2014 Conference
Australasian Brachytherapy Group

20th–22nd February 2014

Stamford Grand Adelaide, Glenelg

Programme and abstracts

Welcome from the ABG 2014
Conference Convenor and ABG Chair

On behalf of the Australasian Brachytherapy Group, we are pleased to welcome you to our 23rd Annual Scientific Meeting. This multidisciplinary meeting will bring together professionals from around the world to share their knowledge, renew acquaintances and welcome the newcomers to our field. We are delighted to have 3 highly regarded keynote speakers join our meeting. **Prof. Mack Roach III** will be known to many in our field as an expert in all aspects of the treatment and management of prostate cancer, in particular locally advanced prostate cancer. We look forward to also hearing his thought provoking and maybe controversial opinion on PSA screening. **Prof. Mira Keyes** again joins us as a popular guest to update us on the brachytherapy work in Vancouver and also in the implementation of the Vancouver training program. Finally, we welcome **Dr Frank-André Siebert**, a clinical brachytherapy physicist and chair of the GEC ESTRO working group BRAPHYQS. Frank-André has been a great supporter of international collaboration and we look forward to hearing about some of the great work being carried out by the many working groups. We hope you will make our visitors welcome and take the opportunity to share with them your questions and comments regarding their work. As usual we have a full program of proffered papers covering the spectrum of all things brachytherapy. We thank those who have worked hard to put together an abstract and presentation and share with us their knowledge and passion for brachytherapy. This year we will be publishing the abstracts in the "Journal of Contemporary Brachytherapy" which we hope will show the world that we are an active and vibrant professional group. We wish to thank our major sponsors, Nucletron, Oncura and Tolmar as well as all of the exhibitors for their tremendous support. It would not be possible to hold this Annual Scientific Meeting without their ongoing belief in us. Please take the time to meet with representatives of the participating companies. We hope you enjoy this meeting and take advantage of the social events to relax and enjoy your time in Adelaide. Outside of the conference proper, we hope you have time for an evening stroll along Glenelg beach or a tram ride into the city to catch one of the countless cultural events at the Adelaide Fringe Festival. If you have even more time up your sleeve, a day of wine tasting in the Barossa Valley, Clare Valley or McLaren Vale is well worth the trip. We would like to sincerely thank the other organising committee members, Angelo Katsilis, Tania Perry, John Lawson, Tom Rutten and Nursing Workshop co-ordinator, Gabby Vigar for their tireless efforts over the last year.

Finally, if you are not a member of the ABG, please consider joining so that you can keep in touch with all the news and events that are related to brachytherapy. We thank you for your help in making this a great meeting and hope you enjoy all that we have prepared for you.

Braden Higgs – Convenor
Annette Haworth – ABG Chair

Programme overview

Thursday, 20th February 2014

12.00 p.m. **Registrations open**

1.25 p.m. **Welcome to ABG 2014**

Nucletron Workshop: Skin and surface brachytherapy

1.30 p.m. **Introduction & Welcome**
Peter Douglas, Nucletron Pty Ltd

1.35 p.m. **Introduction to non-melanoma skin cancer**
Dr Emma Haverhoek, Department of Dermatology, Royal Adelaide Hospital

2.05 p.m. **Electronic brachytherapy for non-melanoma skin cancer, an analysis of scientific evidence**
Mr Ate Loonstra, Nucletron Veenedaal

2.35 p.m. **HDR brachytherapy solutions for treating superficial skin cancers**
Dr Stan Gauden, W P Holman Clinic, Launceston Hospital

3.05 p.m. **Leipzig HDR: commissioning planning & scheduling at the RAH**
Dr Wendy Harriss-Phillips, Royal Adelaide Hospital

3.20 p.m. **Surface mould brachytherapy – a heritage revisited**
Dr Mamun I. Haque, Royal Adelaide Hospital

3.35 p.m. **Esteya installations and early experiences**
Mr Ajan Groenevelt, Nucletron Pty Ltd

3.50 p.m. **Question time for speakers**
Peter Douglas and Kirsten Bell, Representing Nucletron Pty Ltd

4.00 p.m. **Afternoon tea**

4.30 p.m. **How to respond to a HDR brachytherapy emergency: role cards and simulation scenario**
Vanessa Panettieri, William Buckland Radiotherapy Centre, Alfred Health

4.45 p.m. **HDR radiation emergency management**
Virendra Patel, Liverpool and Macarthur Cancer Therapy Centres

5.00 p.m. **Simulated learning in emergency training for HDR**
Yen Tran, Epworth Radiation Oncology

Friday, 21st February 2014

7.30 a.m. **Registrations open**

8.00 a.m. *Keynote Speaker*
Education in brachytherapy
A/Prof. Mira Keyes, University of British Columbia and Vancouver Cancer Centre

8.45 a.m. **Survey of high-dose-rate prostate brachytherapy practice in Australia & New Zealand, 2010/2011**
Jane van Nieuwenhuysen, Sir Charles Gairdner Hospital

9.00 a.m. *Keynote Speaker*
Controversies in the management of immediate to high risk prostate cancer
Prof. Mack Roach III, UCSF Helen Diller Family Comprehensive Cancer Centre

9.45 a.m. **Morning tea**

10.15 a.m. *Keynote Speaker*
Modern algorithms in brachytherapy, what will change in the clinics?
Dr Frank-André Siebert, University Medical Center Schleswig-Holstein

11.00 a.m. **Brachytherapy and Liverpool Cancer Therapy Centre's In-House MRI**
Ewa Juresic, Liverpool Health

11.15 a.m. **Implementing MRI for cervical brachytherapy planning: moving away from CT imaging**
Lucy Ohanessian, Liverpool Cancer Therapy Centre

11.30 a.m. **The use of megavoltage CT data for planning of shielded applicator treatments**
Zoe Baldwin, Royal Brisbane and Women's Hospital

11.45 a.m. **A unique approach to 3D catheter placement in vaginal mould brachytherapy**
Sanna Nilsson, Royal Brisbane and Women's Hospital

12.00 p.m. **Lunch**

1.00 p.m. *Keynote Speaker*
Overview on BRAPHYQS work packages
Dr Frank-André Siebert, University Medical Center Schleswig-Holstein

1.45 p.m. **Towards image guidance for eye plaque brachytherapy treatment planning**
Joe Poder, Prince of Wales Hospital

2.00 p.m. **PANOPTES: Plaque brachytherapy dosimetry**
Michael Weaver, University of Wollongong

2.15 p.m. **HDR brachytherapy vs. IMRT treatment techniques for total scalp irradiation: a case study**
Natasha Mason, William Buckland Radiation Oncology

2.30 p.m. **Afternoon tea**

3.00 p.m. **Introducing a new approach for high precision skin cancer treatment, Esteya**
Ajan Groenevelt and Peter Douglas, Nucletron Pty Ltd

3.30 p.m. **Initial clinical experience with HDR treatment verification using a flat panel detector**
Ryan Smith, William Buckland Radiotherapy Centre, The Alfred Hospital & School of Applied Sciences, RMIT University

3.45 p.m. **BrachyPix: a quality assurance system for high dose rate brachytherapy**
Anthony Espinoza, University of Wollongong

4.00 p.m. **Verification of a high dose rate brachytherapy treatment planning system using TLD and Monte Carlo methods**
James Rijken, Royal Adelaide Hospital/University of Adelaide

4.15 p.m. **A real-time beryllium oxide (BeO) ceramic fibre-coupled luminescence dosimetry system for high dose rate brachytherapy dosimetry**
Alexandre Santos, Royal Adelaide Hospital/University of Adelaide

4.30 p.m. **ABG Annual General Meeting**

5.00 p.m. **Day 2 concludes**

Saturday, 22nd February 2014

7.45 a.m. **Registrations open**

8.15 a.m. *Keynote Speaker*
US Preventive Task Force on Prostate Cancer Screening: what is wrong with their conclusions?
Prof. Mack Roach III, Helen Diller Family Comprehensive Cancer Center

9.00 a.m. **The use of normal saline as transperineally inserted spacer material into peri rectal space prior to high dose-rate brachytherapy boost for prostate cancer**
Dr Raghu Gowda, Royal Adelaide Hospital

9.15 a.m. **The use of polyethylene glycol hydrogel spacer in brachytherapy patients: technical feasibility, benefits and ramifications**
Dr Nadine Beydoun, St George Hospital Cancer Care Centre

9.30 a.m. **Long-term erectile function and factors influencing EF preservation in men treated with permanent seed brachytherapy for localized prostate cancer**
Dr Ben Hindson, William Buckland Radiotherapy Centre

9.45 a.m. **Prediction of erectile dysfunction following prostate seed brachytherapy: a dose volume analysis of penile structures**
Dr Ben Hindson, William Buckland Radiotherapy Centre

10.00 a.m. **Morning tea**

10.30 a.m. *Keynote Speaker*
LDR planning
A/Prof. Mira Keyes, University of British Columbia & Vancouver Cancer Centre

11.15 a.m. *Keynote Speaker*
Post-planning in LDR prostate implants
Dr Frank-André Siebert, University Medical Center Schleswig-Holstein

11.40 a.m. **10 year experience of LDR prostate brachytherapy with real-time planning**
Dr James Mackean, The Wesley Hospital, Brisbane, Genesis Cancer Centre

