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Journal of Polish Brachytherapy Society

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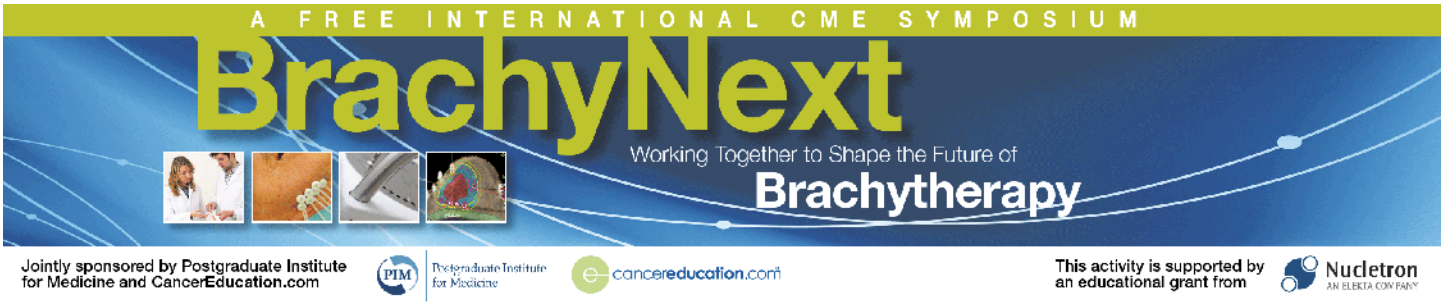

Welcome to Miami Beach!

Thank you for joining us this weekend for ***BrachyNext–Working Together to Shape the Future of Brachytherapy***. On behalf of our esteemed Organizing Committee and Faculty, we are pleased to welcome you to this groundbreaking symposium jointly sponsored by the *Postgraduate Institute for Medicine* and *CancerEducation.com*.

The field of brachytherapy is constantly evolving and improving with breakthrough techniques and clinical innovation. This clinically relevant symposium—featuring an international selection of experts—has been designed to improve participants' skills and advance their understanding of innovative treatment techniques to improve patient outcomes and program performance. Whether you are looking to learn about recent advancements in improving patient outcomes or establishing a brachytherapy program in your region, this symposium provides the key insights and learnings to help develop these capabilities.

The meeting is dispersed into sessions, designated as either Science, Challenge, or Hands-On, to offer several opportunities in the types of learning and interaction. Please visit the poster display during the breaks and lunch times, where you can meet some of the leaders in brachytherapy research.

Abstracts from the Faculty of the Science and Challenges sessions, as well as the posters, are contained in this Program Supplement. The Program Supplement is also available through the *Journal of Contemporary Brachytherapy* Web site (www.jocb.eu) and at the BrachyNext Web site at (www.cancereducation.com/brachynext/).

We are pleased that this program has been recommended by the European Society for Radiotherapy & Oncology (ESTRO) and that physicist credit is being provided by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP). We would like to thank *Nucletron*, *an Elekta Company*, for their generous support of this educational activity. We would also like to thank our in-kind supporters who have provided tools and equipment for the Hands-On sessions.

Your role in the meeting cannot be overstated. The collective discussion from a group of leaders from varied disciplines will dramatically enhance the value of this program. We appreciate your participation as we work to advance the practice of brachytherapy and improve patient outcomes.

Welcome Again!

Most sincerely,

Janusz Skowronek, MD, PhD
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Poznań University of Medical Sciences
Head of Brachytherapy Department
Greater Poland Cancer Centre
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BrachyNext

Working Together to Shape the Future of Brachytherapy

Agenda

Friday, May 30, 2014

7:00 AM CONTINENTAL BREAKFAST

8:00 – 8:05 AM WELCOME

8:05 – 8:30 AM KEYNOTE LECTURE – PHILLIP M. DEVLIN, MD, FACR, FASTRO, FFRCSI (HON)

The Current Value and Usefulness of Brachytherapy in the Overall Management of the Oncology Patient

8:30 – 10:15 AM

SESSION A1: BREAST BRACHYTHERAPY IN THE HEAT OF COMPETITION

Chairs: Atif J. Khan, MD; Jean-Michel Hannoun-Levi, MD, PhD; Csaba Polgár, MD, PhD, MSc

- **Overview of APBI Phase III Trials: Validation of the APBI Concept According to the Irradiation Technique Used**
  Atif J. Khan, MD
- **Breast Brachytherapy "State-of-the-Art"**
  Robert R. Kuske, MD, FAACE
- **Salvage Brachytherapy as a New Indication After Previous BCT**
  Jean-Michel Hannoun-Levi, MD, PhD
- **Why Choose Brachytherapy and Not External Beam RT or IORT?**
  Csaba Polgár, MD, PhD, MSc
- **Results of APBI Clinical Trials Using Intracavitary Single- and Multi-Channel Breast Brachytherapy Applicators**
  Frank A. Vicini, MD, FACR
- **Panel Discussion**

SCIENCE

SESSION A2: BRACHYTHERAPY IN GYNECOLOGIC CANCERS: CHALLENGES AND DEVELOPMENTS

Chair: Umesh Mahantshetty, DMRT, MD, DNB (RT)

- **Transition From 2D to 3D Brachytherapy in Cervical Cancers: The Vienna Experience**
  Richard Pötter, MD
- **Implementation in Clinical Practice: Challenges in Developing Economies**
  Umesh Mahantshetty, DMRT, MD, DNB (RT)
- **Imaging Modalities: Current Challenges and Future Directions**
  Johannes C. Athanasios Dimopoulos, MD
- **Gynecologic Brachytherapy Case Discussion**

CHALLENGES

SESSION A3: PHYSICS

Chair: Luc Beaulieu, PhD

- **Prostate Brachytherapy Ultrasound QA: A Practical Approach**
  Frank-André Siebert, PhD
- **Everything You Wanted to Know About Skin Brachytherapy But Were Too Busy to Ask**
  Zoubir Ouhib, MS, DABR
- **Advanced Dose Calculations in Brachytherapy: First Contact**
  Luc Beaulieu, PhD

HANDS-ON WORKSHOP

10:15 – 10:45 AM BREAK

10:45 AM – 12:30 PM

SESSION B1: GYNECOLOGY – 100 YEARS OF EXPERIENCE, NEW CHALLENGES

Chairs: Christian Kirisits, MSc, PhD; Subhakar Mutyala, MD

- **Vaginal Cylinders for Modern Brachytherapy**
  D. Jeffrey Demanes, MD, FACRO, FACR, FASTRO
- **The Overall Concept for Definitive Endometrium Radiotherapy**
  Subhakar Mutyala, MD
- **Modern Interstitial Techniques**
  Umesh Mahantshetty, DMRT, MD, DNB (RT)
- **The New ICRU/GEC-ESTRO Report in Clinical Practice**
  Christian Kirisits, MSc, PhD
- **Update of EMBRACE and Retro-EMBRACE**
  Kari Tanderup, PhD
- **Panel Discussion**

SCIENCE

SESSION B2: BREAST BRACHYTHERAPY: STATE-OF-THE ART AND CHALLENGING PERSPECTIVES

Chairs: Jean-Michel Hannoun-Levi, MD, PhD; Csaba Polgár, MD, PhD, MSc

- **Breast Brachytherapy: State-of-the-Art and Challenging Perspectives**
  Jean-Michel Hannoun-Levi, MD, PhD
- **Brachytherapy for Breast Cancer: Which Device for Which Patient?**
  Robert R. Kuske, MD, FAACE
- **How to Prevent/Avoid Late Side Effects**
  Csaba Polgár, MD, PhD, MSc
- **Challenges Faced in Setting Up a Breast Brachytherapy Service**
  Johann Tang, MBBS, FRANZCR
- **Breast Brachytherapy: How to Allay Fears of Patients and Colleagues, and What Are Our Expectations for the Future?**
  Vratislav Strnad, MD, PhD, Prof.

CHALLENGES

SESSION B3: NEW HORIZONS–BREAKTHROUGH TECHNOLOGIES

Chair: Atif J. Khan, MD

- **Y90 Microsphere Liver Treatment: Set Up, Tips & Tricks**
  Phillip M. Devlin, MD, FACR, FASTRO, FFRCSI (Hon)
- **Robotic Brachytherapy**
  Gabriel Kacsó, MD
- **Post-Craniotomy Cesium Implants**
  Atif J. Khan, MD
- **Practical Aspects of CT-Guided Biliary Duct Brachytherapy**
  Atif J. Khan, MD, and Phillip M. Devlin, MD, FACR, FASTRO, FFRCSI (Hon)

HANDS-ON WORKSHOP

12:30 – 1:30 PM LUNCH

BrachyNext

Working Together to Shape the Future of Brachytherapy

Agenda

Friday, May 30, 2014

1:30 – 3:15 PM

SESSION C1: PHYSICS – ADDING CERTAINTY TO SAFETY

Chair: Luc Beaulieu, PhD

- **State-of-the-Art in Brachytherapy Dose Calculation**
  Luc Beaulieu, PhD
- **Clinical Uncertainties: What Is the Magnitude?**
  Kari Tanderup, PhD
- **Advancements in Real-Time Imaging for Brachytherapy**
  Frank-André Siebert, PhD
- ***In Vivo* Dosimetry in Brachytherapy: Feasible and Needed?**
  Annette Haworth, PhD, FACPSEM
- **Panel Discussion**

SCIENCE

SESSION C2: BUILDING A GLOBAL BRACHYTHERAPY COMMUNITY

Chairs: André-Guy Martin, MD, MSc, FRCP; Tim R. Williams, MD

- **How to Develop a Brachytherapy Community: The Need for an Interconnected Global Community for Brachytherapy**
  Tim R. Williams, MD
- **The International Cancer Expert Corps: A Peace Corps for Oncology**
  C. Norman Coleman, MD
- **Challenges and Accomplishments for Globalization of Brachytherapy: The (GEC)-ESTRO Perspective**
  Richard Pötter, MD
- **Radioactive Seed Brachytherapy in China: Lessons From the First 14 Years**
  JunJie Wang, MD, PhD, and Fuquan Zhang, MD
- **The Concept of an Interconnected Global Brachytherapy Community**
  André-Guy Martin, MD, MSc, FRCP
- **Panel Discussion: A Rollout Plan for an Interconnected Global Brachytherapy Community**

CHALLENGES

SESSION C3: PRACTICAL TIPS & TRICKS FOR A GOOD BREAST BRACHYTHERAPY IMPLANT USING STANDARD AND NEW DEVICES

Chairs: Csaba Polgár, MD, PhD, MSc; Vratislav Strnad, MD, PhD, Prof.

- **Video Presentation on Postoperative CT- and Template-Guided Breast Implantation**
  Csaba Polgár, MD, PhD, MSc
- **GEC-ESTRO Recommendations for APBI PTV Definition After Open- and Closed-Cavity Surgery**
  Vratislav Strnad, MD, PhD, Prof.
- **Tips & Tricks for a Good Interstitial Implant – Choice Between Different Types of Brachytherapy Techniques**
  Johann Tang, MBBS, FRANCZR
- **Pros & Cons of Single-Lumen (MammoSite®) and Multi-Lumen Balloon Brachytherapy**
  Frank A. Vicini, MD, FACR
- **Panel Discussion**

HANDS-ON WORKSHOP

3:15 – 3:45 PM BREAK

3:45 – 5:30 PM

SESSION D1: WHAT MAKES BRACHYTHERAPY SO EXCITING?

Chairs: Vincenzo Valentini, MD; Yasuo Yoshioka, MD

- **Why Patients Should Choose Brachytherapy**
  Vincenzo Valentini, MD
- **The Awareness to Cure Patients**
  Phillip M. Devlin, MD, FACR, FASTRO, FFRCSI (Hon)
- **The Organ-Sparing Capacity of Brachytherapy**
  Peter Grimm, DO
- **The Portfolio of Technical Innovations**
  Yasuo Yoshioka, MD
- **Panel Discussion: Which Messages Can Reach Your Patients**

SCIENCE

SESSION D2: EMBRACING THE KNOWLEDGE OF RADIOBIOLOGY AND RADIATION

Chair: Christian Kirisits, MSc, PhD

- **The EQD2 Concept for Practical Reporting of Cervix Brachytherapy**
  Christian Kirisits, MSc, PhD
- **Background of Brachytherapy for Different Sites**
  Alexandra Stewart, DM, MRCP, FRCR
- **Hidden Issues in the Use of LQ and Other Models**
  William H. McBride, PhD, DSc
- **Operator Training in HDR Brachytherapy: Preventing Treatment Errors**
  Zoubir Ouhib, MS, DABR
- **Panel Discussion**

CHALLENGES

SESSION D3: WHAT DOES ADVANCED GYNECOLOGIC BRACHYTHERAPY LOOK LIKE IN PRACTICE?

Chairs: Mitchell Kamrava, MD;
Umesh Manhantshetty, DMRT, MD, DNB (RT)

- **CT- and U/S-Guided Brachytherapy Ablation for Gynecologic Cancers**
  Mitchell Kamrava, MD
- **Advanced Brachytherapy Procedures for Local Disease**
  Umesh Manhantshetty, DMRT, MD, DNB (RT)
- **The Planning Process in Adaptive Gynecologic Brachytherapy**
  Razvan Galalae, MD, PhD
- **Planning: Tips & Tricks**
  Johannes C. Athanasios Dimopoulos, MD, and
  Kari Tanderup, PhD

HANDS-ON WORKSHOP

BrachyNext

Working Together to Shape the Future of Brachytherapy

Agenda

Saturday, May 31, 2014

7:00 AM CONTINENTAL BREAKFAST

8:00 – 8:05 AM WELCOME

8:05 – 8:30 AM KEYNOTE LECTURE – RICHARD PÖTTER, MD

Shaping the Future of Brachytherapy - Between New Technologies, Diagnostic Tools, and Improved Outcomes

8:30 – 10:15 AM

SESSION E1: PROSTATE CANCER: IS PROVEN QUALITY AN ARGUMENT?

Chairs: Janusz Skowronek, MD, PhD; Mitchell Kamrava, MD; André-Guy Martin, MD, MSc, FRCP

- **LDR, HDR, or PDR – Crossroads**
  Janusz Skowronek, MD, PhD
- **Why Choose Brachytherapy and Not EBRT?**
  Mitchell Kamrava, MD
- **Is LDR Brachytherapy Still an Option for Developing Countries?**
  André-Guy Martin, MD, MSc, FRCP
- **The Role of HDR Monotherapy for Intermediate-/High-Risk Prostate Cancer Patients**
  John K. Hayes, Jr, MS, MD
- **The Role of HDR Boost for High-Risk Prostate Cancer Patients**
  Ferrán Guedea, MD, PhD
- **Prostate Cancer Results Study Group 2014 – Results Comparing Treatment of Prostate Cancer**
  Peter Grimm, DO
- **Panel Discussion: How Brachytherapy Can Overcome Tremendous Competition**

SCIENCE

SESSION E2: DEVELOPING A BRACHYTHERAPY PROGRAM

Chair: Tim R. Williams, MD

- **How to Start a Brachytherapy Program: It Depends on Where You Live!**
  Tim R. Williams, MD
- **The Essential Components: The Brachytherapy Suite**
  Akila Viswanathan, MD, MPH
- **Starting a Brachytherapy Program in Government-Controlled Healthcare Systems**
  Razvan Galalae, MD, PhD
- **Building a Brachytherapy Program in Developed Countries Outside of the USA and Europe**
  Keith H. C. Lim, MBBS, FRANZCR
- **The Process of Care, Reimbursement Potential, Program Costs, and Pro Forma for Starting a New Brachytherapy Program in the USA**
  Tim R. Williams, MD
- **Panel Discussion**

CHALLENGES

SESSION E3: UNDERVALUED TECHNIQUES EXPOSED

Chairs: Vratislav Strnad, MD, PhD, Prof.; Antonio Cássio Assis Pellizzon, MD, PhD, MSc

- **Brachytherapy for Penile Carcinoma: Technique, Target Definition/Delineation, and Dose Schedule**
  Vratislav Strnad, MD, PhD, Prof.
- **Brachytherapy for Bladder Cancer: Technique, Intraoperative, and Postoperative Target Definition, and Dose Schedule**
  Geert Smits, MD
- **Brachytherapy for Sarcomas: Techniques, Intraoperative Target Definition and Postoperative Target Delineation, and Dose Schedule**
  Antonio Cássio Assis Pellizzon, MD, PhD, MSc
- **Endorectal Brachytherapy: Equipment, Technique, Target Definition, and Dose Schedule**
  Té Vuong, MD, FRCP

This session includes round robin demonstrations using a phantom.

HANDS-ON WORKSHOP

10:15 – 10:45 AM BREAK

10:45 AM – 12:30 PM

SESSION F1: PALLIATIVE BRACHYTHERAPY – A CARE FOR PATIENTS

Chairs: Janusz Skowronek, MD, PhD; Subhakar Mutyala, MD

- **Palliative Brachytherapy: A Solution for Advanced Esophageal Cancer**
  Té Vuong, MD, FRCP
- **Brachytherapy Against Deadly Threat: Dyspnea**
  Subhakar Mutyala, MD
- **"Rendez–Vous" as a Solution for Biliary Duct Cancer**
  Janusz Skowronek, MD, PhD
- **Palliative Brachytherapy of Head and Neck Cancer – When, Why, How?**
  Antonio Cássio Assis Pellizzon, MD, PhD, MSc
- **Panel Discussion: Is Palliative Brachytherapy Always Better Than Supportive Treatment?**

SCIENCE

SESSION F2: CHALLENGES IN ADVANCING YOUR PROSTATE PRACTICE

Chairs: André-Guy Martin, MD, MSc, FRCP; Yasuo Yoshioka, MD; Mitchell Kamrava, MD

- **Are We Going in the Right Direction? Expectations of a Better Cure and Survival Gain With HDR Brachytherapy**
  John K. Hayes, Jr, MS, MD
- **Would SBRT Hypofractionated Approach Be as Good? Then Why Bother With Brachytherapy?**
  Yasuo Yoshioka, MD
- **Can We Salvage Local Recurrence With Brachytherapy Better Than With Surgery or SBRT?**
  D. Jeffrey Demanes, MD, FACRO, FACR
- **Is Focal Therapy Really the Right Step Forward?**
  Mitchell Kamrava, MD
- **Advancing Your Prostate Practice: Could a Robotic Telemanipulator Integrated to Functional Imaging Be of Help?**
  André-Guy Martin, MD, MSc, FRCP
- **Clinical Case Discussions**

CHALLENGES

SESSION F3: IMAGING IN BRACHYTHERAPY

Chair: Christian Kirisits, MSc, PhD

- **MRI-Based Imaging and Contouring of Gynecologic Cases**
  Johannes C. Athanasios Dimopoulos, MD
- **CT-Based Imaging and Contouring of Gynecologic Cases**
  Akila Viswanathan, MD, MPH
- **Registration and Reconstruction of Different Image Modalities (MRI, CT, and U/S) and Applicators**
  Christian Kirisits, MSc, PhD
- **Imaging for Prostate and Other Sites**
  Bradley R. Pieters, MD, PhD
- **Hands-On Cases**

HANDS-ON WORKSHOP

12:30 – 1:30 PM LUNCH

1:30 – 3:15 PM

SESSION G1: NEW HORIZONS – BREAKTHROUGH TECHNOLOGIES

Chair: Vincenzo Valentini, MD

- **Can Protons Replace Eye Brachytherapy?**
  Richard Pötter, MD
- **High-Dose-Rate Intraoperative Radiation Therapy: The Nuts and Bolts of Starting a Program, and New Directions**
  Joseph M. Herman, MD, MSc
- **CT-Guided HDR Brachytherapy in Oligometastases**
  Jens Ricke, MD, PhD
- **HDR and SBRT: Competitive Treatments?**
  Ferrán Guedea, MD, PhD
- **Panel Discussion**

SCIENCE

SESSION G2: BRACHYTHERAPY FOR HEAD & NECK AND SKIN TUMORS – CHALLENGE OR ROUTINE FOR PHYSICIAN AND PHYSICIST?

Chairs: Tim R. Williams, MD; Vratislav Strnad, MD, PhD, Prof.

- **Surface Brachytherapy for Squamous and Basal Cell Carcinomas of the Skin**
  Michael E. Kasper, MD, FACRO
- **Head & Neck Brachytherapy: Primary or Salvage – When, Why, Who?**
  Vratislav Strnad, MD, PhD, Prof.
- **Interactive Session: Solve a Problem — Large-Volume Skin Brachytherapy — Scalp, Skin, Breast Wall, etc.**
  Alexandra Stewart, DM, MRCP, FRCR
- **Clinical Case Discussion**

CHALLENGES

SESSION G3: PROSTATE BRACHYTHERAPY: FROM NEEDLE INSERTION AND BASIC PLANNING TO INTEGRATED REAL-TIME ULTRASOUND-BASED PROCEDURES

Chairs: André-Guy Martin, MD, MSc, FRCP; Luc Beaulieu, PhD

- **Why HDR Prostate Brachytherapy and for Whom?**
  André-Guy Martin, MD, MSc, FRCP
- **Overview of an HDR Brachytherapy Procedure**
  André-Guy Martin, MD, MSc, FRCP
- **Hands-on Session**
  John K. Hayes, Jr, MS, MD; Luc Beaulieu, PhD; André-Guy Martin, MD, MSc, FRCP
- **Ask the Experts**

HANDS-ON WORKSHOP

3:15 – 3:45 PM BREAK

3:45 – 5:30 PM

SESSION H1: HIDDEN HEROES OF BRACHYTHERAPY: UNDERVALUED TECHNIQUES

Chairs: Vratislav Strnad, MD, PhD, Prof.; Antonio Cássio Assis Pellizzon, MD, PhD, MSc

- **Penile Carcinoma – Organ Preservation With Brachytherapy**
  Vratislav Strnad, MD, PhD
- **Bladder Cancer: Is Brachytherapy an Alternative for Cystectomy?**
  Bradley R. Pieters, MD, PhD
- **Sarcoma: Benefit From Brachytherapy in Curative Intention**
  Antonio Cássio Assis Pellizzon, MD, PhD, MSc
- **Is High-Dose-Rate Brachytherapy a Treatment Option for Patients With Rectal Cancer?**
  Té Vuong, MD, FRCP
- **Interstitial Brachytherapy for Lung Cancer: Techniques and Results**
  Alexandra Stewart, DM, MRCP, FRCR
- **Panel Discussion**

SCIENCE

SESSION H2: THE COMPELLING CASE FOR BRACHYTHERAPY IN THE PALLIATIVE SETTING

Chairs: Janusz Skowronek, MD, PhD; Yasuo Yoshioka, MD; Tim R. Williams, MD

- **Re-irradiation of Lung Cancer: Undervalued Possibility**
  Janusz Skowronek, MD, PhD
- **Re-irradiation Using HDR Interstitial Brachytherapy for Locally Recurrent Cervical Cancer**
  Yasuo Yoshioka, MD
- **Esophageal Cancer: Is Combination With Surgery (Stents) or EBRT a Better Solution?**
  Razvan Galalae, MD, PhD
- **Quality of Life: To Treat or Not to Treat?**
  Tim R. Williams, MD
- **Clinical Case Discussion**

CHALLENGES

SESSION H3: SKIN, HEAD & NECK

Chair: Subhakar Mutyala, MD

- **Leipzig Applicators and E-brachytherapy**
  Zoubir Ouhib, MS, DABR
- **Surface Molds – Believe it or Not, Not All Skin Cancers Are Flat and Round!**
  Subhakar Mutyala, MD
- **Head & Neck Brachytherapy (Clinical)**
  Phillip M. Devlin, MD, FACR, FASTRO, FFRCSI (Hon)
- **Head & Neck Brachytherapy (Physics)**
  Frank André-Siebert, PhD

HANDS-ON WORKSHOP

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Abstracts from

BrachyNext

Working Together to Shape the Future of Brachytherapy

OA-A100

Breast Brachytherapy in the Heat of Competition

Atif J. Khan, MD[1], Jean-Michel Hannoun-Levi, MD, PhD[2], Csaba Polgár, MD, PhD, MSc[3]

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This is an exciting session that will begin with a brief overview by Dr. Khan of currently reported phase III randomized data comparing partial-breast radiation therapy (RT) with whole-breast RT, as well as pending randomized trials that will be reported in the coming years. Next, Dr. Kuske will report current indications of breast brachytherapy, including its use in the setting of the augmented breast. Dr. Hannoun-Levi will update the group on his reported experience of using multi-catheter brachytherapy for salvage of local recurrence in the irradiated breast. Dr. Polgár will contrast the brachytherapy experience and data with that of intraoperative RT (IORT) and external beam accelerated partial-breast irradiation (APBI) approaches. Finally, Dr. Vicini will review the reported experiences on balloon-based brachytherapy.

OA-A101

Overview of APBI Phase III Trials: Validation of the APBI Concept According to the Irradiation Technique Used

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The past year has seen early reporting of several major randomized trials of partial- versus whole-breast irradiation. The Hungarian trial reported by Polgár *et al*. (*Int J Radiat Oncol Biol Phys* 2007; 69: 694-702) will be reviewed. This will be followed by a discussion of the data reported from the TARGIT-A (Vaidya *et al*., *Lancet* 2010; 376: 91-102) and ELIOT trials (Veronesi *et al*., *Lancet* 2013; 14: 1269-1277). Early toxicity results from the Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) trial and the Canadian RAPID trial (Olivotto *et al*., *J Clin Oncol* 2013; 31: 4038-4045) will also be discussed. Finally, a brief overview of the design of currently pending and unreported randomized trials will be presented.

