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Evidence Update

January 2018

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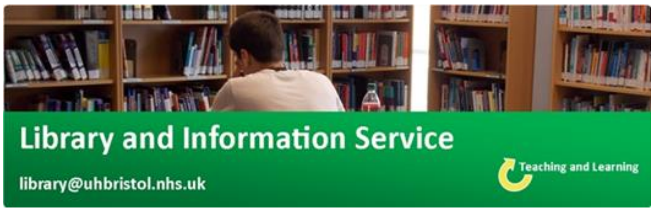

Contents

Current Journals: Tables of Contents

Click on journal title (+ Ctrl) for hyperlink

Journal	Month	Volume	Issue
Radiotherapy and Oncology	December 2017	125	3
International Journal of Radiation Oncology Biology and Physics	February 01 2018	100	2
Clinical Oncology	February 2018	30	2

If you require full articles please email: library@uhbristol.nhs.uk

Lunchtime Drop-in Sessions

All sessions last one hour

February (12.00-13.00)

1st (Thu)	**Literature Searching**
9th (Fri)	**Critical Appraisal**
12th (Mon)	**Statistics**
20th (Tue)	**Literature Searching**
28th (Wed)	**Critical Appraisal**

March (13.00-14.00)

8th (Thu)	**Statistics**
12th (Mon)	**Literature Searching**
20th (Tue)	**Critical Appraisal**
28th (Wed)	**Statistics**

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Latest Evidence

NICE National Institute for Health and Care Excellence

Cochrane Library
Lawrie TA, Green JT, Beresford M, Wedlake L, Burden S, Davidson SE, Lal S, Henson CC, Andreyev HJN. **Interventions to reduce acute and late adverse gastrointestinal effects of pelvic radiotherapy for primary pelvic cancers**. Cochrane Database of Systematic Reviews 2018, Issue 1. Art. No.: CD012529. DOI: 10.1002/14651858.CD012529.pub2. Tsao MN, Xu W, Wong RKS, Lloyd N, Laperriere N, Sahgal A, Rakovitch E, Chow E. **Whole brain radiotherapy for the treatment of newly diagnosed multiple brain metastases**. Cochrane Database of Systematic Reviews 2018, Issue 1. Art. No.: CD003869. DOI: 10.1002/14651858.CD003869.pub4. van der Veen J, Laenen A, Nuyts S. **Modern radiotherapy techniques versus three-dimensional conformal radiotherapy for head and neck cancer (Protocol).** Cochrane Database of Systematic Reviews 2017, Issue 12. Art. No.: CD012904. DOI: 10.1002/14651858.CD012904.

UpToDate® *OpenAthens login required. Register here: https://openathens.nice.org.uk/*
Radiation therapy for the management of painful bone metastases Authors: Lisa A Kachnic, MD; Steven J DiBiase, MD **Literature review current through:** Dec 2017. | **This topic last updated:** Jan 10, 2018.

Stereotactic body radiation therapy for lung tumors

Authors: Josh H Heinzerling, MD; Robert D Timmerman, MD

Literature review current through: Dec 2017. | **This topic last updated:** Jan 26, 2018.

Royal College of Radiologists

The Society of Radiographers

Important update on ionising radiation regulations

17 January, 2018

Author: Maria Murray, Professional Officer for Radiation Protection

The New UK Ionising Radiations Regulations 2018 came into force on 1 January 2018.

New 'Obtaining consent' resources look at practical and ethical issues

19 January, 2018

Institute of Physics and Engineering in Medicine

Recent Database Articles

Below is a selection of articles recently added to the healthcare databases, grouped in the categories:

- **Clarity – prostate verification**
- **Immobilisation techniques**

If you would like any of the articles in full text, or if you would like a more focused search on your own topic, please contact us: library@bristol.nhs.uk

Clarity – prostate verification

1. Intrafraction monitoring of prostate motion during radiotherapy using the Clarity® Autoscan Transperineal Ultrasound (TPUS) system.

Author(s): Richardson, A K; Jacobs, P

Source: Radiography (London, England : 1995); Nov 2017; vol. 23 (no. 4); p. 310-313

Publication Date: Nov 2017

Publication Type(s): Journal Article

Abstract:INTRODUCTIONImplementation of the Clarity® Autoscan (Elekta) Transperineal Ultrasound (TPUS) system in Bristol is the first of its kind in the UK and we have already shown its utility in interfractional Image Guided Radiotherapy (IGRT).14 This study establishes the extent of intrafraction prostate motion as measured by Clarity and explores the potential benefits of TPUS for intrafraction monitoring.METHODSMonitoring data was analysed for 526 fractions from 20 localised prostate cancer patients. Intrafraction prostate displacements exceeding thresholds of 3 mm, 7 mm and 10 mm along patient axes were assessed for frequency and duration of motion.RESULTSProstate motion exceeds the above displacement thresholds during 52%, 8%, and 2% of fractions analysed. Displacement at the 3 mm threshold occurred for 100% of patients, 60% at 7 mm and 35% at 10 mm. The mean frequency and duration of displacements is low for the overall population. In contrast specific patients exhibit much higher displacement values. Posterior motion is most common, averaging at 24% of the treatment time at 3 mm, 3% at 7 mm and 1% at 10 mm, ranging up to 92%, 35% and 10% for individual patients.CONCLUSIONSIntrafraction monitoring with Clarity has the potential to improve accuracy through application of in-treatment motion correction. This is most beneficial for specific patients who exhibit a higher frequency and/or duration of prostate motion. Consideration must be given to the added time implications and radiographer workload in clinical practice to correct for prostate motion. Clarity could help facilitate future protocols using tighter treatment margins, although further research is required.

2. A Monte Carlo study of the effect of an ultrasound transducer on surface dose during intrafraction motion imaging for external beam radiation therapy

Author(s): Martyn M.; Foley M.J.; O'Shea T.P.; Harris E.; Bamber J.; Gilroy S.

Source: Medical Physics; Oct 2017; vol. 44 (no. 10); p. 5020-5033

Publication Date: Oct 2017

Publication Type(s): Article

Abstract: Purpose: The aim of this study was to estimate changes in surface dose due to the presence of the Clarity AutoscanTM ultrasound (US) probe during prostate radiotherapy using Monte Carlo (MC) methods. Methods: MC models of the Autoscan US probe were developed using the BEAMnrc/DOSXYZnrc code based on kV and MV CT images. CT datasets were converted to voxelized mass density phantoms using a CT number-to-mass density calibration. The dosimetric effect of the probe, in the contact region (an 8 mm x 12 mm single layer of voxels), was investigated using a phantom set-up mimicking two scenarios (a) a transperineal imaging configuration (radiation beam perpendicular to the central US axial direction), and (b) a transabdominal imaging configuration (radiation beam parallel to the central US axial direction). For scenario (a), the dosimetric effect was evaluated as a function of the probe to inferior radiation field edge distance. Clinically applicable distances from 5 mm separation to 2 mm overlap were determined from the radiotherapy plans of 27 patients receiving Clarity imaging. Overlaps of 3 to 14 (1 to 3 SD) mm were also considered to include the effect of interfraction motion correction. The influence of voxel size on surface dose estimation was investigated. Approved clinical plans from two prostate patients were used to simulate worst-case dosimetric impact of the probe when large couch translations were applied to correct for interfraction prostate motion. Results: The dosimetric impact of both the MV and kV probe models agreed within +/-2% for both beam configurations. For scenario (a) and 1 mm voxel model, the probe gave mean dose increases of 1.2% to 4.6% (of the dose at isocenter) for 5 mm separation to 0 mm overlap in the probe-phantom contact region, respectively. This increased to 27.5% for the largest interfraction motion correction considered (14 mm overlap). For separations of >= 2 mm dose differences were < 2%. Simulated dose perturbations were found to be superficial; for the 14 mm overlap the dose increase reduced to < 3% at 5.0 mm within the phantom. For scenario (b), dose increases due to the probe were < 5% in all cases. The dose increase was underestimated by up to ~13% when the voxel size was increased from 1 mm to 3 mm. MC simulated dose to the PTV and OARs for the two clinical plans considered showed good agreement with commercial treatment planning system results (within 2%). Mean dose increases due to the presence of the probe, after the maximum interfraction motion correction, were ~16.3% and ~8.0%, in the contact region, for plan 1 and plan 2, respectively. Conclusions: The presence of the probe results in superficial dose perturbations for patients with an overlap between the probe and the radiation field present in either the original treatment plan or due to translation of the radiation field to simulate correction of interfraction internal prostate motion.

3. Intrafractional prostate motion and dose variation during radiation therapy for prostate cancer using 4D-TPUS

Author(s): Qi X.; Gao X.; Zhao B.; Qin S.; Zhang S.