11.55 a.m. **Biological imaging for focal brachytherapy for prostate cancer**
A/Prof. Annette Haworth, Peter MacCallum Cancer Centre/University of Melbourne

12.10 p.m. **Assessing the feasibility of sentinel lymph node identification by 68Ga-nanocolloid PET/CT**
Dr Jacki Doughton, Peter MacCallum Cancer Centre

12.25 p.m. **Lunch**

1.20 p.m. *Keynote Speaker*
Prostate brachytherapy salvage of local failures after radiotherapy
Prof. Mack Roach III, Helen Diller Family Comprehensive Cancer Center

2.05 p.m. *Keynote Speaker*
Real-time planning in HDR prostate brachytherapy
Dr Frank-André Siebert, University Medical Center Schleswig-Holstein

2.30 p.m. **13 year experience of prostate HDR brachytherapy in immediate and high risk disease**
Dr John Yaxley, The Wesley Hospital, Brisbane, Genesis Cancer Centre

2.45 p.m. **Single fraction high dose rate brachytherapy boost for immediate and high risk prostate cancer: update of the Royal Adelaide Hospital experience**
Dr Raghu Gowda, Royal Adelaide Hospital

3.00 p.m. **Afternoon tea**

3.30 p.m. *Keynote Speaker*
Long term outcomes and toxicity after prostate brachytherapy
A/Prof. Mira Keyes, University of British Columbia & Vancouver Cancer Centre

3.45 p.m. **BrachyView: 3D seed position reconstruction in low dose rate brachytherapy**
Prof. Anatoly Rozenfeld, University of Wollongong

4.45 p.m. **The effect of prostatic calcifications on low dose rate brachytherapy dosimetry**
Dane Pope, University of Wollongong, St George Hospital Cancer Care Centre & Chris O'Brien Lifehouse

5.00 p.m. **Closing remarks**

5.15 p.m. **Day 3 concludes**

How to respond to a HDR brachytherapy emergency: role cards and simulation scenario

Vanessa Panettieri, M. Haynes, N. Mason, S. Miller, H. Mack

William Buckland Radiotherapy Centre, Alfred Heath, Melbourne, Australia

E-mail for correspondence: V.Panettieri@wbrc.org.au

Abstract

Purpose: ARPANSA recommendations clearly state that all radiotherapy facilities offering HDR brachytherapy should have a site-specific emergency procedure protocol that is simple and clear to read. ARPANSA also recommends that all HDR brachytherapy staff undertake emergency procedure rehearsals at regular intervals. At WBRC, emergency procedures have been organised in the brachytherapy suite by means of role cards. Each of these cards, which have been tailored according to the role of the user (radiation oncologist, physicist, radiation therapist, and responders), is modelled on the cards used in Alfred Hospital theatre emergencies. Role cards list the steps that each person needs to undertake in the case of a HDR brachytherapy emergency, in order to safely and efficiently locate and remove the Ir-192 source as soon as possible from the patient.

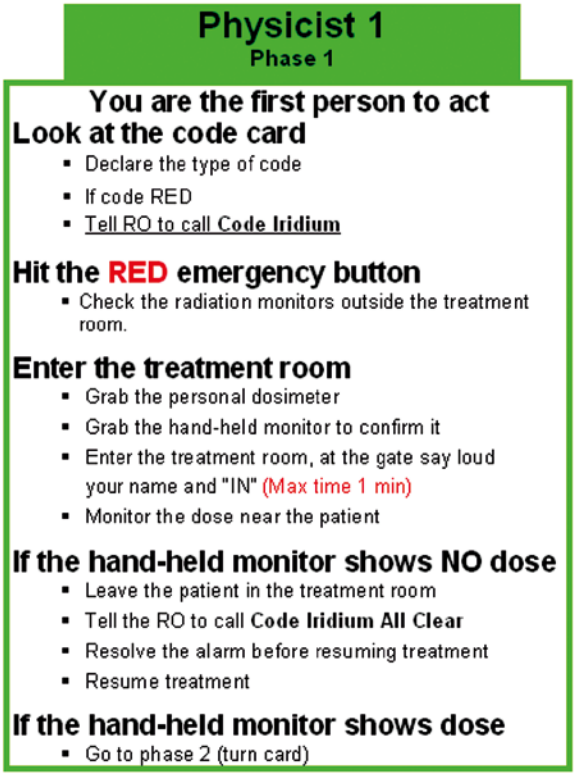

Fig. 1. Example of role card

A full simulation scenario was designed with the help of the Australian Centre for Health Innovation (CHI), to train staff to cope with the crisis situation of a real HDR emergency, and to externally assess our emergency procedures and protocols.

Material and methods: A full size adult manikin was set-up in the treatment room with a prostate HDR template attached as per clinical protocol. A scenario was designed to simulate the case of an Iridium-192 source detachment from the cable inside the patient. During the scenario, brachytherapy staff were instructed to perform their normal roles in treatment delivery. Once the emergency was initiated, staff had to deal with the error code, according to WBRC emergency procedure with the assistance of role cards. The full emergency simulation was recorded, timed and discussed in a debriefing session, which was used to determine strengths and weaknesses of the emergency procedures, how staff responded during the scenario and to identify areas of improvement.

Results and conclusions: Simulation scenario, with the assistance of role cards, has been implemented at WBRC to enable proficiency in managing HDR emergency situations. By using these tools, all brachytherapy staff have the opportunity to become familiar and confident with all steps and processes involved in such an emergency, to act effectively to minimise staff and patient radiation exposure.

HDR radiation emergency management

Virendra Patel, Sankar Arumugam, Shalini Vinod, Lucy Ohanession, Alison Dunning, Adrian Scotti

Liverpool and Macarthur Cancer Therapy Centres, Liverpool BC, Australia

E-mail for correspondence: vp2109@gmail.com

Abstract

MicroSelectron HDR unit is a well-designed brachytherapy treatment unit, incorporating various safety features to prevent an accident. However, a small, but real possibility of an accident does exist and cannot be ruled out completely. As a result, a back plan needs to be structured to safely manage such an emergency situation. At Liverpool Cancer Therapy Centre, such a plan has been designed to take care of such an incident. Various possible error situations were taken into account while designing this program, and necessary corrective actions were defined to address these error situations. Well defined procedures are outlined with details of roles played by different individuals, and the order in which various steps need to be taken. Radiation safety aspects of patient, as well as staff members involved in the recovery procedure were also considered while designing this protocol. Electronic personal radiation monitors are to be used by everyone involved in the process to alert the patient when the radiation exposure limit is being approached. It will

also record actual exposure received by that individual. A training program is also outlined for initial training, as well as periodic refresher training suggestions. This presentation outlines the protocol including philosophy followed in designing this protocol.

Simulated learning in emergency training for HDR

Yen Tran, Thang Nguyen, Venkata Seshadri

Epworth Radiation Oncology, East Melbourne, Australia

E-mail for correspondence: yen.tran@epworth.org.au

Abstract

Purpose: Epworth Radiation Oncology (ERO) commenced its high dose rate brachytherapy (HDRB) service in July 2013. Emergency procedures (EPs) in the unlikely event of a non-retraction of the ^{192}Ir source have been developed and a training program established. A state of the art simulated learning program has been developed with the Epworth Clinical Education team to simulate and record a HDR emergency, testing and evaluating the EP. A simulated learning program has been developed by Epworth to provide training and feedback to the Brachytherapy staff in the case of a HDR emergency.

Material and methods: Using a Laerdal SimMan Essential Patient Simulator™, a HDR emergency was simulated with the Nucletron® applicator and remote afterloader. The simulation was recorded on 3 cameras, with 4 members of the brachytherapy team performing the documented EP. Critical review of the simulation was undertaken against the documented procedure and fed back to the staff.

Results: The responsiveness, opportunities for improvement, and critical review of the ERO EP will be presented for each of the staff members that undertook the learning simulation. The emergency response time and dose results will be benchmarked against ARPANSA occupational dose limits.

Conclusions: HDR remote loader systems design minimise the possibility of non-retraction of the ^{192}Ir source, however, staff must be well versed in the emergency procedure with regular training sessions. A simulated learning program has been developed that can provide feedback on timeliness, success, and potential improvement in the emergency system. Using simulation is a novel learning tool for Brachytherapy avoiding dose to staff with the potential to be deployed at other health services.

Education and quality assurance in brachytherapy

Mira Keyes

Radiation Oncology, Division of Surgery, University of British Columbia, Vancouver, Canada

E-mail for correspondence: mkeyes@bccancer.bc.ca

Abstract

Purpose: To review current status of brachytherapy in Canadian institutions and residency training programs; outline future national credentialing programs in Canada and the US; review Canadian residency training objectives in brachytherapy; present new ways of teaching brachytherapy; outline the critical components of quality assurance.

Survey of high-dose-rate prostate brachytherapy practice in Australia and New Zealand, 2010/2011

Jane van Nieuwenhuysen[1], David Waterhouse[1], Sean Bydder[1], David Joseph[1], Martin Ebert[1], Nikki Caswell[2]

[1]Sir Charles Gairdner Hospital, Nedlands, [2]WP Holman Clinic, Hobart, Tasmania, Australia

E-mail for correspondence: jane.van.nieuwenhuysen@health.wa.gov.au

Abstract

Purpose: A survey was designed to establish a baseline dataset for the current routine practice of high-dose-rate prostate brachytherapy (HDR-PB) in Australia and New Zealand. Existing treatment protocols and clinical implementations were not generally known.