OA-A102

Breast Brachytherapy "State-of-the-Art"

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Accelerated partial-breast irradiation (APBI) is a 5-day alternative to the conventional 5-7 weeks of external beam whole-breast irradiation (WBI). The extended time for WBI is difficult for many busy, modern women. The exposure of normal tissues such as the heart and lung is unattractive to these patients as well. These issues inspired us 22 years ago to investigate a treatment that only covers the involved portion of the breast, lasts 1 week or less, and causes minimal collateral damage. Brachytherapy was the ideal choice for such a treatment.

Clinical trials have supported the concept of brachytherapy APBI. The Radiation Therapy Oncology Group (RTOG) 95-17 phase II trial of 99 patients treated with interstitial brachytherapy, now out 12.5 years, has demonstrated a very low (5%) breast recurrence rate with broad selection criteria. A Hungarian phase III trial (Polgár *et al*., *Int J Radiat Oncol Biol Phys* 2007; 69: 694-702) comparing brachytherapy to WBI was positive for brachytherapy, and tumor control was equivalent with better cosmesis in the brachytherapy arm. Large phase III trials from North America (National Surgical Adjuvant Breast and Bowel Project [NSABP] B39/RTOG 0413, n = 4214) and Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) are maturing after closure and should be published in 2-3 years.

Simplifying APBI with single-entry balloon catheters or a strut-based device has been reported in large registry trials. A very large registry trial (NSABP B39/RTOG 0413) with interstitial brachytherapy is demonstrating excellent long-term outcomes. Disappointing pretreatment path review, dosimetry, quality assurance, and clinical outcomes have plagued intraoperative radiotherapy with intrabeam or electron beam. APBI appears to be an acceptable treatment option of select tumors < 3 cm, excised with clear margins, with 0-3+ nodes without extracapsular extension.

OA-A103

Salvage Brachytherapy as a New Indication After Previous BCT

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Purpose: In cases of ipsilateral breast tumor recurrence (IBTR), radical mastectomy represents the treatment option frequently proposed. A second, conservative treatment (2nd CT) has been proposed using either lumpectomy alone or

lumpectomy associated with a re-irradiation of the tumor bed. However, in both clinical situations, the evidence of effectiveness of these therapeutic approaches remains low, based on cased-series or retrospective studies (level C).

Material and methods: In order to assess the different strategies of local treatment proposed in cases of IBTR, a PubMed literature review was performed using the following keywords: breast cancer, ipsilateral recurrence, mastectomy, radiation therapy, brachytherapy. Four different salvage options were analyzed: a) salvage mastectomy alone, b) salvage mastectomy with postoperative re-irradiation, c) 2nd CT with surgery alone, d) and 2nd CT with re-irradiation.

Results: The rate of second local recurrence is about 10% (3-32%), about 25% (7-36%), and about 10% (2-26%) after salvage mastectomy, salvage lumpectomy alone, or salvage lumpectomy combined with a re-irradiation of the tumor bed, respectively. However, the 5-year overall survival rates after salvage mastectomy and 2nd CT seem to be equivalent (≈75%), mainly influenced by distant metastatic progression.

Conclusion: In terms of evidence-based medicine, future studies such as phase II or III randomized trials comparing salvage mastectomy to 2nd CT retrospective studies based on a matched-pair analysis or observatory studies should be explored. Such study designs and outcomes are needed to be able to propose new treatment options for women who experience IBTR.

OA-A104

Why Choose Brachytherapy and Not External Beam RT or IORT?

Csaba Polgár, MD, PhD, MSc

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There has been great interest in treating patients with early-stage breast cancer with accelerated partial-breast irradiation (APBI). We review the results of studies using external beam radiation therapy (EBRT) and intraoperative radiation therapy (IORT).

Recent improvements in brachytherapy have reduced the local recurrence (LR) rates from a range of 1.4% to 6.2% to LR rates ranging from 0.0% to 1.1% (Table). The results of the Budapest study suggest that multi-catheter APBI brachytherapy for select patients produces similar results to whole-breast irradiation (WBI) and significantly better cosmetic outcomes. Furthermore, toxicity results of the Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) APBI trial suggest that multi-catheter APBI brachytherapy is associated with significantly less skin-related side effects. While APBI studies using the MammoSite® brachytherapy applicator are encouraging, some concerns have arisen about increased skin toxicity and subsequent mastectomy rates associated with the MammoSite radiation therapy system. Multilumen hybrid brachytherapy applicators have been developed to increase the flexibility of dose shaping. The results of 3D conformal radiation therapy (3D-CRT) APBI studies are also encouraging. Unfortunately, some studies and toxicity analyses of the RAPID trial suggest that 3D-CRT APBI increased the rates of adverse cosmesis and late side effects. Recently, 2 trials proved that the use of IORT significantly increased the risk of subsequent local recurrence.

In conclusion, long-term results of phase II and III clinical trials prove that APBI with multi-catheter brachytherapy is a safe alternative of conventional WBI for low-risk breast cancer patients. APBI trials failed to demonstrate non-inferiority of IORT. Mid-term toxicity results of the RAPID trial also raised some concerns. Long-term results of the National Surgical Adjuvant Breast and Bowel Project/Radiation Therapy Oncology Group (NSABP/RTOG) and GEC-ESTRO phase III trials are eagerly awaited and will hopefully clarify the value of different APBI techniques.

Table

Institute	Study period	APBI technique	Patient No.	Median FUP (y)	Total LR%	Annual LR%
Christie Hospital*	1982-1987	ELE	353	8	20	2.5
Guy's Hospital I	1987-1988	LDR BT	27	6	37	6.2
Cookridge Hospital*	1986-1990	EBI	84	8	12	1.5
Guy's Hospital II	1990-1992	MDR BT	49	6.3	18	2.9
Uzsoki Hospital	1987-1992	MDR BT	70	12	24	2.0
University Florence I	1989-1993	LDR BT	115	4.2	6	1.4
London Regional Cancer Center	1992-1996	HDR BT	39	7.6	15	1.97
All patients	1982-1993		698	4.2-12	17	1.4-6.2
Interstitial brachytherapy series						
Oschner Clinic	1992-1993	LDR/HDR BT	51	6.25	2	0.32
William Beaumont Hospital	1992-2001	LDR/HDR BT	199	10.7	5	0.47
Örebro Medical Center	1993-2003	PDR BT	51	7.2	5.9	0.82

Table. Continue

Institute	Study period	APBI technique	Patient No.	Median FUP (y)	Total LR%	Annual LR%
Budapest Phase II	1996-1998	HDR BT	45	13.8	11.1	0.80
RTOG 95-17	1997-2000	LDR/HDR BT	99	7	6.1	0.87
Tufts University	1997-2001	HDR BT	33	5.9	9.1	1.54
Harvard, Boston	1997-2001	LDR BT	50	11.2	12	1.07
Budapest Phase III*	1998-2004	HDR BT/ELE	128	10.2	5.5	0.53
Ninewells Hospital	Before 1999	LDR BT	11	5.6	0	0
German-Austrian	2000-2005	PDR/HDR BT	274	5.2	2.9	0.56
University Navarra	2000-2007	HDR BT	26	4.4	3.8	0.86
Washington University	2002-2007	HDR BT	202	> 5	2.5	0.50
All patients	1992-2007		1169	4.4-13.8	0-11.1	0-1.54
MammoSite brachytherapy series						
Registry trial	2000-2001	MammoSite BT	43	5.5	0	0
ASBS trial	2002-2004	MammoSite BT	1449	5.3	2.8	0.53
Kiel-Budapest	2002-2004	MammoSite BT	11	5	0	0
Pittsburgh	2002-2007	MammoSite BT	157	5.5	2.5	0.46
All patients	2000-2007		1660	5-5.5	0-2.8	0-0.53
3D-CRT series						
New York University	2000-2005	3D-CRT	98	5.3	1	0.19
William Beaumont Hospital	2000-2011	3D-CRT	192	4.8	1.6	0.33
RTOG 0319	2003-2004	3D-CRT	52	4.5	5.8	1.29
Dana-Farber/Harvard	2003-2005	3D-CRT/IMRT	98	5.9	5.1	0.86
Rocky Mountain Cancer Centers	2004-2007	3D-CRT	136	4.4	0.7	0.16
Budapest	2006-2011	3D-CRT	44	4.5	2.3	0.51
All patients	2000-2011		620	4.4-5.9	0.7-5.8	0.16-1.29
IORT series						
ELIOT*	2000-2007	ELE	1307	5	5.3	1.1
TARGIT*	2000-2009	50 KV photons	3451	2.4	> 3	> 1
All patients	2000-2009		4758		> 35.3	> 1

**Randomized clinical trial.*
BT – brachytherapy, EBI – external beam irradiation, ELE – electron radiation, FUP – follow-up, HDR – high-dose-rate, IMRT – intensity-modulated radiation therapy, LDR – low-dose-rate, MDR – medium-dose-rate, PDR – pulsed-dose-rate

OA-A105

Results of APBI Clinical Trials Using Intracavitary Single- and Multi-Channel Breast Brachytherapy Applicators

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The equivalence of breast-conserving therapy (BCT) to mastectomy has been demonstrated in several phase III trials with over 20 years of follow-up. Recent investigations have evaluated reductions in treatment duration as well as toxicity. Accelerated partial-breast irradiation (APBI) has been investigated as a possible option that incorporates both a decrease in the overall treatment time and a reduction in the amount of normal tissue irradiated. This presentation will review the results of APBI using both single- and multi-channel applicators.

Randomized data from the Hungarian trial (Polgár *et al., Radiother Oncol* 2013; 108: 197-202) with long-term follow-up has demonstrated equivalence between multicatheter interstitial brachytherapy (MIB) and whole-breast irradiation, with several prospective and retrospective studies confirming these findings. Mature data from the American Society of Breast Surgeons MammoSite® Registry trial have demonstrated low rates of ipsilateral breast tumor recurrence, with a rate of 3.8% at 5 years and

93% of patients having excellent/good cosmesis. With single-channel applicators offering limited dosimetric shaping capabilities, multi-lumen applicators have been developed to address critical dosimetric shortcomings of single-lumen breast brachytherapy applicators. These improvements resulted from the ability of the additional lumens to improve dose coverage of the breast target while concurrently reducing doses to adjacent structures such as the skin, chest wall, and pectoralis muscle.

Data from MIB and single-channel brachytherapy applicators have confirmed the clinical efficacy of APBI utilizing brachytherapy. Multi-channel applicators represent the current standard based on dosimetric studies with long-term clinical outcomes data expected in the years to come.

OA-A200

Brachytherapy in Gynecologic Cancers: Challenges and Developments

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Cervical cancers are the most common gynecologic (GYN) cancers worldwide. Radical radiation or chemotherapy with brachytherapy is the mainstay of treatment for inoperable disease. Over the past 2 decades, significant technological advances in imaging radiation technology have been implemented in routine clinical practice, which have translated into better therapeutic ratio. This session will focus on "Challenges and Developments in Brachytherapy for GYN Cancers" in different environments.

The first presentation will be a first-hand experience from Vienna, one of the pioneering institutions for transition from 2D to 3D image-based brachytherapy in cervical cancers. The presentation will highlight various hurdles, evolution, solutions, practical tips and tricks, and the success story.

The second presentation will focus on challenges of implementation in developing economies. The discussion will highlight the working environment, practical hurdles, optimal utilization of resources, implementation and clinical experience, ongoing research, and collaborative efforts.

The third presentation will discuss imaging modalities, current challenges, and future directions. This talk will include evolution of incorporation of imaging modalities in image-based brachytherapy for cervical cancers in terms of establishing various imaging protocols, advantages and disadvantages of various imaging modalities, ongoing research, and future directions.

The session will be concluded by a panel discussion on some interesting clinical case capsules that will be interactive and involve active participation for the contributing panel members and participants. These case capsules will highlight the workflow, decision making, practical tips and tricks, and discussion on optimum brachytherapy solutions.

OA-A201

Transition From 2D to 3D Brachytherapy in Cervical Cancers: The Vienna Experience

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In the treatment of locally advanced cervical cancer, 2D radiographs have been used for decades for brachytherapy point-based treatment planning and reporting. For 2 decades, the University of Vienna has been gaining experience in 3D image-guided brachytherapy (1st CT [Fellner *et al*., *Radiother Oncol* 2001; 58: 53-62], 2nd MRI), optimizing dose distributions to the individual patient anatomy, including clinical target volumes (CTVs) and organs at risk (OARs).

While 2D brachytherapy was based on dose prescription to point A and OAR dose reporting of ICRU points, the introduction of 3D imaging in the planning process has lead to an adaptive MRI-based target concept (high-risk CTV) and the use of dose-volume parameters for dose prescription and reporting. DVH-based treatment protocols have been developed using, for example, D_{90} for CTV_{HR} and $D_{0.1cm^3}$ and D_{2cm^3} for OAR dose prescription and reporting. Dosimetric studies show that 3D brachytherapy reduces OAR doses and escalates target doses (Kirisits *et al*., *Int J Radiat Oncol Biol Phys* 2005; 62: 901-911). Comparison of point A-based plans with 3D-optimized techniques reveal that, for limited size targets, the mean target coverage by a 2D standard plan is high, while OAR doses are more often violated than by 3D-optimized plans; however, coverage of large targets can only be achieved by advanced intracavitary/interstitial implants without violating OAR dose volume constraints (Kirisits *et al*., *Int J Radiat Oncol Biol Phys* 2006; 65: 624-630, Tanderup *et al*., *Radiother Oncol* 2010; 94: 173-180). 3D applicator reconstruction protocols are mandatory. The Vienna clinical experience (n = 228) indicates an excellent 3-year local control of 95-100% in limited disease (stage I/II) and 85-90% in large/poor response patients (stage III/IVA) (Pötter *et al*., *Radiother Oncol* 2007; 83: 148-155, *Radiother Oncol* 2011; 100: 116-123).

Detailed reporting of DVH parameters and outcomes in large patient cohorts was used to derive dose-response relationships for target (Dimopoulos *et al*., *Radiother On-*

col 2009; 93: 311-315, *Int J Radiat Oncol Biol Phys* 2009; 75: 56-63), as well as for OAR (bladder, rectosigmoid, Georg *et al*., *Radiother Oncol* 2009; 91: 173-180, *Int J Radiat Oncol Biol Phys* 2011; 79: 356-362, *Int J Radiat Oncol Biol Phys* 2012; 82: 653-657).

OA-A202

Implementation in Clinical Practice – Challenges in Developing Economies

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Cancer of the uterine cervix is the leading cancer among the female population in developing countries including India. Brachytherapy after radical external radiation chemotherapy is vital in terms of both control rates and toxicities. There have been significant technological advances in imaging and radiation technology. However, advances in brachytherapy are less pronounced and slower. Availability and implementation of newer radiation technologies in developing countries is an even bigger challenge.

Although image-guided brachytherapy (IGBT) appears promising, it needs critical review for applicability and adaptation in our setting, especially in high-volume centers and other developing countries. The challenges in practical implementation of an IGBT program in India and other developing economies can be discussed under the following headings:

Imaging: Availability of magnetic resonance imaging (MRI) for IGBT still remains a major challenge. The diagnostic indications outweigh the availability of MRI for IGBT.

Applicators: One of the pivotal components of IGBT is the use of an appropriate applicator. The conventional intracavitary brachytherapy applicators are not suitable for computed tomography (CT)/MRI, as they are fragile, expensive, and not cost-effective.

Training and education: IGBT is associated with a learning curve. The major hurdles include imaging protocols, contouring, catheter reconstruction, prescription, optimization, plan evaluation, and reporting of dose volume parameters. Focused training and workshops for physicians, physicists, etc. are necessary.

Although published data on 3D image-based brachytherapy in cervical cancers from India is sparse, it does not preclude its use. There is a need to generate data on CT or MR 3D image-based brachytherapy planning, participate in international research studies to optimize treatment, and continue to upgrade in existing facilities and enhance training and quality care.

OA-A203

Imaging Modalities: Current Challenges and Future Directions

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High-precision radiotherapy techniques, such as image-guided adaptive brachytherapy (IGABT) for gynecological malignancies, offer the option of enhancement of the therapeutic ratio. Magnetic resonance imaging (MRI) represents the gold standard for IGABT for gynecological malignancies.

MRI with its improved soft tissue depiction is integrated in each link of the modern brachytherapy chain, from pre-treatment disease assessment to choice of appropriate brachytherapy application technique, target and organ definition, applicator reconstruction, and treatment planning. For the individual patient, all single steps of the chain depend on parameters that are obtained from MRI and/or clinical examination. To meet the demands for IGABT, MRI must provide sufficient information about tumor/target extent, tumor/target growth pattern, and patho-anatomical structure topography at the time of diagnosis and brachytherapy, as well as comprehensive information about quantitative and qualitative tumor regression.

To reduce contouring uncertainties and to identify the target and organs with high accuracy, a radiation oncologist has to apply image acquisition protocols adapted to the needs of IGABT. T2-weighted MRI sequences are considered to be the gold standard. Accurate target and organ delineation has to be performed according to standardized protocols.

The near future of IGABT will be defined by the increased availability of high field 3T MRI scanners. Preliminary reports aimed at integrating the additional information provided by functional imaging (e.g., positron-emission/computed tomography [PET-CT] and multiparametric MRI) into the procedure of IGABT for gynecological malignancies. However, a systematic methodology allowing the routine implementation of these imaging modalities is not available.

OA-B100

Gynecology – 100 Years of Experience, New Challenges

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This session focuses on endometrium and cervix carcinoma brachytherapy and other relevant gynecological brachytherapy procedures. State-of-the-art endometrium techniques are also discussed. Vaginal cylinders are a standard treatment technique. However, clinical issues, dosimetry, and the most optimal dose distribution can be improved. Multi-channel vaginal cylinders are one option. Their use and potential will be presented in detail.

Also, for cervix cancer brachytherapy, the conventional intracavitary approach can be improved by optimizing the implant geometry including more degrees of freedom for dwell position placement. Most modern interstitial techniques are summarized.

The use of image-guided approaches with optimized dose distributions needs clear terminology for prescribing and reporting. The upcoming International Commission on Radiation Units & Measurements (ICRU)/ Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) report will provide an overall concept for target and organs-at-risk (OAR) definitions and for dose assessment. One discussion will focus on how to apply these new concepts in daily clinical practice.

Nowadays, prescribing is based on dose constraints for target and OAR. These constraints are based on the current evidence on dose response. An update of the most recent results from the ongoing EMBRACE and Retro-EMBRACE trials will summarize the current basis.

OA-B101

Vaginal Cylinders for Modern Brachytherapy

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Postoperative vaginal high-dose-rate (HDR) brachytherapy is commonly used for intermediate-risk endometrial cancer. Treatment can begin 4-6 weeks after hysterectomy as long as pelvic examination confirms the vaginal apex is healed. Applicator selection varies with anatomy. The largest diameter cylinder that can be comfortably inserted improves dosimetry. The dose (7 Gy x 3 to 6 Gy x 5) is prescribed to the upper vagina (≈4 cm) at 5 mm (standard) or less at the mid-lateral applicator. Applicator tip and surface (mucosal) doses are calculated, and multiple organs-at-risk (OAR, bladder, urethra, rectum) reference points should be ≤ 80-90%.

The low-dose-rate single-channel vaginal cylinder (SC-VC) was "cross-walked" to HDR technology. Dosimetry control with SC-VC is limited and doses to normal structures are higher than necessary. Tissue lateral to the apex may be underdosed by a single-channel applicator so ovoids are sometimes used, but the dose to the mid-apex and mid-vagina may be inadequate.

Multi-channel vaginal cylinders (MC-VCs) enhance dosimetry (Demanes *et al*., *Int J Radiat Oncol Biol Phys* 1999; 44: 211-219) by customizing the target-to-OAR ratio. The pattern 5 (like dice) is most suitable. MC-VCs are commercially available with up to 13 channels. One or more isodose calculations are needed (preferably 3D). Park *et al*. (*Int J Radiat Oncol Biol Phys* 2013; 87: S424) has evaluated the dosimetry of various channel configurations. MC-VC must not be allowed to rotate out of position, and the applicator must be mechanically secured and snug at the apex. Fiducial seeds and imaging confirmation for each fraction are advisable. Vaginal brachytherapy is an effective low-morbidity measure to reduce local recurrence in selected cases of endometrial cancer.

OA-B102

The Overall Concept for Definitive Endometrium Radiotherapy

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This session will consider the definitive radiation therapy for endometrial carcinoma. This technique is not commonly used and not well studied in a prospective fashion, and therefore no treatment standard has been created. The variety of brachytherapy implant techniques will be examined, such as Heyman capsules and Horiot applicators. A discussion will be held concerning various fractionations. Clinical experience and published data will be presented, along with current recommendations of the American Brachytherapy Society (ABS).

OA-B103

Modern Interstitial Techniques

Umesh Mahantshetty, DMRT, MD, DNB (RT), Swamidas V. Jamema, MSc, Yogesh Ghadi, MSc, Reena Engineer, DMRT, MD, DNB, Supriya Chopra, MD, Deepak D. Deshpande, PhD, Shyam K. Shrivastava, MD, DNB

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Interstitial brachytherapy in gynecologic cancers is essentially performed to adequately treat extensive

local disease, parametrial or vaginal disease, and distorted anatomy unsuitable for standard intracavitary brachytherapy. Interstitial brachytherapy techniques have evolved from free hand placement to the use of templates and various imaging modalities for accurate needle placement and optimum target coverage. The evolution of interstitial brachytherapy in gynecologic cancers can be discussed in terms of:

Applicator development: Newer applicators range from customized endo-vaginal with needles, computed tomography/magnetic resonance imaging (CT/MRI)-compatible intracavitary with interstitial to newer templates with titanium and plastic needles.

Imaging: Imaging enables accurate placement of needles/tubes. Various imaging modalities include fluoroscopy, ultra-sonography, CT, MRI, and laparotomy. Imaging is used in 3D planning processes including contouring, accurate catheter reconstruction, and plan evaluation. Finally, imaging is being evaluated to report inter-fraction and intra-fraction variations and quality assurance.

Treatment planning: Treatment planning systems for brachytherapy have evolved with powerful tools for catheter reconstruction, better optimization algorithms, and quality.

In cervical cancers, interstitial brachytherapy is used in < 10% to 15% of patients with advanced disease and inadvertent surgery (extensive parametrial disease and local anatomy not suitable for intracavitary), post-operative local relapses and post-hysterectomy vault cancers, vaginal cancers and post-operative vaginal relapses in endometrial cancers, and vulval cancers.

Recent advances in interstitial brachytherapy approaches include real-time tracking of needles, MRI and laparoscopy guidance to improve needle/catheter placement accuracy, adaptive approaches with combination of various imaging modalities, introduction of spacers to reduce toxicities, newer brachytherapy applicators, and robotic remote approaches. Further research is essential in combining external and brachytherapy doses in radiobiological models, incorporation of newer imaging sequences, and dose adaptation to improve the therapeutic ratio.

OA-B104

The New ICRU/GEC-ESTRO Report in Clinical Practice

Christian Kirisits, PhD, and Richard Pötter, MD, on behalf of the ICRU Report 88 Committee

Medical University of Vienna, Vienna, Austria

The upcoming International Commission on Radiation Units & Measurements (ICRU)/Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) report for gynecological brachytherapy (anticipated in 2014) will contain concepts for prescribing, reporting, and recording using volumetric imaging or radiographic imaging. The key elements are a 4D adaptive target and organs-at-risk (OAR) concept, together with dose and volume parameters. Three different levels allow the choice of a minimum standard, an advanced standard, or research-oriented reporting. The documentation of the clinical examination, total reference air kerma (TRAK), and point A remains essential for all levels. With volumetric imaging, the delineation of the bladder and rectum and reporting of D_{2cm^3} and $D_{0.1cm^3}$ is recommended. The recto-vaginal point, identical to the previous ICRU rectum point, is mandatory. For advanced reporting, the delineation of the high-risk clinical target volume (CTV_{HR}) based on the residual gross tumor volume (GTV) and surrounding areas, assumed to carry a high risk for residual cancer cell involvement, is included. The heterogeneous dose in the target volumes is represented by D_{98}, D_{90}, and D_{50}. In addition to contours including the entire organ, the report emphasizes the presence of different morbidity endpoints and related substructures within the organ (e.g., bladder neck). The radiobiology chapter encourages the use of the equivalent dose in 2 Gy (EQD2) concept as the current best option for treatment planning and overall dose reporting. It is emphasized to report dose parameters sensitive to the intermediate dose region, especially to also take into account the external beam contribution. For the vagina, a set of dose points are proposed to report the dose close to the brachytherapy applicators, but also at different reproducible positions within the vagina to take into account the external beam fields.

OA-B105

Update of EMBRACE and Retro-EMBRACE

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The Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) GYN network initiated the prospective EMBRACE trial in 2008 (International Study of MRI-guided Brachytherapy in Cervix Cancer) (www.embracestudy.dk). EMBRACE comprises 30 key international centers that deliver MRI-guided brachytherapy in locally advanced cervical cancer according to the GEC-ESTRO recommendations. The aim of the EMBRACE protocol is to benchmark MRI-guided brachytherapy in a multicenter setting within the frame of a prospective observational study and to correlate image-based dose-volume histogram (DVH) parameters for the clinical target volume and for organs at risk with outcome. More than 1000 patients have been enrolled, and accrual will finalize in 2014. Furthermore, the retrospective Retro-EMBRACE study has enrolled

> 700 patients treated with image-guided brachytherapy from 12 international centers (www.retroembrace.com). Upcoming data from EMBRACE and Retro-EMBRACE show significant correlation between dose and outcome for both local control and normal tissue (bladder, rectum, bowel, and vagina). While there is currently not international consensus on dose prescription in cervix cancer, a new study (EMBRACE II) will for the first time implement a prospective dose prescription protocol for both target and organs at risk based on clinical outcome data from EMBRACE and Retro-EMBRACE. EMBRACE II will be initiated in 2014.