Source: International Journal of Radiation Oncology Biology Physics; Oct 2017; vol. 99 (no. 2)

Publication Date: Oct 2017

Publication Type(s): Conference Abstract

Available at International Journal of Radiation Oncology Biology Physics - from ScienceDirect

Abstract: Purpose/Objective(s): More recently, noninvasive 4D transperineal ultrasound (4D-TPUS) has been introduced in tracking intrafractional prostate motion in radiotherapy. Compared to other tracking method, the ultrasound has its own advantage in precise identification of soft tissue without invasive procedure or extra radiation dose. In this study, we investigated the prostate motion model and dose variation during radiotherapy using a transperineal autoscan ultrasound system (Clarity, Elekta Inc., Sweden). Purpose/Objective(s): From July 2014 through December 2016, 57 prostate cancer patients were enrolled with a median age of 74 years (range 61-85). All patients were asked to have a full bladder and empty rectum before each treatment. A simultaneous CT and TPUS simulation was conducted to provide a fused CT/US reference. Before radiation delivery, prostates were localized using CBCT to determine setup offsets relative to the patients' skin tattoos. During the treatment, real-time ultrasound images were acquired and data was collected for direct monitoring of 3D motion of the prostate. Then dose distributions were recalculated with the isocenter shifts relative to the simulation CT images according to the real-time data using the leaf sequences/MUs based on the original treatment plan. The doses were compared with the original doses planned on the simulation CT using the clinical acceptance criteria. Results: A total of 1207 fractions were evaluated. The mean (+/-SD) of the infraction displacements were [mm]: I(+)/S: (0.03 +/- 0.92); L(+)/R: (0.12 +/- 1.03); and A(+)/P: (-0.01 +/- 1.37), respectively. There were 41/1207 (3.4%), 29/1207 (2.4%), and 66/1207 (5.5%) fractions with deviation exceeded 3 mm in the IS, LR, and AP directions, respectively. The A/P direction has the largest extent of prostate displacement. The percentage of time with displacements 0-1mm, 1-2mm, 2-3mm and larger than 3 mm was 88.1%, 9.8%, 1.7% and 0.4% in the IS direction, 89.3%, 8.9%, 1.5% and 0.3 % in the LR direction, 84.5%, 11.1%, 3.7%, and 0.7% in the AP direction. We classified our patients into three groups according to the motion model: stable (n=50), irregular (n=3) and intention (n=4). The intention group was defined as persistent deviation to the same direction (the maximal displacement should exceed 3 mm) that repeated in at least 50% fractions. All these patients had obviously anxiety and urinary frequency and/or urgency. Recalculated dose distributions showed that all the 4 patients in the intention group did not meet our criterion of D95% of PTV prostate> 8000 cGy or V70 of rectum< 20%, which may leading to insufficient treatment and increased toxicity. Conclusion: The present study demonstrated that for over 90% of fractions, a CTV-PTV margin of 3 mm would be good coverage with the planned prescribed dose. However, it is important to identify the patients belonging to the intention group. Pre-treatment with anti-anxiety drugs and alpha receptor blocker may be useful in relief the prostate motion.

4. Real-time ultrasound and electromagnetic transmitter based tracking systems for adaptive radiotherapy in prostate cancer patients

Author(s): Biston M.C.; Delcoudert L.; Gorsse C.; Munoz A.; Pommier P.

Source: International Journal of Radiation Oncology Biology Physics; Oct 2017; vol. 99 (no. 2)

Publication Date: Oct 2017

Publication Type(s): Conference Abstract

Available at International Journal of Radiation Oncology Biology Physics - from ScienceDirect

Abstract: Purpose/Objective(s): Hypofractionated radiotherapy protocols in prostate cancer treatment require a better accuracy in dose delivery because of an increased risk of toxicity in the surrounding tissues. To achieve this goal, a robust pre-treatment imaging device combined with a real-time prostate monitoring system for correcting inter and intrafraction motion is required. Two monitoring modalities are available in our department: intra-prostatic electromagnetic transmitters (EM-T) (RayPilot, Micropos Medical, Sweden) and ultrasound imaging using transperineal probe (TP-US) (Clarity, Elekta, Sweden). The objective is to report the monitoring results obtained with the two

devices used concomitantly. Purpose/Objective(s): The accuracy of the two systems was first investigated in a phantom study. Then intra-fraction motions measured with the two devices used simultaneously were analyzed for 3 intermediate risk prostate adenocarcinoma patients (60 sessions). Patients were implanted with the EM-T and two fiducial markers 8 days before the simulation CT. Pre-treatment positioning was first performed with the TP-US. The shifts obtained were then controlled by a Cone Beam CT (CBCT) imaging (+ fiducial markers)/CT registration. During CBCT imaging the 2 devices monitoring mode were started. Irradiation was stopped and patient positioning adjusted for shifts above a threshold of 3 mm for at least 15 seconds for both devices. Each time threshold was exceeded a CBCT was performed to confirm the obtained shifts. Results: On phantom, differences between TP-US and EM-T were below 1.5 mm in all directions if only translational shifts were applied on the target volume. When large rotations were applied (pitch 4degree, yaw 9degree), the correlation between EM-T vs CBCT was superior than between TP-US vs CBCT (i.e. 1.6 mm difference vs 5.3 mm in supero-inferior direction for EM-T vs TP-US, respectively). Mean differences between displacements observed on patients with EM-T and TP-US were less than 0.5 mm in all directions (Table 1). A larger variability was found in the antero-posterior direction where more important shifts were observed. However, the maximum differences over all the sessions were found less than 1.5 mm. Conclusion: EM-T is a reliable technique for monitoring prostate during radiotherapy treatment. It can be implemented rapidly and in situ dosimetry will be soon operational. TP-US is a promising option because it is non-invasive and enables visualization of the target and organs at risk. However the accuracy of the TP-US system needs further investigations in case of prostate rotations.

5. In vivo validation of ultrasound intrafraction motion monitoring in prostate radiotherapy patients

Author(s): Grimwood A.; Mason S.; Tree A.; McNair H.; O'Shea T.; Harris E.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 2762

Publication Date: Jun 2017

Publication Type(s): Conference Abstract

Abstract: Purpose: To validate ultrasound monitoring of prostate position during IMRT by comparison with prostate position derived from pre-treatment conebeam CT (CBCT) and electronic portal images (EPIs). Methods: Using the Elekta Clarity system, the prostate was imaged transperineally during CBCT, couch shift and radiotherapy delivery. The locations of intraprostatic fiducial markers on CBCT and EPIs were used to derive the prostate position for comparison with prostate positions estimated by Clarity. Ultrasound monitoring data of 6 fractions across 5 patients was analysed. Three observers manually identified the locations of markers visible in EPIs and CBCT projections acquired at the same detector angle. Marker locations in the CBCT projections were normalised to the initial prostate position recorded by Clarity. CBCT marker locations were projected onto the EPI detector plane and shifted by an amount derived from the monitoring data at the time of EPI acquisition. Monitoring accuracy was defined as the difference between the Clarity-shifted CBCT and EPI marker locations. Only markers identified by all observers were considered. Sag effects were corrected for in both CBCT and EPIs, as were variations in source-detector distances between the two. Results: From 138 EPID-CBCT projection image pairs 95 contained visible markers. Clarity-shifted markers were accurate to EPI marker positions within a 2.1 mm standard deviation horizontally (u-axis) and 1.4 mm vertically (v-axis). Mean u and v differences between Clarity and EPI marker positions were -1.3 mm and -0.5 mm respectively, with mean absolute errors of 1.7 mm and 1.2 mm. Observer standard deviation from mean marker locations was 0.3 mm with 0 mm mean difference. Conclusion: This initial validation of Clarity monitoring of intrafraction prostate motion

has shown Clarity to be in good agreement with estimates of prostate position derived from CBCT and EPI images in patients with fiducial markers.

