI of the Lower Pelvic Area at First Brachytherapy (Figure A.8.4)	220
A.8.5.3 Treatment Planning Aim	220
A.8.5.4 Treatment Delivery	220
A.8.5.5 Equipment Used for Brachytherapy (Figure A.8.5)	221
A.8.6 Treatment Planning and Reporting Brachytherapy and EBRT	222
A.8.6.1 Example of Dose Distribution	224
A.8.7 Current Patient Status (Figure 8.7)	224
A.9 Case 9: Cervical Cancer Stage IIA2 Treated with 3D Conformal External-Beam Irradiation, Concomitant Chemotherapy, and Radiograph-Based Intracavitary Low Dose-Rate Brachytherapy with Tandem and Ovoids	225
A.9.1 General Patient Information	225
A.9.2 Tumor Extension at Diagnosis	225
A.9.2.1 Gynecological Examination (Figure A.9.1, Table A.9.1)	225
A.9.2.2 CT of the Pelvis (Figure A.9.1, Table A.9.1)	225
A.9.2.3 Other Findings	225
A.9.2.4 Conclusion	225
A.9.3 Treatment Intention	225
A.9.4 External Beam Radiotherapy (Figure A.9.3 and Table A.9.2)	225
A.9.5 Brachytherapy	228
A.9.5.1 Gynecological Examination at the Time of First Brachytherapy (Figure A.9.4, Table A.9.1)	228
A.9.5.2 Treatment Planning Aim	228
A.9.5.3 Treatment Delivery	228
A.9.5.4 Equipment Used for Brachytherapy (Table A.9.4, Figure A.9.5)	229
A.9.6 Treatment Planning and Reporting EBRT and Brachytherapy	229
A.9.7 Current Patient Status	229
References	234