OA-B201

Breast Brachytherapy: State-of-the-Art and Challenging Perspectives

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Brachytherapy represents the smartest way to deliver a high dose in a small volume, especially in breast cancer, which is highly sensitive to dose escalation. While boost after whole-breast post-operative irradiation has been the main brachytherapy indication, during the last 2 decades, breast brachytherapy appeared increasingly attractive in other situations, such as accelerated and partial-breast irradiation as sole therapy and for second conservative treatment in ipsilateral breast tumor recurrence.

Currently, we have new radiation therapy technologies from external beam to intra-operative going through new brachytherapy devices. New challenges for brachytherapists include placing their radiation technique at the right place in this therapeutic arsenal and finding the optimal brachytherapy technique to achieve the best clinical outcome for the patient. Indeed, achieving good local control with a very low rate of side effects remains a key objective. This concept appears strongly correlated with certain rules of vector implantation, dose distribution constraints, and target delineation.

Beside technological and medico-economic evolutions, the radiation oncology community has to face methodological and statistical developments. In the frame of evidence-based medicine, clinical research represents the main asset to progress and development of new validated treatments. Is it still possible to continue to wait 10-15 years after the inclusion of thousands of patients and the expense of thousands (millions) of dollars/euros? Is "overall survival" always the smartest primary endpoint? What could be the next step in clinical research for the promotion of breast brachytherapy? Clinical research needs to evolve along with the evolution of our environment.

OA-B202

Brachytherapy for Breast Cancer: Which Device for Which Patient?

Robert R. Kuske, MD, FAACE

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Breast brachytherapy is becoming an attractive 5-day option for women with select breast cancers. In the United States, approximately 12% of breast cancers are receiving accelerated partial-breast irradiation (APBI).

Interstitial multi-catheter brachytherapy treats 1.5-2 cm beyond the lumpectomy cavity, while single-entry intracavitary devices are limited to treat only 1 cm beyond the lumpectomy cavity edge.

I choose interstitial multi-catheter brachytherapy in patients: 1) aged < 50 years, 2) with aggressive breast cancers such as estrogen receptor (–), 3) augmented women, 4) after oncoplastic surgery where there is no cavity, 5) with tight surgical margins < 2 mm or lobular histologies, lymphovascular invasion (LVI), extensive intraductal component (EIC), or node-positive, or 6) with inner quadrant or axillary tail breast cancers.

I choose single-entry devices when: 1) the patient is aged > 60 years, 2) there are generous surgical margins ≥ 5 mm, 3) node-negative, or 4) surgeon's preference.

I choose 3D conformal radiation therapy APBI in patients who are needle-phobic or so sick from comorbidities that they cannot tolerate a procedure.

Intraoperative radiation therapy can present challenges: 1) no pathology confirmation that the patient is a candidate for APBI, such as positive margins or multiple positive nodes or extracapsular extension, 2) a single large dose of radiation could cause normal tissue damage, 3) there may be insufficient quality control, defining the target volume, ensuring coverage of the planning target volume (PTV), and 4) there may be potential difficulty in treating the patient with whole-breast radiation therapy if adverse lumpectomy/axillary pathology is encountered.

OA-B203

How to Prevent/Avoid Late Side Effects

Csaba Polgár, MD, PhD, MSc

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Before implementation of accelerated partial-breast irradiation (APBI), in addition to non-inferior local control and survival results, at least a comparable long-term toxicity profile should be documented according to each APBI technique.

Long-term results of multi-catheter brachytherapy APBI studies proved that skin and parenchymal side

effects are at least comparable to those experienced with whole-breast irradiation (WBI). The Budapest trial results suggest that significantly better cosmetic outcome can be achieved with multi-catheter implants compared with the outcome after WBI. The toxicity results of the Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) APBI trial suggest that multi-catheter APBI is associated with significantly less skin-related side effects. According to multiple trials, the keystones of low rates of late side effects after multi-catheter brachytherapy are to limit the skin dose below 70% of the prescribed dose, avoid large volume implants, limit dose non-uniformity ratio below 0.35, and limit the volume of high-dose region as low as possible.

On the other hand, in a recent large retrospective population-based cohort study, brachytherapy was associated with significantly higher incidence of subsequent mastectomy and postoperative complications compared with WBI. In the Budapest trial, only 1 patient in the APBI arm and 3 in the WBI arm underwent subsequent mastectomy. Results of MammoSite® APBI suggest a balloon-to-skin distance of ≥ 15 mm is advised. The results of 3D conformal radiation therapy (3D-CRT) APBI studies are encouraging. Unfortunately, some studies suggest that 3D-CRT APBI increased rates of adverse cosmesis and late radiation toxicity compared with WBI.

In conclusion, long-term results of multiple clinical trials prove that APBI with multi-catheter brachytherapy is a safe alternative to WBI for low-risk breast cancer patients.

OA-B204

Challenges Faced in Setting Up a Breast Brachytherapy Service

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Setting up a new breast brachytherapy service is a challenge to most departments given that departments are frequently restricted by limited resources. A heavy investment, especially in staff training and equipment, can be required to establish a brachytherapy site. Other potential barriers may include additional administrative staffing and/or training, physician preference, and patient acceptance. These can be particularly daunting outside of the multidisciplinary setting. Overcoming these challenges is key, given the potential benefits of breast brachytherapy in terms of better clinical cosmesis, lower toxicity, and improved breast adjuvant radiotherapy compliance outcomes. This talk will present some of the challenges faced and how these challenges might be overcome.

OA-B205

Breast Brachytherapy: How to Allay Fears of Patients and Colleagues, and What Are Our Expectations for the Future?

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Often, when considering accelerated partial-breast irradiation (APBI) using adjuvant interstitial brachytherapy after breast-conserving surgery, we have to counter the fears of patients (will there be pain? will scars remain?) as well as those of physicians (isn't an enormous amount of experience and skill necessary?). This presentation analyzes the fears, facts, and expectations surrounding APBI using brachytherapy in terms of clinical experience, quality assurance, and clinical results.

The long-term results of APBI using brachytherapy for selected patients, with a published mean annual local recurrence rate of approximately 0.7% per year, compare favorably to trials with similar patient populations using whole-breast irradiation (WBI). When addressing the reservations and fears held by some patients concerning pain and the risk of scarring, it quickly becomes obvious that these fears are mostly unfounded. The experience and skill of physicians are important in decision-making situations. Guidelines that are constantly refined to reflect the published results of clinical outcomes with APBI will help alleviate physicians' concerns about experience and skill. Also, further improvements in brachytherapy technology with "easy implant devices" will make it possible to simplify the utilization of brachytherapy for APBI and to select the most appropriate APBI techniques according to the patient's anatomy and preferences.

When summarizing the facts available to date, it is apparent first that APBI using brachytherapy techniques is an excellent treatment method and second that brachytherapy is one of the best techniques for APBI today.

OA-C100

Physics – Adding Certainty to Safety

Luc Beaulieu, PhD[1,2]

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In this scientific session, we intend to address 4 topics that constitute hot clinical subjects as well as state-of-the-

art research topics in brachytherapy physics. These topics address issues related to uncertainty from a dose calculation perspective and day-to-day clinical activities, as well as tools such as advanced treatment planning, imaging, and *in vivo* dosimetry that will potentially increase the overall treatment accuracy and precision and provide real-time feedback to the end users. The session will further provide a forum for exchange between the participants via a panel discussion.

OA-C101

State-of-the-Art in Brachytherapy Dose Calculation

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Over the past few years, advanced brachytherapy calculation approaches are being released by treatment planning systems (TPS) manufacturers. These algorithms are meant to provide greater accuracy and precision for a variety of brachytherapy treatment sites relative to the current dose calculation standard, TG43.

The Monte Carlo method is used extensively in the definition of the TG43 dose calculation parameters. It is also considered the reference gold standard for dose calculation. Alternative methods, namely the Boltzmann solver and the Collapsed-Cone techniques, have been adopted and commercialized by TPS manufacturers.

In this presentation, we will review the need for new dose calculation algorithms in brachytherapy. Next, we will take a critical look at the above-mentioned new algorithms in terms of impact for various clinical sites, with illustration from specific clinical examples. Factors influencing the accuracy of dose calculation such as source energy, shielding, and others will be discussed. We will also try to address the current limitations of the new algorithms and provide a forward-looking picture of the next-generation brachytherapy TPS.

OA-C102

Clinical Uncertainties: What Is the Magnitude?

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While uncertainties related to 3D image-based electron beam radiation therapy (EBRT) have been investigated in detail for decades, so far there has been a limited overview of the uncertainties related to 3D volumetric image-guided brachytherapy. There have been "dogmas" that the applicator, tumor, and surrounding tissues represent a stable system. However, brachytherapy dose gradients are steep and geometric variations can potentially lead to significant dosimetric differences that cannot be neglected. Recently, a specific issue of *Radiotherapy and Oncology* focused on uncertainties in image-guided brachytherapy (*Radiother Oncol* 2013; 107(2)), and a review of clinical brachytherapy variations has been published with analysis guidelines of the Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) and the American Association of Physicists in Medicine (AAPM) (Kirisits *et al*., *Radiother Oncol* 2014; 110: 199-212). These efforts have significantly improved the knowledge and overview of brachytherapy variations and uncertainties. Particular progress has been made within evaluations of clinical variations. In gynecological brachytherapy, the total deviation on target dose-volume histogram (DVH) parameters has been estimated to be around 10%, which is mainly driven by contouring disparities. For organs at risk (OARs), the major uncertainty component is intra- and inter-fraction ambiguity, which leads to a total variation of 20-25%. These levels of uncertainty are related to one fraction, and when combining several fractions of brachytherapy and EBRT, the total precision level is increased. The clinical impact of uncertainties depends significantly on prescription dose levels, and future progress in reduction of uncertainties should focus on those variations that are most likely to lead to more accurate dose delivery, which will have clinical impact in terms of disease control and development of side effects.

OA-C103

Advancements in Real-Time Imaging for Brachytherapy

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Advanced imaging can significantly improve patient outcomes in brachytherapy. One very successful imaging technique is real-time imaging. Real-time image planning contents are continuously updated, and thus catheters can be placed under real-time guidance and dose calculation can be adapted to the actual situation.

Real-time planning can be used for intraoperative planning, interactive planning, and dynamic dose calculation. It can be used for low-dose-rate (LDR, seed) implants and high-dose-rate (HDR) implants. Needle paths and implanted seeds can be tracked during insertion, allowing precise reproducibility. Transversal and sagittal real-time views can be used for tracking needle or seed positions and directly applied in the treatment planning system. Moreover, this technique can be used to adapt to the shapes of the organs during the procedure. Using

magnetic resonance imaging (MRI)-guided real-time imaging inadvertent needle placements can be reduced. The 3D MRI is a good base for optimized treatment planning.

With real-time techniques, a very realistic view of the present organ situation and the catheter's position can be performed. This is one of the advantages of modern brachytherapy. By means of few technical efforts, much benefit can be reached for the patient. The resulted dose-volume histograms are not necessarily better with real-time planning than with offline procedures. However, the computed dose distributions are more realistic. Moreover, as the systems become more and more complex, the user must understand the equipment and the interplay of the components and ensure the correct calibration.

Real-time planning is a modern and powerful tool in brachytherapy that enables the user to deliver the dose to patients in a highly accurate and cost-efficient way.

OA-C104

In Vivo Dosimetry in Brachytherapy: Feasible and Needed?

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In vivo dosimetry is infrequently used in brachytherapy despite the use of high dose per fraction treatments and the multiple planning and treatment processes that create an opportunity for treatment errors.

A range of detectors have been tested for their suitability for use in brachytherapy applications. Ideally, detectors would be small, tissue equivalent, have a high signal-to-noise ratio, have no energy dependence, provide real-time readout, be inexpensive, have a linear dose/dose rate response, etc (Tanderup *et al*., *Med Phys* 2013; 40: 070902). While a number of detectors have been investigated for their use in brachytherapy, there currently appears to be no single detector that is capable of providing highly accurate *in vivo* dose measurements that is suitable for all applications.

A lack of systematic reporting of errors in brachytherapy, along with the lack of detailed record and verification systems, makes it difficult to judge the frequency and type of errors that typically occur in clinical practice. The International Commission on Radiation Protection (ICRP) Report 97 (ICRP publication 97. Stockholm, 2005) provides many examples of incidents related to human error; however, it is likely that errors leading to a geographical miss due to organ motion or minor catheter displacement go largely undetected due to the under-utilization of *in vivo* dosimetry. In this presentation we will review the performance of state-of-the-art detectors, potential errors they may catch, and how their limitations may be complemented with a comprehensive quality assurance program.

It is proposed that the brachytherapy community combines efforts to produce convincing evidence for the need for routine *in vivo* dosimetry through detailed reporting of all brachytherapy incidents. In particular, those centers using *in vivo* dosimetry should openly report the type and frequency of errors that their systems detect so that cost-benefit analyses can be made.

In conclusion, whilst practical, non-invasive techniques for high-accuracy *in vivo* dosimetry remain elusive, emerging systems designed for a specific purpose and used in conjunction with a complementary quality assurance program offer the possibility of a practical and feasible method of assuring high treatment delivery accuracy and minimizing the risk of gross error. However, utilization of routine *in vivo* dosimetry is likely to remain limited until the clinical evidence for the need for these systems is demonstrated.

OA-C200

Building a Global Brachytherapy Community

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Brachytherapy is a skill set that requires significant training and experience. Only a fraction of the overall global need for brachytherapy services is being met. As the demand for brachytherapy increases, it will become increasingly difficult to educate enough providers to perform these highly technological procedures. Through internationally recognized experts in both brachytherapy and global health, this session will outline the global need to connect brachytherapy providers, present some possible alternatives, and conclude with a discreet, consensus-driven plan to create a "global brachytherapy community". The outreach efforts of the European Society for Radiotherapy & Oncology (ESTRO) and the American Society for Radiation Oncology (ASTRO) will be showcased, and an emerging American non-governmental organization (NGO), the International Cancer Expert Corps, will be presented as examples of a process to disseminate brachytherapy knowledge and mentor providers. A perspective from 2 major centers in China will be included to outline issues and difficulties associated with bringing advanced technology into the world's most populous country. A proposed structure for a global brachytherapy community will be presented and refined through an interactive panel discussion. From this discussion, and with input and suggestions from the audience, a plan will be developed to move the process forward.

OA-C201

How to Develop a Brachytherapy Community: The Need for an Interconnected Global Community for Brachytherapy

Tim R. Williams, MD

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A quick survey of brachytherapy programs around the world shows a great amount of diversity. Many programs provide only a limited number of services, many perform a limited number of procedures, and some programs treat only a few patients a year. In addition, there is only minimal use of standardized guidelines. It can be difficult for programs to develop their skills and learn from the experience of others. An "interconnected global brachytherapy community" would allow for programs to rapidly and effectively diversify their portfolio of services and improve the quality and safety of their treatments. A network of centers sharing information and offering mentoring services would require only a simple infrastructure. At minimal cost, this global community could provide an easy platform for expanding the specialty of brachytherapy.

OA-C202

The International Cancer Expert Corps: A Peace Corps for Oncology

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Disclaimer: The opinions are of the authors and not their institution or any US government agency.

A 2011 United Nations' Declaration highlighted the need to address the growing incidence and mortality from non-communicable diseases (NCDs) in low- and lower-middle income countries (LMICs). Cancer is among the leading causes, and it is projected that by 2030 over two-thirds of the cases of cancer worldwide will be in resource-limited settings. Radiation therapy (RT) is a cost-effective and potentially curative modality by itself and in combination with standard chemotherapy; however, establishing sustainable programs in LMICs is a challenge.

The Directory of Radiotherapy Centers of the International Atomic Energy Agency indicates that there is a worldwide shortfall of over 5000 RT facilities, with some countries having essentially no capacity. New approaches are needed to develop sustainable programs.

An effective solution to NCDs and cancer requires a complex systems approach with support from government and non-government sectors. The issues include the shortage of physical resources, weak health systems, human rights issues, corruption, and a "brain drain". We have proposed the concept of Public Health Oncology (Love *et al*., *Ann Oncol* 2012; 23: 3040-3045). To address the workforce shortage, a mentoring model has been created with a corps of mentors from resource-rich countries working with local champions from LMICs. This necessitates valuing, rewarding, and supporting this activity so that it becomes a *bona fide* career path.

The International Cancer Expert Corps (ICEC) (www.iceccancer.org) addresses the "people problem". It is a multinational, multi-institutional non-governmental organization. With support and commitment, radiation oncology can be a world leader in addressing this huge unmet need.

OA-C203

Challenges and Accomplishments for Globalization of Brachytherapy: The (GEC)-ESTRO Perspective

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Brachytherapy has gone through major changes, mainly due to technical developments. As brachytherapy represents an essential treatment of major malignancies, continuous research and development and change management is mandatory to reach progress, knowledge dissemination, and education and training (E&T) in a global perspective. E&T, a major tool for overcoming these challenges, includes knowledge transfer, training of skills, and competencies building. Major players in these fields are working groups, networks, radiation oncology societies, the International Atomic Energy Agency (IAEA), and the active industry. ESTRO has been major driver of E&T in brachytherapy for over 25 years. ESTRO has been running 3 GEC-ESTRO brachytherapy teaching courses (TC) since 1990, with an annual 5-day TC for

modern brachytherapy accumulating 28 editions and > 2500 participants. In 2001, a 3-day prostate brachytherapy TC started and repeated in 13 editions with 951 participants. In 2004, the 5-day gynecologic IGABT course started with 14 editions with 1621 participants. So far, GEC-ESTRO has published > 10 international brachytherapy recommendations on prostate, cervix (I-IV, new International Commission on Radiation Units & Measurements [ICRU] report), breast, and head and neck cancers, and physics. Beside the GEC-ESTRO working groups for prostate, gynecologic, breast, head and neck, and ano-rectum cancers, and physics, a GYN GEC-ESTRO network has been built through annual meetings. Clinical and physics research and clinical trials (APBI, EMBRACE) have been initiated through these groups/networks which – facilitated through ESTRO – were partly supported by unrestricted E&T and R&D industry grants. Recently, e-learning is added through ESTRO School (e.g., FALCON, DOVE). ESTRO will continue the global efforts, based on its mission for knowledge dissemination, E&T, and research facilitation in Europe and beyond (www.estro.org).

OA-C204

Radioactive Seed Brachytherapy in China: Lessons From the First 14 Years

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Peking University Third Hospital began to utilize iodine-125 (^{125}I) seed brachytherapy to treat prostate cancer under the guidance of Professor Gordon L. Grado in 2001 and has performed seed implantation on 2000 patients with solid tumor cancers. We innovated a series of modalities for seed implantation and combined this process with computed tomography (CT) guidance or ultrasound, which we are continuing to improve today. There are now a total of 6 ^{125}I seed companies and 3 treatment planning system (TPS) companies in China. One million ^{125}I seeds are used for cancer treatment every year. More than 1000 hospitals utilize ^{125}I as adjuvant and salvage therapy for cancer patients. We established the Chinese Seed Brachytherapy Association in 2007, edited 7 books, and trained more than 5000 doctors.

CT guidance for seed implant brachytherapy provides more accuracy and efficiency. It took us more than 10 years to set up clinical protocols for CT guidance in recurrent head and neck cancer, lung carcinoma, thoracic wall metastases, primary spinal carcinoma or metastases, and pelvic cancer and soft tissue sarcoma. Intraoperative ultrasound guidance ^{125}I seed implantation for unresectable pancreatic carcinoma was also investigated. ^{125}I seed implant brachytherapy-assisted surgery with preservation of the facial nerve for treatment of malignant parotid cancer has shown very good local control and organ function conservation. Self-expandable esophageal stents loaded with ^{125}I seeds in patients with advanced esophageal cancer show very good palliative outcomes. Non-planar and multiple template fusion modality have also been developed in China and make it possible for different geometric-shaped targets with seed implantation. Seed implantation will soon become the mainstream in the comprehensive treatment for cancer patients.

OA-C205

The Concept of an Interconnected Global Brachytherapy Community

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Brachytherapy was the first type of radiation therapy to be used in the treatment of cancer (1901). Many clinical applications were developed, including techniques for prostate and cervical cancers. The use of brachytherapy declined in the middle of the twentieth century (American Brachytherapy Society, 2009, Aronowitz JN. *Brachytherapy* 2008; 7: 55-59) because of the risks to operators from the manual handling of the radiation sources. To overcome this problem, remote afterloading systems and new radioactive sources were introduced in the 1950s and 1960s (Gupta VK. *J Med Phys* 1995; 20: 31-38). These systems have made brachytherapy procedures safer for both patients and providers (Gerbaulet *et al*., *The GEC-ESTRO Handbook of Brachytherapy*. ACCO, Leuven 2005).

In recent years, 3D imaging and computerized treatment planning systems have made brachytherapy a much safer and more effective treatment. However, applications can vary between physicians, centers, and countries (Vishwanathan *et al*., *Int J Radiat Oncol Biol Phys* 2012; 82: 250-255). Given that we all share the same goals, opportunities exist to disseminate knowledge and increase the level of expertise to allow for greater participation in future clinical trials (Vishwanathan *et al*., *Int J Radiat Oncol Biol Phys* 2012; 82: 250-255).

In an era of telecommunication, Web access permits the development of distant collaboration and teaching opportunities. Establishment of a worldwide (Web-based) brachytherapy community would create an ecosystem joining brachytherapists who have the same interests, goals, and brachytherapy language. More so, it could permit the sharing of knowledge, experience, and even data (to answer common questions).

In this session, many contemporary examples of such distant collaborations with successful results will be presented. Input in regards to building such a community will be solicited. Orientation of future goals will be explored.

OA-D100

What Makes Brachytherapy So Exciting?

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Over the past 20 years we have seen different technological evolutions in the field of brachytherapy – 3D imaging (computed tomography [CT], magnetic resonance imaging [MRI], positron-emission tomography [PET]/CT, and ultrasound) favored image-guided brachytherapy (IGBT) and the diffusion of single-source devices – which allowed treatment plans with dose painting using intensity modulation by mathematical computer algorithms (intensity-modulated brachytherapy [IMBT]), promoting organ-sparing capacity. In fact, brachytherapy showed firm evidence of good local control and reduced toxicity compared with surgery, external beam radiation therapy (EBRT), and chemotherapy. A significant contribution to this development has come from technological improvement by miniaturized sources and small, handy, and MRI/CT-compatible applicators. These improvements enable us to perform interstitial brachytherapy to many disease sites, allowing more curving for the source-transferring cables and plastic applicators. Consequently, brachytherapy indications have significantly broadened. A much shorter irradiation time makes the computer-calculated dose distribution more reliable (realistic), compared to low-dose-rate (LDR) brachytherapy with several-day irradiation time. Moreover, the diffusion of high-dose-rate (HDR) brachytherapy allows the use of hypofractionated treatment schemes with lower overall treatment time that offers clinical advantages and more comfortable treatment for patients.

OA-D101

Why Patients Should Choose Brachytherapy

Vincenzo Valentini, MD

Università Cattolica del Sacro Cuore, Rome, Italy

Modern oncology offers personalized treatment options. The choice of the best treatment is made based on efficacy, feasibility, and cost benefit, but it also considers the patient's age, clinical condition, presentation of disease, and the patient's particular needs (travel, work, family).

Intensity-modulated brachytherapy (IMBT) and image-guided brachytherapy (IGBT) have led to some clinical benefits. Brachytherapy is a minimally invasive treatment option compared to surgery. This leads to the use of safer anesthetic techniques, especially for the elderly, such as local or spinal anesthesia or mild sedation. Moreover, brachytherapy could reduce the cost and time of hospitalization.

High-dose-rate (HDR) brachytherapy allows the use of hypofractionated treatment schemes. This allows a lower overall treatment time that offers radiobiological advantages and also provides a treatment more comfortable for the patient. In fact, it can be more compatible with the patient's work and family needs. It is also an advantage for the patient who needs to have treatment away from home while reducing costs for accommodation.

Brachytherapy is a localized treatment and reduces toxicity compared to external beam radiation therapy (EBRT) and chemotherapy. This provides an advantage, especially in the retreatment of relapses and in early-stage tumors. In addition, brachytherapy can be used as a boost after EBRT, increasing local control and reducing toxicity.

In the future, we could see more patients with localized disease and more elderly. For this reason, brachytherapy could be a viable and effective treatment option.

OA-D102

The Awareness to Cure Patients

Phillip M. Devlin, MD, FACR, FASTRO, FFRCSI (Hon)

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Abstract not available at time of printing.

OA-D103

The Organ-Sparing Capacity of Brachytherapy

Peter Grimm, DO

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Intensity-modulated radiation therapy (IMRT) and brachytherapy have larger target volumes than surgery and have markedly different dose distributions to adjacent organs and structures. These dose variations can have significant effects on the adjacent structures.

Nerve-sparing radical prostatectomy (RP) is difficult due to the radial distance variability of the nerve location and the fan-like pattern of nerves. Tumor failure after RP is due to nerve sparing and extracapsular extension (ECE). IMRT and brachytherapy have margins that completely encompass the nerves and ECE. Despite this, IMRT and brachytherapy potency rates are typically reported as better than nerve-sparing techniques, and in the short-term, brachytherapy appears to have a slightly better potency rate than IMRT.

IMRT/Proton techniques require prostate movement adjustment techniques to ensure adequate dose coverage. Despite these efforts, the volume of the rectum receiving

high doses is substantially greater than brachytherapy, which has the advantage of rapid fall-off of dose.