6. An automatic 3D ultrasound image registration algorithm for daily prostate localization in radiotherapy

Author(s): Zhou H.; Rivaz H.; Grimwood A.; Harris E.; McNair H.; Tree A.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 2761

Publication Date: Jun 2017

Publication Type(s): Conference Abstract

Abstract: Purpose: To develop and evaluate the performance of an automatic ultrasound registration algorithm for ultrasound-guided radiotherapy of the prostate. Methods: Three-dimensional transperineal ultrasound images of the prostate were acquired from 13 patients at simulation (US-SIM) and daily treatment (US-Tx) using the Elekta Clarity Autoscan system. US-Tx images were randomly selected for each patient and divided into training (20 US-Tx) and test (21 US-Tx) datasets. Shifts in prostate position between US-SIM and US-Tx were determined by 3. Methods: (1) Manual identification of 3 or more landmark (LM) positions (3 observers); (2) Clarity Guide Review software (3 observers) and (3) prostate registration framework (PRF) which used 3D normalised cross-correlation of volume-of-interests (VOIs) split into N equally-sized patches and a hierarchical framework with L levels. Training data was used to determine N, VOI and L. Mean LM-shifts of 3 observers were used as ground truth. PRF-errors and Clarity-errors were LM-shifts minus PRF-shifts and Clarity-Shifts, respectively. PRF-errors greater than a visually detectable threshold (10 mm) were considered registration failures and replaced by Clarity-errors, giving 3 sets of PRF-C-errors for a clinicallysupervised PRF. Pair-wise comparisons of errors were performed using the Wilcoxon signed-rank test. Results: Median absolute error[interquartile range] (mm) were PRF: 2.1[4.9], 1.5[8.6], 1.7[1.6] and Clarity: 0.8[1.2], 1.7[2.1], 1.5[2.0] for the test dataset, in the left-right, superior-inferior, anteriorposterior directions, respectively. PRF failed for 5 US-Tx, giving PRF-C: 1.2 [1.6], 1.1[2.0], 1.6[1.5] for the test dataset. Median PRF-C-errors were significantly smaller than Clarity-Error in the anterior-posterior direction and no different from Clarity-errors in other directions. Conclusion: PRF combined with Clarity, will provide modest improvements in accuracy if supervised by the operator (i.e., PRF-C). Implementation of PRF may, on-average, result in reduced registration times compared to Clarity manual registration.

7. Real-time monitoring of the prostate bed using ultrasound

Author(s): Smith A.; Stephans K.; Kolar M.; Mian O.; Tendulkar R.; Xia P.; Godley A.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 2794

Publication Date: Jun 2017

Publication Type(s): Conference Abstract

Abstract: Purpose: To measure real-time intra-fractional motion of the prostate bed volume of prostatectomy patients with ultrasound during radiation treatment and to determine margin guidelines for such radiation therapy. Methods: The Elekta Clarity system was used to monitor in real-time a defined prostate bed position in 3 patients for a total of 76 successful tracking sessions with an average monitoring time of 4 minutes. This volume was defined as the space lining the neck of the bladder to the rectum. The raw displacement versus time data was smoothed with a moving average window of 2 seconds, to remove quickly resolved jumps in the data. Time points were taken from the corrected data when the bed volume initially left a 1, 2 and 3 mm margin. A Kaplan-Meier

(KM) estimate was derived to predict the probability that a certain fraction would remain within a given margin at a specific time into tracking. Results: The maximum shift for any fraction was found to be 5.87 mm, with the average maximum shift over all fractions and patients being 1.9 +/- 1.4 mm. At the average treatment time of 4 minutes, the probability of remaining entirely within 1, 2 or 3 mm is 0.16, 0.63 and 0.83, respectively. For all fractions, the average percent of time beyond a 3 mm margin was 0.9%, excluding fractions that remained within the margin, this increases to 15.2%. Only 58% of fractions had the maximum shift occur within the final two-tenths of treatment time, indicating that a post-treatment CBCT may not catch the full extent of intra-fraction motion. Conclusion: Motion generally increased with treatment time, with the maxima located towards the end of treatment. A 3 mm margin is reasonable for prostate bed treatment <4 minutes. If smaller margins are desired, real-time tracking would be necessary to gate the treatment.

8. Analysis of prostate SBRT treatments using 3D transperineal ultrasound image guidance methods

Author(s): Szegedi M.; Boehm C.; Ager B.; Sarkar V.; Rassiah-Szegedi P.; Zhao H.; Huang L.; Huang J.; Paxton A.; Su F.; Tward J.; Salter B.

Source: Radiotherapy and Oncology; May 2017; vol. 123

Publication Date: May 2017

Publication Type(s): Conference Abstract

Abstract: Purpose or Objective A 2nd generation 3D ultrasound image guidance (USIG) system (Clarity, Elekta Inc), that allows for transperineal (TP) localization and intra-fractional tracking of the prostate has been used in SBRT of the prostate at our institution. We have analyzed 35 patients (175 fractions) regarding the localization and tracking performance of our USIG based prostate SBRT protocol. Material and Methods Our clinical workflow for prostate SBRT (5 fractions of 7.25 Gy each) involves setting the patient up based on skin tattoos and using TP localization for image guidance. A trans-abdominal (TA) ultrasound study (BAT, Nomos Inc) is also performed to independently check the patient's position once TP-USIG-based shifts are applied. A detailed description of our workflow has been presented before [1]. Once the TP-based alignment has been approved by both a physicist and physician with extensive USIG experience, TP-based tracking is initiated. During the treatment, the beam is manually switched off for any migrations greater than 3 mm in any direction. If this migration occurs for more than 5 seconds, the patient's position is re-adjusted before treatment resumption. For all 175 treatments in the present cohort, the tracking data was analyzed to determine the number of incidents and duration the target's excursion was greater than 3 mm. Further we evaluate the potential for partial PTV miss, by subtracting couch movement from target movement shown in Figure 1, showing the potential excursion if no corrective action was taken and contrast this with the PTV margins used. Results Figure 2 shows the number of instances where the position of a patient had to be corrected. Only 10 of the 35 patients did not require any corrective action. In two patients (cases 29 and 32), the position had to be corrected more than 20 times over the five fractions. Conclusion With more than 70% of the patients analyzed requiring repositioning, it is clear that intra-fractional tracking should be used when treating with a hypo-fractionated approach, where large excursions should be avoided. Lastly we will present the early follow up data (average follow up 1.5 years) of rate and type of complications observed and contrast it to our non-tracked SBRT population. This will indicate if SBRT tracking does prevent over-radiation of sensitive structures. References: [1] Salter BJ et al., 3D Transperineal Ultrasound Image Guidance Methods for Prostate SBRT Radiotherapy Treatment, Radiotherapy and Oncology, 115, S460. Figure 1: Example of the tracking of one patient in one dimension and the subtraction of table movement. Figure 2: Number of events a corrective positional shift was required during treatment per patient. Each blue

dot represents one of the 35 patients. Only 10 patients did not require a corrective action to bring the PTV within tolerance levels (3mm or less).

9. A comparison of interfraction setup error, patient comfort, and therapist acceptance for 2 different prostate radiation therapy immobilization devices

Author(s): Pang E.P.P.; Knight K.; Baird M.; Loh J.M.Q.; Boo A.H.S.; Tuan J.K.L.

Source: Advances in Radiation Oncology; Apr 2017; vol. 2 (no. 2); p. 125-131

Publication Date: Apr 2017

Publication Type(s): Article

Available at Advances in Radiation Oncology - from nih.gov

Abstract: Purpose Our purpose was to investigate interfraction setup error of the immobilization device required to implement transperineal ultrasound compared with the current, standard immobilization device. Patient comfort and radiation therapist (RT) satisfaction were also assessed. Methods and materials Cone beam computed tomography images were acquired before 4069 fractions from 111 patients (control group, n = 56; intervention group, n = 55) were analyzed. The intervention group was immobilized using the Clarity Immobilization System (CIS), comprising a knee rest with autoscan probe kit and transperineal ultrasound probe (n = 55), and control group using a leg immobilizer (LI) (n = 56). Interfraction setup errors were compared for both groups. Weekly questionnaires using a 10-point visual analog scale were administered to both patient groups to measure and compare patient comfort. RT acceptance for both devices was also compared using a survey. Results There was no significant difference in the magnitude of interfraction cone beam computed tomography-derived setup shifts in the lateral and anteroposterior direction between the LI and CIS (P = .878 and .690, respectively). However, a significant difference (P = .003) was observed in the superoinferior direction between the 2 groups of patients. Patient-reported level of comfort and stability demonstrated no significant difference between groups (P = .994 and .132). RT user acceptance measures for the LI and CIS were ease of handling (100% vs 53.7%), storage (100% vs 61.1%), and cleaning of the devices (100% vs 64.8%), respectively. Conclusions The CIS demonstrated stability and reproducibility in prostate treatment setup comparable to LI. The CIS device had no impact on patient comfort; however, RTs indicated a preference for LI over the CIS mainly because of its weight and bulkiness.

10. Interand intra-observer variation of patient setup shifts derived using the 4D TPUS Clarity system for prostate radiotherapy

Author(s): Pang E.P.P.; Knight K.; Baird M.; Tuan J.K.L.