Material and methods: The survey, collected data for the 2010 and 2011 calendar years, including number of patients treated; equipment used; imaging modalities; applicator verification, and correction methods; dose prescriptions and normal tissue dose constraints. The number of HDR-PB patients treated was compared with the most recently published prostate cancer incidence data in Australia and in New Zealand. Total biologically equivalent doses in 2.0 Gy fractions (EQD2) were calculated for each prescription regime reported.

Results: There were reductions of 25-60%, in patients treated with HDR-PB from 2010 to 2011 in four departments. Prostate cancer patients are two to six times more likely to be prescribed HDR-PB in Western Australia than elsewhere in Australia and New Zealand. There were 12 different combined treatment prescriptions, with EQD2 doses ranging from 73.5 to 97.6 Gy, among the 18 prescriptions reported by survey respondents. Normal tissue definition methodology and dose constraints varied, and

13 of 15 departments reported that no particular published external guidelines were followed in full.

Conclusions: The high survey response rate, 15 of 17 departments, has provided a representative baseline data set of contemporary HDR-PB practice in Australia and New Zealand that may assist government and professional bodies, such as the Australasian Brachytherapy Group, in formulating recommendations, setting standards, and future planning. An expanded repeat survey is planned after consultation with the brachytherapy community in Australia and New Zealand.

Brachytherapy and LCTC'S in house MRI

Ewa Juresic

Liverpool Hospital, Casula, Australia

E-mail for correspondence: ewa.juresic@sswahs.nsw.gov.au

Abstract

Purpose: Brachytherapy has been utilised at LCTC since 1996. Historically, plans were done on x-rays or CT data sets. As of September 2012, all gynaecological brachytherapies have been planned using MRI scans exclusively. Up until August 2013, our patients were being sent to Liverpool Hospitals Diagnostic Department. Since August 2013, we have been able to scan our patients on our own RT dedicated MRI simulator, which is located within the Cancer Therapy Centre.

Material and methods: Once the MRI simulator was commissioned, radiation therapy and physics staff at the Liverpool Cancer Therapy Centre were required to determine the best sequences to run on our gynaecological brachytherapy patients to ensure a smooth planning process. Logistics needed to be investigated to ensure an efficient streamlined process was performed, and all necessary data was obtained quickly and safely. This was done through a variety of methods, including communication and training from the radiology department, Siemens, and a number of volunteer scans. The transfer of data needed to be tested to ensure that all datasets were transferred correctly and that the quality of the images was not degraded during the transfer.

Results: The introduction of our own MRI simulator has come with a number of successes, as well as challenges. We have been able to improve the timeframe, in which the patient is simulated and planned. This in turn leads to a reduction in discomfort, improving their quality of care. Challenges included training of radiation therapy and nursing staff of MRI safety issues, along with scanning protocols, and being able to determine the best sequences to use for this cohort of patients.

Implementing MRI for cervical brachytherapy planning: moving away from CT imaging

Lucy Ohanessian, Annie Lau, Ewa Juresic, Shalini Vinod, Karen Lim, Jacqueline Veera

Liverpool Cancer Therapy Centre, Ryde, Australia

E-mail for correspondence: lucy.ohanessian@swsahs.nsw.gov.au

Abstract

Purpose: Three-dimensional (3D) image-guided brachytherapy (IGB) using magnetic resonance imaging (MRI) has been shown to be a significant improvement in the management of cervical malignancies, and leading to better clinical outcomes. This method of IGB allows for dose to be delivered to a defined target volume, whereas the traditional Manchester System method calculates dose to Point A only. As a step towards IGB and following GEC ESTRO group recommendations, it was decided to move away from computed tomography (CT) imaging and make MR imaging our standard practice for all cervical brachytherapy patients.

Material and methods: There were a number of steps that we needed to undertake before we could implement MR brachytherapy planning within our department. Firstly, we needed to gain experience in delineating structures using MR datasets. Diagnostic MRI datasets were sent to our planning system and radiation therapists, and radiation oncologists were asked to gain practice by contouring OAR's and high risk clinical target volumes (HR CTV), respectively. With assistance from radiology and taking on board GEC ESTRO recommendations, a contouring protocol was established. In November 2011, we upgraded our planning system from Plato to Oncentra. Following this upgrade, in order to familiarise ourselves with the process and imaging differences, a series of patients were scanned with both CT and MRI during their first brachytherapy fraction only. Patients still had a CT scan used for their actual treatment delivery, but a retrospective plan comparison was done using the two imaging datasets, ensuring that the required contours had been delineated correctly, and that there were no significant differences in planning outcomes.

Results: The use of MRI in cervical brachytherapy cases was found to be quite beneficial when outlining target volumes. It displayed high quality images with greater soft tissue delineation when compared to CT. This has allowed us to assess the dose received by the HR CTV & OAR, leading to better target volume coverage and assessment of OAR DVH. However, we are restricted in taking that final step towards completely adopting 3D volume based planning due to our current applicator limitations. The use of a Utrecht applicator with interstitial needles, would allow for greater target dose conformation.

Conclusions: MRI has become standard practice within our department, displaying superior soft tissue delineation in comparison to CT. This has been once step closer in moving towards 3D volume based planning.

The use of megavoltage CT data for planning of shielded applicator treatments

Zoë Baldwin, Rachael Wilks, Phil Back

Cancer Care Services, Royal Brisbane and Women's Hospital, Australia
E-mail for correspondence: zoe.baldwin@health.qld.gov.au

Abstract

Shielded brachytherapy applicators are regarded as a useful tool in permitting the radical treatment of tumours in sites that are directly adjacent to radio sensitive organs. Their use, however, is limited and often disregarded due to the artifacts these high atomic number (Z) shields produce in kilovoltage computed tomographic (kVCT) images. Due to the physical interactions generating the images, megavoltage CT (MVCT) image acquisition is less prone to producing artifacts when a high Z material is present. This study evaluates the suitability in using (MVCT) data for the purpose of planning brachytherapy treatments for applicators containing high Z shields in comparing delineation of critical structures and geometric accuracy.

A unique approach to 3D catheter placement in vaginal mould brachytherapy

Sanna Nilsson, Zoe Baldwin, Phil Back, Jodi Dawes

Royal Brisbane and Women's Hospital, Herston, Australia
E-mail for correspondence: sanna.nilsson@gmail.com

Abstract

Purpose: At the Royal Brisbane and Women's Hospital, brachytherapy is a standard component of the treatment of vaginal cancer. Patients with vaginal cancer sometimes have a less straightforward approach for choice of brachytherapy treatment, due to the tumour's location and clinical presentation. Standard cylindrical vaginal applicators have a uniform diameter, and are designed to produce an even dose around the surface of the applicator. To produce this dose distribution, the cylindrical applicator needs to be in contact with the vaginal mucosa. For patients with irregular vaginal vault configurations, good contact may not be achievable. The staff at Royal Brisbane & Women's Hospital in Queensland, Australia, is trying to solve this problem by the use of an old technique in a new approach, vaginal moulds. With a patient specific vaginal mould, the shape of the applicator and the dose distribution can be optimized to fit the patient needs. A unique catheter placement is used within the mould to achieve enhanced and more homogeneous dose coverage of the target, and to spare the organs at risk.

Material and methods: The primary mould is created during a pre-treatment session several days before the patient's first HDR brachytherapy treatment. The primary mould is based on a vaginal impression made of Fricotan with central swab stick inserted. A negative is created by packing Alginate around the mould in an empty plastic container. While waiting for the Alginate to set, catheters are glued together in a desirable configuration. Instead of using several straight catheters, fewer catheters are used where some of them are looped around in the upper part of the mould. A new positive is made with the catheters in place. A study between dose coverage of target and dose sparing of organs at risk were performed between straight catheters and looped catheters placement in the same mould.

Results: To create the complete mould from scratch is an easy and straightforward process. Looping the catheters within the mould compared with straight catheters allows for larger adjustment of the dose distribution around the target and organs at risk.

Conclusions: The presented technique improves the efficiency and accuracy of a homogeneous target cover and sparing of organs at risk for vaginal mould brachytherapy treatments at RBWH.

Towards image guidance for eye plaque brachytherapy treatment planning

Joel Poder, Simon Downes, Stéphanie Corde

Radiation Oncology, Prince of Wales Hospital, Randwick, Australia
E-mail for correspondence: Joel.Poder@sesiahs.health.nsw.gov.au

Abstract

Purpose: Eye plaque brachytherapy using I-125 seeds (Amersham Health model 6711) and Radiation Oncology Physics and Engineering Services Australia (ROPES) type eye plaques has been performed at Prince of Wales Hospital since 2001. The Plaque SimulatorTM (v5.5.0) ophthalmic treatment planning system was commissioned in 2013 for these treatments. The imaging component of this software uses multi modalities imaging (CT/MRI, ultrasound, fundus camera photographs) to build a 3D model of the patient's eye and tumour. This functionality has not yet been implemented in our centre and doses are prescribed based on tumour height only. To evaluate the benefits of image guidance, both pre- or post-implant, the dose received by critical organs surrounding tumours of different size, and locations were evaluated. The effect of small plaque displacements on the tumour apex dose and critical organs was also studied.

