



Workshop on Reference Dosimetry in External Beam Radiotherapy and Brachytherapy | (SMR 4111)

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Feasibility and dosimetric impact of intensity-modulated radiotherapy for cervical cancer patients in Nepal: A retrospective analysis.



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Title:

Implementation of Code of Practice for Quality Assurance Program in High Dose Rate Brachytherapy with Ir-192 source

Prospective/Objective: To develop and implement the code of practice for Quality Assurance (QA) program in Brachytherapy (BT) with Ir-192 source. Because of the existence of variable BT equipment, AAPM TG-56 recommended each clinic to develop a dedicated QA program that suites its brachytherapy machine. In this thesis work, the code of practice for QA was written and implemented at Modena University Hospital aiming to assure accurate operation of BT equipment with a major focus on security controls, geometrical and dosimetrical measurements and to verify safety conditions for radiation protection purposes as required by national regulations. Multichannel applicators were commissioned to establish its baseline operating performance.

Materials and methods. Following the guidelines (IAEA TECDOC-1274, AAPM TG56, and GEC-ESTRO booklet-8), the code of practice for QA in BT was developed for microSelectron HDR-V3 unit and OnCentra treatment plan system (TPS). Transfer tubes, well type chamber, electrometer, Gafchromic films, check ruler, set of applicators and film scanner were used for source calibration and for commissioning of Multichannel applicator. For radiation protection purposes, a calibrated Automess (6150 Ad-B) was employed to verify the existing shielding and to check the leakage radiation. An end-to-end test was performed by using Gafchromic films that were placed within Multichannel applicator in a solid

PMMA water equivalent phantom. By means of 2D-gamma analysis, films dose maps were compared to RTDoses from the OnCentra TPS after being loaded into PTW-Verisoft software.

Results. The results from the source calibration showed optimal agreement between the measured air kerma rate (source strength) and the value of source certificate with a difference of 1.82% and the measured source positions were within ± 0.2 mm on average from the expected positions. The radiation protection results were in agreement with recommended limits, and the highest annual equivalence dose rate evaluated was 0.154 mSv/year in controlled areas. Results of first source positions for all Multichannel transfer tubes and needles evaluated were in agreement with respect to declared values, with a maximum difference of ± 0.5 mm. Gamma passing rate calculated between film and RTDose maps was 100% for the intrauterine VT and was 91.8% for needle-10, with 3%/3mm criteria.

Conclusion. Results showed that the status of the machine and its components ensured an acceptable clinical outcome. The deviation in source activity was less than the recommended tolerance limit 5%, uncertainties in source positions are less than 1mm and agreed with the GEC ESTRO (2004) recommendations. The walls bunker shielding were still suitable according to national regulations. The end-to-end results guarantee the correct dose delivery to patient.

A Comparative Analysis of Virtual 2D VMAT-Based SFRT and 3D Lattice Radiotherapy: Evaluation of Dosimetric and Therapeutic Outcomes

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Background: Spatially Fractionated Radiotherapy (SFRT) can be implemented using Volumetric-Modulated Arc Therapy (VMAT) in either two-dimensional (2D) or three-dimensional (3D) configurations. **Objective:** This study aimed to compare the dosimetric and clinical outcomes of two VMAT-based SFRT techniques for large lung tumors. **Material and Methods:** In this experimental study, SFRT plans were designed for each patient using cylindrical and spherical grid targets. Single-fraction prescription doses of 15 and 20 Gy were delivered to the grid target isocenters using 6-MV flattening-filter-free (FFF) photon beams. **Results:** The 2D SFRT plan demonstrated higher Gross Tumor Volume (GTV) mean dose, GTV Equivalent Uniform Dose (EUD), and Valley-to-peak Dose ratio (VPDR) compared to the 3D lattice plan. However, the 3D Lattice Radiotherapy (3D-LRT) technique provided a better therapeutic ratio and more uniform valley-peak dose distribution. Both plans demonstrated therapeutic ratios greater than one with minimal Normal Tissue Complication Probability (NTCP). **Conclusion:** Both 2D and 3D lattice VMAT-based SFRT techniques effectively delivered high radiation doses with steep dose gradients within the GTV, minimizing normal tissue exposure and reducing the risk of complications.