Source: Biomedical Physics and Engineering Express; Mar 2017; vol. 3 (no. 2)

Publication Date: Mar 2017

Publication Type(s): Article

Abstract: This study assessed inter- and intra-observer variation in the derivation of setup positioning using four-dimensional (4D) transperineal ultrasound (TPUS). Seven radiation therapists with 4-16 months of TPUS clinical experience independently derived the setup position on a single fraction for 10 patients undergoing prostate radiotherapy. For each patient, the reference TPUS prostate contour was co-registered to a TPUS image acquired during treatment and inter-observer variation assessed. Intra-observer variation was assessed after two weeks. Inter-observer setup variation from the group median was.<=2mmin 93.8% of cases (maximum deviation 5.4mm). Spearman's rho correlation test resulted in a moderate to high positive correlation for inter-observer variation. The

median (range) Spearman's rho correlation coefficients were 0.675 (0.439-0.939), 0.912 (0.669-1.000) and 0.964 (0.8674-1.000) for the x, y and z directions respectively. The median (range) intra-observer variation was.<=2mmin 93.3% (60%-100%) of cases (maximum deviation 4.9mm). Wilcoxon matched-pairs signed ranks tests yielded no statistically significant difference for intra-observer TPUS-derived setup shifts (p-value range=0.151-0.803). The magnitude of observer variation appeared to be influenced by training and/or the length of user experience. 4D TPUS is a promising non-invasive ultrasound-based image-guided radiation therapy solution for daily treatment setup with minimal inter- and intra-observer variation.

11. Implementation of ultrasound-guided intrafraction monitoring and correction in prostate cancer treatments at Townville Cancer Centre

Author(s): Brown A.; Shirley B.; Angkawijaya W.; Albantow C.; Tan A.

Source: Journal of Medical Radiation Sciences; Mar 2017; vol. 64 ; p. 57

Publication Date: Mar 2017

Publication Type(s): Conference Abstract

Available at Journal of Medical Radiation Sciences - from Wiley Online Library Free Content - NHS

Available at Journal of Medical Radiation Sciences - from Europe PubMed Central - Open Access

Available at Journal of Medical Radiation Sciences - from nih.gov

Abstract: Objectives: To implement intrafraction monitoring and correction using the Clarity 4D Autoscan transperineal ultrasound (TPUS) system in prostate radiotherapy at Townsville Cancer Centre (TCC), and evaluate in the first 10 clinical patients. Methods: Clarity 4D was installed at TCC in June 2016, with 1 week of specialist training and first clinical use in August 2016. Patients treated during implementation had gold seed fiducial markers and daily cone beam computed tomography (CBCT) as per department protocol, for comparison to the TPUS acquired with Clarity 4D. Tolerances for beam interruption and isocentre correction were 10 mm isotropic except for 5 mm posteriorly, based on planning margins. Monitoring data of the first 10 clinical patients was evaluated and differences between US and CBCT assessed. Results: Between August and October 2016, 10 patients commenced treatment with Clarity 4D. Of the 206 fractions analysed, 3 required interruption, and of those, 2 required isocentre correction. The mean vector difference across all patients between the CBCT and TPUS was 6.2 mm (0.4-17.3; SD 3.1). Intra-patient mean vectors however varied from 3.6 mm (SD 1.1) and 7.5 mm (SD 3.4), with an improvement in vectors observed over time. Conclusion: Clarity 4D has been successfully implemented at the TCC, thus allowing intrafraction correction in prostate radiotherapy. Intrafraction motion requiring correction at current tolerances has been minimal. Further analysis into the differences between CBCT and TPUS is warranted.

Immobilisation techniques

1. 3D-Printed masks as a new approach for immobilization in radiotherapy - A study of positioning accuracy

Author(s): Haefner M.F.; Mattke M.; Debus J.; Sterzing F.; Giesel F.L.; Rath D.; Wade M.; Kuypers J.; Preuss A.; Unterhinninghofen R.; Kauczor H.-U.; Schenk J.-P.

Source: Oncotarget; 2018; vol. 9 (no. 5); p. 6490-6498

Publication Date: 2018

Publication Type(s): Article

Available at Oncotarget - from Europe PubMed Central - Open Access

Abstract: We developed a new approach to produce individual immobilization devices for the head based on MRI data and 3D printing technologies. The purpose of this study was to determine positioning accuracy with healthy volunteers. 3D MRI data of the head were acquired for 8 volunteers. In-house developed software processed the image data to generate a surface mesh model of the immobilization mask. After adding an interface for the couch, the fixation setup was materialized using a 3D printer with acrylonitrile butadiene styrene (ABS). Repeated MRI datasets (n=10) were acquired for all volunteers wearing their masks thus simulating a setup for multiple fractions. Using automatic image-to-image registration, displacements of the head were calculated relative to the first dataset (6 degrees of freedom). The production process has been described in detail. The absolute lateral (x), vertical (y) and longitudinal (z) translations ranged between -0.7 and 0.5 mm, -1.8 and 1.4 mm, and -1.6 and 2.4 mm, respectively. The absolute rotations for pitch (x), yaw (y) and roll (z) ranged between -0.9 and 0.8degree, -0.5 and 1.1degree, and -0.6 and 0.8degree, respectively. The mean 3D displacement was 0.9 mm with a standard deviation (SD) of the systematic and random error of 0.2 mm and 0.5 mm, respectively. In conclusion, an almost entirely automated production process of 3D printed immobilization masks for the head derived from MRI data was established. A high level of setup accuracy was demonstrated in a volunteer cohort. Future research will have to focus on workflow optimization and clinical evaluation.

2. To frame or not to frame? Cone-beam CT-based analysis of head immobilization devices specific to linac-based stereotactic radiosurgery and radiotherapy.

Author(s): Babic, Steven; Lee, Young; Ruschin, Mark; Lochray, Fiona; Lightstone, Alex; Atenafu, Eshetu; Phan, Nic; Mainprize, Todd; Tsao, May; Soliman, Hany; Sahgal, Arjun

Source: Journal of applied clinical medical physics; Jan 2018

Publication Date: Jan 2018

Publication Type(s): Journal Article

Abstract:PURPOSENoninvasive frameless systems are increasingly being utilized for head immobilization in stereotactic radiosurgery (SRS). Knowing the head positioning reproducibility of frameless systems and their respective ability to limit intrafractional head motion is important in order to safely perform SRS. The purpose of this study was to evaluate and compare the intrafractional head motion of an invasive frame and a series of frameless systems for single fraction SRS and fractionated/hypofractionated stereotactic radiotherapy (FSRT/HF-SRT).METHODSThe noninvasive PinPoint system was used on 15 HF-SRT and 21 SRS patients. Intrafractional motion for these patients was compared to 15 SRS patients immobilized with Cosman-Roberts-Wells (CRW) frame, and a FSRT population that respectively included 23, 32, and 15 patients immobilized using Gill-Thomas-Cosman (GTC) frame, Uniframe, and Orfit. All HF-SRT and FSRT patients were treated

using intensity-modulated radiation therapy on a linear accelerator equipped with cone-beam CT (CBCT) and a robotic couch. SRS patients were treated using gantry-mounted stereotactic cones. The CBCT image-guidance protocol included initial setup, pretreatment and post-treatment verification images. The residual error determined from the post-treatment CBCT was used as a surrogate for intrafractional head motion during treatment.RESULTSThe mean intrafractional motion over all fractions with PinPoint was 0.62 ± 0.33 mm and 0.45 ± 0.33 mm, respectively, for the HF-SRT and SRS cohort of patients (P-value = 0.266). For CRW, GTC, Orfit, and Uniframe, the mean intrafractional motions were 0.30 ± 0.21 mm, 0.54 ± 0.76 mm, 0.73 ± 0.49 mm, and 0.76 ± 0.51 mm, respectively. For CRW, PinPoint, GTC, Orfit, and Uniframe, intrafractional motion exceeded 1.5 mm in 0%, 0%, 5%, 6%, and 8% of all fractions treated, respectively.CONCLUSIONSThe noninvasive PinPoint system and the invasive CRW frame stringently limit cranial intrafractional motion, while the latter provides superior immobilization. Based on the results of this study, our clinical practice for malignant tumors has evolved to apply an invasive CRW frame only for metastases in eloquent locations to minimize normal tissue exposure.

3. Immobilization and image-guidance methods for radiation therapy of limb extremity soft tissue sarcomas: Results of a multi-institutional survey.