The radiation effect to the hips is underreported. IMRT/Proton isodose curves from both techniques demonstrate the hips typically receive approximately 4000 cGy. Short-term studies indicate a low risk; however, long-term risk may be substantially greater. Women who have had treatment for cervical or uterine cancer and received 42 Gy to the hips have a hip fracture rate of 15%. While the risk to men is likely less, care should be taken to avoid hip dose if possible. Brachytherapy doses to the hips are less than 5% of prescription dose, and there are no reported hip fractures related to brachytherapy treatment.

The dose to the bladder from IMRT/proton is a pattern similar to the rectal distribution with greater volume and dose compared with brachytherapy.

OA-D104

The Portfolio of Technical Innovations

Yasuo Yoshioka, MD

Osaka University Graduate School of Medicine, Osaka, Japan

We examine technical innovations in the treatment of tongue, cervix, and prostate cancers, identify challenges to innovation in high-dose-rate (HDR) brachytherapy over 20 years, and discuss the current excitement in the field.

The gold standard in treatment of tongue cancer should be low-dose-rate (LDR) brachytherapy using ^{192}Ir-wire (hairpin) or ^{137}Cs-needle. However, LDR requires patients to be isolated in a shielded room and exposes medical staff to radiation. HDR overcomes this and permits dwell time optimization, with increased dosimetric certainty secured by short irradiation time. We attempted a small randomized controlled trial, resulting in HDR showing non-inferiority to LDR.

The gold standard in the treatment of primary cervical cancer should be intracavitary brachytherapy (ICBT). However, some radiation oncologists continue to use Point-A ICBT. We actively use interstitial brachytherapy (ISBT) for large tumors > 4 cm, where Point-A dose prescription would not be logical. When treating central pelvic recurrence of cervical (also corpus) cancer, palliative external beam radiation therapy (EBRT) might be considered, possibly after radiotherapy. We actively attempt to cure such patients using ICBT for < 5-mm thick vaginal recurrence, or ISBT for the others.

While LDR brachytherapy is a standard treatment for prostate cancer, HDR has advantages. HDR sources can be placed outside the prostate and inside seminal vesicles or the bladder. Dwell times can be optimized, leading to homogeneous dose distribution and a reduced dose to the urethra. The biologically effective dose (BED) can be enhanced by hypofractionation because of smaller alpha/beta ratio of prostate cancer compared to normal tissue. If you could obtain a satisfactory dose distribution by HDR brachytherapy, what is the reason for adding EBRT? Thus, we advocate HDR monotherapy.

OA-D200

Embracing the Knowledge of Radiobiology and Radiation

Christian Kirisits, MSc, PhD

Medical University of Vienna, Vienna, Austria

This session will first focus on the different radiobiology aspects to take into account when prescribing and reporting brachytherapy treatments. Several models have been proposed to describe the heterogeneous dose and dose rate distribution. For combined external beam radiation therapy and brachytherapy concepts, additional methods are needed. There is already evidence that more simple approaches, such as the equivalent dose at 2 Gy (EQD2) concept, can help to better understand and describe dose response relationships. However, it is necessary to look at several parameters for high-, intermediate-, and low-dose regions to take into account the special aspects of brachytherapy dose distributions. Then, the EQD2 concept is straightforward and applicable in daily clinical practice. However, there are limitations that need a more detailed view, which will be discussed in this session.

The second part of this session will present the state-of-the-art radioprotection for brachytherapy. The main focus of this section is appropriate training of personnel. In addition, peer review is discussed as an essential part in daily clinical practice.

OA-D201

The EQD2 Concept for Practical Reporting of Cervix Brachytherapy

Christian Kirisits, MSc, PhD

Medical University of Vienna, Vienna, Austria

The equivalent dose in 2 Gy (EQD2) measurement was included in various recommendations and will be an essential part of the International Commission on Radiation Units & Measurements/Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (ICRU/GEC-ESTRO) report for gynecological brachytherapy. There are well-known limitations, especially uncertainty in the estimations of alpha/beta values and half-time of repair. For large fraction doses, often applied with high-dose-rate (HDR) brachytherapy, this model might not predict appropriate values. Several radiobiological effects on repopulation are neglected. However, it allows comparison of many standardized treatment

schedules (e.g., a typical combination of external beam and fractionated HDR brachytherapy within a period of 7 weeks). Several dose-response curves, based on the total EQD2 doses and outcomes, could be produced in recent analysis. With the currently ongoing multicenter trials investigating dose-response analysis, the underlying radiobiological parameters will be fine tuned. In daily clinical practice, standardized spreadsheets allow tracking of the prescribed and delivered dose and comparison to the initial planning aim dose for each patient within adaptive treatment planning. Previous prescription methods using "100% isodose-lines" or relative dose values in percentages were often unclear. Nowadays, prescription methods can be based on meaningful EQD2 dose levels for the entire treatment schedule.

OA-D202

Background of Brachytherapy for Different Sites

Alexandra Stewart, DM, MRCP, FRCR

Royal Surrey County Hospital and University of Surrey, Guildford, UK

The goal of this presentation is to provide an overview of clinical radiobiological concepts at different clinical sites and use interactive examples to demonstrate how these are used in clinical practice. The clinical applications of key radiobiological concepts such as equivalent uniform dose (EUD), equivalent dose at 2 Gy (EQD2), and biological effective dose (BED) will be presented. Specific examples will be demonstrated using gynecologic intracavitary and interstitial implants and partial-breast irradiation. The effect of EUD on dose prescription and its relevance to potential toxicity will be discussed. The importance of dose heterogeneity and dose homogeneity in different situations will be compared and contrasted.

OA-D203

Hidden Issues in the Use of LQ and Other Models

William H. McBride, PhD, DSc

University of California, Los Angeles, CA, USA

The linear-quadratic (LQ) model is the mathematical standard that is by far the most commonly used algorithm in radiation biology. Many treatment schemes use the LQ model. There are many assumptions upon which these calculations are based. Some of these assumptions are based on a "standard" dose rate, and many unrecognized biological effects may be occurring in tissue being radiated using either "low-dose-rate" or "high-dose-rate" treatments. This presentation will explore the issues and controversies surrounding the use of the LQ model (and other models). Hidden within these models are questions that can have a profound effect on the dose specification, and ultimately the clinical outcomes, of both low- and high-dose-rate brachytherapy treatments.

OA-D204

Operator Training in HDR Brachytherapy: Preventing Treatment Errors

Zoubir Ouhib, MS, DABR

The Lynn Cancer Institute at Boca Raton Regional Hospital, Boca Raton, FL, USA

This presentation will review the importance of high-dose-rate (HDR) brachytherapy training, including the methods and its correlation with treatment errors.

Initial and continuous training for the brachytherapy team is necessary for a safe and successful program. Treatment errors in HDR brachytherapy have been associated with lack of or simply inadequate training. In addition, documents such as checklists, policies, and procedures were either not used or not implemented.

The training should be provided by an application specialist and a proctor (Radiation Oncologist). Three to five clinical cases under their direct supervision should be performed and documented. Staff education on reported medical events, specific to the devices and procedures, should be part of the training curriculum.

Several professional associations (American Brachytherapy Society [ABS], European Society for Radiotherapy & Oncology [ESTRO], American Society for Radiation Oncology [ASTRO], American Association of Physicists in Medicine [AAPM], etc.) provide training at workshops and schools. This training, while valuable, might lack the "hands-on" component. Recently, the ABS has introduced fellowship to both radiation oncologists and medical physicists to overcome this deficit.

At the end of training, policies, procedures, and checklists for each procedure should be created and used. Re-training should be considered whenever "close call" or "near misses" occur and when procedures are not as frequently used to maintain the skills of the brachytherapy team.

Training in HDR brachytherapy is critical to every user. Policy and procedures, checklists, and departmental peer-to-peer review (tumor board, chart rounds) should be implemented. Continuous evaluation of the quality management should be performed and staff re-training should be considered when needed.

OA-E100

Prostate Cancer: Is Proven Quality an Argument?

Janusz Skowronek, MD, PhD[1,2], Mitchell Kamrava, MD[3], André-Guy Martin, MD, MSc, FRCP[4,5]

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Prostate brachytherapy has some of the best long-term clinical results and lowest morbidities of any treatment modality. Data supporting brachytherapy as an essential component of treatment for all risk levels continues to mount. Despite this, utilization of prostate brachytherapy has been declining. Analysis of reasons for this trend should be discussed. This session discusses research on the comparative effectiveness of brachytherapy versus stereotactic body radiation therapy (SBRT) versus intensity-modulated radiation therapy (IMRT), presents various brachytherapy treatment modalities available for prostate cancer (low dose rate [LDR], high dose rate [HDR], and pulsed dose rate [PDR]), and investigates the utilization of LDR brachytherapy in developing countries. This is followed by an update of long-term outcomes using brachytherapy compared with other modalities and the growing data supporting HDR monotherapy/combination therapy for intermediate-/high-risk patients.

OA-E101

LDR, HDR, or PDR – Crossroads

Janusz Skowronek, MD, PhD[1,2]

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Permanent low-dose-rate (LDR) brachytherapy and temporary high-dose-rate (HDR) or pulse-dose-rate (PDR) brachytherapy are competitive techniques for clinically localized prostate radiotherapy. Although a randomized trial will likely never be conducted comparing these techniques, a comparative analysis proves useful in understanding some of their intrinsic differences.

The main goals of treatment include cancer control, preservation of urinary control (continence), and preservation of sexual function (potency). Indications for monotherapy or as a boost (based on recommendations from the American Brachytherapy Society [ABS], American Society for Radiation Oncology [ASTRO], Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology [GEC-ESTRO], and ESTRO/European Association of Urology [EAU]/European Organization for Research and Treatment of Cancer [EORTC]) are discussed. Advantages and disadvantages of all methods are discussed. All techniques are also compared from a technical point of view, and costs are also analyzed.

Each of these techniques represents an extreme end of the spectrum with respect to dose rate and fractionation and therefore have inherently different radiobiological properties. LDR brachytherapy has the great advantage of being practically a one-time procedure and enjoys a long-term follow-up database supporting its excellent outcomes and low morbidity. On the other hand, HDR is a fairly invasive procedure requiring several sessions associated with a brief hospital stay. Although lacking in significant long-term data, it possesses the technical advantage of control over its post-implant dosimetry (by modulating the source dwell time and position), which is absent in LDR brachytherapy.

Radiobiological models support the current clinical evidence for equivalent outcomes in localized prostate cancer with either LDR or HDR brachytherapy using current dose regimens. At present, the available clinical data with these techniques suggests that they are equally effective, stage for stage, in providing high tumor control rates.

OA-E102

Why Choose Brachytherapy and Not EBRT?

Mitchell Kamrava, MD

Gynecologic Cancers and Sarcoma, Division of Brachytherapy, UCLA Department of Radiation Oncology, Los Angeles, CA, USA

Advancements in radiation oncology have led to multiple platforms to deliver high doses of radiation to the prostate while limiting doses to surrounding normal tissues. Intensity-modulated radiation therapy (IMRT), stereotactic body radiation therapy (SBRT), and brachytherapy are popular methods to deliver prostate radiation therapy treatment. They have significantly different lengths of treatment and means of dose delivery. This session presents comparative effectiveness research to compare the effectiveness, benefits, harms, and costs of each of these treatments for prostate cancer.

OA-E103

Is LDR Brachytherapy Still an Option for Developing Countries?

André-Guy Martin, MD, MSc, FRCP[1,2]

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Seed brachytherapy is recommended for localized prostate cancer by the National Comprehensive Cancer Network (NCCN), the American Brachytherapy Society (ABS), and the European Society for Radiotherapy & Oncology (ESTRO). With 25 years of clinical experience and excellent treatment outcomes, there are now up to 15 years of published data on overall survival, disease-free survival, and toxicities. In the United States, it is the least expensive form of radiation treatment. In countries with socialized health systems, most cancer facilities offer high-dose-rate (HDR) brachytherapy capabilities. HDR brachytherapy has become less expensive, especially when used for > 20-30 patients per year. Iodine-125 (^{125}I) and palladium-103 (^{103}Pd) brachytherapy have some physical limitations for which they have been used in conjunction with external beam radiation therapy in intermediate- and high-risk disease. Literature supports its efficacy as comparable to that of an HDR brachytherapy boost. Since local economic factors, availability of technical and physical resources, and professional expertise tend to modulate the use of such therapies, low-dose-rate (LDR) brachytherapy should always be considered in the perspective of offering a cure for prostate cancer.

OA-E104

The Role of HDR Monotherapy for Intermediate-/High-Risk Prostate Cancer Patients

John K. Hayes, Jr, MS, MD

Gamma West Cancer Services, Salt Lake City, UT, USA

This presentation will present the case that high-dose-rate (HDR) brachytherapy as monotherapy has an important role in intermediate-risk prostate cancer and an as yet undefined role in high-risk prostate cancer. The published data from Gamma West Cancer Services and other institutions will be reviewed and compared with outcomes from surgery and external beam radiation therapy techniques.

HDR brachytherapy for prostate cancer has demonstrated excellent biochemical disease-free survival and low toxicity. It holds great promise for men with this disease. Meeting the future demands will require greater will to action on the part of health care systems in the world. For men with prostate cancer, HDR brachytherapy as monotherapy represents an important modality of hope–now and increasingly in the future.

OA-E105

The Role of HDR Boost for High-Risk Prostate Cancer Patients

Ferrán Guedea, MD, PhD, Cristina Gutierrez, MD, PhD, Joan Pera, MD, PhD, E. Martinez, MD

Radiation Oncology Department, Catalan Institute of Oncology (ICO), Barcelona, Spain

Introduction: Prostate cancer has a growth fraction, doubling time, and proliferation rate similar to normal tissues. While the α/β ratio for the rectum is > 5 Gy, and surrounding normal tissues have been estimated to be > 3 Gy, prostate cancer has been estimated to be approximately 1.5 Gy, indicating greater sensitivity to hypofractionation.

Hypofractionation with brachytherapy: Brachytherapy offers advantages, including the ability to deliver highly conformal doses while sparing surrounding healthy tissue, minimal adverse effects, excellent survival, and high quality of life post-treatment. The standard approach to intermediate- and high-risk locally advanced prostate cancer is external beam radiation therapy (EBRT). Studies have found improved results through dose escalation. High-dose-rate brachytherapy (HDR-BT) is a preferred method to escalate the dose without excessively increasing late genitourinary and gastrointestinal toxicities.

Since 2002, at our center, we use 60 Gy EBRT plus a single fraction boost of 9 Gy HDR-BT for all high-risk (and selected intermediate-risk) prostate cancer patients. Dose escalation with the brachytherapy boost technique improves outcomes and reduces toxicity because a higher biologically equivalent dose can be delivered to the tumor while sparing the rectum and bladder.

Early results were previously reported. We have recently reviewed our long-term experience in a large series of patients (n = 377), with excellent results: 5- and 7-year biochemical relapse-free survival rates were 91% and 89%, respectively. Outcomes are similar to those reported in other studies, with the advantage of requiring only a single fraction boost.

Conclusion: In high-risk patients, results can be improved through dose escalation with HDR-BT without increasing late genitourinary and gastrointestinal toxicities.

OA-E106

Prostate Cancer Results Study Group 2014 – Results Comparing Treatment of Prostate Cancer

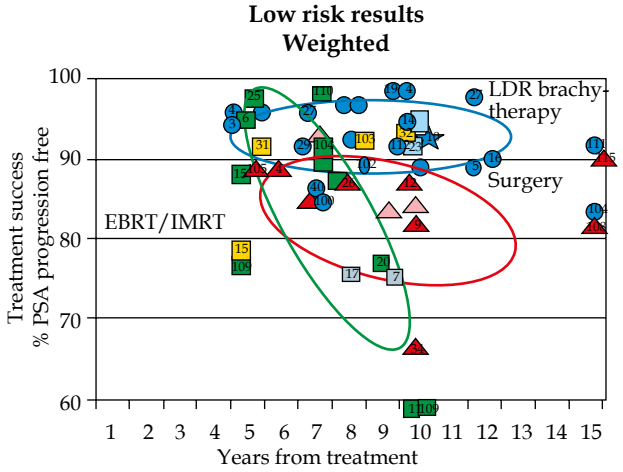
Peter Grimm, DO

Prostate Cancer Center of Seattle, Seattle, WA, USA

Purpose: A complete comparative review study of the current literature for prostate cancer treatments.

Material and methods: Between January 2000 and June 2013, approximately 28,000 prostate studies were published. Of these studies, 1127 featured treatment results. A total of 233 of those studies met the following criteria, established by an expert panel to be included in this review study: 1) Patients separated into low-, intermediate-, and high-risk groups, 2) Success determined by prostate-specific antigen (PSA) analysis, 3) All treatment types considered: seeds (brachytherapy), surgery (standard or robotic), intensity-modulated radiation therapy (IMRT), high-frequency ultrasound (HIFU), cryotherapy (CRYO), protons, high-dose-rate (HDR) brachytherapy, 4) Article must be in a peer-reviewed journal, 5) Low- and intermediate-risk articles must have a minimum of 100 patients, high-risk articles, 50 patients, and 6) Patients must have been followed for a median of 5 years.

Results:



Prostate cancer results study group
Numbers within symbols refer to references

EBRT & Seeds Robot RP Seeds Surgery
EBRT CRYO HIFU Protons HDR

BJU Int 2012; 100 (Suppl 1) Prostate Cancer Center of Seattle

Conclusion: Meta-analysis of the PCa results suggests that brachytherapy offers superior cancer control results for all risk groups.

OA-E200

Developing a Brachytherapy Program

Tim R. Williams, MD

The Lynn Cancer Institute at Boca Raton Regional Hospital, Boca Raton, FL, USA

Beyond learning the skill of performing the procedures themselves, starting a brachytherapy program requires space, equipment, personnel, procedures, and money. The economics and logistics of starting a program vary depending on geography and the core aspects of the various global healthcare systems. This session will approach these manifold issues by first reviewing the essential equipment and facility needs common to all programs. Using this as a foundation, the session will separate into 3 distinct groups, depending on the relevant aspects of their particular healthcare system. Individuals from developed countries with government-controlled and sponsored systems in Europe will meet with Dr. Razvan Galalae, MD, PhD. Dr. Keith Lim, MBBS, FRANZCR, will meet with groups from developing countries outside the US and Europe. Tim R. Williams, MD, will meet with groups from the US and review the economics of starting a program in the United States.

OA-E201

How to Start a Brachytherapy Program: It Depends on Where You Live!

Tim R. Williams, MD

The Lynn Cancer Institute at Boca Raton Regional Hospital, Boca Raton, FL, USA

There is a great need to expand the availability of brachytherapy, not just in the United States and Europe, but worldwide. There is no "one-size-fits-all" strategy to starting a new program. The process will vary considerably, depending on the economics and policies of the practitioners' health care system. This session will start with an overview of the physical needs of a brachytherapy program (the room, device, applicators, or requirements, etc.). We will then split up into 3 groups. One group will approach the process of starting a program from a European perspective, one from the perspective of a developing country outside of the United States and Europe, and the third will review the process of developing a successful pro forma and business plan from an American perspective. Attendees of this session will also be provided with resources to use after the meeting to assist them in starting a new program.

OA-E202

The Essential Components: The Brachytherapy Suite

Akila Viswanathan, MD, MPH

Dana-Farber/Brigham and Women's Cancer Center and Harvard Medical School, Boston, MA, USA

Developing a brachytherapy program requires a multifaceted approach to care. Discussions with radiology, anesthesiology, and surgical oncology must all take place as part of development. Creating frameworks for space and equipment needs, physician and physicist effort, and imaging requirements must be accounted for in the overall proposal. Budgetary approval requires collaborative efforts amongst many parties. This lecture will review these aspects and provide an open forum for discussion amongst the participants.

OA-E203

Starting a Brachytherapy Program in Government-Controlled Healthcare Systems

Razvan Galalae, MD, PhD

Associate Professor, Medical Faculty, Christian-Albrecht-University Kiel, Germany, and Head of Radiotherapy Department, Evangelical Clinics Gelsenkirchen, Germany

Starting in 1999, the University Cooperation Platform implemented an exchange program of researchers and clinicians/physicists between the Christian-Albrechts-University Kiel in Germany and Chiang Mai University in Thailand to create a sustainable base for long-term development of image-guided brachytherapy in Chiang Mai. Three protocols, based constructively on each other, were evaluated.

In the first protocol, addressing computed tomography (CT)-optimized brachytherapy for advanced cervical cancer (n = 17), CT-based optimization showed a significant reduction of D_{2cc} for the bladder and sigmoid (< 0.001) while maintaining a very high dose in D_{90} high-risk clinical target volume (HR-CTV) in comparison with standard point-based planning (Tharavichitkul *et al*., *J Radiat Res* 2011; 52: 634-640).

The second protocol, testing the impact of magnetic resonance imaging (MRI) guidance (n = 15) in patients with cervical carcinoma, proved significantly smaller D_{2cc} doses for the bladder, rectum, and sigmoid (0.003, 0.015, and 0.012) and secured highly curative mean doses in D_{90} HR-CTV of 99.2 Gy (Tharavichitkul *et al*., *J Radiat Res* 2012; 53: 313-318).

In the third protocol, the combination of image-guided brachytherapy (IGBT) and whole pelvis intensity-modulated external beam radiotherapy (WP-IMRT) (n = 15) reaffirmed the significant reduction of D_{2cc} doses for the bladder, rectum, and sigmoid (0.001 or < 0.001) along with high equivalent dose at 2 Gy (EQD2) in the HR-CTV, and demonstrated very low acute therapy-related toxicity in absence of grade 3 morbidity (Tharavichitkul *et al*., *J Contemp Brachytherapy* 2013; 5: 10-16).

Analyses revealed excellent results for the high-dose-rate IGBT in patients with advanced gynecological cancer both by CT and MRI, and/or the combination with WP-IMRT. These results reconfirm the importance of the established program that will continue with subsequent projects. Acknowledgments are expressed to the Chiang Mai team and especially to Dr. Ekkasit Tharavichitkul for excellent and sustainable cooperation.

OA-E204

Building a Brachytherapy Program in Developed Countries Outside of the USA and Europe

Keith H. C. Lim, MBBS, FRANZCR

National University Cancer Institute, Singapore

Cancer is one of the fastest-growing diseases in developed countries outside of the United States and Europe. However, one of the major challenges faced in delivering care to patients is the lack of radiotherapy machines and difficulty gaining access to these machines in terms of distances and/or cost. Brachytherapy offers a viable alternative as treatment can be delivered quickly to patients over a short period of time, reducing the waiting list of many departments and meeting their needs. However, as brachytherapy is not widely practiced in most developed countries other than for gynecologic cancers, challenges abound in obtaining input from doctors, start-up costs, and patient confidence in this form of treatment.

This session aims to address many of the common problems encountered by new centers outside of the United States and Europe as they set up their brachytherapy practice or transition from 2D to 3D imaging. We review some of the newer indications for brachytherapy and discuss how these can be translated into less-developed economies. Success stories and strategies to overcome the economic and logistical considerations will be shared. We also review the basic requirements for a comprehensive brachytherapy program.

OA-E205

The Process of Care, Reimbursement Potential, Program Costs, and Pro Forma for Starting a New Brachytherapy Program in the USA

Tim R. Williams, MD

The Lynn Cancer Institute at Boca Raton Regional Hospital, Boca Raton, FL, USA

Starting a brachytherapy program in the United States is easier than one might think. This session will review the case-mix issues, payer-related matters, staffing requirements, operational issues, and compensation prospects that must be considered when starting a new high-dose-rate (HDR) brachytherapy program. Specific attention will be given to the process of care, patient flow, and code set for the typical HDR breast, gynecology, prostate, and skin cancer patient. Resources will be provided at the end of the session to provide guidance and assistance in developing a new program.

OA-F100

Palliative Brachytherapy – A Care for Patients

Janusz Skowronek, MD, PhD[1,2], Subhakar Mutyala, MD[3]

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The session will review current and relevant scientific data and knowledge on indications for palliative brachytherapy versus other types of cancer treatment. Dilemmas and controversies having an impact on the future of palliative brachytherapy will be highlighted, and there will be discussion of possible resolutions, new research, and/or innovations needed. Moreover, this session will also address the impact of scientific results on modern clinical practice.

Palliative brachytherapy as a solution for advanced esophageal cancer will be discussed. The role of brachytherapy in treating dyspnea – one of the most common cancer consequences – will be presented. The speakers will also present a "rendez-vous" technique in bile duct cancer treatment and possible indications for brachytherapy in advanced head and neck cancers. In the summary of the session, presenters along with the audience will answer the question if "palliative brachytherapy is always better than supportive treatment"?

OA-F101

Palliative Brachytherapy: A Solution for Advanced Esophageal Cancer

Té Vuong, MD, FRCP

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Abstract not available at time of printing.

OA-F102

Brachytherapy Against Deadly Threat: Dyspnea

Subhakar Mutyala, MD

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This session will discuss the role for endobronchial brachytherapy for palliation. The indications discussed will be on the prevention and improvement of dyspnea. Speiser scoring is used to grade dyspnea and monitor response. The procedure used involves sedation, a flexible bronchoscopy with a side-port, and a 5 or 6 Fr catheter.

A variety of radiation treatments have been used for the prevention and improvement of dyspnea. Clinical trials and meta-analyses comparing external beam radiation therapy (EBRT) and brachytherapy will be discussed, showing EBRT with a slight edge over endobronchial brachytherapy (Reveiz *et al*., *Cochrane Database Syst Rev* 2012; 12: CD004284). Low-dose-rate (LDR) and high-dose-rate (HDR) brachytherapy have been compared in retrospective series and found to have no difference (Lo *et al*., *Radiother Oncol* 1995; 35: 193-197). Preventative brachytherapy has not been found to be advantageous to delayed brachytherapy (Falk *et al*., *BMJ* 2002; 325: 465). The addition and/or combination of radiation with mechanical palliation techniques such as stent, photodynamic therapy (PDT), and Nd: YAG laser with data will be presented. The audience can participate in a discussion of multiple fractionation schema and dosimetry.