Material and methods: Twelve positions of eye tumours of three different heights were simulated in Plaque SimulatorTM. A dose of 85 Gy was prescribed to the tumour apex for the four types of ROPES eye plaques available, and the dose to the fova, optic disc, lens, opposite eye wall, and sclera calculated as recommended

by AAPM Report TG1292. Tumour displacements were simulated by offsetting the plaque up to 2 mm from the prescribed position, and recalculating the dose to the tumour apex and critical structures.

Results: As expected, tumours close to the limbus resulted in a significant lens dose, and tumours close to the posterior pole caused significant dose to the fovea and optic disc. Tumour height was also found to be proportional to the dose to all critical structures. Small displacements of the plaque relative to the tumour central axis had minimal effect on the dose to the tumour apex, and the effect on critical organs was tumour location dependent.

Conclusions: The dose received by critical organs during eye plaque brachytherapy is dependent on both size and location of the tumour within the eye. Accurate localization of the tumour using image guidance, allows better quantification of critical organ dose. The effect of small plaque displacements over the tumour may also have a significant effect on critical organ dose. Therefore, pre and post-implant imaging is beneficial in order to calculate the actual dose received by the critical organs.

Panoptes: plaque brachytherapy dosimetry

Michael Weaver[1], Marco Petasecca[1], Michael L. F. Lerch[1], Gianluigi De Geronimo[2], Donald A. Pinelli[2], Dean L. Cutajar[1], Michael Jackson[3], Anatoly Rosenfeld[1]

[1]Centre for Medical Radiation Physics, University of Wollongong, [2]Brookhaven National Laboratory, Upton, NY, USA, [3]Prince of Wales Private Hospital, Randwick, NSW, Australia

E-mail for correspondence: mweaver@uow.edu.au

Abstract

Purpose: Plaque brachytherapy is an innately difficult treatment for dosimetry due to its high dose gradients, driven by small tumour sizes and nearby healthy structures. Currently, in plaque brachytherapy, treatment planning is primarily based on the Task Group-43U1 formalism for calculation. These calculations are inadequate for accurately predicting treatment doses in plaque brachytherapy, due to its incapability in accounting for heterogeneous materials, such as the plaque backing. Whilst there are limited treatment planning tools available commercially, none of these have been certified with either the European Conformity (CE) marking or U.S. Food and Drug Administration approval, and thus are not recommended for use by American Association of Physicists in Medicine (AAPM) or the American Brachytherapy Society (ABS). There is no current dosimetry system that can be used for preoperative treatment verification. Previous studies have shown that silicon detectors can provide excellent results in dosimetry for plaque brachytherapy. With the development of the PANOPTES, a means has been established for real-time, volumetric dosimetry.

Material and methods: To calibrate the system several procedures were conducted. The detector was exposed to flat-field 250 keVp x-rays from an orthovoltage machine at a distance of three meters. Monte Carlo simulation was used for energy correction of silicon to water. Additionally, the energy spectra of the diodes, needed for correct energy thresholding, was measured by configuring its readout electronics as a single channel analyser, and scanning across the allowable energies. Three dimensional dose volumes were automatically created by taking plaque measurements at multiple angles using a stepper motor.

Results: The flat-field calibration procedures showed that there was consistent behaviour across the diodes. The Monte Carlo simulations generated a diode specific energy correction factor based on the mean value across all angles of a ROPES 15 mm plaque rotated axially about the detector. The energy spectra produced for each diode, showed clearly resolvable I-125 peaks and its suitability for event based dosimetry. The three dimensional dose maps provide a quantitative output that can be compared to treatment planning, such as those from the TG-43U1 or Plaque Simulator.

Conclusions: The PANOPTES has yielded promising results as a preoperative dosimetry tool for plaque brachytherapy. Further calibration and optimisation of the system is underway, and needs will provide more accurate dosimetry and establish the limitations of the system.

HDR brachytherapy vs. IMRT as a treatment technique for total scalp irradiation: a case study

Natasha Mason, Vanessa Panettieri, Hayley Mack, Stephanie Miller

William Buckland Radiation Oncology, Prahran, Australia

E-mail for correspondence: N.Mason@wbrc.org.au

Abstract

Purpose: Total scalp irradiation is a complex treatment technique due to the curvature of the treatment surface, sharp dose fall off, superficial nature of the planning target volume (PTV), and the close proximity of organs at risk. A number of megavoltage treatment techniques have been developed to address these challenges, including combined photon-electron moving junctions, electron, and photon arcs. These modalities are often not able to achieve adequate dose coverage, could provide dose uncertainty at junctions and due to the complexity of daily treatment positioning have the potential to cause considerable set-up errors. In our work, we compared high dose rate (HDR) brachytherapy and intensity modulated radiation therapy (IMRT) as treatment alternatives for whole scalp irradiation.

Material and methods: An 80-year-old man presented with multiple metastatic melanoma dermal deposits on the scalp for consideration of radiotherapy management. *HDR brachytherapy:* a cobex helmet was made encompassing the whole scalp. Dental wax was layered over

the helmet to create 0.7 cm of build-up. The HDR catheters were attached to the helmet and a further 1.0 cm of dental wax was placed over the catheters. The patient was CT scanned supine while wearing the helmet. The PTV and organs at risk were defined on the Oncentra Version 4.1 treatment planning system (TPS), the catheters appended, and a treatment plan calculated using geometrical optimisation. *IMRT*: At simulation the patient was positioned prone. A thermoplastic cast was made, 0.7 cm of build-up was placed over the cast to cover the treatment area and a CT scan was performed. The PTV and organs at risk were defined in the Eclipse TPS, and an IMRT plan was calculated.

Results: The isodose distribution and dose volume histograms (DVH) of the PTV and critical structures were compared. The IMRT plan provided the best dose coverage of the PTV and achieved the best dose sparing of critical structures.

Conclusions: IMRT was selected as the treatment option for this patient, as it provided the best dose coverage of the PTV, while minimising the dose received by the brain and optic structures. HDR brachytherapy is a clinically acceptable treatment option for extensive scalp irradiation if IMRT is not available or the patient is unable to attend a long course of external beam radiotherapy.

Initial clinical experience with HDR treatment verification using a flat panel detector

Ryan L Smith[1], Jeremy L Millar[1], Annette Haworth[2], Michael L Taylor[1], Leah N McDermott[1], Rick D Franich[1]

[1]William Buckland Radiotherapy Centre, The Alfred Hospital & School of Applied Sciences, RMIT University, Melbourne, [2]Physical Sciences, Peter MacCallum Cancer Centre, East Melbourne, Australia

E-mail for correspondence: ryan.smith@wbrc.org.au

Abstract

Purpose: We have previously demonstrated the potential use of a flat panel imager, such as an Electronic Portal Imaging Device (EPID), for high dose rate (HDR) brachytherapy source position verification and dosimetry. Determination of source position in a solid water phantom was achieved to within ± 0.5 mm (x, y plane) and ± 2 mm in the source to detector distance (SDD). In this study, we extend the work to assess the additional complexities introduced in a clinical scenario. These include couch type, patient positioning, source orientation to imager, patient contour/shape, and inhomogeneities.

Material and methods: The EPID (AS500, Varian Medical Systems, Palo Alto, CA) was mounted in a standard operating theatre couch (BetaStar, Marquet) under a customised carbon fibre couch top assembly adapted from a linac. The patient was aligned such that the treatment (target) region was centred over the sensitive imaging area. Three x-ray markers were inserted into the catheters and a radiograph acquired to locate the implant relative to the imager. EPID images were acquired, as the source dwells were delivered to the patient. Images were processed post-treatment and the data was analysed for comparison against the plan. This procedure was undertaken for both treatment fractions.

Results: The EPID system was sensitive to the patient exit radiation, for SDDs that ranged from 90 to 150 mm for this patient, providing satisfactory images for analysis via our established method. The profiles analysed for position information, feature additional asymmetry not present in phantom studies, attributable to the effects of patient contour and inhomogeneity. Relative source dwell positions were evaluated using the treatment length for each catheter. The system overestimated treatment lengths by up to 15 mm. Source dwell timing and movement can be correlated with image capture intervals to confirm consistent delivery profiles and correct catheter channel connections.

Conclusions: The system as trialled is already capable of independently confirming catheter channel connections and correct treatment plan selection. The process of using a flat panel imager in a clinical scenario has provided us with valuable information impossible to achieve with a simple uniform phantom model. It has shown that the system responds well to the source exit radiation with acceptable image quality at large source to imager distances. The focus of ongoing work is refinement of the method accounting for inhomogeneities and minimising source position uncertainty. Further work is required to establish a true *in vivo* real time verification system, but the current experience is a promising step forward.

BrachyPix: a quality assurance system for high dose rate brachytherapy

Anthony Espinoza[1], M. Petasecca[1], D. Cutajar[1], S. Conde[2], A. Howie[3], M. Jackson[2], J. Bucci[3], A. Rozenfeld[1]

[1]Centre for Medical Radiation Physics, University of Wollongong, Wollongong, [2]Prince of Wales Hospital, [3]St George Cancer Care Centre, Randwick, Australia

E-mail for correspondence: aae718@uowmail.edu.au

Abstract

Purpose: Due to the high risk of complications resulting from an incorrect treatment of high dose rate (HDR) brachytherapy, it is essential that there are methods for quality assurance that can directly and accurately verify the treatment plan, and the functionality of the remote afterloader. Currently, there are no comprehensive, inexpensive quality assurance (QA) solutions available for HDR brachytherapy.