Author(s): Swinscoe, James A; Dickie, Colleen I; Ireland, Rob H

Source: Medical dosimetry : official journal of the American Association of Medical Dosimetrists; Jan 2018

Publication Date: Jan 2018

Publication Type(s): Journal Article

Abstract: Radiation therapy for limb-extremity soft tissue sarcoma (STS) requires accurate, reproducible dose delivery. However, patient positioning is challenging and there is a lack of existing guidelines to assist institutional standardization. Therefore, we conducted a multi-institutional international survey of STS immobilization, image guidance methods, and treatment protocols to investigate current practice. Seventy-three UK radiotherapy centers and 15 hospitals in 7 other countries completed a questionnaire on STS immobilization and image-guidance procedures. Specifically, the survey collated information on the current usage of immobilization equipment, including custom devices, patient setup tolerances, the use of written protocols, the modality and frequency of image guidance, the method of treatment, allocated treatment times, and the application of surgical clips. Multiple combinations of immobilization devices were reported. In the UK, 12%, 40%, 30%, 12%, and 5% use 1, 2, 3, 4, and 5 types of device for lower limb STS. Vacuum bag plus either foot or ankle support was most common (66%). Of 15 international centers, 27%, 60%, 7%, 0%, 7% use 1, 2, 3, 4, 5 devices, with vacuum bags (73%) and thermoplastic (47%) predominant, similar to UK values of 77% and 52%. For image guidance, in the UK, 37% use kV planar, 34% use MV planar, and 16% use cone-beam CT for the first 3 fractions and then weekly. Internationally, daily imaging was more prevalent with 33% using kV planar, 7% MV planar, and 40% cone-beam CT daily. Custom devices plus combinations of devices, along with 5- and 10-mm set-up tolerances, were most commonly reported. Less than half of centers have written treatment protocols. Conventional treatment is most common in the UK, with only 42% using conformal techniques. Treatment is allocated between 10 and 30 minutes. Twenty-six percent of UK centers and 53% of international centers use surgical clips. Across treatment centers, there is no consistent approach to STS immobilization, image-guidance methods, or treatment protocols assessed by this survey. A wide variety of immobilization devices and configurations are utilized, and the frequency and modality of imaging are similarly diverse. In the absence of guidelines, the creation of an online repository of example immobilization techniques could enable centers to compare a diversity of cases. The

availability of a forum for viewing and discussing a range of cases could potentially lead to improved patient setup and reduce the time taken to devise an individual immobilization strategy.

4. Minimal mask immobilization with optical surface guidance for head and neck radiotherapy.

Author(s): Zhao, Bo; Maquilan, Genevieve; Jiang, Steve; Schwartz, David L

Source: Journal of applied clinical medical physics; Jan 2018; vol. 19 (no. 1); p. 17-24

Publication Date: Jan 2018

Publication Type(s): Journal Article

Abstract:PURPOSEFull face and neck thermoplastic masks provide standard-of-care immobilization for patients receiving H&N IMRT. However, these masks are uncomfortable and increase skin dose. The purpose of this pilot trial was to investigate the feasibility and setup accuracy of minimal face and neck mask immobilization with optical surface guidance.METHODSTwenty patients enrolled onto this IRB-approved protocol. Patients were immobilized with masks securing only forehead and chin. Shoulder movement was restricted by either moldable cushion or hand held strap retractors. Positional information, including isocenter location and CT skin contours, were imported to a commercial surface image guidance system. Patients typically received standard-of-care IMRT to 60-70 Gy in 30-33 fractions. Patients were first set up to surface markings with optical image guidance referenced to regions of interest (ROIs) on simulation CT images. Positioning was confirmed by in-room CBCT. Following six-dimensional robotic couch correction, a new optical real-time surface image was acquired to track intrafraction motion and to serve as a reference surface for setup at the next treatment fraction. Therapists manually recorded total treatment time as well as couch shifts based on kV imaging. Intrafractional ROI motion tracking was automatically recorded by the optical image guidance system. Patient comfort was assessed by self-administered surveys.RESULTSSetup error was measured as six-dimensional shifts (vertical/longitudinal/lateral/rotation/pitch/roll). Mean error values were -0.51 ± 2.42 mm, -0.49 ± 3.30 mm, 0.23 ± 2.58 mm, -0.15 ± 1.01o , -0.02 ± 1.19o , and 0.06 ± 1.08o , respectively. Average treatment time was 21.6 ± 8.4 mins). Subjective comfort during surface-guided treatment was confirmed on patient surveys.CONCLUSIONThese pilot results confirm feasibility of minimal mask immobilization combined with commercially available optical image guidance. Patient acceptance of minimal mask immobilization has been encouraging. Follow-up validation, with direct comparison to standard mask immobilization, appears warranted.

5. Utility of intraoral stents in external beam radiotherapy for head and neck cancer.

Author(s): Doi, Hiroshi; Tanooka, Masao; Ishida, Toshihisa; Moridera, Kuniyasu; Ichimiya, Kenji; Tarutani, Kazuo; Kitajima, Kazuhiro; Fujiwara, Masayuki; Kishimoto, Hiromitsu; Kamikonya, Norihiko

Source: Reports of practical oncology and radiotherapy : journal of Greatpoland Cancer Center in Poznan and Polish Society of Radiation Oncology; 2017; vol. 22 (no. 4); p. 310-318

Publication Date: 2017

Publication Type(s): Journal Article

Abstract:AIMThis study aimed to assess the utility and stability of intraoral stent during intensity-modulated radiation therapy (IMRT).BACKGROUNDThe benefits of intraoral stents in radiotherapy are unclear.MATERIALS AND METHODSWe analyzed 386 setup errors in 12 patients who received IMRT for head and neck cancers without intraoral stents (intraoral stent [-]) and 183 setup errors in 6 patients who received IMRT with intraoral stents (intraoral stent [+]). All patients were matched according to the immobilization method (masks and boards). Setup errors were measured as the distance from the initial setup based on the marking on the skin and mask to the corrected position

based on bone matching on cone beam computed tomography.RESULTSThe mean interfractional setup errors in the right-left, craniocaudal, anterior-posterior (AP), and three-dimensional (3D) directions were -0.33, 0.08, -0.25, and 2.75 mm in the intraoral stent (-) group and -0.37, 0.24, -0.63, and 2.42 mm in the intraoral stent (+) group, respectively (P = 0.50, 0.65, 0.01, and 0.02, respectively). The systematic errors for the same directions were 0.89, 1.46, 1.15, and 0.88 mm in the intraoral stent (-) group and 0.62, 1.69, 0.68, and 0.56 mm in the intraoral stents (+) group, respectively. The random errors were 1.43, 1.43, 1.44, and 1.22 mm in the intraoral stent (-) group and 1.06, 1.11, 1.05, and 0.92 mm in the intraoral stents (+) group, respectively.CONCLUSIONSetup errors can be significantly reduced in the AP and 3D-directions by using intraoral stents.

6. Intrarectal fixative for positioning of the prostate for intensity modulated radiotherapy

Author(s): Stumpf J.; Balasundaram S.; Ramadas R.; Perumal K.; Kurup P.G.G.; Venkatraman M.

Source: Journal of Cancer Research and Therapeutics; 2017; vol. 13 (no. 6); p. 1050-1052

Publication Date: 2017

Publication Type(s): Article

Available at Journal of Cancer Research and Therapeutics - from EBSCO (MEDLINE Complete)

Available at Journal of Cancer Research and Therapeutics - from ProQuest (Hospital Premium Collection) - NHS Version

Available at Journal of Cancer Research and Therapeutics - from cancerjournal.net

Abstract: Dose escalation improves local control in carcinoma prostate, but rectal toxicity remains a concern. Various techniques have been there to reduce the dose to the rectum. Mobility of the prostate results in a necessary expansion of the target volume. We describe a new intrarectal fixative, developed in-house with transrectal ultrasonography through the fixative itself for localization of the organ by reporting a case with early carcinoma prostate. Concerns of rectal toxicity limit dose escalation in the treatment of prostate cancer. Intra- and interfraction prostate motion is a concern in dose conformity techniques. The intrarectal fixative system developed in-house physically separates the prostate and rectum during radiation treatment. Thus, both intra- and inter-fractional movement of the organ are addressed, therefore planning target volume expansion can be kept minimal.

7. Radiobiological analysis of stereotactic body radiation therapy for an evidence-based planning target volume of the lung using multiphase CT images obtained with a pneumatic abdominal compression apparatus: a case study.