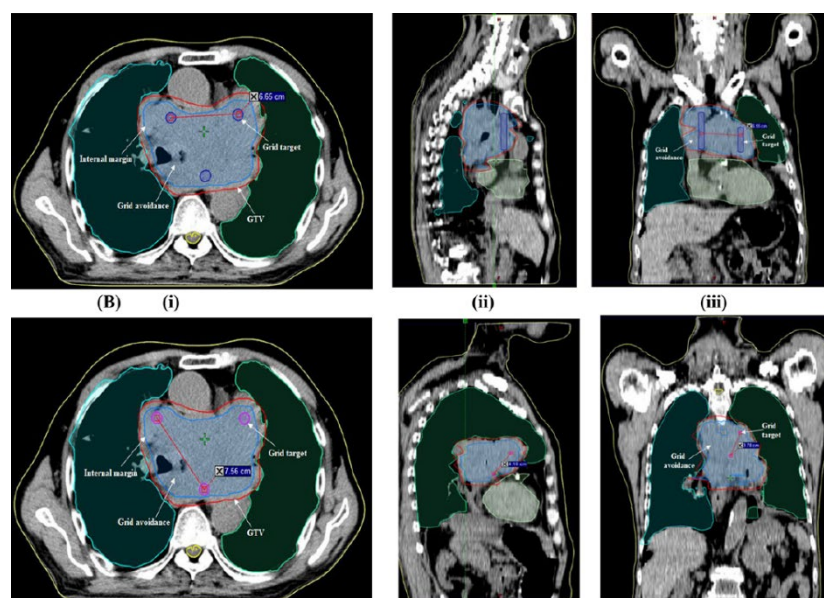


Figure 1: Position of the cylindrical (A) and spherical grid targets (B) within the gross tumor volume (red) and internal margin (blue) in (i) axial, (ii) sagittal, and (iii) coronal views.

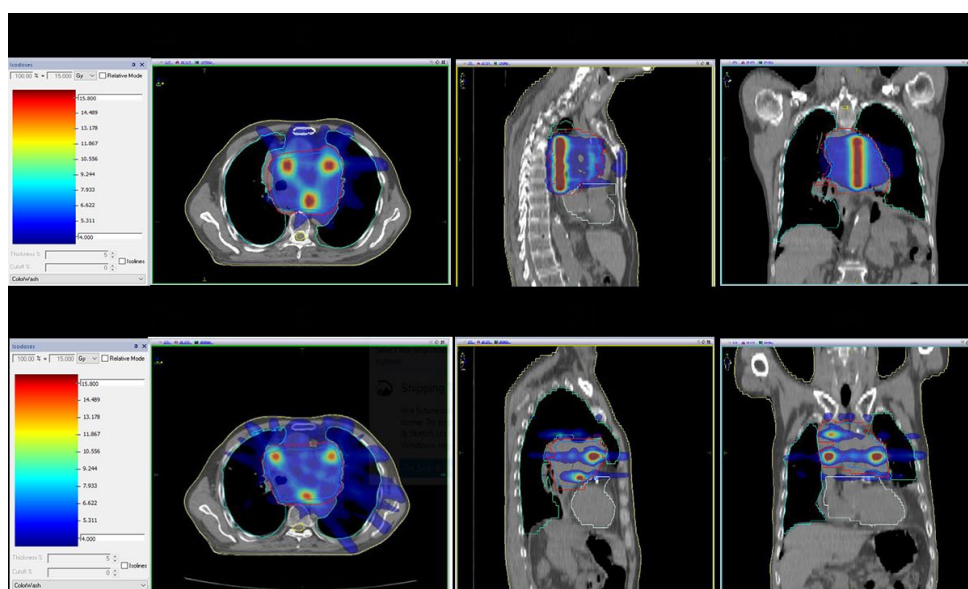


Figure 2: The dose distribution map of (A) cylindrical and (B) spherical grid targets in (i) axial, (ii) sagittal, and (iii) coronal views, respectively.

Table 1: Mean dose, Equivalent Uniform Dose (EUD), and Valley-to-peak Dose Ratio (VPDR) values in the Gross Tumor Volume (GTV) for 15 and 20 Gy doses.