Material and methods: At the Centre for Medical Radiation Physics (CMRP), a novel QA device, "BrachyPix", has been developed that will allow for verification of

plans in HDR brachytherapy, by assessing source positions and dose distribution within the treatment volume [1]. The system has been designed using the CMRP Magic Plate (MP), a two-dimensional array of silicon diodes with minimal perturbation to the radiation field. The MP system is embedded within a tissue equivalent phantom between two rows (10+10) of HDR brachytherapy catheters. Readout electronics are capable of extremely fast and accurate measurements with testing, and analysis performed in real time. Treatment plans were imported into the BrachyPix software where a dose image was simulated on the MP. Four dimensional source tracking in each catheter was based upon a fast iterative algorithm. Using the angular dependence corrected response of the MP, comparisons were made between the final dose image with and without the source in transit against the TPS.

Results: BrachyPix allowed for the tracking of the HDR source providing accurate determination of source dwell positions, derived within 0.50 mm of the expected position. With a timing resolution of 0.25 ms, dwell times and source transit times were measured, allowing for the calculation of the instantaneous source speed (up to 55.0 ± 0.5 cm/s) and acceleration (124 ± 6 cm/s^2). Comparisons were made between treatment plans and dose images obtained using BrachyPix, and to a modified dataset which neglects dose due to the source in transit.

Conclusions: A feasibility study of BrachyPix QA device demonstrated the promising performance for real-time source position tracking in four dimensions and testing of treatment parameters. Further development of this system will allow for a full suite for dosimetry QA in HDR brachytherapy and for future real time *in vivo* source tracking.

Verification of a high dose rate brachytherapy treatment planning system using TLD and Monte Carlo methods

James Rijken, Wendy Harriss-Phillips, John Lawson

Royal Adelaide Hospital/University of Adelaide, Australia

Abstract

Purpose: Thermoluminescent dosimeters (TLDs) have applications in dose measurement for radiation research, clinical cancer treatment, and personal safety dose monitoring. In this work, LiF TLD are used to verify the accuracy of a high dose rate prostate brachytherapy treatment planning system. As they have a response that is dependent on the energy spectrum of the incoming radiation, it was first necessary to calibrate them for use with ^{192}Ir.

Material and methods: The TLD energy response was investigated for a set of TLD700:LiF (Mg, Ti) chips exposed to a ^{192}Ir brachytherapy source. The absolute dose was calibrated through Monte Carlo simulation methods, using the package GEANT4. The TLDs were exposed to the source in air, as well as varying depths in water. The response for each scenario was compared to the response from a nominal 6 MV linac beam. Once calibrated, the TLD chips were used to verify the accuracy of the treatment planning system, Oncentra Prostate (OCP) v3.2.3 (based on TG43 formalism). A realistic prostate treatment plan was created on a reconstructed ultrasound image data set of the phantom. The treatment plan was delivered to a water/Perspex phantom with the TLD chips at known locations. The doses delivered to the TLDs were compared to the doses predicted by Oncentra Prostate.

Results and conclusions: The TLD700 chips over-responded by approximately 11% when exposed to ^{192}Ir in air (compared to 6 MV irradiation), and had a depth dependent response in water. The TLDs used to verify a realistic Oncentra Prostate treatment plan, produced a mean dose ratio, DTLD/DOCP, of 1.023 ± 0.041, which was not statistically different from the expected value of 1.0, with a confidence level of 95%. When compared directly with Monte Carlo predictions for a single dwell treatment plan, the mean dose ratio, DMC/DOCP was 1.029 ± 0.064, which was also not statistically different to 1, with a confidence level of 95%. These experiments have independently verified the predicted doses in water of Oncentra Prostate.

A real-time beryllium oxide (BeO) ceramic fibre-coupled luminescence dosimetry system for high dose rate brachytherapy dosimetry

Alexandre Santos[1,2], Mohammad Mohammadi[1,2], Shahraam Afshar V[2]

[1]Department of Medical Physics, Royal Adelaide Hospital, [2]Institute for Photonics and Advanced Sensing, School of Chemistry and Physics, University of Adelaide, Australia

E-mail for correspondence: alexandre.santos@adelaide.edu.au

Abstract

Purpose: Beryllium oxide (BeO) ceramics have been investigated since the 1950s for dosimetric use. Initially, as an alternative thermolumienscent dosimeter to lithium fluoride (LiF), and more recently investigated as an optically stimulated luminescence (OSL) dosimeter. This interest in BeO ceramics has come from their near water equivalent effective atomic number, Zeff ~7.1, compared to water, Zeff ~7.4.

Material and methods: We have developed a portable and real time, BeO ceramic optical fibre-coupled luminescence dosimeter, named RL/OSL BeO FOD. Our dosimetry system is capable of reading the radioluminescence (RL) or scintillation and OSL from a 1 mm diameter, 1 mm long BeO ceramic cylinder, optically coupled to the tip of a silica/silica optical fibre. The RL reading

allows for real-time dose-rate measurements during exposure, and following exposure the OSL can be read for an accumulated dose measurement. The small size of the RL/OSL BeO FOD makes it capable of being inserted into a 6 F plastic Oncosmart Proguide needle, commonly used for HDR prostate treatments.

Results: The dosimetry system is evaluated for dosimetric use in HDR using an ^{192}Ir source. The RL/OSL BeO FOD and ^{192}Ir source were inserting it into 6 F needles and immersed in a water tank. A custom built Perspex frame was used, which can hold 6 F needles with a separation of 1 cm from each other. The RL/OSL BeO FOD response was compared to doses calculated based on the AAPM TG43 formalism, using Oncentra Brachytherapy v4.3 (OCB) planning system. Dose linearity was measured for dose below 15 Gy and showed a linear RL response for all doses up to the measured 15 Gy, and that the OSL response is slightly supralinear for doses above ~10 Gy. This is not a problem, as it can be corrected using an appropriate calibration curve. We also found little angular or depth dependency from the RL/OSL BeO FOD compared to that calculated from OCB.

Conclusions: In summary, we have developed a small, real-time and near "water equivalent" BeO ceramic fibre-coupled luminescence dosimetry system. In a clinical case, our RL/OSL BeO FOD can be inserted in a 6 F needle and is capable of a real-time dose-rate measurement during treatment and an independent accumulated dose measurement once the treatment has ceased. Current results indicate that the RL/OSL BeO FOD could be a useful dosimeter for *in vivo* HDR brachytherapy dosimetry.

The use of normal saline as transperineally inserted spacer material into peri rectal space prior to high dose-rate brachytherapy boost for prostate cancer

Raghu Gowda, J Titus, J Lawson, A Katsilis, T Perry

Radiation Oncology Department, Royal Adelaide Hospital, Adelaide, Australia

E-mail for correspondence: raghu.gowda@health.sa.gov.au

Abstract

Purpose: To evaluate the safety and efficacy of normal saline as transperineally inserted rectal spacer (TIS) in the treatment of prostate cancer using high-dose rate (HDR) brachytherapy boost.

Material and methods: Between May and Aug 2013, 7 HDR brachytherapy implants were performed as boost (before or after radiation therapy) in the treatment of intermediate – high risk prostate cancer at the Royal Adelaide Hospital. HDR Ir-192 brachytherapy was administered as a single implant of 15 Gy using ultrasound based live implant technique under general anaesthesia. Before the catheters were inserted, an 18 G spinal needle was introduced transperineally under ultrasound guidance into the peri rectal space. 10-15 mls of normal saline was injected to increase the distance between prostate and rectum. Prostate to rectal distance at midgland (point of maximal contact) was recorded using 2D images. Brachytherapy treatment plans were analysed to quantify rectal dose sparing. Records of 7 consecutive patients treated with HDR boost without spacer was used as a comparison group. RTOG/EORTC scoring system was used to assess gastro intestinal toxicity. Median follow up time was 5 months.

Results: Normal saline injection was straightforward. The table below shows rectal spacing and dosimetry.

Table 1.

	No spacer (n = 7)	Normal saline spacer (n = 7)
Mean prostate-rectal distance	1.9 mm	5 mm
Rectum V_{75} (mean)	0.55cc	0.13cc
Rectum max (mean)	87%	78%
Target (V_{100}) (mean)	93%	95%

Early follow up (median 5 months, range 3-6 mo) shows no > Gr2 rectal toxicity in either group.

Conclusions: Normal saline as a TIS is feasible, safe, effective, and economical in terms of rectal sparing during single fraction HDR brachytherapy. Mean rectal spacing of 6 mm is achievable. This enhanced spacing provides significant dosimetric advantages with lower rectal doses and better target coverage, which can translate into better prostate cancer outcomes. Longer follow-up with more patients will be necessary to confirm these findings. Selective usage of spacer in those with narrow recto prostate distance may be more beneficial.

The use of polyethylene glycol hydrogel spacer in brachytherapy patients-technical feasibility, benefits, and ramifications

Nadine Beydoun[1], Joseph Bucci[1], Yaw Chin[1], David Malouf[2]

[1]St George Hospital Cancer Care Centre, [2]Department of Urology, St George Hospital, Kogarah, Australia

E-mail for correspondence: nadine.beydoun@sesiahs.health.nsw.gov.au

Abstract

Purpose: Radiation proctitis remains the rate limiting step for prostate cancer patients undergoing radiotherapy of any form. The risk of chronic rectal injury following brachytherapy is less than 10%, but serious complications such as rectal ulcer or fistula formation have been reported. We prospectively assessed feasibility and toxicities

associated with the use of a transperineally injected, polyethylene glycol-based spacer into the anterior perirectal fat in a group of brachytherapy patients.