Author(s): Chairmadurai, Arun; Goel, Harish Chandra; Jain, Sandeep Kumar; Kumar, Pawan

Source: Radiological physics and technology; Dec 2017; vol. 10 (no. 4); p. 525-534

Publication Date: Dec 2017

Publication Type(s): Journal Article

Abstract: This study evaluated the efficiency of stereotactic body radiation therapy of lung (SBRT-Lung) in generating a treatment volume using conventional multiple-phase three-dimensional computed tomography (3D-CT) of a patient immobilized with pneumatic abdominal compression. The institutional protocol for SBRT-Lung using the RapidArc technique relied on a planning target volume (PTV) delineated using 3D-CT and accounted for linear and angular displacement of the tumor during respiratory movements. The efficiency of the institutional protocol was compared with that of a conventional method for PTV delineation based on radiobiological estimates, such as tumor control probability (TCP) and normal tissue complication probability (NTCP), evaluated using dose-volume parameters. Pneumatic abdominal compression improved the TCP by 15%. This novel protocol improved the TCP by 0.5% but reduced the NTCP for lung pneumonitis (0.2%) and rib fracture (1.0%). Beyond the observed variations in the patient's treatment setup, the institutional protocol yielded a significantly consistent TCP ($p < 0.005$). The successful clinical outcome of this case study corroborates predictions based on radiobiological evaluation and deserves validation through an increased number of patients.

8. A Noninvasive Body Setup Method for Radiotherapy by Using a Multimodal Image Fusion Technique.

Author(s): Zhang, Jie; Chen, Ying; Chen, Yunxia; Wang, Chenchen; Cai, Jing; Chu, Kaiyue; Jin, Jianhua; Ge, Yun; Huang, Xiaolin; Guan, Yue; Li, Weifeng

Source: Technology in cancer research & treatment; Dec 2017; vol. 16 (no. 6); p. 1187-1193

Publication Date: Dec 2017

Publication Type(s): Journal Article

Available at Technology in cancer research & treatment - from nih.gov

Abstract:PURPOSETo minimize the mismatch error between patient surface and immobilization system for tumor location by a noninvasive patient setup method.MATERIALS AND METHODSThe method, based on a point set registration, proposes a shift for patient positioning by integrating information of the computed tomography scans and that of optical surface landmarks. An evaluation of the method included 3 areas: (1) a validation on a phantom by estimating 100 known mismatch errors between patient surface and immobilization system. (2) Five patients with pelvic tumors were considered. The tumor location errors of the method were measured using the difference between the proposal shift of cone-beam computed tomography and that of our method. (3) The collected setup data from the evaluation of patients were compared with the published performance data of other 2 similar systems.RESULTSThe phantom verification results showed that the method was capable of estimating mismatch error between patient surface and immobilization system in a precision of <0.22 mm. For the pelvic tumor, the method had an average tumor location error of 1.303, 2.602, and 1.684 mm in left-right, anterior-posterior, and superior-inferior directions, respectively. The performance comparison with other 2 similar systems suggested that the method had a better positioning accuracy for pelvic tumor location.CONCLUSIONBy effectively decreasing an interfraction uncertainty source (mismatch error between patient surface and immobilization system) in radiotherapy, the method can improve patient positioning precision for pelvic tumor.

9. Use of surface scanner to create prior CT 3D-printed bolus to increase efficiency for radiation therapy treatment of patients with immobilization masks

Author(s): Dipasquale G.; Poirier A.; Sprunger Y.; Terzic A.; Miralbell R.

Source: International Journal of Radiation Oncology Biology Physics; Oct 2017; vol. 99 (no. 2)

Publication Date: Oct 2017

Publication Type(s): Conference Abstract

Available at International Journal of Radiation Oncology Biology Physics - from ScienceDirect

Abstract: Purpose/Objective(s): 3D-printed (3DP) boluses created from computed tomography (CT) data allows optimal bolus shaping and assigning correct Hounsfield Unit (HU), but requires a second CT simulation when masks are used to later fit the bolus under it. The use of surface scanner to produce 3DP bolus pre-CT simulation could solve this issue, reduce CT radiation dose to the patient and improve efficiency. In this study we investigate the use of surface scanner images to produce

3DP boluses. Purpose/Objective(s): The head of a RANDO phantom was used to produce boluses in the orbital region either form CT data, (bolusCT) or from surface scanner images (bolusS). A wax bolus was also handmade. The CT and the surface scanner (HandySCANTM, Creaform) resolution were 0.9*0.9*0.8mm3 and 0.05 mm, respectively. Several 3D-printing techniques and materials were tested. To quantify the bolus fitting on the RANDO each bolus, once printed and inspected, was applied on the phantom to acquire CT images for air gap analysis. The air gap present at the contact surface was then measured at different points (n=30). Using the CT images, HU profiles were traced perpendicular to the RANDO surface to measure the HU depths corresponding to the air gap. Using known air gaps, created with water equivalent slabs, HU values were correlated to distances. The Wilcoxon signed-rank test and the Mann-Whitney test were used and p-values smaller than 0.05 were considered statistically significant. Results: The bolusS reproduced properly the shape and thickness like bolusCTs, but visually showed a better fitting on the RANDO. This translated into smaller mean (SD) air gaps compared to bolusCT and wax bolus (p<0.0001),-130 (88) HU,-384(135) HU and,-469 (219) HU, respectively. This difference was independent of the material or 3DP method used (see Table). No statistical difference was seen when comparing the air gaps between the wax bolus and the bolusCT (p =0.0645). Predefined air gaps of 2 mm, 1 mm and 0.6 mm corresponded to mean (SD) HU of-876(5),-586 (4) and-463(3) respectively, implying that mean gaps for all boluses were smaller than 0.6 mm. Nevertheless the maximum air gaps (see table) were: 2 mm for the wax bolus, 1-2 mm for bolusCT and, < 0.6 mm for bolusS. Conclusion: A surface scanner was successfully used on a phantom to create 3DP bolus and showed superior fitting compared to 3DP bolus using CT data. Regardless of the 3D printing method, the printer precision or material used, the air gap of a bolusS created from a high resolution surface scanner was always inferior to 0.6 mm.

10. An electromechanical, patient positioning system for head and neck radiotherapy.

Author(s): Ostyn, Mark; Dwyer, Thomas; Miller, Matthew; King, Paden; Sacks, Rachel; Cruikshank, Ross; Rosario, Melvin; Martinez, Daniel; Kim, Siyong; Yeo, Woon-Hong

Source: Physics in medicine and biology; Sep 2017; vol. 62 (no. 18); p. 7520-7531

Publication Date: Sep 2017

Publication Type(s): Journal Article

Abstract: In cancer treatment with radiation, accurate patient setup is critical for proper dose delivery. Improper arrangement can lead to disease recurrence, permanent organ damage, or lack of disease control. While current immobilization equipment often helps for patient positioning, manual adjustment is required, involving iterative, time-consuming steps. Here, we present an electromechanical robotic system for improving patient setup in radiotherapy, specifically targeting head and neck cancer. This positioning system offers six degrees of freedom for a variety of applications in radiation oncology. An analytical calculation of inverse kinematics serves as fundamental criteria to design the system. Computational mechanical modeling and experimental study of radiotherapy compatibility and x-ray-based imaging demonstrates the device feasibility and reliability to be used in radiotherapy. An absolute positioning accuracy test in a clinical treatment room supports the clinical feasibility of the system.

11. Rectal balloon use limits vaginal displacement, rectal dose, and rectal toxicity in patients receiving IMRT for postoperative gynecological malignancies.

Author(s): Wu, Cheng-Chia; Wuu, Yen-Ruh; Yanagihara, Theodore; Jani, Ashish; Xanthopoulos, Eric P; Tiwari, Akhil; Wright, Jason D; Burke, William M; Hou, June Y; Tergas, Ana I; Deutsch, Israel

Source: Medical dosimetry : official journal of the American Association of Medical Dosimetrists; Sep 2017

Publication Date: Sep 2017

Publication Type(s): Journal Article

Abstract: Pelvic radiotherapy for gynecologic malignancies traditionally used a 4-field box technique. Later trials have shown the feasibility of using intensity-modulated radiotherapy (IMRT) instead. But vaginal movement between fractions is concerning when using IMRT due to greater conformality of the isodose curves to the target and the resulting possibility of missing the target while the vagina is displaced. In this study, we showed that the use of a rectal balloon during treatment can decrease vaginal displacement, limit rectal dose, and limit acute and late toxicities. Little is known regarding the use of a rectal balloon (RB) in treating patients with IMRT in the posthysterectomy setting. We hypothesize that the use of an RB during treatment can limit rectal dose and acute and long-term toxicities, as well as decrease vaginal cuff displacement between fractions. We performed a retrospective review of patients with gynecological malignancies who received postoperative IMRT with the use of an RB from January 1, 2012 to January 1, 2015. Rectal dose constraint was examined as per Radiation Therapy Oncology Group (RTOG) 1203 and 0418. Daily cone beam computed tomography (CT) was performed, and the average (avg) displacement, avg magnitude, and avg magnitude of vector were calculated. Toxicity was reported according to RTOG acute radiation morbidity scoring criteria. Acute toxicity was defined as less than 90 days from the end of radiation treatment. Late toxicity was defined as at least 90 days after completing radiation. Twenty-eight patients with postoperative IMRT with the use of an RB were examined and 23 treatment plans were reviewed. The avg rectal V40 was 39.3% ± 9.0%. V30 was65.1% ± 10.0%. V50 was 0%. Separate cone beam computed tomography (CBCT) images (n = 663) were reviewed. The avg displacement was as follows: superior 0.4 + 2.99 mm, left 0.23 ± 4.97 mm, and anterior 0.16 ± 5.18 mm. The avg magnitude of displacement was superior/inferior 2.22 ± 2.04 mm, laterally 3.41 ± 3.62 mm, and anterior/posterior 3.86 ± 3.45 mm. The avg vector magnitude was 6.60 ± 4.14 mm. For acute gastrointestinal (GI) toxicities, 50% experienced grade 1 toxicities and 18% grade 2 GI toxicities. For acute genitourinary (GU) toxicities, 21% had grade 1 and 18% had grade 2 toxicities. For late GU toxicities, 7% had grade 1 and 4% had grade 2 toxicities. RB for gynecological patients receiving IMRT in the postoperative setting can limit V40 rectal dose and vaginal displacement. Although V30 constraints were not met, patients had limited acute and late toxicities. Further studies are needed to validate these findings.