Patient	Dose (15 Gy)						Dose (20 Gy)					
	2D-Spatially Fractionated Radiotherapy			3D- Lattice Radiotherapy			2D-Spatially Fractionated Radiotherapy			3D- Lattice Radiotherapy		
	D _{mean} (Gy)	Equivalent Uniform Dose (Gy)	Valley-to- peak Dose Ratio	D _{mean} (Gy)	Equivalent Uniform Dose (Gy)	Valley-to- peak Dose Ratio	D _{mean} (Gy)	Equivalent Uniform Dose (Gy)	Valley-to- peak Dose Ratio	D _{mean} (Gy)	Equivalent Uniform Dose (Gy)	Valley-to- peak Dose Ratio
1	8.66	6.39	0.34	8.00	4.67	0.26	8.95	8.39	0.31	7.99	4.87	0.18
2	8.56	6.76	0.37	7.98	4.95	0.32	8.56	6.90	0.25	8.16	6.04	0.28
3	8.36	5.90	0.32	7.84	4.72	0.29	9.17	8.82	0.36	8.07	5.91	0.29
4	8.09	5.31	0.29	7.84	4.42	0.23	8.18	5.94	0.24	8.19	5.89	0.19
5	8.15	4.87	0.28	8.28	5.50	0.29	8.52	6.11	0.26	8.11	5.44	0.18

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This study aims to compare the dosimetric performance of the Field-in-Field (FIF) technique and Intensity Modulated Radiation Therapy (IMRT) in delivering hypofractionated radiation therapy to patients with prostate cancer. The FIF approach employed 6 photon beams, while IMRT used a 9-field step-and-shoot technique.

Methods and Materials:

Fifteen prostate cancer patients, previously treated with step-and-shoot IMRT, were retrospectively analyzed. Each received a prescribed dose of 60 Gy in 20 fractions. FIF plans were generated using 6 beams, while IMRT plans involved 9 fields. Comparative analysis was performed using dose-volume histograms and dose distribution metrics.

Results:

For the planning target volume (PTV), FIF demonstrated lower maximum dose, D2%, and improved homogeneity index. IMRT showed superiority in mean dose, D98%, and D95. Regarding organs-at-risk (OARs), FIF reduced rectum and bladder volumes receiving 60 Gy. However, IMRT better spared the rectum and femoral heads at 30 Gy and achieved a lower mean dose to the rectum. Notably, IMRT required a higher number of monitor units (886 MU) and segments (64) compared to FIF (434 MU, 6 segments).

Conclusions:

Both techniques yielded clinically acceptable plans for hypofractionated prostate radiotherapy. FIF provided advantages in treatment simplicity and reduced MU, while IMRT offered superior conformality and OAR sparing in certain aspects. These results may guide clinicians in choosing appropriate techniques based on individual patient and resource considerations.

References

- [1] A. Author, B. Coauthor, *J. Sci. Res.* 13, 1357 (2012).
- [2] A. Author, B. Coauthor, *J. Sci. Res.* 17, 7531 (2013).

Comparative Study of Dosimetric Accuracy between Farmer and Semiflex Ionization Chambers in MR-Guided External Beam Radiotherapy

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Abstract

Purpose:

To evaluate and compare the dosimetric accuracy and magnetic field effects on Farmer and Semi flex ionization chambers for absolute dose measurements in MR-guided external beam radiotherapy using a 1.5T MR Linac system.

Materials and Methods:

A dosimetric comparison was conducted using PTW Farmer (0.6 cc) and Semi flex 3D (0.07 cc) ionization chambers in a water MR-compatible phantom. Measurements were performed in a 1.5T MR Linac environment under magnetic field. Beam quality was 7 MV FFF. Calibration was traceable to a reference standard following TRS-398 protocol with magnetic field-specific corrections. Dose measurements were taken at depths of 5 cm and 10 cm at SSD 133.5 cm. Chamber positioning and alignment were verified with MRI guidance. Reproducibility, dose linearity, and angular response were also evaluated.