Material and methods: Patients with localized prostate cancer suitable for Iodine-125 prostate seed brachytherapy or external beam radiotherapy (EBRT) and high dose rate (HDR) brachytherapy boost were recruited to this study. Seed patients included those who underwent spacer insertion at the time of their seed implant (seed group), and those in whom it was inserted subsequently due to suboptimal rectal dosimetry on their day 30 post-implant dosimetric assessment (post-seed group). HDR patients underwent spacer insertion at the time of their HDR procedure (HDR group). Primary endpoints were toxicity related to spacer insertion, and prostate-rectum separation with and without spacer. Secondary endpoints included rectal dosimetry in the presence of spacer, rectal toxicity (NCI CTCAE v4.0), and quality of life (EORTC QLQC30 and EPIC).

Results: Ten HDR, 9 seed, and 8 post-seed patients underwent transperineal, TRUS-guided insertion of spacer under GA. Minimum follow-up was 6 months (range 6-19 months). Mean increase in prostate-rectum separation achieved at all intervals along the prostate-rectum interface with the spacer was 10.2 mm (±4.0). In the HDR group, mean rectal Dmax (maximum dose to 0.1cc of rectum) was 6.0 Gy (±1.2). Mean rectal volume receiving prescribed dose (RV100) in the seed group was 0.2cc (±0.1). In the post-seed group, mean RV100 was decreased to 0.09cc (±0.1) following spacer insertion. Three patients (2 HDR, 1 seed) experienced complications following the procedure, including 1 localized infection resolving after spacer dissolution, 1 rectal ulcer due to intramucosal injection of spacer, and 1 fistula 12 months after HDR and spacer insertion. The remaining patients all reported G0 (19/27) or G1 (5/27) rectal toxicity at 4-6 weeks and 6 months.

Conclusions: In patients undergoing spacer insertion after seed implantation, significant reductions in rectal radiation dose were seen and no associated toxicity. Whilst rectal dose reductions were also seen in the seed and HDR groups, the 10% incidence of serious complications suggests that simultaneous insertion of spacer at the time of the brachytherapy procedure should be avoided.

Long-term erectile function and factors influencing EF preservation in men treated with permanent seed brachytherapy for localized prostate cancer

Ben Hindson[1], WL Ong[2], Catherine Beaufort[1], J Millar[1]

[1]William Buckland Radiation Centre, Prahran, Vic., Australia,
[2]Department of Public Health and Primary Care, University of Cambridge, United Kingdom
E-mail for correspondence: ben.hindson@wbrc.org.au

Abstract

Purpose: To evaluate erectile function (EF) and factors influencing EF preservation following brachytherapy (BT) in men with optimal EF before treatment.

Material and methods: The cohort consisted of patients with newly diagnosed localized prostate cancer treated with BT at the William Buckland Radiotherapy Centre (1998-2011). Erectile function was assessed prior to BT and at each follow-up visit, using the validated International Index of EF (IIEF-5). Normal EF was defined as IIEF5 > 21 and mild erectile dysfunction (ED) was defined as IIEF5 17-21. Baseline medical co-morbidities and clinical characteristics of prostate cancer were collected. Radiation dose was quantified with D90 to the prostate. The probability of EF preservation following BT was estimated using the Kaplan-Meier method, and the log-rank test was used to compare factors influencing EF preservation, with Bonferroni correction for multiple testing. Cox regression was used for multivariate analysis, adjusting for potential confounders.

Results: 613 of the patients completed the IIEF5 survey prior to BT, of which 389 patients reported IIEF5 > 16 (292 no ED, and 97 mild ED). The mean age of prostate cancer diagnosis was 61 and the patients were followed-up for a median of 50 months. 60% of the patients reported mild or no ED at 5-year follow-up. In Cox regression analysis, age at BT, Gleason grade, and D90 (prostate) significantly influence EF preservation, after adjusting for medical co-morbidities, smoking histories, and PDE5I use. Patients above age 60 had 1.39-times (95% CI: 1.02-1.89) increased risk of developing greater than mild ED compared to those under age 60. Higher Gleason grade (7 vs. < 7) and higher D90 (> 150 Gy vs. < 150 Gy) were also associated with poorer EF preservation with HR of 2.50 (95% CI: 1.84-3.39) and 1.53 (95% CI: 1.15-2.04), respectively.

Conclusions: 60% of the patients with no or mild ED before BT do not develop worse ED at five-year follow-up. Increasing age at BT, higher Gleason grade, and higher D90 are associated with poorer EF preservation following BT.

Prediction of erectile dysfunction following prostate seed brachytherapy: a dose volume analysis of penile structures

Ben Hindson[1], Catherine Beaufort[1], Eldho Paul[2]

[1]William Buckland Radiotherapy Centre, Prahran, [2]Department of Epidemiology and Preventive Medicine, Monash University, Australia
E-mail for correspondence: ben.hindson@wbrc.org.au

Abstract

Purpose: To identify if the dose to penile structures is a potential causative factor for severe erectile dysfunction following low dose rate brachytherapy (LDRB) for prostate cancer in men with normal pre-treatment erectile function.

Material and methods: The post- brachytherapy dosimetry CT datasets for 69 men with low risk prostate cancer treated between April 2004 and November 2007 were used. Patients with pre-treatment moderate or poor erectile dysfunction were excluded. The penile bulb (PB), neuro-vascular bundle (NVB), and the penile crura (PC) were retrospectively volumed in a standardised manner and dose-volumetric parameters were generated. All patients had low or intermediate risk disease and received LDRB monotherapy. Four patients received hormone therapy. The dose prescribed was 145 Gy and the dosimetery CT was undertaken at 4 weeks post brachytherapy. All patients were followed prospectively using the International Index of Erectile Function (IIEF) questionnaires. For the analysis, the patients were divided into a severe erectile dysfunction group (IIEF < 13; group A) or adequate erectile function group (IIEF ≥ 13; group B). Generalised linear modelling was used to assess the impact of dose, hormones, and time to erectile dysfunction.

Results: The median age of the group was 61 years and the median follow up was 71 months. The PB dose received was significantly higher in group A than group B. For group A and B, respectively, the following differences in geometric means were found at various doses; D10 – 87.4 Gy and 71.8 Gy (p = 0.01); D30 – 56.6 Gy and 46.7 Gy (p = 0.01); D50 – 40.4 Gy and 33.3 Gy (p = 0.01); D70 – 29.1 Gy and 23.9 Gy (p = 0.003); D90 – 19.5 Gy and 16.2 Gy (p = 0.003). Hormone therapy did not have a significant impact. These results did not significantly change over the follow-up period. NVB and PC doses did not differ significantly between the 2 groups.

Conclusions: The dose received to the PB appears to be higher in men who develop severe erectile dysfunction than those who maintain adequate erectile function. This finding was consistent over the follow up period. As the PB is usually outside the treated volume, this may imply over-estimation of the volume or seed migration post implant. Caution should be used to minimise the dose to the PB.

LDR brachytherapy – whole gland and focal therapy planning

Mira Keyes

Radiation Oncology, Division of Surgery, University of British Columbia, Vancouver, Canada
E-mail for correspondence: mkeyes@bccancer.bc.ca

Purpose: To outline components of planning whole prostate LDR brachytherapy; review the LDR Vancouver planning algorithm; review the rational for focal therapy, outline uncertainties and controversies; present the LDR focal brachytherapy planning strategies.

Long term results of I-125 LDR brachytherapy for low and intermediate risk prostate cancer using real-time intra-operative planning and robotic after-loading seed insertion

J MacKean, JW Yaxley, JA Yaxley, K Lah

Genesis Cancer Centre – The Wesley Hospital, Brisbane, Australia
E-mail for correspondence: jamesmackean@gmail.com

Abstract

Material and methods: A total of 546 low dose rate brachytherapy monotherapy implants were performed from July 2003 to December 2013 at a single centre. The long term results of the prospective data on the first 249 cases with a minimum follow up of 4 years, treated by a single radiation oncologist (JM) and urologist (JY) are presented. The median follow up is 6.5 years. In the cohort 51% (127/249) had Gleason sum 6 prostate cancer, 48.5% (121/249) Gleason sum 7, and Gleason sum 8-10 in 3 patients. The median PSA was 6.2 (0.09-20). Clinical stage T2 was identified in 30.1% and T1b-T1c in 69.9%, and the median age was 65 yrs (47-81 yr).

Results: Using the Phoenix definition, 94% (236/249) remain free of recurrent disease. The prostate cancer specific survival is 99.6%. As a pre-operative, bladder neck incision was performed on patients with sub-optimal flow rate studies, only 1 patient required intermittent self-catheterisation for post implant urinary retention.

Conclusions: LDR brachytherapy using a live intra-operative planning technique for low and intermediate disease is associated with an excellent cancer specific survival. This is an appropriate management option for those patients who are unsuitable for, or who do not wish to have alternative curative treatments such as radical prostatectomy or external beam radiotherapy.