12. Development of the breast immobilization system in prone setup: The effect of bra in prone position to improve the breast setup error.

Author(s): Kawamura, Mariko; Maeda, Yoshikazu; Yamamoto, Kazutaka; Takamatsu, Shigeyuki; Sato, Yoshitaka; Minami, Hiroki; Saga, Yusuke; Kume, Kyo; Tameshige, Yuji; Sasaki, Makoto; Tamamura, Hiroyasu; Ohta, Kouji; Itoh, Yoshiyuki; Naganawa, Shinji

Source: Journal of applied clinical medical physics; Jul 2017; vol. 18 (no. 4); p. 155-160

Publication Date: Jul 2017

Publication Type(s): Journal Article

Abstract:PURPOSE/OBJECTIVE(S)Accurate and reproducible positioning of the breast is difficult due to its deformability and softness; thus, targeting a breast tumor or tumor bed with fractionated radiotherapy using external beam radiation is difficult. The aim of this study was to develop a novel bra to aid in breast immobilization in the prone position.MATERIALS & METHODSTo assess the accuracy of prone position fixation of breast tumors, 33 breast cancer patients with 34 lesions were recruited. The bra used in this verification was customized from a commercially available bra.

Duplicate MRI were acquired in the prone position, alternating with and without the bra, and for each series, patients were asked to step off the MRI table and re-set up in the prone position. Patients were also asked to remove and re-fit the bra for the second MRI. Each pair of images were superimposed to match the shape of the skin surface, and the maximum difference in tumor geometric center in three axes was measured. The required set up margin was calculated as: required margin = mean difference in geometric center + 2.5 standard deviation. The volumetric overlap of the tumor, as well as contouring uncertainties, was evaluated using contour analysis software.RESULTSThe median breast size was 498 cc. The required margins for the lateral, vertical, and longitudinal directions were estimated to be 4.1, 4.1, and 5.0 mm, respectively, with the bra, and 5.1, 6.9, and 6.7 mm, respectively, without the bra. These margins covered the dislocation of more than 33 lesions in total. With the bra, 33 lesions had achieved an objective overlap of 95% and 99% with 2 and 4 mm margins, respectively, whereas 4 and 8 mm, respectively, were needed without the bra.CONCLUSIONThe use of an immobilizing bra reduced the setup margin for prone position fixation of breast tumors.

13. Cost-effective immobilization for whole brain radiation therapy.

Author(s): Rubinstein, Ashley E; Ingram, W Scott; Anderson, Brian M; Gay, Skylar S; Fave, Xenia J; Ger, Rachel B; McCarroll, Rachel E; Owens, Constance A; Netherton, Tucker J; Kisling, Kelly D; Court, Laurence E; Yang, Jinzhong; Li, Yuting; Lee, Joonsang; Mackin, Dennis S; Cardenas, Carlos E

Source: Journal of applied clinical medical physics; Jul 2017; vol. 18 (no. 4); p. 116-122

Publication Date: Jul 2017

Publication Type(s): Journal Article

PubMedID: 28585732

Abstract: To investigate the inter- and intra-fraction motion associated with the use of a low-cost tape immobilization technique as an alternative to thermoplastic immobilization masks for whole-brain treatments. The results of this study may be of interest to clinical staff with severely limited resources (e.g., in low-income countries) and also when treating patients who cannot tolerate standard immobilization masks. Setup reproducibility of eight healthy volunteers was assessed for two different immobilization techniques. (a) One strip of tape was placed across the volunteer's forehead and attached to the sides of the treatment table. (b) A second strip was added to the first, under the chin, and secured to the table above the volunteer's head. After initial positioning, anterior and lateral photographs were acquired. Volunteers were positioned five times with each technique to allow calculation of inter-fraction reproducibility measurements. To estimate intra-fraction reproducibility, 5-minute anterior and lateral videos were taken for each technique per volunteer. An in-house software was used to analyze the photos and videos to assess setup reproducibility. The maximum intra-fraction displacement for all volunteers was 2.8 mm. Intra-fraction motion increased with time on table. The maximum inter-fraction range of positions for all volunteers was 5.4 mm. The magnitude of inter-fraction and intra-fraction motion found using the "1-strip" and "2-strip" tape immobilization techniques was comparable to motion restrictions provided by a thermoplastic mask for whole-brain radiotherapy. The results suggest that tape-based immobilization techniques represent an economical and useful alternative to the thermoplastic mask.

14. Influence of Institutional Experience and Technological Advances on Outcome of Stereotactic Body Radiation Therapy for Oligometastatic Lung Disease.

Author(s): Rieber, Juliane; Abbassi-Senger, Nasrin; Adebahr, Sonja; Andratschke, Nicolaus; Blanck, Oliver; Duma, Marciana; Eble, Michael J; Ernst, Iris; Flentje, Michael; Gerum, Sabine; Hass, Peter; Henkenberens, Christoph; Hildebrandt, Guido; Imhoff, Detlef; Kahl, Henning; Klass, Nathalie Desirée; Krempien, Robert; Lohaus, Fabian; Lohr, Frank; Petersen, Cordula; Schrade, Elsge; Streblow, Jan; Uhlmann, Lorenz; Wittig, Andrea; Sterzing, Florian; Guckenberger, Matthias

Source: International journal of radiation oncology, biology, physics; Jul 2017; vol. 98 (no. 3); p. 511-520

Publication Date: Jul 2017

Publication Type(s): Multicenter Study Journal Article

Available at International journal of radiation oncology, biology, physics - from ScienceDirect

Abstract:PURPOSEMany technological and methodical advances have made stereotactic body radiotherapy (SBRT) more accurate and more efficient during the last years. This study aims to investigate whether experience in SBRT and technological innovations also translated into improved local control (LC) and overall survival (OS).METHODS AND MATERIALSA database of 700 patients treated with SBRT for lung metastases in 20 German centers between 1997 and 2014 was used for analysis. It was the aim of this study to investigate the impact of fluorodeoxyglucose positron-emission tomography (FDG-PET) staging, biopsy confirmation, image guidance, immobilization, and dose calculation algorithm, as well as the influence of SBRT experience, on LC and OS.RESULTSMedian follow-up time was 14.3 months (range, 0-131.9 months), with 2-year LC and OS of 81.2% (95% confidence interval [CI] 75.8%-85.7%) and 54.4% (95% CI 50.2%-59.0%), respectively. In multivariate analysis, all treatment technologies except FDG-PET staging did not significantly influence outcome. Patients who received pre-SBRT FDG-PET staging showed superior 1- and 2-year OS of 82.7% (95% CI 77.4%-88.6%) and 64.8% (95% CI 57.5%-73.3%), compared with patients without FDG-PET staging resulting in 1- and 2-year OS rates of 72.8% (95% CI 67.4%-78.8%) and 52.6% (95% CI 46.0%-60.4%), respectively (P=.012). Experience with SBRT was identified as the main prognostic factor for LC: institutions with higher SBRT experience (patients treated with SBRT within the last 2 years of the inclusion period) showed superior LC compared with less-experienced centers (P≤.001). Experience with SBRT within the last 2 years was independent from known prognostic factors for LC.CONCLUSIONInvestigated technological and methodical advancements other than FDG-PET staging before SBRT did not significantly improve outcome in SBRT for pulmonary metastases. In contrast, LC was superior with increasing SBRT experience of the individual center.