OA-F103

"Rendez-Vous" as a Solution for Biliary Duct Cancer

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Purpose: Treatment options for bile duct cancer remain limited because of the large number of patients with advanced disease at the time of diagnosis. Radical surgery is possible in less than 10-15% of these cases. Indications for brachytherapy include all malignant strictures of the bile duct that can be cannulated. Our aim was to assess the feasibility of intraluminal palliative brachytherapy in the treatment of locally advanced bile duct cancer using trans-hepatic "rendez-vous" technique.

Material and methods: Forty-eight patients with advanced bile duct cancer, disqualified from surgery or radical external beam radiation therapy (EBRT), were treated with trans-hepatic technique and intraluminal brachytherapy. Forty-four patients were treated exclusively with brachytherapy and 4 were treated with brachytherapy and concomitant chemotherapy or surgery (stents). Percutaneous trans-hepatic technique was used to implant catheters into bile ducts. The decision to irradiate patients was based on clinical presence of a tumor and increased risk of jaundice. This technique allowed the passage of a catheter through the bile duct stricture. Details of technique are presented, and summarized published data are discussed.

Results: All patients with advanced bile duct cancer had an unfavorable prognosis. In 65.5% of bile duct cancer cases, clinical improvement (decrease in jaundice) was noted in first control after 4 weeks. Median overall survival time for patients with bile duct cancer was 11.2 months. No complications connected with technique were observed.

Conclusions: It has been established that the use of brachytherapy is feasible and has a low early complication rate. A percutaneous trans-hepatic technique allows for the whole treatment (insertion of catheter, brachytherapy) to be performed in 1 day. In most cases, a satisfactory palliative effect can be achieved.

OA-F104

Palliative Brachytherapy of Head and Neck Cancer – When, Why, How?

Antonio Cássio Assis Pellizzon, MD, PhD, MSc

AC Camargo Cancer Center, São Paulo, Brazil

The management of recurrent head and neck cancer (HNC) is one of the most challenging procedures in oncology. Locoregional failures, recurrence, or second primary after curative radiotherapy alone or in combination with surgery and/or chemotherapy are significant problems and represent a challenge. Re-irradiation is generally not considered the first-line approach for its management. Surgical treatment remains the mainstay of therapy in these instances, but the intimate anatomic relation between disease and critical structures often makes surgical re-resection impossible or inadequate, with complications unacceptable to the patient, making the recurrent HNC a very poor prognosis disease. If the recurrent tumor is left untreated, a median survival of only 5-6 months is expected. Additionally, chemotherapy alone in this setting, even with the development of new drugs, is associated with an even poorer survival rate, with no chance of long-term control.

For some selected cases, brachytherapy using pulsed-dose-rate (PDR) or high-dose-rate (HDR) techniques can be used as the last-line or palliative therapy. Local and symptom control, despite no increase in survival, can be expected with improvement in quality of life. Possible complications, and sometimes even the reduction of quality of life, should be considered before indicating this treatment modality. This section will give an overview of techniques, indications, and results in terms of palliative effect and complication rates associated with brachytherapy as a palliative option.

OA-F200

Challenges in Advancing Your Prostate Practice

André-Guy Martin, MD, MSc, FRCP[1,2], Yasuo Yoshioka, MD[3], Mitchell Kamrava, MD[4]

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Brachytherapy practice is evolving in a fast-paced, ever-changing world. At one time the only way to treat

cancer was with radiation therapy, but brachytherapy is now challenged by other methods of administering radiation. It has provided the means to dose escalate and hypofractionate in a focal way, protecting nearby organs at risk. With the increase of imaging modalities and technical possibilities, could brachytherapy be replaced by techniques like stereotactic body radiation therapy (SBRT)? Can this be applied to salvage therapy? Or, can brachytherapy be brought up-to-date using technical support and developments? This session will explore prostate brachytherapy challenges to what it (Brachy-Next) may be in the near future.

OA-F201

Are We Going in the Right Direction? Expectations of a Better Cure and Survival Gain With HDR Brachytherapy

John K. Hayes, Jr, MS, MD

Gamma West Cancer Services, Salt Lake City, UT, USA

This presentation will present the argument that high-dose-rate (HDR) brachytherapy is the direction health care systems should support to optimize cure and minimize toxicity for men with prostate cancer. Processes by which this treatment can be realized in public and private health care settings will be proposed. This will be supported by the experience of the presenter as well as the published literature.

From the standpoint of epidemiology, public health, radiation safety, quality of life, socioeconomics, and radiation biology, HDR brachytherapy for prostate cancer is the most promising modality for genitourinary health related to prostate cancer. HDR brachytherapy for prostate cancer has a bright future clinically and a challenging road ahead from a health care policy standpoint. Educating health systems experts and energizing genitourinary oncology leaders is important for the sake of men with this disease.

OA-F202

Would SBRT Hypofractionated Approach Be as Good? Then Why Bother With Brachytherapy?

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Osaka University Graduate School of Medicine, Osaka, Japan

Purpose: To compare the stereotactic body radiation therapy (SBRT) approach and high-dose-rate (HDR) brachytherapy, especially as monotherapy, for prostate cancer using extremely hypofractionated dose fractionation.

Material and methods: Clinical results of HDR brachytherapy for prostate cancer have been accumulated and matured, both in the forms of boost and monotherapy. Updated results of HDR monotherapy for 177 patients with a median 7-year follow-up were reported by Yoshioka *et al.* (presented at ESTRO 33, 2014, Vienna, abstract OC-0318). Referring to the successful results of HDR and its dose fractionation, use of SBRT for prostate cancer is rapidly increasing. The possibility and justification to replace HDR with gantry-based or robotic SBRT were examined by literature review.

Results: Fuller *et al.* (*Int J Radiat Oncol Biol Phys* 2008; 70: 1588-1597) tested the ability of robotic SBRT plans to approximate the dose distribution of HDR brachytherapy and concluded that this is indeed possible, naming the procedure the "virtual HDR" robotic SBRT treatment. King *et al.* (*Radiother Oncol* 2013; 109: 217-221) and McBride *et al.* (*Cancer* 2012; 118: 3681-3690) reported promising preliminary results with 3- and 3.7-year follow-up using robotic SBRT.

Conclusions: SBRT has potential to be substituted for HDR brachytherapy. Specifically, the tracking device of the robotic SBRT system may allow a tighter margin and overcome interplay effect by controlling intra-fractional organ motion, mimicking HDR. However, the optimal dose fractionation or potentially increased toxicity is still unknown in the field of extreme hypofractionation, and thus HDR monotherapy should be referred to as the gold standard with a more experienced dosimetric certainty and matured clinical results.

OA-F203

Can We Salvage Local Recurrence With Brachytherapy Better Than With Surgery or SBRT?

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UCLA Medical Center, Los Angeles, CA, USA

If recurrent disease is detected after definitive irradiation, additional local intervention may be warranted. Salvage treatment for prostate is challenging. Salvage treatment assumes absence of metastasis, which correlates with original risk group status and prostate-specific antigen (PSA) kinetics. The re-staging work-up is not standardized but may include bone scan (Tc99 or F18), prostate magnetic resonance imaging (MRI), or C11 positron-emission tomography (PET) scan. The 5-year results for radical prostatectomy, cryotherapy, and high-intensity focused ultrasound (HIFU) are ≈50% BCC with urinary morbidity (incontinence, strictures) of ≈20-60%.

Permanent seeds after external beam radiation therapy (EBRT) have a range of 5-year BCC from ≈30-90%.

Table

	N	Dose	BCC	GU G3-4	GI G3-4
Tharp *et al*., *Brachytherapy*, 2008	7	7 Gy × 6	71% (5 y)	41% 1 G4	0%
Chen *et al*., *Int J Radiat Oncol Biol Phys*, 2013	52	6 Gy × 6	51% (5 y)	2%	0%
Yamada *et al*., *Brachytherapy*, 2014	42	8 Gy × 4	69% (3 y)	10%	0%
Kukielka *et al*. (Hyperthermia), *Strahlenther Onkol*, 2014	25	10 Gy × 3 in 6 weeks	74% (2 y)	0%	0%
Jo *et al*. (Partial/Focal), *BJU Int*, 2011	11	11 Gy × 2	7/11 (2 y)	0%	0%

Incontinence rates are less than surgery, but urinary and rectal complications are not insignificant (again highly variable). There are no direct comparisons between surgical approaches and brachytherapy.

Salvage high-dose-rate (HDR) brachytherapy provides reliable dosimetry and potential for selective dosimetry. The results of 5 HDR brachytherapy studies are presented in the table above. HDR brachytherapy provides the physician the ability to purposefully direct and modulate radiation dose to the salvage target and to avoid dosing to adjacent normal structures.

OA-F204

Is Focal Therapy Really the Right Step Forward?

Mitchell Kamrava, MD

Gynecologic Cancers and Sarcoma, Division of Brachytherapy, UCLA Department of Radiation Oncology, Los Angeles, CA, USA

Whole gland therapy represents the standard of care for prostate cancer treatment. Focal therapy is an emerging treatment area that sets out to provide equal cancer control as whole gland therapy but with reduced acute and late-term morbidity by treating less than the whole gland. A review of 137 prostatectomy specimens from our institution shows about 30% of patients could have all their disease treated using a hemi-gland approach. This number is closer to about 40% for patients with Gleason score 3 + 3 or 3 + 4 disease and 20% for those with Gleason score 4 + 3 or higher disease. This suggests a significant number of men have disease amenable to more focal treatment. When considering brachytherapy approaches to treat less than the whole gland, high-dose-rate (HDR) brachytherapy represents an appealing approach. A dosimetric comparison of HDR whole gland versus hemigland, 1/3 gland, or 1/6 gland brachytherapy plans shows marked reductions of > 50% in the D_{2cc} doses to the rectum, bladder, and urethra with 1/3 and 1/6 gland treatments. Focal therapy is a very promising treatment for appropriately selected patients, and this presentation will discuss the rationale for less than whole gland treatment, appropriate patient evaluation and selection, various brachytherapy treatment options, and early clinical data using focal therapy for definitive treatment.

OA-F205

Advancing Your Prostate Practice: Could a Robotic Telemanipulator Integrated to Functional Imaging Be of Help?

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In America, prostate cancer is the most common non-cutaneous malignancy affecting men and the second leading cause of cancer death. Most afflicted patients (90%) are over 60 years of age and are diagnosed with a localized tumor using prostate-specific antigen (PSA) testing.

We performed a literature review in search of technologies to improve the approach to brachytherapy and patient treatments. Many imaging modalities were explored to identify the best visualization technique. Color Doppler transrectal ultrasound (TRUS)-guided biopsies increase specificity of the diagnostic procedure. Improving furthermore, magnetic resonance imaging (MRI) permits a higher soft-tissue resolution. Multiparametric MRI using diffusion-weighted imaging with dynamic contrast material enhancement and spectroscopy permits assessment of tissue functionalities. Additional information on active tumor extension can be obtained with a positron-emission tomography (PET) scan using fluorodeoxyglucose (FDG), choline, carbon acetate, or other markers.

The key to exploiting this wealth of information is precision catheter guidance using robotic telemanipulation. This would allow, for example, treatment to be focused on the dominant involved lesion (DIL) in a focal therapy approach.

High cure rates (95% range) and low rates of side effects are reported, leaving little place for improvements. Functional imaging permits identification of the DIL while avoiding critical structures. Integrating the imagery to a robotic telemanipulator provides a more repeatable and precise procedure for brachytherapy, especially in a focal therapy dose-escalation setting.

Improvements in cure rates with low rates of side effects are to be expected with integration of robotic-guided brachytherapy with developing imaging modalities.

OA-G100

New Horizons – Breakthrough Technologies

Vincenzo Valentini, MD

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Over the past 20 years we have seen a technological evolution in the field of brachytherapy (Hoskin *et al*., *Semin Radiat Oncol* 2006;16: 209-217).

The use of 3D imaging (computerized tomography [CT], magnetic resonance imaging [MRI], positron-emision tomography [PET]/CT, and ultrasound), both in the planning and in the catheter placement, have led to the emergence of image-guided brachytherapy (IGBT) (Haie-Meder *et al*., *Radiother Oncol* 2011; 100: 333-343).

A significant contribution to this development has come from technological improvement by miniaturized sources and small, handy, and MRI/CT-compatible applicators (Hoskin *et al*., *Semin Radiat Oncol* 2006; 16: 209-217).

The diffusion of single-source devices has allowed treatment plans with the possibility of dose optimization (intensity-modulated brachytherapy [IMBT]) (Niehoff *et al*., *Strahlenther Onkol* 2006; 182: 102-107).

The use of IMBT and IGBT have led to clinical benefits (Williamson, *Int J Radiat Oncol Biol Phys* 2008; 71 (1 Suppl): S18-S22). The introduction of "image fusion", autoconturing, dose optimization, and automatic catheter reconstruction software have further contributed to improving outcomes (Van Der Laarse *et al*., In: Joslin *et al.* (eds.), *Principles and Practice of Brachytherapy Using Afterloading Systems*, 2001; Mould *et al.* (eds.), *Brachytherapy From Radium to Optimistaion*, 1994).

In parallel, we have seen considerable development of external beam radiation therapy (EBRT) with the advent of IMRT, IGRT, and protons.

Brachytherapy may find increasing use in intra/perioperative radiation therapy (IORT). In fact, modern surgical techniques are less invasive with endoscopy. This could lead to the abandonment of the "open" technique with difficulty in performing IORT with electrons. Unlike a plastic-tube, placement by endoscopy could allow a precision irradiation of the tumor bed.

Large, multicentric databases including imaging, outcomes, and additional clinical data could contribute to the development of predictive models of response and the creation of support tools to improve catheter positioning, treatment plans, and to help choose the best treatment modalities (Valentini *et al*., *Future Oncol* 2013; 9: 311-313).

OA-G101

Can Protons Replace Eye Brachytherapy?

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Medical University Vienna/AKH Wien, Vienna, Austria

Purpose: To compare treatment options for choroidal melanoma (CM). For brachytherapy, episcleral plaques with Ruthenium-106 (Ru-106) and iodine-125 are widespread. For proton therapy, CM is one of the few accepted indications. Linear accelerator (LINAC)-based stereotactic radiotherapy (SRT) with photons is an upcoming alternative.

Material and methods: The Medical University of Vienna offers both brachytherapy (Ru-106, since 1985, > 80 Gy to tumor apex) and LINAC-based SRT for patients with CM (since 1997). Patients with centrally located tumors and large tumors considered unsuitable for Ru-106 brachytherapy (> 300) have been treated with SRT using the fractionation schedule of proton therapy (5×10^{-14} Gy/80% isodose). Local control and side effects are compared for brachytherapy, SRT, and reported clinical proton experience.

Results: Local control rate was 96% in the SRT and brachytherapy group, comparable to proton therapy. Dose homogeneity in the target is best for protons. Dose exposure of adjacent structures is minimized with brachytherapy and proton therapy. Secondary radiation retinopathy was ~30% for brachytherapy. Morbidity spectrum is partly comparable and partly different for these treatment modalities, depending mainly on tumor size and location and dosimetric factors. The least overall radiation to the eye is delivered through brachytherapy (Ru-106), except for the radio-resistant sclera.

Conclusions: Brachytherapy remains the method of choice in limited-size non-centrally located CM, leading to excellent local control with very limited morbidity. Proton or SRT photon radiotherapy can be used for any tumor size and location and can achieve excellent local control with moderate rates of side effects. They are the methods of choice in centrally located and large-sized tumors (> 5 mm height). Large comparative clinical studies and cost-efficiency analyses are necessary but not yet available.

OA-G102

High-Dose-Rate Intraoperative Radiation Therapy: The Nuts and Bolts of Starting a Program, and New Directions

Joseph M. Herman, MD, MSc

Johns Hopkins Medicine, Baltimore, MD, USA

Purpose: High-dose-rate intraoperative radiation therapy (HDR-IORT) has demonstrated efficacy in improving local control and survival in patients undergoing surgical resection for primary and locally recurrent tumors. However, HDR-IORT programs are limited to specialized institutions, and minimal literature regarding program initiation and implementation exists. We aim to review a multidisciplinary approach to the initiation of a safe HDR-IORT program based on the success of our institutional experience.

Material and methods: The Johns Hopkins Hospital HDR-IORT program was initiated in November 2006. Prior to program initiation, the team spent several weeks at existing IORT programs. Subsequently, a systematic approach was developed using workflow grids and checklists. Safety simulations and risk assessment workshops were organized in coordination with the Armstrong Institute for Patient Safety and Quality. Patients are selected based on established criteria during multidisciplinary consultations.

Results: Common outcomes and acute and chronic toxicity associated with IORT cases will be presented at the meeting. Device acquisition, applicator issues, scheduling, patient flow in the operating room, and follow-up will all be discussed.

Conclusions: A safe and efficient HDR-IORT program can be developed with proper planning, resources, and multidisciplinary collaboration. Utilization of IORT is likely common due to lack of awareness and access. Initiation of additional regional IORT programs will likely improve utilization of IORT, thus increasing the likelihood of durable local control. At the end of the session, attendees will have a familiarity with the treatment technique and clinical outcomes and be prepared to explore the technology for their own program.

OA-G103

CT-Guided HDR Brachytherapy in Oligometastases

Jens Ricke, MD, PhD

University of Magdeburg, Magdeburg, Germany

Brachytherapy has a long tradition in gynecological, urogenital, ear, nose, and throat (ENT), and other tumors. Limitations most often apply when tumors are located in regions deep in the human body or are moving due to breathing motion. Techniques adopted by Interventional Radiologists, such as fluoroscopic computed tomography (CT) or magnetic resonance imaging (MRI) guidance for catheter placement, enable access to virtually any target inside the human body. In addition, prevention and management of complications such as bleeding embolization or protection of organs at risk by inserting inflatable balloons (stomach adjacent to liver metastases, bowel nearby kidney in renal cancer) are standard applications in radiation therapy. Access to these techniques has recently enabled a completely new range of indications – extensive tumor ablation in metastatic or oligometastatic disease of the liver, lung, or retroperitoneum, treatment of hepatocellular carcinoma (HCC) primary tumors, and many more. In this presentation, interventional techniques that allow treatment of moving or hidden targets anywhere in the human body, as well as clinical evidence of safety and efficacy available today, will be described in detail.

OA-G104

HDR and SBRT: Competitive Treatments?

Ferrán Guedea, MD, PhD, Ferran Ferrer, MD, PhD, Cristina Gutierrez, MD, PhD, Anna Boladeras, MD, Joan Pera, MD, Arturo Navarro, MD

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Introduction: Radiation therapy has never been more complex. The technological leap from the 1950s' linear accelerators to today's powerful machines has been astounding. Advances have continued apace as computers become more sophisticated. We are now able to deliver high-dose radiation therapy with remarkable precision using external beam radiation therapy (EBRT) or high-dose-rate brachytherapy (HDR-BT).

New technologies: One of the most exciting developments is the emergence of stereotactic body radiation therapy (SBRT), originally designed for the curative treatment of peripheral, small-volume, medically inoperable stage I non-small cell lung cancer (NSCLC). SBRT allows for accurate delivery of highly conformal, high-dose radiation therapy to limited-volume targets with high dose per fraction (> 7-10 Gy), few fractions (1-5) in 1-1.5 weeks, highly precise image-guided radiation delivery, and rapid dose fall-off gradients encompassing the target. Surprisingly, this is also the definition of HDR-BT.

HDR-BT is widely used as a primary treatment. It offers numerous advantages including delivery of highly conformal doses while sparing surrounding healthy tissue, minimal adverse effects, excellent survival, and high quality of life post-treatment. Compared to EBRT, brachytherapy has the added advantages of reduced

treatment times, less acute toxicity, and fewer concerns over treatment setup uncertainty and organ motion.

Conclusions: SBRT and HDR-BT are complementary treatments and similar in definition, with excellent results through dose escalation while reducing treatment-related morbidity. The available evidence suggests that certain treatments may offer improved tumor control, less toxicity, and shortened treatment courses. All of these benefits may decrease the indirect costs of cancer care, including factors related to lost time and productivity.

OA-G200

Brachytherapy for Head and Neck and Skin Tumors – Challenge or Routine for Physician and Physicist?

Tim R. Williams, MD[1], Vratislav Strnad, MD, PhD, Prof.[2]

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In this session, the current role of brachytherapy in head and neck cancer and in skin tumors will be analyzed. The indications for brachytherapy for head and neck and skin tumors, imaging procedures for target definition, implant techniques, and treatment results with special emphasis on local control rate and late toxicity will be described and critically evaluated.

These presentations will provide evidence that brachytherapy in head and neck tumors is an integral part of curative and palliative treatments and outline that, depending on the tumor size, brachytherapy has a high curative potential, frequently enables preservation of organs and function, and, thanks to unsurpassable conformity of the administered dose, is associated with few side effects in experienced hands. These sessions seek to provide evidence that interstitial brachytherapy of head and neck tumors in selected patients is a proven, effective, and safe treatment method with excellent long-term data, as well as a sole treatment modality, a postoperative method, and a unique treatment method of head and neck tumors in previously irradiated areas.

For skin tumors, the results of standardized surface applicators (Leipzig applicator, Valencia applicator) as the possibilities of mold techniques will be reviewed.

OA-G201

Surface Brachytherapy for Squamous and Basal Cell Carcinomas of the Skin

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The Lynn Cancer Institute at Boca Raton Regional Hospital, Boca Raton, FL, USA

Squamous and basal cell carcinomas of the skin affect 2-3 million people each year in the United States – more than lung, prostate, breast, and colorectal cancers combined. Although non-melanomatous skin cancers (NMSC) have a low mortality rate, the incidence continues to rise and they significantly affect quality of life. Additionally, NMSC has a substantial financial impact on the healthcare system.

Brachytherapy has been used in curing skin cancer for over 100 years. Nevertheless, the role of radiation therapy, especially in managing some of the more challenging lesions, is underappreciated by other clinicians managing NMSC. Brachytherapy techniques have evolved over the years, but they have frequently consisted of rarely used methods and applicators well known by only 1 or 2 individuals of a given radiotherapy department. The techniques often varied significantly from patient to patient and department to department, and the learning curve in mastering these techniques was quite steep. Over the past 10 years, however, with the development of standardized applicators, flaps and molds, easily reproducible brachytherapy techniques for skin cancer have flourished. These techniques are simple and quick, with good clinical effectiveness and little early or late morbidity. As in all brachytherapy techniques, attention to detail in set-up and applicator placement is extremely important.

A varied arsenal of treatment techniques including external beam radiation therapy is helpful in customizing the correct treatment approach for the particular lesion. Patient selection is paramount.

OA-G202

Head & Neck Brachytherapy: Primary or Salvage – When, Why, Who?

Vratislav Strnad, MD, PhD, Prof.

University Hospital Erlangen, University of Erlangen-Nürnberg, Erlangen, Germany

This presentation will provide an overview of the current role of interstitial brachytherapy in oral cavity and oropharyngeal cancer.

Interstitial brachytherapy as sole treatment and in combination with external beam radiation therapy is a valuable treatment modality in the treatment of both primary and recurrent head and neck cancer. The results of low-dose-rate (LDR) brachytherapy with iridium-192 wires were considered the gold standard up to the end of the 20th century. Pulsed-dose-rate (PDR) brachytherapy as a substitute for LDR brachytherapy is considered a useful modern option in the treatment of head and neck tumors. Recent results of high-dose-rate (HDR) brachytherapy for some indications are also encouraging.

Excellent local control rates of interstitial brachytherapy in head and neck cancer have been demonstrated in different studies. The published local control rates vary between 75-90%. Brachytherapy avoids xerostomia, extensive mucositis affecting the whole oral cavity, and trismus. Brachytherapy also permits future radiation therapy of possible secondary tumors in the head and neck area due to the excellent protection of surrounding healthy tissues. Recent results indicate that PDR interstitial brachytherapy is also an effective and safe option for curative therapy in selected patients with head and neck cancer in previously irradiated areas who are not suitable for salvage surgery (local control rates up to 70%).

Interstitial brachytherapy of head and neck tumors in selected patients is a proven, effective, and safe treatment method with excellent long-term data as a sole treatment modality, a postoperative method, and as a unique treatment method of head and neck tumors in previously irradiated areas.

OA-G203

Interactive Session: Solve a Problem – Large-Volume Skin Brachytherapy – Scalp, Skin, Breast Wall, etc.

Alexandra Stewart, DM, MRCP, FRCR

Royal Surrey County Hospital and University of Surrey, Guildford, UK

The goal of this presentation is to demonstrate solutions to challenging clinical scenarios for complex skin brachytherapy.

Superficial targets are transformed into complex targets when they are large volume, highly curved, difficult to access, close to critical normal structures, or a combination of these factors. This session examines the challenges of treating superficial targets with complex features. Specific clinical examples will be used for post-operative keloids, angiosarcoma of the scalp, and sarcoma of the foot and groins. The importance of dose and fractionation will be discussed, and the manufacture of custom-made molds to enhance treatment capability will be presented.

OA-H100

Hidden Heroes of Brachytherapy: Undervalued Techniques

Vratislav Strnad, MD, PhD, Prof.[1], Antonio Cássio Assis Pellizzon, MD, PhD, MSc[2]

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The aim of this session is to provide a profound overview of the current role of brachytherapy in penile cancer, bladder cancer, rectal cancer, and sarcomas. These presentations critically evaluate the indications for brachytherapy for all of these special indications, assess the value of imaging procedures for target definition, describe implant techniques, and analyze treatment results with special emphasis on local control rate and late toxicity.