Biological imaging for focal brachytherapy for prostate cancer

A. Haworth[1,2], H. Reynolds[1], A. Zhang[3], D. Rawlinson[3], R. Chakravorty[3], C. Ong[3], N. Hardcastle[1], Leckie C[2], G. Liney[4], M. Ebert[5,6], S. Williams[1,2]

[1]Peter MacCallum Cancer Centre, Melbourne, Vic., [2]University of Melbourne, Melbourne, Vic, [3]NICTA, University of Melbourne Vic, [4]Ingham Institute of Applied Medical Research, Liverpool, NSW, [5]Sir Charles Gairdner Hospital, Nedlands, WA, [6]University of Western Australia, Nedlands, WA, Australia

E-mail for correspondence: annette.haworth@petermac.org

Abstract

Purpose: Low dose rate brachytherapy is a highly efficacious treatment for low risk prostate cancer, but produces undesirable toxicity. A bioeffect model has been developed to determine the optimal dose distribution to maximise tumour control and minimise toxicity. Biological imaging, along with atlas based data and patient specific clinical data is used to inform parameters of the biological model to target an ablative dose at known regions of significant tumour burden with a lower, therapeutic dose to low risk regions. We describe our novel approach in deriving tumour parameters, including tumour location (TL), tumour cell density (TCD), Gleason Score (GS-representing tumour proliferation), and hypoxia from in-vivo multiparametric MRI (MP-MRI) data to obtain 3D maps of prostate tumour characteristics.

Material and methods: Patients scheduled for routine radical prostatectomy were recruited to the project. Each underwent MP-MRI scanning prior to surgery. The excised specimens provided the 'ground-truth' data for validation of tumour characteristics observed in MP-MRI. Specimens were formalin fixed and mounted in agarose gel. T2w MRI of the specimens were acquired prior to sectioning. Whole mount sections were stained using a variety of agents to assess TL, TCD, GS, and hypoxia, including H&E and HIF1-α. A tile based approach was used to produce 3D tumour cell density maps. Image recognition techniques were applied to grade the tumours and identify regions of hypoxia. Image processing was applied to a range of MP-MRI sequences for correlation with the histology data. All data sets were assembled into a common geometric frame of reference, using rigid and deformable registration methods. Machine learning provides methods to identify key features within the MP-MRI for defining tumour characteristics.

Results: 3D maps of tumour characteristics may be defined from a combination of MP-MRI techniques. Ongoing development of our existing image processing and 3D registration methods, combine with machine learning will continue to improve the sensitivity and specificity for defining tumour characteristics from *in vivo* MRI.

Conclusions: MP-MRI may be used to define tumour characteristics for the purpose of focal brachytherapy treatment planning. Advanced imaging processing techniques produce the required biological input parameters. These data are combined with atlas based and patient specific clinical data along with Bayesian statistical methods to produce a probability map for treatment planning using biological optimisation.

Assessing the feasibility of sentinel lymph node identification by 68Ga-nanocolloid PET/CT

Jacki Doughton, Scott Williams, Rod Hicks, Michael Hofman, Annette Haworth

Peter MacCallum Cancer Centre, Radiation Oncology, Melbourne, Australia

E-mail for correspondence: jacki.doughton@petermac.org

Abstract

Purpose: Localisation of sentinel lymph nodes using a radioactive tracer can be performed successfully for prostate cancer patients. The technique of lymphoscintigraphy in prostate cancer can guide surgeons to remove disease that would not be found in an extended pelvic lymph node dissection. A sentinel lymph node atlas derived from SPECT/CT in prostate patients shows that 65.6% of patients have sentinel nodes outside the traditional radiation field borders, particularly in the external iliac, perirectal, para-aortic, and sacral regions.

Material and methods: With improvements in target localisation using SPECT/CT or PET/CT and secondly, radiation treatment with IMRT, we look to implement lymphoscintigraphy in prostate cancer management. Our goal is to use PET/CT to identify the primary echelon of lymphatic drainage, that is, the sentinel lymph nodes, whilst acquiring the standard images used to plan the radiation dose. Furthermore, it is hypothesised that the sensitivity of PET/CT imaging may increase our understanding of patterns of prostate cancer spread by being able to visualise alternate routes of spread.

Results: Our pilot imaging study involves optimising the SPECT/CT technique with three patients and then proceeding to PET/CT. A transperineal template technique for intra-prostatic injection of tracer has been designed to provide homogenous distribution of tracer throughout the prostate gland. A gallium-38-nanocolloid tracer is injected at the time of gold seed fiducial placement. A particle size of 30 nm, with a hydrodynamic diameter of approximately 50 nm has been designed by our radiopharmacist. This size is expected to be small enough to allow movement to lymphatic vessels, but large enough to be trapped by sentinel lymph nodes.

Conclusions: We have been able to coordinate the opportunities of gold seed placement, access to brachytherapy techniques, and institutional interest in PET/novel tracers to test the feasibility of PET lymphoscintigraphy

in prostate cancer. It is hoped this endeavour will lead to improved targeting of the pelvis for high risk prostate cancer patients. The initial images and findings from our pilot study will be presented.

EBRT + HDR brachytherapy boost for intermediate and high risk prostate cancer is a safe and effective form of dose escalation

John Yaxley, J MacKean, JA Yaxley, K Lah

The Wesley Hospital, Genesis Cancer Centre – Wesley, Brisbane, Australia

E-mail for correspondence: jyaxley@bigpond.com

Abstract

Purpose: A total of 989 HDR prostate brachytherapy procedures have been performed between August 2000 and December 2013.

Material and methods: The long term results of the prospective data on the first 512 consecutive patients with a minimum follow up of 5 years, treated by a single urologist (JY) and radiation oncologist (JM) are presented. The median follow up is 8.5 years (5-13 yr). High risk disease by the D'Amico classification was identified in 66.1% of this cohort, the remainder had intermediate risk cancer. External beam radiotherapy 46 Gy in 23 fractions was given in conjunction. Ten patients were excluded due to HDR monotherapy protocol.

Results: The median PSA is 13.9 (0.4-150). The clinical stage is T3b-T4a in 13.5%, T3a – 33.6%, T2 – 35.1%, T1c – 17.6%, and T1b in 0.2%. Gleason score 8-10 is identified in 39.2% of patients, 4 + 3 in 21.2%, 3 + 4 in 33.2%, and Gleason 3 + 3 in 6.4%. The median age is 67 yrs (41-84 yrs). Using the Phoenix definition, 78.2% (393/502) of patients remain free of recurrent disease. Of the 21 patients with all 3 high risk features, only 52.3% (11/21) remain free of recurrent disease. The bNED for the intermediate group is 90% (160/170). The prostate cancer specific survival is 96% despite this high risk cohort.

Conclusions: HDR brachytherapy provides excellent long term prostate cancer specific survival and biochemical freedom of disease, and should be considered as an alternative to a radical prostatectomy in men with high and intermediate risk prostate cancer; especially if they have significant surgical risk factors.

Single fraction high dose rate brachytherapy boost for intermediate and high risk prostate cancer: update of the Royal Adelaide Hospital experience

Raghu Gowda, J Titus, E Yeoh, J Lawson, A Katsilis

Radiation Oncology Department, Royal Adelaide Hospital, Adelaide, Australia

E-mail for correspondence: raghu.gowda@health.sa.gov.au

Abstract

Purpose: To evaluate outcomes with single fraction HDR brachytherapy boost in intermediate and high risk prostate cancer.

Material and methods: Between April 2012 and Aug 2013, 28 patients treated consecutively with intermediate – high risk prostate cancer were treated with single implant of 15 Gy, using ultrasound based live implant technique under general anaesthesia. This was preceded or superseded by external beam radiation therapy (46 Gy/23 F). Patients were prospectively followed up for efficacy (PSA failure-Phoenix definition), toxicity (IPSS, EPIC (bowel)), and IIEF-5. Modified late RTOG (bowel and bladder) toxicity data were also collected.

Results: Patient factors *N* = 28; median age (range) 67 (55-79); intermediate/high risk (*n*/%) 9 (32%)/19 (68%); median PSA (range) 8.7 (3.3-125); GS7/GS8/GS9 15/5/8. No. patients with ADT – 11 (39%). Treatment factors: No. of catheters used 18 (13-28); median OTT (range) 43 (35-99); median V100 (range) 94 (91-97) Gy; Median V150 (range) 24 (17-33) Gy; median V200 (range) 5 (3-11) Gy; Urethra > V115 none; median rectum V75 0.52 (0.07-1.2) cc; EBRT dose 46 Gy/23 F. With a median follow up of 9.5 months (3-22 mo), 4 of 28 patients have failed. Median time to failure was 8 months (3-12 mo). No > Gr2 late bladder or rectal toxicity. All patients with satisfactory erectile function pre-treatment (and not on ADT) had this preserved.

Conclusions: Single fraction HDR brachytherapy boost for intermediate and high risk prostate cancer using live US based implant technique is feasible. Early follow up data shows low urinary and rectal toxicity with maintenance of erectile function with good PSA control. Long term follow up is required to confirm these positive findings.