15. Development and applicability of a new elastic immobilization with metal markers for postoperative radiotherapy for breast cancer

Author(s): Fujimoto T.; Shioji M.; Miyamae Y.; Yano S.; Nakata M.; Higashimura K.; Yoshimura M.; Ishihara Y.; Hirata K.; Ono Y.; Mizowaki T.; Asada H.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 3129

Publication Date: Jun 2017

Publication Type(s): Conference Abstract

Abstract: Purpose: The purpose of this study was to develop an elastic immobilization with metal markers for postoperative radiotherapy for breast cancer. Methods: An elastic immobilization for the supine position was developed with a commercially available bra. This elastic immobilization had seven small metal markers to improve patient setup accuracy. First, the surface and reference doses for X-ray and electron beams were measured using ionization chambers, a water-equivalent

phantom, and an elastic immobilization. Influences of dose attenuation with immobilization were estimated using measured doses. Next, the reproducibility for the immobilization position was evaluated using a human phantom and elastic immobilization. Landmarks were drawn on the human phantom to indicate positional relationship between the immobilization and body, and then several x-ray images were produced. The reproducibility with the landmarks was compared with that without landmarks using the displacement from the metal markers. Furthermore, structure similarity (SSIM) indexes were calculated using several CT sets to evaluate the difference in breast shape under the same conditions. Results: By using the immobilization, the surface dose was increased by 4.0% at maximum. The attenuation of X-ray beams and electron beams was less than 2%. When using the landmarks, the displacement of the metal marker was 0.53 +/- 0.28 cm. The SSIM index with and without landmarks was 0.900 (0.897-0.902) and 0.724 (range 0.559-0.928), respectively. The utilization of landmarks decreased the displacement of the metal markers and showed the possibility to stabilize the breast shape. Conclusion: This study showed the dose characteristics and position accuracy for radiotherapy for breast cancer patients with immobilization with metal markers, which could provide positional accuracy on the setup with minimum skin markers and may be useful for reducing the physical and psychological burden for patients.

16. Comparison of two immobilization systems' stability capabilities on SBRT lung patients

Author(s): Page C.; Dellit E.; Ryan D.; Mitin T.; Thomas C.; Tanyi J.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 2844

Publication Date: Jun 2017

Publication Type(s): Conference Abstract

Abstract: Purpose: In a preliminary study that analyzed which immobilization device produced the largest alignment deviation using cone beam CT (CBCT), it was found that patients in a BodyFIX system required shifts up to four times greater than that of patients in a Vac-Lok system. We now seek to compare BodyFIX and Vac-Lok immobilization systems in regards to patient stability on stereotactic body radiation therapy (SBRT) lung patients. Methods: In lung SBRT, the variability of intrafractional target motion can contradict the potential benefits of four-dimensional treatment planning that serves to account for the dosimetric impacts of body motion. Immobilization systems, specifically BodyFIX and Vac-Lok were chosen for each patient on the day of CT simulation. On the day of treatment, patients underwent routine alignment and setup methods, however, once the beam was turned on, body motion was monitored with VisionRT which uses the body structure contour from planning and infrared light to produce a continuous log of data. The continuous data on patient motion provides information that would be lost by a simply taking a CBCT before and after treatment. Results: VisionRT provides data points over eight positional directions (translation, vertical, longitudinal, lateral, rotation, roll, pitch, and amplitude). Direct comparison of patient stability between BodyFIX and Vac-Lok can therefore be analyzed over all eight groups of data individually. We have interest is making these discrete comparisons and come to a conclusion involving twenty patients. Conclusion: Radiation therapy requires submillimeter precision especially in SBRT cases where field sizes are much smaller than normal external beam treatment. The findings of this study will allow us to treat patients with higher confidence in those small fields.

17. Effects of immobilization devices in PET/CT on multimodality image fusion for head-and-neck cancer patients

Author(s): Valenciaga Y.; Ghaly M.; Klein E.; Cozza S.

Source: Medical Physics; Jun 2017; vol. 44 (no. 6); p. 2816

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Abstract: Purpose: To examine the effect of radiotherapy immobilization devices on head-and-neck cancer patients, for PET/CT scans on image distortion and fusion. Methods: In order to deliver the prescription dose to the tumor while sparing the healthy tissue, it's critical to correctly delineate the volumes of interest. Multimodality imaging fusion such as PET-CT provides a valuable tool in target contouring by the overlap of anatomical and functional information. The inaccuracy of target contour is affected by factors such as patient motion during scans, inter-observer variability, and poor image fusion/registration. The use of immobilization devices in radiation therapy is well established, but not typically the case for diagnostic PET/CT scanners. This poses a challenge when fusing the PET/CT images to the CT simulator image set, and deformable registration becomes the only solution to a visually acceptable fusion. However, the accuracy of the multimodality image fusion in head-and-neck cancer (HNC) cases following deformable registration can be questionable. In this study we address: whether the use of immobilization devices on HNC patients during PET/CT scans 1) introduces image distortion, 2) improves the accuracy of PET/CT-CT SIM image fusion. Scans will be acquired with a Jaszczak phantom and HNC patients. Results: Based on SUV histogram comparison and visual inspection, the results showed no image distortion when introducing immobilization devices in PET scans. There was no need for deformable registration, which is expected when using a rigid cylindrical phantom. Conclusion: This work demonstrates the feasibility of introducing radiation therapy immobilization devices in PET/CT scans. Future work includes analyzing the accuracy of PET/CT-CT SIM image fusion of real HNC patients scans when the PET/CT scans are obtained with/without immobilization devices.

18. Impact of immobilization accessories on geometric distortions for H&N MRI sequences

Author(s): Claps L.; Klein E.; Cao Y.; Diaz-Molina F.; Saggese J.

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Abstract: Purpose: Geometric distortions should be considered when MR images are used for head and neck (H&N) radiation therapy planning. We investigated the impact of radiotherapy immobilization accessories on MRI geometric distortions for various MRI sequences commonly used to image the H&N for IMRT and SBRT treatments. Methods: We used a 3T Siemens Magnetom Skyra to acquire images of the ACR MRI accreditation phantom with a flexible 18-channel TIM coil. We imaged the phantom alone; positioned on an MRI-compatible table overlay; and positioned on a headrest with a leveling aquaplast accessory made from thermoplastic pellets for stability, atop the MRI-compatible table overlay and under a thermoplastic mask. Each image was acquired via T1-weighted turbo spin echo; T2-weighted SPACE gradient echo; and T1-weighted MPRAGE gradient echo sequences. For each sequence, we resampled each of the MR images of the phantom and immobilization accessories, to the MR-image of the phantom without accessories. Using a rigid fusion tool, we fused this resampled image set to a CT of the ACR phantom positioned with the same immobilization accessories. Results: Initial results for 54 fusions have been obtained. We compared each of these fusions' translational and rotational matrices to quantify variations in the magnitude of

the geometric distortions across different sequences and accessory-combinations as described above. The data obtained shows that these devices do not produce geometric distortions. Conclusion: We believe that this is a viable and productive method for evaluating geometric distortions produced in MR images. Future work will repeat measurements for different combinations of immobilization accessories and MR sequences, using different phantoms, and by alternative analytical means, i.e., volume, center of mass, and surface-area measurements.

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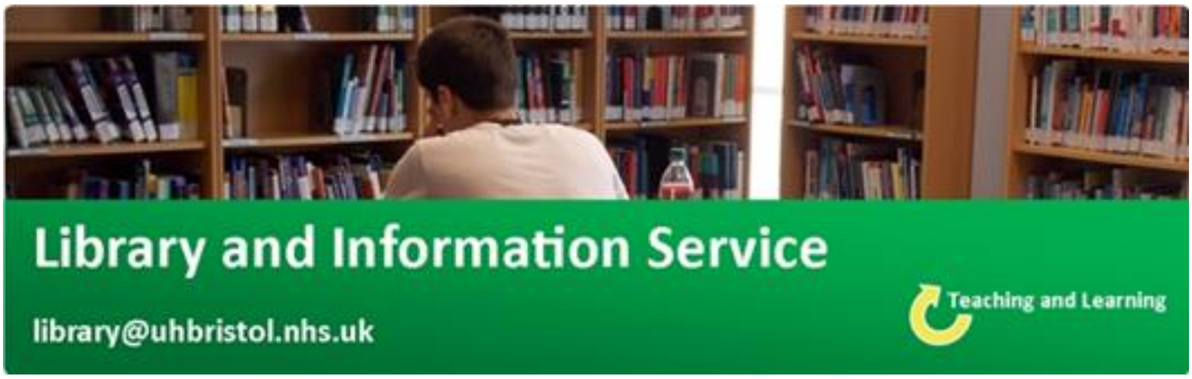

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