This session also reviews the evidence that brachytherapy should also be an integral part of oncological treatments in rare tumors and that, depending on the tumor size, brachytherapy has a high curative potential, particularly in comparison to surgery. Brachytherapy enables the preservation of organs and function in the majority of patients and is associated with very few side effects in experienced hands. Together, these presentations present strong evidence that brachytherapy for carefully selected patients with penile cancer, bladder cancer, rectal cancer, and sarcomas is a very effective and safe treatment method with excellent long-term data.

OA-H101

Penile Carcinoma – Organ Preservation With Brachytherapy

Vratislav Strnad, MD, PhD, Prof.

University Hospital Erlangen, University of Erlangen-Nürnberg, Erlangen, Germany

The goal of this presentation is to analyze the current role of sole interstitial brachytherapy as a conservative approach in penile cancer.

Because of the rarity of penile cancer, no randomized trials exist to compare the results of different treatment modalities. The evidence for the treatment of penile cancer is based entirely on observational retrospective studies. The results of low-dose-rate (LDR) brachytherapy with iridium-192 wires using the rules of the Paris system was considered the gold standard up to the beginning of the 21st century. Nowadays, pulsed-dose-rate (PDR) brachytherapy as a substitute for LDR brachytherapy is considered a useful modern option in the treatment of penile tumors. Some results of high-dose-rate (HDR)

brachytherapy have also been reported, unfortunately by a very limited number of patients and short follow-up.

Excellent local control rates of interstitial brachytherapy in penile cancer have been demonstrated in different studies using LDR/PDR brachytherapy. Using interstitial LDR/PDR brachytherapy, conservation rates of 87% and 70% at 5 and 10 years, respectively, can be achieved. The most common late sequel of penile brachytherapy is soft tissue ulceration, urethra stenosis, and late fibrosis of the corpora cavernosa. Soft tissue ulcerations are reported in 6-26% of cases. Urethral stenosis is reported in 10-45% and is typically related to proximity of sources to the meatus.

Interstitial brachytherapy in selected patients with penile tumors < 4 cm is a proven, effective, and safe organ- and function-saving treatment method with excellent long-term results. Brachytherapy for penile cancer stage I and II is an alternative for mutilating surgery.

OA-H102

Bladder Cancer: Is Brachytherapy an Alternative for Cystectomy?

Bradley R. Pieters, MD, PhD

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Standard treatment for muscle-invasive bladder cancer is a radical cystectomy with pelvic lymph node dissection. In certain cases, bladder function replacement can be given with a neo-bladder. However, after radical cystectomy normal bladder function will always be impaired. This is one of the reasons to explore the possibilities for bladder-sparing procedures. Chemoradiation with advanced radiation techniques, such as lipiodol-based tumor delineation and daily position verification, results in good local control. A disadvantage of external beam radiation therapy is the accumulated dose on the small bowel that can result in late abdominal complaints. Partial cystectomy for small lesions maintains bladder function; however, invasive recurrences are often observed. Therefore, partial cystectomy is not advised as an alternative for radical cystectomy.

The addition of radiation to partial cystectomy has been shown to decrease the incidence of invasive recurrences. This substantial reduction has also been shown after a transurethral resection. By giving part of the radiation treatment with brachytherapy radiation dose to the small bowel, the rest of the bladder can be spared. In several studies, local control of 70-85% has been shown after brachytherapy for muscle-invasive bladder cancer.

Brachytherapy for bladder cancer is indicated for solitary pT1-pT2 or limited pT3 tumors < 5 cm. The conventional technique is done by performing a sectio alta and inserting flexible catheters into the bladder wall. These catheters exit through the abdominal wall. Afterloading treatment is given with a pulsed-dose-rate (PDR) or high-dose-rate (HDR) source. A new development is by placing the catheters with a laparoscopic or robot-assisted technique.

OA-H103

Sarcoma: Benefit From Brachytherapy in Curative Intention

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This session will discuss the contemporary use of high-dose-rate brachytherapy (HDR-BT) in the management of soft tissue sarcoma (STS) of the extremities. A variety of radiation approaches have been used in the adjuvant local management of STS, particularly in those treated with limb-sparing surgery for function preservation. The adjuvant radiation treatments include external beam radiation therapy (EBRT), HDR-BT, and intraoperative radiation therapy. Although randomized trials comparing HDR-BT plus EBRT and EBRT alone have not been published, retrospective data have provided evidence that HDR-BT offers several advantages for boosting EBRT. In this session, the audience will be able to discuss the radiobiology, dose and fraction schedules, treatment time reduction, and impact of HDR-BT on local control and function preservation.

OA-H104

Is High-Dose-Rate Brachytherapy a Treatment Option for Patients With Rectal Cancer?

Té Vuong, MD, FRCP[1], Tamim Niazi, MDCM[2], Slobodan Devic, PhD, FCCPM[3]

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Purpose: In the total mesorectal excision (TME) era, patterns of failure suggested that pelvis nodal recurrence is very low. This presentation reviews the results of this approach with neoadjuvant high-dose-rate endocavitary brachytherapy (HDREBT) in operable rectal cancer over 15-years' experience.

Material and methods: Between 1998 and 2013, 483 patients referred for preoperative radiation elected for HDREBT. The median age was 68.2 years (range, 28-90 years). Preoperative endorectal ultrasound and magnetic resonance imaging (MRI) were performed. Patients with

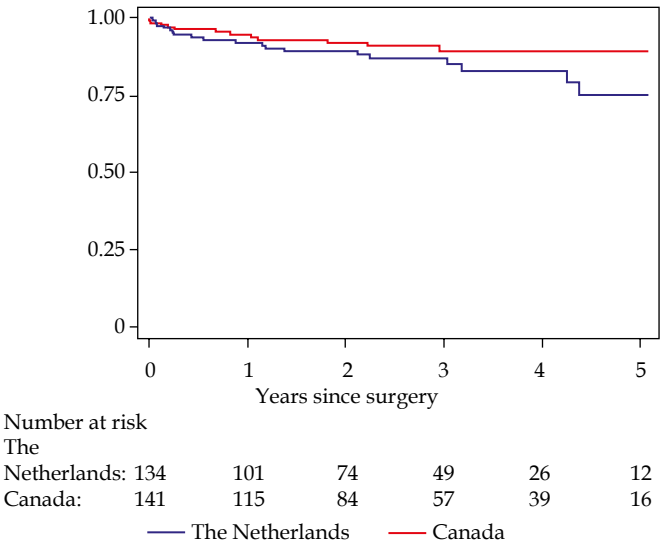

Fig. 1. Kaplan-Meier of Overall Survival (event = death due to all causes). Comparative Overall Survival Results From a Matched-Pair Analysis: HDREBT vs. External Beam Radiotherapy (p = 0.03)

T3 and low T2 with positive circumferential resection margins (CRM) were included. HDREBT was prescribed to the gross tumor volume and intramesorectal deposits seen on MRI. A total prescription dose of 26 Gy was given over 4 daily treatments (6.5 Gy per day). TME surgery was performed 6 to 8 weeks after completion of treatment. Adjuvant chemotherapy was at the discretion of the medical oncologist.

Results: A total of 483 patients received neoadjuvant HDREBT alone. The complete sterilization rate was 27% and the rate of positive nodes was 30.7%. The median follow-up time is presently 63 months, the local recurrence rate is 4.8%, the disease-free survival is 65.5%, and the overall survival rate is 72.8%. The contribution of pelvic node relapse in local failure is relatively small compared to that of the tumor bed.

Conclusions: Our experience suggests that targeted radiation with HDREBT allows for excellent local control and limited toxicities in a select group of patients. The nodal contribution in local relapse is low and opens the debate on present clinical target volumes used in current routines.

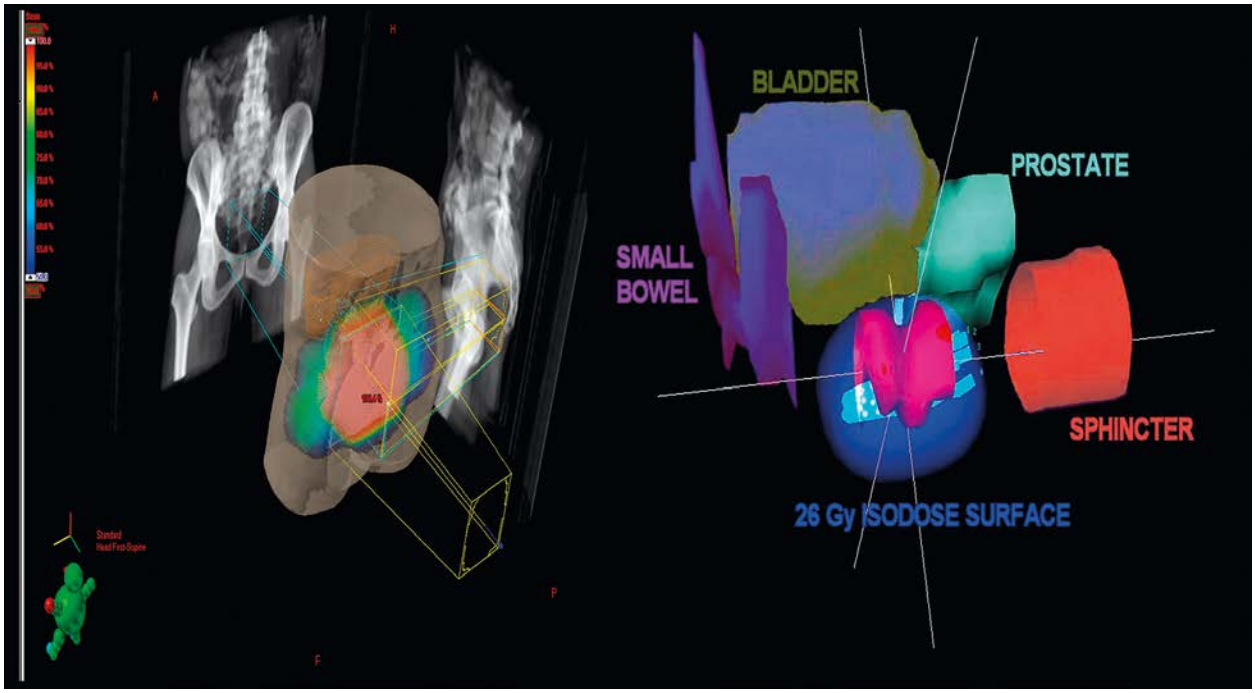

Fig. 2. Treatment Volume Difference: HDREBT vs. External Beam Radiotherapy

OA-H105

Interstitial Brachytherapy for Lung Cancer: Techniques and Results

Alexandra Stewart, DM, MRCP, FRCR

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The goal of this presentation is to discuss the techniques and results of interstitial brachytherapy for lung cancer. The principles governing interstitial brachytherapy for lung cancer will be presented. Techniques of administration will be examined and compared. Current evidence associated with the use of interstitial brachytherapy in thoracic cancers will be discussed. Reference will be made to the forthcoming updates to the American Brachytherapy Society (ABS) consensus guidelines for thoracic interstitial brachytherapy.

OA-H200

The Compelling Case for Brachytherapy in the Palliative Setting

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The session will focus on indentifying issues in palliative brachytherapy that require innovations. Various gaps in the knowledge as well as novel approaches will be discussed. Attendees will have the possibility to participate in active learning with the opportunity for discussion and ideation. The presentations will cover chosen aspects of re-irradiation in the treatment of lung cancer and cervical cancer and an attempt to define conditions of application. Another practical topic that will be covered is the possibility of combining brachytherapy with other palliative methods, such as stents or external beam radiation therapy (EBRT). This session should help promote this approach in daily practice. The importance of quality of life (QoL) after palliative brachytherapy will be highlighted. Improvement in QoL is one of the main objectives of brachytherapy. A clinical case discussion at the end of this session should help in making future decisions.

OA-H201

Re-irradiation of Lung Cancer: Undervalued Possibility

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Purpose: Endobronchial obstruction associated with lung cancer represents a common and potentially life-threatening complication of newly diagnosed or recurrent disease. High-dose-rate brachytherapy (HDR-BT) represents a therapeutic option with several advantages over external beam radiation therapy (EBRT), particularly in previous irradiated patients. The primary objective of this analysis was to assess palliation efficacy and complication rates of repeated brachytherapy treatment in previously irradiated patients.

Material and methods: Analysis was based on 270 patients with endobronchial recurrence or progression after prior HDR-BT who were re-irradiated with HDR-BT. Repeated HDR-BT was delivered as single fractions with a dose level of 8 or 10 Gy depending on size of recurrent tumor, general condition, previous total dose including EBRT and brachytherapy, and tolerance of the mucosa in irradiated area. Data obtained by different authors are also discussed.

Results: Of 270 patients, 218 had follow-up endoscopic examination (1-3 months after brachytherapy completion). Total response rate in this group was 80%. Of 200 patients whose chest X-ray showed evidence of collapse or atelectasis caused by endobronchial recurrence obstruction, 146 (73%) had evidence of reaeration. The median (range) duration of palliation, marked by symptoms or a chest X-ray that worsened, was 5 months (2-14 months). Tolerance of repeated treatment using HDR-BT was good in most cases, with superficial mucosal necrosis observed in 166 patients and bronchoesophageal fistula recorded in 6 patients.

Conclusions: Repeated HDR-BT effectively relieves the symptoms of endobronchial obstruction due to recurrent lung cancer and can be given safely as an outpatient procedure. Future studies should aim to determine the maximum tolerated dose and appropriate patient selection.

OA-H202

Re-irradiation Using HDR Interstitial Brachytherapy for Locally Recurrent Cervical Cancer

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Purpose: Recurrent cervical cancer after previous radiation therapy (RT) is a difficult clinical problem. Surgical salvage (pelvic exenteration) for the previously irradiated field is technically challenging because of its operative mortality and morbidity, as well as loss of structures and functions. We evaluated effectiveness and feasibility of re-irradiation using high-dose-rate interstitial brachytherapy (HDR-ISBT) in patients with recurrent cervical cancer.

Material and methods: Between 1995 and 2012, 52 consecutive women with central pelvic recurrence after prior RT who were salvaged with HDR-ISBT at Osaka University Hospital in Japan were analyzed retrospectively. The prior RT was comprised of 17 definitive and 35 postoperative RT. The median diameter of the recurrent tumor was 23 mm. All patients were treated with 42 Gy in 7 fractions over 4 days.

Results: Of 52 patients, 31 achieved complete response (CR) and 9 achieved partial response (PR, overall response rate, 77%). The 5-year overall survival rate was 53%, and the median survival period after recurrence was 32 months. After the median follow-up period of 56 months, 13 patients (25%) developed grade 3 or 4 late toxicities. Of these, 9 patients showed rectovaginal or

vesicovaginal fistula, or both. Multivariate analysis identified the following 2 independent prognostic factors of a poor outcome: the recurrent tumor diameter > 40 mm (p = 0.017) and the interval between prior treatment and recurrence < 6 months (p = 0.015).

Conclusions: Re-irradiation using HDR-ISBT is effective and feasible in patients with recurrent cervical cancer, although one-quarter develop severe late toxicities. Early detection of recurrence may lead to successful salvage.

OA-H203

Esophageal Cancer: Is Combination With Surgery (Stents) or EBRT a Better Solution?

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While esophageal brachytherapy has a role as a curative treatment of locally advanced T2-T3 tumors in combination with external beam radiation therapy, especially in bleeding, ulcerating, and/or obstructive tumors, the main indication of endoluminal high-dose-rate brachytherapy (HDR-BT) in esophageal cancer is generally the palliative situation. Brachytherapy can be performed as monotherapy to improve dysphagia or combined with surgical procedures (e.g., endoscopic dilatation, laser deobstruction, self-expansible metallic stents).

In the curative setting, the use of brachytherapy appears useful due to the high potential in local tumor control. However, strong evidence in the literature in favor of this boost technique is lacking. In addition, brachytherapy may increase the rate of severe toxicity, especially in terms of fistula and stenosis. In contrast, in a phase III clinical trial in the palliative indication, endoluminal brachytherapy improved both survival without dysphagia and quality of life compared to metallic stents. The duration of freedom from tumor symptoms after laser surgery can be increased by brachytherapy as well.

Optimal management of esophageal cancer requires multidisciplinary collaboration and careful assessment of tumor stage/growth form and of the patient's condition. Endoluminal brachytherapy boost may be carefully used in experienced hands. However, prospective comparative studies with alternative boost methods are required. In the palliative situation, HDR-BT is very effective and improves outcomes. While it can be performed as a substitute for metallic stents used as monotherapy, it may also be combined with several surgical procedures (e.g., laser surgery or endoscopic dilatation).

OA-H204

Quality of Life: To Treat or Not to Treat?

Tim R. Williams, MD

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Palliative radiation is one of the areas of radiation oncology that does not receive enough attention, and palliative brachytherapy receives even less. Generally considered too expensive for palliative use, brachytherapy can be a very effective tool to control bleeding, obstruction, and even relieve pain. Palliative brachytherapy is generally quick, painless, and inexpensive, particularly compared with palliative chemotherapy. This session will review the decision-making process used to determine whether or not to treat a patient for palliation with brachytherapy. Real-world case examples of patients with lung, esophageal, gynecologic, and head and neck cancers will be used. Not all of the case examples actually required treatment. At the completion of the session, the attendee will have a greater understanding of the usefulness and utility of brachytherapy in the palliative setting.

PA-001

Intra-Observer Variability in HR-CTV Delineation on MR/CT Imaging in Cervical Cancer Image-Guided BT

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Purpose: Magnetic resonance (MR) is the gold-standard imaging modality for cervical cancer (CC) image-guided brachytherapy. Nevertheless, the possibility of multiple MR scans for each brachytherapy fraction is not commonly available. The aim of this work is to investigate the robustness of high-risk clinical target volume (HR-CTV) contouring on CT based on pre-brachytherapy MR findings by measuring the intra-observer variability.

Material and methods: 30 consecutive CC patients (FIGO I-IV) treated between September 2012 and August 2013 were included. All patients received 4 brachytherapy fractions of 7 Gy within 2 applications. At first application a full MR-based approach was adopted and HR-CTV contoured according to the Groupe Européen de Curiethérapie – European Society for Radiotherapy & Oncology (GEC-ESTRO) recommendations on T2 FSE 1.5 T MR scans (3.5-mm slice thickness). At the time of second brachytherapy application, HR-CTV was

Table

	Delivered			Recontoured			Absolute deviation (Δ)			Relative deviation (Δ%)			
	HRCTV VOL cc	HRCTV D_{90} Gy	HRCTV V_{100}	HRCTV VOL cc	HRCTV D_{90} Gy	HRCTV V_{100}	HRCTV Δvol cc	HRCTV ΔD_{90} Gy	HRCTV ΔV_{100}	HRCTV Δvol	HRCTV ΔD_{90}	HRCTV ΔV_{100}%	
MR based	38.7	7.8	96.7	34.9	7.6	95.8	1.8	0.1	0.6	5.3	1	0.7	Median
	54.2	7.5	93.3	51.7	7.4	92.3	2.6	0.1	1	3.6	1.1	1	Average
	47.2	1	8.9	47.9	1	8.7	8.4	0.3	2.3	17.5	4.5	2.6	SD
CT based	41.4	7.5	95.8	37.7	7.5	94.5	3.8	–0.1	–0.1	7.5	–1	–0.1	Median
	60.4	7.3	91.6	57.6	7.4	91.7	2.7	–0.1	–0.1	2	–1.6	–0.3	Average
	49.7	0.8	8.3	47.6	0.8	8.2	8	0.4	4.3	18.7	6.3	4.9	SD

delineated on CT (with IV contrast, 2-mm slice thickness) based on a pre-brachytherapy MR scan without applicator in place (T2 FSE sequence 1 T MR scans 5-mm slice thickness). Dose was optimized to respective HR-CTV contours. Within a minimum interval of 4 months, the HR-CTV was re-contoured on MR and CT image set. Delivered BT plans were applied to re-contoured HR-CTVs and dose-volume histogram (DVH) parameters analyzed.

Results: DVH results and variations are summarized in the table above.

Linear regression showed good agreement between original and re-delineated HR-CTV contours sets.

Conclusions: CT-based HR-CTV contouring based on information obtained with an MR scan taken a few days before BT application may result in acceptable intra-observer variability.

PA-002

Surface Dose Evaluation Outside Treatment Area for Breast Cancer Irradiation Modalities Using TLDs

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Purpose: To measure and compare surface dose outside treatment area at 6 different points of interest (POIs) for 5 different breast cancer radiation treatment modalities.

Material and methods: TLDs (TLD-100) were calibrated according to the University of Wisconsin Radiation Calibration Laboratory protocol. Twenty-five breast cancer patients were included in the study. The TLDs were placed at 6 different locations on the patient. Energy response factors for different energy beams were applied in absorbed dose calculation. Breast quadrant analysis was performed.

Results: Average absorbed doses in cGy with standard deviation for different modalities at POIs for Accuboost, SAVI, MammoSite ML, electron boost, photon boost, and contralateral breast are provided in Table 1. The maximum possible doses out of delivered dose at POIs are: 7.90% in contralateral breast, 6.32% in sternum, 5.70% in thyroid, 5.50% in shoulder, 1.93% in eye, and 4.3% in lower abdomen. The absorbed surface doses strongly depend on the location of the tumor in the quadrant.

Discussion: There is no significant difference in out-of-field surface doses at POIs among 3 studied accelerated partial-breast irradiation (APBI) modalities. However, APBI modalities are significantly different with electron boost and photon boost. Although the surface doses are not as high compared to the target dose, they would be deposited to a large part of the body with a potential to induce secondary malignancy. It would be useful to consider various possible effects of the out-of-field surface dose while treating a breast cancer patient with radiations.

Table 1.

	Accuboost	SAVI	MammoSite ML	Electron boost	Photon boost
Sternum	6.51 ± 2.93	3.06 ± 1.28	5.27 ± 2.12	0.52 ± 0.19	2.62 ± 1.82
Shoulder	5.18 ± 2.21	2.26 ± 1.11	5.58 ± 2.77	0.66 ± 0.16	1.03 ± 0.42
Eye	1.74 ± 0.84	1.51 ± 0.52	2.65 ± 0.68	0.52 ± 0.29	0.64 ± 0.20
Thyroid	5.50 ± 2.75	2.00 ± 0.73	3.38 ± 1.03	0.52 ± 0.13	0.96 ± 0.55
Contralateral breast	8.52 ± 3.86	2.74 ± 1.49	2.80 ± 1.22	0.41 ± 0.24	1.84 ± 0.69
Lower abdomen	4.50 ± 2.63	1.67 ± 1.22	2.82 ± 2.25	0.32 ± 0.18	0.76 ± 0.11

PA-003

A Comparison of Two Fractionation Schedules of HDR Brachytherapy in Treatment of Carcinoma Cervix

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Purpose: Intracavitary brachytherapy (ICBT) is essential in the treatment of cervical carcinoma; however, optimum fraction size and number of fractions are yet to be defined. We performed a prospective study to compare the toxicity profile and clinical outcome between 2 different dose-fractionation schedules of high-dose-rate (HDR)-ICBT for the treatment of locally advanced carcinoma cervix.

Material and methods: A total of 302 patients with invasive carcinoma of uterine cervix (FIGO stage IIB-IIIB) were enrolled between January 2007 and December 2010. All patients were treated with external beam radiation therapy (EBRT) and HDR-ICBT. After EBRT, patients were randomized to one of the ICBT arms. In control Arm A (n = 150), 6.5 Gy per fraction, 3 fractions, 1 week apart were delivered and in study Arm B (n = 152), 9 Gy per fraction, 2 fractions, 1 week apart were delivered.

Results: The patients were followed-up for a median of 3 years. Late toxicity in rectal, bladder, and vaginal stenosis in Arm B (19.07%, 10.5%, and 8.55%, respectively) was similar to Arm A (12%, 5.33%, and 6.67%, p = 0.96, 0.97, 0.7, respectively). However, median time to develop rectal and bladder toxicity in Arm B (10.87 and 20.05 months) was earlier than Arm A (17.92 and 27.48 months, p = 0.0001 and 0.004). Overall survival (OS) in both the arms (Arm A: 34.79 months, Arm B: 47.03 months, p = 0.003) was significantly in favor of Arm B.

Conclusion: Two fractions of HDR brachytherapy is a safe and effective alternative in the management of carcinoma cervix with manageable normal tissue toxicity.

PA-004

The Clinical Outcome of HDR-ICBT Combined With Concomitant Complimentary IMRT in Cervical Cancer

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Objectives: To observe the clinical and dosimetric outcome of high-dose-rate intracavitary brachytherapy (HDR-ICBT) combined with concomitant complimentary intensity-modulated radiotherapy (IMRT) in locally advanced cervical cancer.

Material and methods: 97 cervical cancer patients (FIGO: IIb-IVa) were retrospectively analyzed. They received radical concomitant chemoradiotherapy. External body radiotherapy was performed with IMRT at a total dose of 45-50 Gy/25 fraction. The patients underwent 4 fractions brachytherapy at 6-6.5 Gy/fraction twice a week. The complementary IMRT was delivered immediately after HDR-ICBT. D_{90}, D_{100}, V_{100}, V_{pd}, and V_{2xpd} volumes of target and $D_{0.1cc}$, D_{1cc}, D_{2cc}, and D_{ICRU} of organs at risk were recorded. Acute and late side effects were evaluated by RTOG criteria.