BrachyView: 3D seed position reconstruction in low dose rate brachytherapy

Marco Petasecca[1], K. Loo[1,2], M. Jalayer[1], C. Tenconi[3], M. Favoino[4], F. Carriero[4], M. Safavi-Naeini[1], J. Bucci[5], M. Zaider[6], J. Jakubek[2], S. Pospisil[2], M.L.F. Lerch[1], A.B. Rosenfeld[1]

[1]Centre for Medical Radiation Physics, University of Wollongong, Australia, [2]Institute of Experimental and Applied Physics, Czech Technical University, Prague, Czech, [3]Medical Physics Unit, Fondazione IRCCS Istituto Nazionale dei Tumori, Milan, Italy, [4]Advanced Computer System Pty Ltd, Rome, Italy, [5]St George Cancer Care Centre, Sydney, Australia, [6]Memorial Sloan-Kettering Cancer Center, NY, USA

E-mail for correspondence: marcop@uow.edu.au

Abstract

Purpose: In permanent prostate brachytherapy (PPB), postimplant dosimetry correlates with treatment outcomes, but does not allow for implant adjustments. The pre-planned technique used for PPB has limitations that may be overcome by intra-operative treatment planning (ITP). Memorial-Sloan-Kettering Cancer Centre (MSKCC) have developed and successfully implemented intra-operative conformal optimization and planning (I-3D) for ultrasound (TRUS)-based ITP, obviating the need for pre-planning. TRUST based system is advanced for prostate volumetric study and needle guidance, however sceptical for seed position identification, which is a major input parameter in ITP. Full realisation of the benefit of PPB can be achieved by real-time seed position imaging, followed by a dynamic dose re-planning that can be achieved by graphical direct comparison of the real seed position with the seeds position calculated by the Treatment Planning System (TPS). CMRP proposed and patented BrachyView, a new direction in real time seed position imaging and intra-operative QA. The aim of this study is to show the seed position reconstruction accuracy of BrachyView in a multi-seeds scenario compared to seeds positions obtained on CT.

Material and methods: BrachyView is based on a pinhole gamma camera using TimePIX as imager. TimePIX is a highly pixelated silicon detectors with sensitive area 14 × 14 mm^2 and 256 × 256 pixels of 55 × 55 μm^2. The distribution of the seeds is reconstructed by a stereoscopic triangulation technique of projective transformed images. Experiments with 20 seeds have been carried out in a prostate PMMA phantom with parallel holes for I-125 seed placement matching template for LDR TRUS guided brachytherapy. The prostate phantom with seeds has been scanned on CT for post-implant verification and seed positions reconstructed. Rigid co-registration method has been used to fuse the 3D datasets and perform a quantitative evaluation of the accuracy of BrachyView.

Results: The seed centres of mass positions have been reconstructed by the algorithm explained in detail in presentation from the 2D maps acquired by the BrachyView probe. The coordinates of the centres of mass are used to create a 3D analytical model of the seeds. The analytical model is then co-registered with the CT 3D data set, and reconstruction discrepancy evaluated within 1-2 mm, depending on the distance of the seed from the collimator. Impact of the scattering background has been minimised subtracting each event map acquisition frame from the previous.

Conclusions: Proof of concept of miniature in body imaging gamma probe based on silicon pixelated detector has been demonstrated in a multi-seed scenario with the evaluation of the impact of the background to the reconstruction accuracy of the seed positions. Further steps are software development for imaging of multiple seeds in a realistic clinical scenario, and engineering of in body gamma camera within a commercial TRUS probe.

Outcomes in LDR brachytherapy and beyond

Mira Keyes

Radiation Oncology, Division of Surgery, University of British Columbia, Vancouver, Canada

E-mail for correspondence: mkeyes@bccancer.bc.ca

Purpose: To review published literature and PSA RFS with LDR brachytherapy; to outline long term side effects with LDR brachytherapy; to outline most significant controversies in prostate cancer treatment and new trends in treatment strategies; to discuss new risk stratification strategies.

The effect of prostatic calcifications on low dose rate brachytherapy dosimetry

Dane Pope[1], D. Cutajar[1], S. Guatelli[1], S. George[1], K. Enari[2], J. Bucci[2], S. Miller[3], R. Siegele[4], A. Rosenfeld[1]

[1]University of Wollongong & Chris O'Brien Lifehouse at RPA, Camperdown, [2]St. George Cancer Care Centre, Kogarah, [3]BC Cancer Agency Centre for the North, [4]Australian Nuclear Science and Technology Organisation, Australia

E-mail for correspondence: djp399@uowmail.edu.au

Abstract

Purpose: Prostatic calcifications are small stones produced through the build-up of calcium based compounds in prostatic soft tissue. Calcifications are visible on the patient images during volume studies and planning, however, the effect of the calcifications on the dosimetry is relatively unknown. This study addresses quantitatively the effect of prostatic calcification in the clinical outcome

of low dose rate brachytherapy treatment, through of experimental measurements and Monte Carlo simulations.

Material and methods: Four pathological calcification samples were characterised through micro-particle induced x-ray emission measurements to determine the heavy, elemental concentrations within the individual formations. After measurement, each calcification sample was embedded in a PMMA phantom and located between a closely placed I-125 brachytherapy seed, and a MOSkinTM detector to measure the dosimetric impact. Geant4 based simulations were also used to evaluate the dosimetric effect of calcifications through Monte Carlo methods. Four real patient brachytherapy treatments were modelled in the simulation experimental set-up, modelling the distribution of brachytherapy seeds and calcifications in the prostate, as revealed using CT and ultrasound imaging. Using varied calcification compositions, the doses deposited within the treatment volume, with and without the presence of the calcifications, were used to determine the local effect of the calcifications on the point dosimetry, as well as the dosimetric parameters (D90, V100, V150 and V200).

Results: Spectral analysis detected eight elements with atomic number greater than 13 in the calcification composition with calcium, phosphorus, and zinc being the most predominant. Through experimental phantom measurements, dose rate reductions between 3.41% and 40.12% were observed, while Geant4 results found local dose reductions of up to 60% due to calcification inclusion. Calcification presence also caused perturbations to the dosimetric parameters, with D90 reduced by between 2.3-2.8%, V100 reduced between 0.5-1.2%, V150 reduced between 0.4-2.5%, and V200 reduced between 0.1-1.0%, across all four patient plans.

Conclusions: Despite producing, dose deposition decreases of up to 60%, the presence of calcifications within the prostate only produces small changes in the dosimetric parameters for low dose rate brachytherapy treatments. It is, however, the local effect, which leads to sharp decreases in the dose deposition within 4 mm from the calcification boundaries that needs to be considered. The higher x-ray absorption within calcifications may shield areas of malignancy from receiving a critical dose, hence, the size and location of calcifications within the treatment volume should be considered when planning for low dose rate brachytherapy treatment of the prostate.

Strengthening brachytherapy programs with ultrasound quality assurance

Thang Nguyen, Yen Tran, Venkata Seshadri

Epworth Radiation Oncology, East Melbourne, Australia

E-mail for correspondence: thang.nguyen@epworth.org.au

Abstract

Purpose: At Epworth Radiation Oncology (ERO), ultrasound (US) is employed for localization of target anatomy and organs at risk (OAR) that require delineation in Brachytherapy treatment planning. US is utilized in both low dose rate (LDR) and high dose rate (HDR) brachytherapy for prostate cancer and its application extends to real time guided cervix brachytherapy and dosimetry. Currently, ERO is exploring the use of US in conjunction with MRI to enable fusion targeted prostate biopsy, which will further enhance localization of disease within the prostate. The American College of Radiology calls for all US accredited facilities to comply with minimum quality control tests, which includes acceptance testing and routine quality control. Epworth Radiation Oncology aims to strengthen its use of US in its Brachytherapy service through implementation of an US QA program that follows the recommendations from the American Association of Physics in Medicine Task Group 128: Quality Assurance Tests for Prostate Brachytherapy Ultrasound Systems (AAPM TG 128).

Material and methods: Perform the AAPM TG 128 acceptance test by using the BK Medical FlexFocus 800 ultrasound scanner, BK Medical Endocavity Biplane 8848 transducer, and CIRS 045 Brachytherapy Phantom.

Results: The following tests were performed on commissioning on US unit:

- greyscale visibility,
- depth of penetration,
- axial and lateral resolution,
- axial and lateral distance measurement accuracy,
- area measurement accuracy,
- volume measurement accuracy,
- needle template/electronic grid alignment,
- treatment planning computer.

Baseline measurements will be presented at the conference.

Conclusions: In brachytherapy, US quality control testing is not mandatory in Australia. Epworth Radiation Oncology has established measurements from the results through undergoing tests according to AAPM TG 128, using the CIRS 045 Brachytherapy Phantom. ERO was able to perform non-routine quality assurance procedures with no additional resources for LDR brachytherapy implant procedures. This QA is now scheduled to be conducted annually to ensure results fall within acceptable limits as per AAPM TG 128 guidelines.

The use of library planning for applicator based brachytherapy treatment techniques at RBWH

Zoë Baldwin, Nancy Yu, Craig Lancaster, Phil Back

Cancer Care Services, Royal Brisbane and Women's Hospital, Australia

E-mail for correspondence: zoe.baldwin@health.qld.gov.au

Abstract

The Royal Brisbane and Women's Hospital Cancer Care Services (RBWH CCS) has employed the use of

a variety of brachytherapy applicators for a number of years. For techniques that are optimized, based on the applicator geometry rather than the anatomy, treatment plans are generally quite similar between patients. The treatment planning process can therefore be made much more efficient with the use of library planning features in a TPS. In moving away from Plato Brachytherapy to Oncentra Brachytherapy and with the inclusion of the library planning feature in Oncentra MasterPlan Brachy (available v 4.0 onwards), we have altered the treatment planning process for a number of techniques. In this study we demonstrate the direct effect on planning process and treatment efficiency these changes have made.