Results: The median follow-up was 24 months. The mean V_{100} of high-risk and intermediate-risk clinical target volume (HR-CTV and IR-CTV) was 93.2% and 92.9%, respectively. The mean D_{2cc} for the bladder, sigmoid, and rectum was 66.2 Gy, 65.8 Gy, and 73.6 Gy, respectively. The 2-year local control rate, distant-free survival rate, overall survival rate was 95.8%, 86.0%, and 89.5%, respectively. The incidence of late side effects of the lower gastrointestinal tract and genitourinary system were 9.3%, 16.5% (G1-2) and 2.1%, 4.1% (G3), respectively. No G4 side effect occurred.

Conclusions: HDR-ICBT combined with concomitant complimentary IMRT is a feasible method to boost the dosage of cervical cancer target, and preliminary clinical outcomes showed a better outcome and tolerable side effects.

PA-005

Initial Experience With Image-Guided Brachytherapy in Cervical Cancer Patients in Aemc, Karachi

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Objective: Cervical cancer is the second most common female malignancy worldwide. Definitive concurrent chemoradiation with external beam radiation therapy (EBRT) and brachytherapy is the sole treatment and surgery in only early stages. Brachytherapy plays a critical role in the treatment and locoregional control corelates with cure and survival.

Material and methods: A total of 30 patients with SCC stages IB-IVA were treated with definitive concurrent chemoradiation. All patients received 3D conformal radiotherapy (3D-CRT) to the whole pelvis with doses ranging from 45 Gy to 50 Gy prior to brachytherapy. Intracavitatory brachytherapy was started 1 week after completion of EBRT. Before brachytherapy, all patients underwent p/v examination, magnetic resonance imaging (MRI) pelvis 24, computed tomography (CT) pelvis 6. Before each session, PV findings were compared with previous one along with planning CT. High-risk clinical target volume (CTV) and organs at risk (OARs) were defined on the Ocentra™ version 4.1 brachytherapy planning system according to the American Brachytherapy Society (ABS) guidelines.

Results: Post-EBRT MRI and CT scan done within 1 week showed partial response in 27 and complete response in 3 patients. All patients had 3-4 sessions of brachytherapy with a dose range of 5-7.5 Gy/session. Seven patients had acute urinary and one rectal toxicity. All patients were assessed for response at 6-8 weeks by MRI pelvis. Twenty-three showed complete response while 7 showed partial response.

Conclusions: While planning patients with IGBT takes about 4 hours, CTV delineation on CT planning was difficult in patients who don't have MRI. In some cases, 90-100% CTV coverage was not possible due to the shape of CTV. Insertion of applicator may be convenient if GA facility is available. IGBT remained an expensive treatment as compared to conventional planning. Advanced stage dictates poor local control. Targeting the population to increase the awareness of screening with pap smear will lower the presentation in advanced disease.

PA-006

Uncertainties in Applicator Reconstruction in Cervical Cancer Image-Guided Adaptive Brachytherapy

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Purpose: To evaluate the uncertainties introduced when the needles and applicator are reconstructed directly in magnetic resonance (MR) image sets.

Material and methods: For 40 consecutive patients treated with MR-based brachytherapy, dose-volume histogram (DVH) parameters for the high-risk clinical target volume (HR-CTV) and organs at risk (OAR; rectum, sigmoid, and bladder) were analyzed. We investigated deviations in dose parameters due to applicator reconstruction uncertainties when the needles and the applicator are reconstructed in the MR image set, related to the computed tomography (CT) reconstruction. The OAR and HR-CTV were contoured in MR and then transferred to the CT using a rigid registration based on the applicator coordinates. The reconstruction methods are the following: A) In the MR set, the applicators are reconstructed with the 3D applicator library installed (Nucletron B.V., Veenendaal, the Netherlands). The needles are reconstructed directly in the images following the air path inside the needle. B) For the CT set, X-ray markers are used for the reconstruction.

Results: The mean differences between the MR HR-CTV and the transferred HR-CTV was –0.07 ± 0.32 cm^3, with a median value of –0.01 cm^3. Relative mean differences in DVH parameters between the reconstruction methods are shown in the table below.

Conclusions: The uncertainties introduced by direct reconstruction in MR image sets are acceptable and do not depend on the use or number of needles.

Table

	Standard plan					Delivered plan				
	HRCTV D_{90} (%)	V_{100} (%)	D_{2cc} Rectum (%)	D_{2cc} Sigmoid (%)	D_{2cc} Bladder (%)	HRCTV D_{90} (%)	V_{100} (%)	D_{2cc} Rectum (%)	D_{2cc} Sigmoid (%)	D_{2cc} Bladder (%)
Average	–1.51	–0.93	–3.94	0.18	0.66	–1.13	–1.09	–2.44	0.45	2.53
Std. deviation	3.08	1.48	4.97	6.03	4.64	2.74	1.81	3.39	5.08	3.88
Median	–0.52	–0.03	–2.80	–0.19	0.47	–0.66	–0.19	–2.49	0.25	1.32

PA-007

Clinical and Radiobiological Evaluation Effects of Radiotherapy Cancer Cervix

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Purpose: To ascertain causal dependence early and late toxicity from value radiobiological summary target dose (STD) for combined radiotherapy carcinoma of the uterine cervix. For radiobiological evaluation results of radiotherapy cancer cervix, we used the LQ model biological effective dose (BED). The terms BED for early-reacting normal tissues and tumors (BEDe), and for late-reacting normal tissues (BEDl) were applied.

Material and methods: 1756 patients with carcinoma of the uterine cervix IB-3B stage, who obtained the radiotherapy in N.N. Petrov Research Institute of Oncology Ministry of Health, Saint-Petersburg were studied. All patients were treated with combined (external beam radiation therapy [EBRT] + brachytherapy) radiotherapy. 542 patients underwent brachytherapy with medium dose rate (MDR) (5-10 Gy/h) and 979 patients underwent treatment with high dose rate (HDR) (> 12 Gy/h). Three modes of MDR and HDR brachytherapy were applied for fractionating the STD: 1-7 Gy, once a week, STD = 28 Gy (BEDe = 48, BEDl = 106), 2-7 Gy, once a week, STD = 35 Gy (BEDe = 60, BEDl = 133), 3-7 Gy, once a week, STD = 42 Gy (BEDe = 71, BEDl = 160). 235 patients underwent brachytherapy with low dose rate (LDR) (0.5 Gy/h). Three modes were applied for fractionating the STD. For clinical and radiobiological evaluation results all patients were separated into 2 groups. In the first group, patients with radiobiological STD from combined radiotherapy BEDe ≤ 85 Gy and BEDl ≤ 160 Gy were included. In the second group, another patient with BED > 85 Gy and BEDl > 160 Gy were included.

Results: The total number of acute toxicity among patients in the second group (29%) treated with combined radiotherapy was substantially more (10%, $p < 0.05$) in comparison to the first group (19%). The total number of late toxicity among patients in the first group (4%) treated with combined radiotherapy was substantially less (5%, $p < 0.05$) in comparison with the second group (9%).

Conclusion: Quantity, early and late toxicity substantially depends on value radiobiological STD for combined radiotherapy carcinoma of the uterine.

PA-008

Evaluation of Toxicity in Locally Advanced Gynecological Malignancies Treated With Brachytherapy

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Purpose: The aim of the study was to assess treatment outcomes for patients with locally advanced gynecological malignancies treated with interstitial brachytherapy using Martinez Universal Interstitial Template (MUPIT) and to study the acute and late toxicity after treatment with this technique.

Material and methods: Three-hundred previously untreated patients with histologically confirmed carcinoma of cervix (n = 108), vault (n = 79), vagina (n = 55), cervical stump/recurrence (n = 37), and others (n = 21) were treated by combination of external beam radiotherapy using megavoltage irradiation to the pelvis to a dose of 4000 to 5000 cGy followed by interstitial brachytherapy using MUPIT. Doses of brachytherapy were 1500 cGy/3#, 1600 cGy/4#, or 1800 cGy/6#. Criteria for inclusion of patients were as follows: Hb minimum 10 g/dL, performance status > 70% or more (Karnofsky scale), and histopathological confirmation FIGO stage IIB/IIIB (excluding frozen pelvis).

Results: Patients were evaluated after 1 month after the brachytherapy. Complete response was seen in 186 patients, whereas 90 patients showed partial response. The local control was 62% at 1 year post-treatment. The acute toxicity was seen in 6% and in late toxicity Grade I toxicity seen in 3%, Grade II toxicity in 4%, Grade III in 14%, and Grade IV in 5%.

Conclusions: Interstitial template brachytherapy by MUPIT is a good alternative to deliver high-dose radiation in locally advanced gynecological malignancies where conventional brachytherapy application is either not feasible or unlikely to encompass tumor volume adequately.

PA-009

PSA Bounce in Patients With Prostate Cancer After HDR and LDR Brachytherapy

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Introduction: The level of prostate-specific antigen (PSA) in serum is the most common method of monitoring prostate cancer patients after definitive treatment. PSA after brachytherapy decreases gradually but usually

remains detectable. The variability of PSA in the blood serum of patients with prostate cancer after low-dose-rate (LDR) brachytherapy is quite well described in the literature. Currently, there is a lack of data about the PSA serum kinetics in patients after high-dose-rate (HDR) brachytherapy and its comparison to patients treated with LDR. The aim of this work is to compare clinical and dosimetric factors in patients with significant increases in the PSA level after HDR and LDR brachytherapy.

Material and methods: Ninety-four patients were qualified to the study. Forty-one patients were treated with LDR brachytherapy for prostate cancer (LDR group) and 53 with HDR brachytherapy (HDR group) at the Department of Brachytherapy at Greater Poland Cancer Centre from June 2008 to December 2010. The patients were in stage T1c to T2c, iPSA from 1.5 to 19.6 ng/mL with histological diagnosed prostate adenocarcinoma (Gleason Scale ≤ 7) and belonged to the low- and intermediate-risk groups. Thirty-three patients received androgen deprivation therapy. LDR brachytherapy TD was 144-145 Gy, HDR brachytherapy TD – 3 x 15 Gy or 3 x 10.5 Gy. Median follow-up was 3 years. The PSA Bounce threshold was > 0.2 ng/mL.

Results: It was observed that in the LDR group patients were younger (median, 64 years) and longer observed (median, 3 years) than in the HDR group (median, 69 and 2.8 years, respectively). PSA bounce phenomenon occurred in 24% (n = 23) of patients. After HDR brachytherapy, PSA bounce occurred in 22% (n = 12) and after LDR in 26% (n = 11) of patients. We observed shorter time to PSA increase after HDR brachytherapy than after LDR (10.7 vs. 18.9 months, p = 0.003). There were no other clinical and dosimetric factors that were correlated with the HDR and LDR groups.

Conclusions: PSA bounce occurs in average after 24% of patients and at the same rate after HDR and LDR brachytherapy. After HDR brachytherapy, the first PSA rise before PSA bounce is observed earlier than after LDR (18.9 vs. 10.7 months), which could help in easier observations of these patients after treatment.

PA-010

Dose Escalation to Dominant Intraprostatic Lesion (DIL) With TRUS-MRI-Guided HDR Brachytherapy

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Purpose: To demonstrate the feasibility and safety of dose escalation to DIL as defined on multiparametric magnetic resonance imaging (mpMRI).

Material and methods: Fifteen patients with intermediate- to high-risk prostate cancer and visible dominant intra-prostatic nodule on mpMRI have been treated prospectively, with combined MRI-transrectal ultrasound (TRUS) fusion high-dose-rate (HDR) brachytherapy (1 fraction of 1500 cGy) and hypofractionated external beam (3750 cGy in 15 fractions) (BED: 265 Gy). Prostate gland, DILs, and organs at risk (OARs) were delineated on MRI datasets, MRI-TRUS fusion performed and contoured structures transferred to the US datasets. Within our standard treatment constraints, a dose of 1875 Gy was delivered to at least 98% of the DIL volume (V_{125}% > 98%) (BED: 351 Gy).

Results: Median age was 71 years, median prostate volume was 23.8 cc, and the median number of needles was 16 (range: 13-18). Dose escalation to DIL was feasible in 14/15 patients (93%) without violating dosimetric constraints, and 1 patient presented a minimal deviation of dosimetric restrictions. Median prostate V_{100}, V_{150}, and V_{200} were 98.2%, 30.6%, and 7.4%, respectively. Median urethral D_{max} was 114.1% and median rectal D_{1cc} was 62.8%. Median V_{100}, V_{125}, V_{150}, and V_{200} to DIL were 100%, 99%, 78.5%, and 20%, respectively. With a maximum follow-up of 8 months, none of the patients developed acute urinary retention. All patients with at least 2 months of follow-up have returned to the pre-treatment IPSS level.

Conclusions: This study demonstrates that dose escalation to DIL with MRI/TRUS fusion-guided HDR brachytherapy is feasible. Longer follow-up will demonstrate the safety of this procedure.

PA-011

Comparison of Inverse Planning Tools for Interstitial Prostate Treatment Planning

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Purpose: Several inverse planning algorithms are available for the treatment planning of interstitial volume brachytherapy. The aim of this study was to find out whether one of these algorithms is able to improve the quality of pulsed-dose-rate (PDR) brachytherapy treatment planning of the prostate. Therefore, a comparison of dose-volume histogram (DVH) values was made between graphical optimized plans used in the clinic and plans created with inverse planning tools.

Material and methods: Twenty-two intermediate- or high-risk prostate cancer patients were retrospectively included in the study. Patient data was anonymized and new plans were made using Inverse Planning Simulated Annealing (IPSA), Hybrid Inverse Planning & Optimization (HIPO), and the combined use of Enhanced Ge-

Table

	DVH constraints		Clinical plans				Friedmans test[1]	Post-hoc analysis[2]
			Graph. Opt.	IPSA	HIPO	EGO-IIP		
PTV	$V_{100\%}$	> 95%	94.8 ± 5.0	95.9 ± 2.1	97.1 ± 1.7	96.9 ± 1.9	*	2,4,5
	$V_{150\%}$	< 50%	43.2 ± 7.8	35.8 ± 5.7	41.4 ± 4.7	44.6 ± 7.0	*	1,4,5
	$V_{200\%}$	< 20%	16.3 ± 3.3	14.8 ± 3.0	15.9 ± 2.0	16.2 ± 2.4	*	5
	$V_{300\%}$		5.5 ± 1.1	5.8 ± 1.5	5.5 ± 0.8	5.8 ± 1.0		
	$D_{90\%}$	> 115%	110.3 ± 10.0	108.6 ± 4.0	112.0 ± 3.6	114.2 ± 4.8	*	4,5,6
Urethra	$D_{0.1cm^3}$	< 130%	133.3 ± 6.6	127.6 ± 8.4	131.4 ± 3.8	137.4 ± 10.0	*	1,4,5,6
	D_{1cm^3}	< 120%	110.7 ± 18.0	100.9 ± 16.4	107.7 ± 15.5	109.9 ± 15.4	*	1,4,5
Rectum	$D_{0.1cm^3}$	< 110%	83.8 ± 17.4	89.5 ± 17.4	85.7 ± 14.8	85.5 ± 17.7		
	D_{2cm^3}	< 81%	61.0 ± 15.2	61.9 ± 12.2	60.3 ± 11.7	61.1 ± 14.4		
Bladder	D_{2cm^3}	< 121%	72.0 ± 11.4	75.1 ± 12.9	77.5 ± 11.0	72.9 ± 8.2		

[1] indicates a rejection of the null hypothesis, i.e. that all groups are equal, at $p < 0.05$*
[2]Given pairs were statistically significantly different at a level of $p < 0.02$. Post-hoc analysis was performed by pairwise comparison using the Wilcoxon signed rank test
1: Graph. Opt. – IPSA
2: Graph. Opt. – HIPO
3: Graph. Opt. – EGO-IIP
4: IPSA – HIPO
5: IPSA – EGO-IIP
6: HIPO – EGO-IIP

ometric Optimization and Interactive Inverse Planning (EGO-IIP). One experienced technician created all plans. For IPSA, a dwell time deviation constraint of 0.3 was applied. For HIPO, the modulation restriction was set to 0.2. DVH parameters were compared using Friedman and Wilcoxon signed-rank tests.

Results: The table above shows the resulting DVH parameters. The differences in V_{100}, V_{200}, and V_{300} are within the range of 1% or 2%. IPSA showed the lowest D_{90} and $V_{150\%}$, resulting in lowest urethral dose. EGO-IIP showed the highest D_{90} and $V_{150\%}$, resulting in highest urethral dose. The differences in rectum and bladder dose were not statistically significant.

Conclusions: In this study, no large differences in DVH parameters were found. None of the algorithms were able to improve the overall quality of the treatment plans. Higher planning target volume (PTV) doses can be achieved at the cost of urethral dose.

PA-012

High-Dose-Rate Interstitial Brachytherapy as Monotherapy in Prostate Cancer Patients

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Purpose: To report the efficacy and toxicity profile of high-dose-rate (HDR) interstitial brachytherapy as monotherapy in prostate cancer patients with localized disease.

Material and methods: Between January 2009 and December 2012, 78 patients with localized prostate cancer (T1-T2c) underwent conformal HDR monotherapy. The mean age of patients was 68 years (range, 49-83), mean prostate-specific antigen (PSA) level and Gleason score were 7,985 ng/mL and 6, respectively. Three fractions of 15 Gy were delivered every 3 weeks using an iridum-192 source and transrectal ultrasound (TRUS)-guided treatment planning. Biochemical failure was defined according to the Phoenix consensus. Toxicity was evaluated using EORTC/RTOG scales.

Results: The median follow-up time was 20.4 months. The 24- and 48-month biochemical control and metastases-free survival rates were 98%, 95% and 100%, 98%, respectively. Four-year overall survival was 100%. The most common acute urinary symptoms were: urinary urgency, urinary frequency, dysuria, and nocturia (G1 – 50.2% and G2 – 17.6% of patients). The rectal symptoms (rectal urgency, frequency, and tenesmus) were rare (4.3%). No grade 3 and 4 acute toxicities, both of genitourinary and gastrointestinal systems, were reported. Two patients developed urethrostenosis and needed urological intervention.

Conclusions: Our results confirm that HDR brachytherapy as monotherapy is a safe and effective modality for clinically localized prostate cancer.

PA-013

Spacer-Enhanced HDR Provides New Radiation Therapy Treatment Planning Options for High-Dose-Rate Prostate Brachytherapy

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Purpose: To illustrate treatment planning options when using an injectable spacer material in conjunction with high-dose-rate (HDR) prostate brachytherapy.

Material and methods: Between January and March of 2014, 20 patients received Ir-192 HDR prostate implants as part of a combined course of HDR and external beam radiation therapy. Each patient received 2 HDR implants. For each implant, a prescribed dose of 800 cGy was delivered twice daily. Implant #1 was performed in the standard manner, while implant #2 was performed with an injectable spacer material (spacer-enhanced HDR [SE-HDR]).

Results: On average, the spacer material expanded the prostate-rectal inter-space by 1.0 cm. The additional separation allows for many dosimetric options. At one end of the spectrum, dose is focused on the standard defined planning target volume (PTV). Because of the high dose gradients characteristic of HDR, the result is a massive reduction in rectal dose. Conversely, PTV posterior margins can be contoured into the prostate-rectal inter-space, resulting in greater dose coverage confidence to the high-risk posterior prostate. V_{100} was increased by an average of 19%, while rectal dose was maintained comparable to that of the standard implant. Either scenario is readily achievable while limiting bladder and urethral dose to acceptable levels.

Conclusions: SE-HDR provides treatment planning options heretofore unavailable. Rectal dose can be kept to an absolute minimum, or dose can be made to cover an expanded PTV. In practice, the dosimetry can be tailored anywhere between the 2 ends of the spectrum. SE-HDR provides many previously unavailable and dosimetrically significant treatment planning options.

PA-014

Conservative Surgery in Early Distal Rectum and Anal Adenocarcinoma

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Purpose: The standard radical treatment for early stages anal adenocarcinoma and very distal rectum is abdomino-perineal amputation. We retrospectively reviewed a small series of patients conservatively treated.

Material and methods: From November 2011 to July 2013, 7 patients came to our department after local excision of ano-rectal adenocarcinoma. Median age was 63 years (range, 38-79). Three and 4 patients had a pT1 and pT2 anal or distal rectal adenocarcinoma, respectively (grade 2, n = 5, grade 3, n = 2). All patients were cM0 and one patient had pelvic metastatic nodes. Four patients underwent a pelvic external beam radiotherapy (ERT) median dose of 49.5 Gy (range, 48-50.8 Gy), followed by a boost of 4-6 Gy ERT, or 8-10 Gy endocavitary high-dose-rate (HDR) brachytherapy. The patient with nodal metastasis underwent concomitant chemo-radiotherapy. One patient, with a previous pelvic irradiation, was treated with endocavitary HDR brachytherapy, 40 Gy (32 Gy plus a 8 Gy boost on the half involved canal), 4 Gy/fz. One patient with pT1 G2 R0 disease underwent no adjuvant treatment.

Results: One patient relapsed locally at 25 months by initial surgery, and after abdomino-perineal amputation, at 30 months is disease free. At a median follow-up of 14 months (range: 2-25) all patients are disease free and sphincterial function is preserved in 6 of 7 patients (85.7%).

Conclusions: Conservative treatment of early adenocarcinoma of distal rectum and anal canal could be feasible, but larger series and longer follow-up are mandatory for a correct patient selection.

PA-015

CT-Guided Radioactive Seed Implantation for Locally Recurrent Rectal Cancer

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Objective: To evaluate the response rate, local control, overall survival, pain control rate and treatment-

related toxicity of computed tomography (CT)-guided radioactive seed implantation for locally recurrent rectal cancer (LRRC).

Material and methods: From September 2003 to October 2011, 31 patients with LRRC received iodine-125 (^{125}I) or palladium-103 (^{103}Pd) seed implantation under CT guidance in our center. Each patient underwent 3D treatment planning pre-implantation and dosimetric verification post-implantation. The range of activity of seed was from 0.40 to 1.40 mCi, and the range of seeds number was from 33 to 137. The range of $D_{90\%}$ was from 75.91 to 159.32 Gy.

Results: The follow-up rate was 93.5% and the median follow-up time was 15.7 months (4.2 ~98.1 months). The response rate of pain relief was 95.2%. The overall response rate was 51.6%, in which complete response rate was 16.1% and partial response rate was 35.5%. The 1-, 2-, and 3-year local control rates were 32.3%, 11.3%, and 11.3%, respectively. The median local control survival was 8.0 months. The 1-, 2-, and 3-year survival rates were 67.6%, 36.0%, and 7.5%, respectively. The median overall survival was 21.5 months. Six patients were observed complications.

Conclusions: CT-guided radioactive seed implantation is a minimally invasive treatment for LRRC with satisfied efficacy and tolerable complications. It is another treatment option for LRRC, especially for those with previous pelvic radiation. These findings need to be validated by conducting further studies with larger cohorts.

PA-016

Dosimetric Characteristics of a New Unit for Electronic Skin Brachytherapy

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Purpose: Brachytherapy with a radioactive high-dose-rate (HDR) iridium-192 (Ir-192) source is applied to small skin cancer lesions using specially designed surface applicators, ie, Leipzig or Valencia type. New developments in the field of radiotherapy for skin cancer include electronic brachytherapy. This technique involves the placement of an HDR X-ray source close to the skin, therefore combining the benefits of brachytherapy with the reduced shielding requirements and targeted energy of low-energy X-rays. Recently, the Esteya® Electronic Brachytherapy System (Esteya EBS, Elekta AB-Nucletron, Stockholm, Sweden) has been developed specifically for HDR brachytherapy treatment of surface lesions. The system provides radionuclide-free HDR brachytherapy by means of a small 69.5 kV X-ray source. The purpose of this study is to obtain the dosimetric characterization required for clinical implementation, providing the detailed methodology to perform the commissioning.

Material and methods: Flatness, symmetry and penumbra, percent depth dose (PDD), kV stability, HVL, output, spectrum, linearity and leakage have been evaluated for a set of applicators (from 10-30 mm in diameter).

Results: Flatness and symmetry resulted better than 5% with around 1 mm of penumbra. The depth dose gradient is about 7%/mm. A kV value of 68.4 ± 1.0 kV (k = 1) was obtained, in good agreement with manufacturer data (69.5 kV). HVL was 1.85 mm Al. Dose rate for a typical 6 Gy to 7 Gy prescription resulted about 3.3 Gy/min and the leakage value was < 100 μGy/min.

Conclusions: The new Esteya electronic brachytherapy system presents excellent flatness and penumbra as with the Valencia applicator case, combined with an improved PDD, allowing treatment of lesions of up to a depth of 5 mm in combination with reduced treatment duration. Because of its low energy, the Esteya unit allows HDR brachytherapy superficial treatment within a minimally shielded environment.

PA-017

Contact Therapy of Localized Skin Cancer in the Facial Region

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Purpose: Evaluation of results of radiation therapy of small-sized skin cancer in the facial region.

Material and methods: Small lesions of squamous cell or basal cell carcinoma with a maximal diameter of 2 cm were treated with contact therapy produced by Leipzig applicators (Nucletron®) of max diameter of 3 cm. Dose prescription: depending from size, age, and circumstances 3 different treatment schedules were applied: First regimen: 12 x 5 Gy 3x/week. Second regimen: 8 x 6 Gy 2x/week. Third regimen: 5 x 8 Gy 2x/week. D_{max} was at surface.

Results: From 2005 to 2013, a total of 224 patients were treated: 47% basal cell carcinomas, 29% squamous cell carcinoma. 27% were recurrent tumors after surgical procedures. Remissions rates: for basal cell carcinoma: CR 98%, squamous cell carcinoma CR 90%. Recurrent basal cell carcinoma: CR 84%, recurrent squamous cell carcinoma: CR 54%. No difference between different treatment schedules concerning local control or cosmetic outcome.

Conclusions: Treatment results of contact therapy of small skin carcinomas in the facial region are very promising and correspond to results known from the literature. Primary lesions are significantly better controlled than recurrent disease. Cosmetic results are excellent. Therefore, contact therapy offers a very good alternative to surgical procedures and is easy to apply.

PA-018

High-Dose-Rate (HDR) Brachytherapy for Nonmelanoma Skin Cancer

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Introduction: Leipzig applicators have allowed high-dose-rate afterload brachytherapy (HDR-BT) to address a number of the challenges associated with the delivery of superficial radiation in the treatment of nonmelanoma skin cancer (NMSC).

Material and methods: Data were collected retrospectively from patients attending the Radiation Oncology department. Patients were considered if they had localized NMSC and refused or were unsuitable for surgery. The stepping source HDR ^{192}Ir Microselectron (Nucletron BV) was used. The planning target volume consisted of the macroscopic lesion plus a 5-mm to 10-mm margin. Depth of treatment was 0.5 cm in smaller tumors and 10 to 15 mm for larger lesions. The total prescribed dose ranged from 300 to 400 cGy in 2 to 5 fractions per week up to 10-12 fractions.

Results: Twelve patients were treated with HDR-BT over the course of 6 years. The median age of presentation was 72 years with 45% of patients being female. Six patients were referred for adjuvant treatment due to positive surgical margins. Seven patients presented with basal cell carcinoma, 5 with squamous cell carcinoma, 9 in the postoperative period, 6 with positive margins after surgery, and 3 with recurrence after previous surgical management. All patients responded very well to treatment. The median follow-up is 32 months (5-60 months).

Conclusions: HDR-BT is associated with excellent outcomes. The effective dose and fractionation prescription for superficial HDR-BT remains uncertain. In the absence of studies suggesting alternative treatment regimens, we suggest a moderate dose of 36 Gy in 12 fractions can be used.

PA-019

Surface Optimization for APBI in Women With Thin Skin Bridges Using a Strut-Based Applicator

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Purpose: Women presenting with very thin skin bridges (< 5 mm) can be difficult to plan using standard methods of volume optimization, while maintaining skin dose limits (< 100% prescription dose [PD]) and dose-volume histogram (DVH) limits on V_{150} and V_{200}. Alternatively, optimizing these accelerated partial-breast irradiation (APBI) implants using dose criteria on the outer planning target volume (PTV) surface can achieve all the treatment goals simultaneously. This presentation outlines the methods and results for surface optimization in these patients.

Material and methods: The Oncentra treatment planning system was used to plan several patients with skin bridges < 5 mm. Several structures are hand drawn (cavity, applicators) and the remainder are automatically created (PTV, external, lung, chest wall). The PTV-Opt (surface optimization structure) is created by generating a 1.0 cm expansion around the cavity, and excluding portions that extend into the chestwall or outside the skin. The PTV-Eval is created as the PTV-Opt minus the cavity. A 100% PD will be limited to the outer PTV-Opt surface while the DVH limits (V_{95} > 95%, V_{150} < 50 cc, V_{200} < 20 cc) will be applied to the PTV-Eval. The applicators are reconstructed and IPSA is used to obtain a plan using surface limits to the PTV-Opt and volume limits to PTV-Eval.

Results: Oncentra routinely creates plans meeting the treatment objectives, with little manual optimization needed. The technique works regardless of skin bridge thickness (> 2 mm has been accomplished) and simultaneous close proximity to chestwall (limits ≤ 100% PD).

Conclusions: This method produces fast, objective, and reproducible treatment plans that meet all planning criteria, including skin limits < 100% and satisfactory coverage and hotspot control.

PA-020

Recurrent Neck Cancer Debulking With Carotid Artery Graft and HDR Brachytherapy Re-Irradiation

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Purpose: A 56-year-old patient with a recurrent squamous cell carcinoma in the right neck was operated on for removal of lymph nodes, carotid artery, submandibular, and parotid glands. High-dose-rate (HDR) brachytherapy was chosen to limit the dose to nearby organs since the area was previously treated with external beam to 70 Gy.

Material and methods: The tumor was surgically removed. The right carotid artery was replaced with Gore-Tex (polytetrafluoroethylene). Seven catheters were implanted on the surgical bed during surgery. The open wound was reconstructed with pectoralis major flap after catheter placement. Leeches were used to treat a small area of venous congestion in the flap. Computed tomography (CT) scans were taken after 4 days of surgery. The tumor volume and the nearby structures were outlined and HDR brachytherapy plan was created using inverse planning on Oncentra system. Treatment dose was 40 Gy in 8 equal fractions given twice daily.

Results: The patient tolerated the treatment very well with no complaints of pain. The dose-volume histogram (DVH) of the target and the structures were analyzed. The median target dose was 6.6 Gy/fx. The maximum dose for the cord, esophagus, and mandible were 1.89, 1.32, and 3.21 Gy/fx, respectively. The prescription dose covered 88% of GTV.

Conclusions: Surgery plus HDR brachytherapy is a good treatment modality available for patients that have exhausted other options. Grafted carotid artery allowed the delivery of high dose to the area, reducing the fear of rupture.

PA-021

Endoscopy-Guided Brachytherapy (EGBT) for Sinonasal and Nasopharyngeal Recurrences

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Objective/Purpose: To evaluate the preliminary outcomes of perioperative endoscopic-guided brachytherapy in recurrences of sinonasal and nasopharyngeal tumors already treated for their primary tumor with a full course of radiotherapy.

Material and methods: Patients with recurrence and treated with a previous full course of radiotherapy > 65 Gy who underwent brachytherapy from December 2010 to January 2014 were considered for this work. Macroscopic disease was resected by an endoscopic approach and catheters for brachytherapy were endoscopically positioned and fixed at the same time on the surgical bed. Surgery was performed under electromagnetic navigation guidance. The irradiation dose was 30 Gy in 12 fractions, 2.5 Gy each, twice a day, in 6 days.

Results: We performed the endoscopy-guided brachytherapy 11 times in 9 patients. In 2 of the cases no previous radiation therapy had been performed, one had a short follow-up. A total of 6 patients were eligible for the analysis. One patient underwent brachytherapy 3 times because of previous target margin recurrences. There were no immediate complications. The median and the mean follow-up are 21 months and 19 months, respectively. The median V_{90} and V_{85} were 93% and 95%, respectively. In one case we had a transient deficit of the VI cranial nerve (G3), and in another patient we diagnosed a non-complicated osteonecrosis (G2). The median disease-free survival is 12 months and the median overall survival is 23 months.

Conclusion: The combination of endoscopy and brachytherapy seems to be a safe option for treating sinonasal and nasopharyngeal recurrences.

PA-022

An Investigation of Interstitial ^{125}I Seed Implantation as a Salvage Therapy for Primary Spinal Tumors After Curative Treatment

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Purpose: In this series, we investigated the safety and short- to mid-term efficacy of computed tomography (CT)-guided iodine-125 (^{125}I) brachytherapy for primary paraspinous and vertebral column tumors.

Material and methods: From November 2002 to June 2013, 11 qualified patients were retrospectively reviewed. Of all patients, 7 were previously treated with traditional open surgical procedures, 8 received conventional radiation therapy and only 1 chose chemotherapy, while the remaining patients received no therapy. The number of ^{125}I seeds implanted ranged from 7 to 122 (median, 92) with the specific activity of 0.5 to 0.8 mCi (median: 0.72 mCi). The minimal peripheral doses were 90-152 Gy (median: 121 Gy).

Results: The median overall survival (OS) time was 41 months (95% confidence interval [CI], 20.4-61.6), and the 1-, 2-, and 5-year survival rates were 79.5%, 68.2%, and 25.6%, respectively, whereas the 1- and 2-year local control rates were 69.3% and 38.5%, respectively, with a median of 25.1 months (95% CI, 15.7-34.6). At the time of data record, 54.5% (6/11) died of metastases, 9.1% (1/11) developed local recurrence at 6 months, and 36.4% (4/11) were still alive. All patients enjoyed pain relief and normal or improved ambulation without radiation myelitis.

Conclusion: Percutaneous ^{125}I implantation can be an alternative or retreatment for primary spine tumors.

PA-023

CT-Guided ^{125}I Seed Implantation for Recurrence of Soft Tissue Sarcoma After Multimodality Treatment

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Purpose: The efficacy and utility of a salvage treatment remains unclear but worthy of consideration. The purpose of this study was to review the efficacy of computed tomography (CT)-guided iodine-125 (^{125}I) seed implantation in patients with recurrent soft tissue sarcoma (STS).

Material and methods: Thirty-one patients after surgical resections and/or external beam radiation therapy (EBRT) underwent percutaneous CT-guided permanent interstitial ^{125}I seed implantation. Patients' treatment history, complications after implantation, local control time, and survival time were reviewed.

Results: The median follow-up period, which was measured from the time of seed implantation, was 21 months (range, 3-53 months). The activity of the ^{125}I seeds ranged from 0.5-0.8 mCi (median: 0.7 mCi). D_{90} was 143-184 Gy (median: 170 Gy). The local control rates after 1 and 3 years were 92.6% and 87.9%, respectively, with a median of 38 months. The median overall survival was 34 months (3-43 months), and 1- and 3-year survival rates were 86.3% and 65.3%, respectively. Among these patients, 8 (25.8%) patients remained alive, 17 (54.8%) died of hematogenous metastasis, and 6 (19.4%) died of pneumonia. Few serious complications occurred during and after implantation.

Conclusions: CT-guided percutaneous interstitial ^{125}I seed implantation of repeatedly recurring STS is likely to prolong local control and survival time.

PA-024

The Results of Interstitial Permanent Implantation of ^{125}I Seeds for Refractory Chest Wall Metastasis or Recurrence

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Purpose: To evaluate the efficacy and safety of iodine-125 (^{125}I) seed implantation for refractory chest wall metastasis or recurrence.

Material and methods: A retrospective review of 23 patients who underwent interstitial permanent implantation of ^{125}I seeds under computed tomography (CT) guidance. All patients received at least one modality treatment before ^{125}I seed implantation and had been reviewed and considered by surgeons and radiation oncologists to be unsuitable for salvage surgery and external beam radiation therapy (EBRT) again, or the patients refused to receive EBRT. The tumor volumes were measured using CT scans at 5-mm intervals 3 to 5 days before seed implantation. Postoperative dosimetry was routinely performed for all patients. The D_{90} (the doses delivered to 90% of the target volume defined by CT using dose-volume histogram) of the implanted ^{125}I seeds ranged from 100 Gy to 160 Gy (median: 130 Gy). The follow-up period ranged from 3 to 65 months (median: 15 months). The survival and local control probabilities were calculated by the Kaplan-Meier method.

Results: The 1-, 3-, and 5-year tumor control rates were all 81.7%, 61.9%, and 61.9%, respectively. The 1-, 3-, and 5-year cancer-specific survival rates were 61.3%, 44.9%, and 44.9%, respectively. Median survival was 16 months (95% confidence interval [CI], 8.6-23.4). Mild brachial plexus injury was seen in 1 patient, and grade 1 or 2 skin reactions were seen in 6 patients (30%) who had received previous EBRT.

Conclusion: Interstitial permanent implantation of ^{125}I seeds under CT guidance is feasible, efficacious, and safe for refractory chest wall metastasis or recurrence.

PA-025

Effects of ^{125}I Seed Radiation on A549 Lung Cancer Cells: G2/M Arrest and Enhanced Cell Death

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Introduction: External beam radiation therapy (EBRT) and iodine-125 (^{125}I) seeds continuous low-dose-rate radiation (CLDR) were used to treat patients with lung cancer. The reasons for the improved therapy of CLDR were not fully understood. We herein investigated the different biological effects of EBRT and CLDR on lung cancer cells and its related mechanisms.

Material and methods: A549 human lung cancer cell line was exposed to different doses of EBRT and CLDR. 6-MV X-ray linear accelerator was used for EBRT and ^{125}I seeds were used for CLDR. Cell survival, death, cycle, and apoptosis were detected. We studied the related molecular mechanism by real-time PCR and Western blotting.

Results: CLDR showed a stronger inhibitory on A549 cell growth than EBRT and induced longer-lasting and stronger G2/M arrest. Cyclin B1 levels were reduced by CLDR. p-H2AX (Ser139) and DNA-PKcs expression were significantly elevated in A549 cell after CLDR. Anti-apoptosis Bcl-2 protein levels in A549 cells were significantly reduced and apoptosis-inducing Bax mRNA and protein levels were increased after CLDR.

Conclusions: CLDR was more efficient to inhibit cell growth than EBRT. CLDR induced increased DNA damage as evidenced by long-lasting p-H2AX activity. The enhanced inhibitory effects of CLDR on lung cancer cell growth may be, at least in part, due to the decreased Bcl2/Bax ratio and cyclin B1-mediated G2/M arrest.

PA-026

Dose Distribution Measurement Around Ir-192 HDR Stepping Source Using Radiochromic Films

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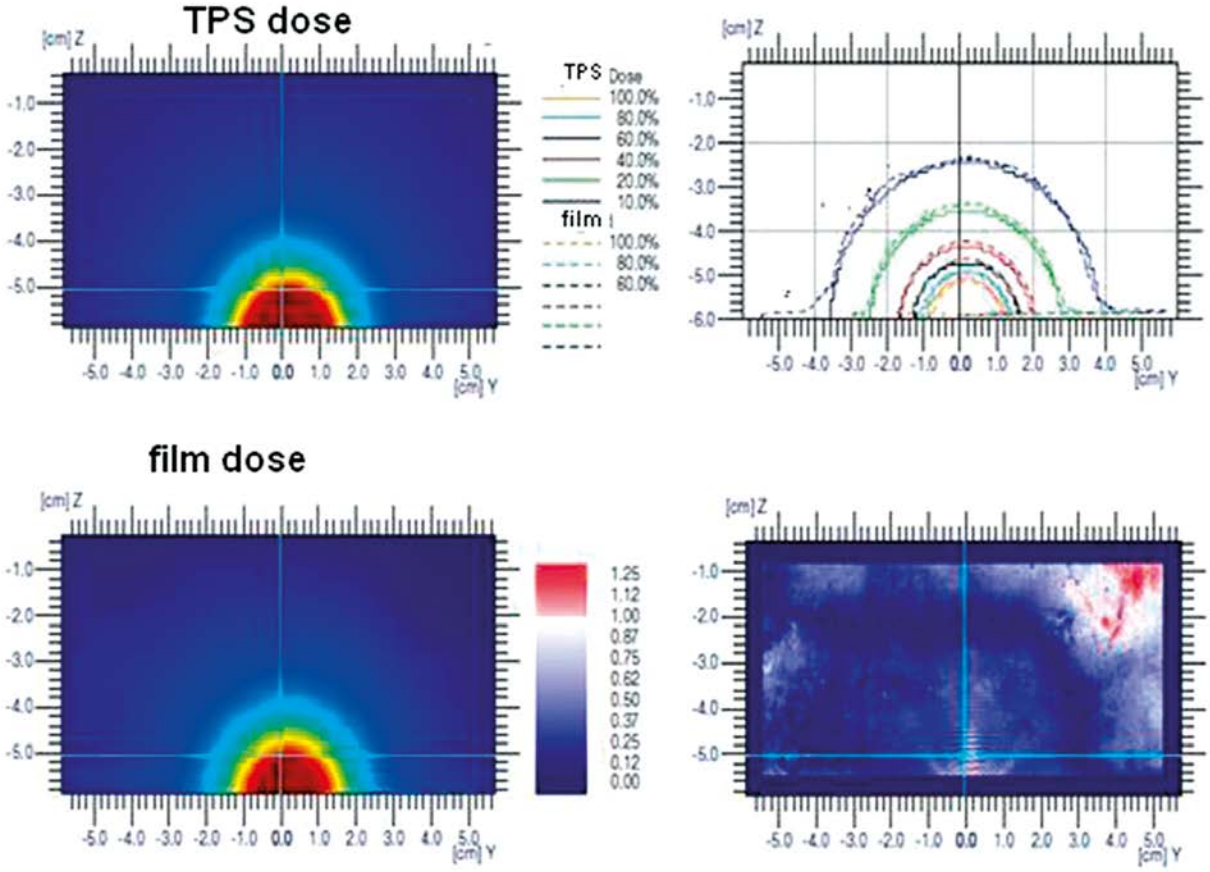
Purpose: The purpose of this study was to verify the spatial dose distribution around a single iridium source using dosimetric films and compare the designated distribution with data generated by the treatment planning system (TPS). The secondary goal was to determine whether such measurements may be used to commission model-based optimization algorithms.

Material and methods: To determine the spatial distribution dose around the radioactive source, radiochromic films MD-55 were irradiated. Films during the irradiation procedure were placed at different depths in the phantom and in the opposite orientation to the long axis of the source. Measured dose distribution has been checked and compared with the calculated spatial distribution of dose generated in the TPS. The dose calculation has been performed according to the TG43 report. To compare 2 images presenting absorbed dose (measured and planned) analysis gamma factor has been used.

Results: Comparison of the measured doses distribution and the corresponding dose grids from TPS has shown that dose distribution around source may be measured using radiochromic films in certain dose ranges. The few areas of the images showed deviations from the acceptance criteria, mainly because of defects of films.

Conclusions: The best matching of the measured and calculated doses were obtained for a considerable distance from the edge of the film. Obtained results differences are minor. Radiochromic films seem to be a fair method to verify spatial dose distribution with high resolution.



PA-027

An Innovative Brachytherapy Parallel Robot Used for Inoperable Cancers

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Purpose: The first developed innovative parallel robot for brachytherapy in Romania is presented, providing a viable solution for the curative and palliative treatment of inoperable cancer patients.

Material and methods: The majority of the robotic devices available today target only the prostate cancer, limiting the curative power and spread of brachytherapy. The authors propose an innovative robot, PARA-BRACHYROB, capable of targeting any area of the patient body, under real-time computed tomography (CT) scan control. The robot is the result of a patent application filled in 2013, where several requirements were defined regarding size, weight, stiffness, degrees and amplitude of movements and safety-blocking mechanism to enable mounting on the CT mobile couch and target deeply located tumor inside the patient body. The virtual prototype of PARA-BRACHYROB is presented with its hybrid kinematic structure, system control, and computer interface. The algorithms for motion and virtual planning of needle insertion allow automatic and manual definition of the needles' trajectories. A virtual reality environment has been modelled as a simulator and validation tool prior to the real procedure.

Results: The first use of the PARA-BRACHYROB parallel robot prototype in specific virtual medical scenarios for different body organs under CT simulation is presented, along with its advantages and some identified problems.

Conclusions: The innovative PARA-BRACHYROB parallel robot might be a viable solution to treat inoperable cancers. The first virtual experimental results have shown that the robot is computed and designed to allow accurate needle positioning in brachytherapy.

PA-028

A Low-Cost Peace Corps BrachyNext With Parallel Microbeam

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Purpose: An affordable advanced humane cancer treatment, cancer stem cell ablative and active local and systemic immunity-inducing system, capable of inhibiting mesenchymal epithelial transformation (MET)-associated tumor recurrence and metastasis is needed.

The MET active stem cell tumors like a prostate cancer with Gleason primary grade of 4, 5, 6, or 7 plus secondary grade of 3 having Gleason score of 7, 8, 9, and 10 respond much differently to conventional radiation therapy due to the progressive presence of MET cancer stem cells. Likewise, to cure stem cell tumors like Merkel cell carcinoma and aggressive melanoma, much higher dose radiation is needed than is possible with the present systems. The low-cost microbeam radiation therapy (MRT) system presented here can meet these challenges.

Material and methods: These 20 to 50 keV microbeam systems are capable of treating a tumor at doses of 100 to 1,000 Gy in seconds. It consists of carbon nanotube (CNT)-based Grenz-ray interstitial implant miniature X-ray tubes and contact therapy X-ray tubes (CNT-XT) attached to coronal, sagittal, and transverse gantries fixed on to a surgical table for radiosurgery. These X-ray tubes are built with CNT cathode and micro-electro-mechanical-systems (MEMS) and metal-oxide-semiconductor field-effect transistors (MOSEFT).

Conclusions: These low-cost but advanced cancer treatment systems do not need expensive machines and facility construction like those to house alternative external beam photon, proton, and ion treatments. It takes the BrachyNext to cancer patients from everywhere.

PA-029

Implementation of Deformable Image Registration for Composite Doses in Multimodality Treatments

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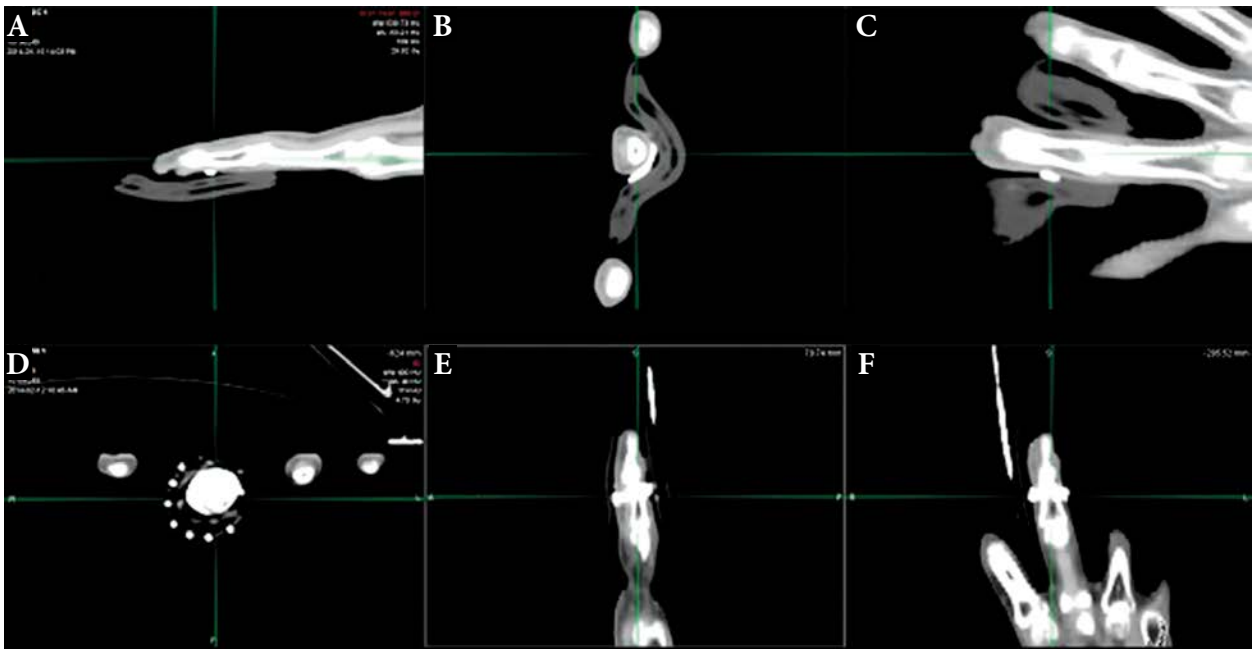
Purpose: It is challenging to create dose composites between external beam radiation therapy (XBRT) and



brachytherapy for patients who undergo changes in orientations, setup techniques, and/or anatomy. Deformable image registration (DIR) software offers a potential solution to these issues.

Material and methods: A squamous cell carcinoma case in the distal left middle phalanx was chosen for its relative simplicity for registration. Figures A-C show the axial, coronal, and sagittal views of the setup for XBRT of the distal left middle phalanx. Similarly, Figures D-F show the axial, coronal, and sagittal views of the patient who has been rotated for the brachytherapy boost setup. Note the pancake-shaped wax bolus for XBRT is markedly different from the custom-made applicator with after-loader channels embedded for brachytherapy. The XBRT prescription was 18 fractions of 225 cGy using 9 MeV electrons and 6 MV photons. The brachytherapy prescription was 5 fractions of 500 cGy using Ir-192.

Results: For initial DIR positioning, the XBRT computed tomography (CT) was rotated and translated using rigid registration to the brachytherapy CT. The XBRT wax bolus and brachytherapy surface mold were contoured for reshaping and the finger was isolated for DIR. Next, 8 match points were selected to anchor DIR. The DIR was checked using localized image inter-comparison. The deformed XBRT dose was summed with existing HDR dose and a dose composite was created.

Conclusions: This case is an example of DIR resolving incompatibility between planning systems (Eclipse and Oncentra) and change in setup/applicator. Promising studies are underway involving DIR for patients who have appreciable anatomy changes in the thoracic area.

PA-030

Do the Benefits of Medical Technology Justify the Costs in Brachytherapy in Hungary?

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Purpose: To examine the evidential question, whether the same incremental improvement in health services value, life expectancy and quality of life is to be administered for the incremental finances on a positron-emission tomography/magnetic resonance (PET/MR) in the University of Kaposvár.

Material and methods: Within the economic conditions in Hungary, the main task was to define the potential indication fields and application possibilities for simultaneous PET and MR in radiation oncology with a special stress on its use in brachytherapy. In the era when governmental administrative and insurance systems are trying to squeeze out savings from the economist's point of view, waste in the health system is not an average, but what is called the marginal/incremental benefits to the marginal/incremental spending on them. The ratio is negative on the input-output curve, with a segment representing not only pure, unambiguous waste, but waste that is inimical to the health of patients (e.g., unnecessary imaging or therapy).

Results and Discussion: MR for radiation therapy has made more than 30 key international centers to consider a switch to image-guided brachytherapy (IGBT) as a powerful and efficient tool in improving treatment

results. The process had partially involved the Hungarian oncology centers, where 92% are still delivering brachytherapy in 2D technique. Adding the power of molecular imaging represents the necessary steps towards modernization, medical innovation, and health care reform processes. Change in the structure, in which professional and economic outcome may be equally measured PET/MR, will provide the possibility for utilizing the best features of adaptive IGBT and sort out unnecessary investigations.