[1] Lagendijk JJW, Raaymakers BW, Van den Berg CAT, Moerland MA, Philippens ME, van Vulpen M. MR guidance in radiotherapy. *Phys Med Biol*. 2014;59:R349–R369

[2] O'Brien DJ, Sawakuchi GO. TH-CD-BRA-07: MRI-linac dosimetry: parameters that change in a magnetic field. *Med Phys*. 2016;43:3874

EVALUATION OF RESULTS BETWEEN 3D AND CONVENTIONAL 2D BRACHYTHERAPY TREATMENT PLANNING FOR CERVICAL CANCER IN HIGH – DOSE -RATE BRACHYTHERAPY AT CAN THO ONCOLOGY HOSPITAL

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ABSTRACT

In this work, evaluating of results between 3D and 2D brachytherapy treatment planning for cervical cancer in high dose rate brachytherapy. New techniques that affect to outcome of treatment should be surveyed and evaluated. It is necessary to find the best way to improve treatment efficiency. We used 3D treatment planning brachytherapy to treat for 62 cervical cancer patients with stage IIB - IIIB who were treated in external beam radiation therapy with 3D treatment planning. Base on available CT imaging, we simulated and planned with 2D treatment planning without two orthogonal films. Collecting the results (D90 of tumor, D2cc of bladder, rectum and sigmoid) of both methods after four fractions for brachytherapy (7Gy/fraction). Calculating equivalent total dose in 2 Gy fraction (EQD2) of EBRT and brachytherapy for tumor and risk organs. Evaluating and comparing the results. In addition, we analyzed the relationship of some factors with dose outcomes of tumor and risk organs.

Key words: brachytherapy, 3D and 2D treatment planning, EQD2.

- [1] Chottaweesak P1, Shotelersuk K, et al (2014), *Comparison of bladder and rectal doses between conventional 2D and 3D brachytherapy treatment planning in cervical cancer*, Biomed Imaging Interv J 2014; 10(1): e2.
- [2] Dongryul Oh, et al (2016), *Clinical outcomes in cervical cancer patients treated by FDG-PET/CT-based 3-dimensional planning for the first brachytherapy session*, Medicine 95:25 (e3895).
- [3] Ekkasit Tharavichitkul, et al (2013), *Image-guided brachytherapy (IGBT) combined with whole pelvic intensity-modulated radiotherapy (WP-IMRT) for locally advanced cervical cancer*, Journal of Contemporary Brachytherapy (volume 5/number 1), 10 -16.
- [4] IAEA (International Atomic Energy Agency) (2013), *Management of cervical cancer: Strategies for Limited-resource centres - A guide for radiation oncologists*, IAEA human health reports, IAEA.
- [5] IAEA (International Atomic Energy Agency) (2015), *The Transition From 2D Brachytherapy to 3D High Dose Rate Brachytherapy*, IAEA human health reports, IAEA.
- [6] ICRU (International Commission on Radiation Units and Measurement) (1985), Report 38 Dose and volume Specification for Reporting in Brachytherapy.
- [7] Julie K Schwarz, *Defining Targets for Brachytherapy*, Washington University School Of Medicine in St. Louis.
- [8] Natalie Govender (2014), *2D Brachytherapy Planning versus 3D Brachytherapy Planning for Patients*

Dosimetric Impact of Implementing IAEA TRS-492 for HDR ^{192}Ir Intracavitary Brachytherapy in Cervical Cancer

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Abstract:

Introduction: The publication of IAEA TRS-492 in 2023 provides the first absorbed dose to water-based code of practice for brachytherapy dosimetry, establishing a standardized approach to calibrating well-type ionization chambers and measuring source strength. This study presents a clinical implementation of TRS-492 in HDR ^{192}Ir intracavitary brachytherapy for cervical cancer and evaluates its dosimetric consequences across five patient cases.^[1-2]

Materials and Methods: Our PTW well-type chamber was recalibrated using the TRS-492 formalism at our affiliated SSDL. A new HDR ^{192}Ir source was then measured for reference air kerma rate (RAKR) using both TRS-492 (ND,w,source) and traditional air-kerma strength (Sk) calibration methods. The TRS-492-based calibration yielded a mean source strength 0.9% higher than the legacy Sk-based calibration.

Five cervical cancer patients treated with tandem-ring intracavitary applicators were selected. Original treatment plans were generated with Sk-based source strength and then recalculated using the updated TRS-492-based calibration.

Results: Although the dose variations remained within clinical tolerance ($\leq 2\%$), the consistent increase in calculated dose with TRS-492 source strength underlined the need for harmonized calibration protocols in treatment planning. No plan modifications were necessary post-implementation; however, institutional QA documents, reference dose checks, and dose constraint policies were updated to reflect the transition.

Conclusion: In conclusion, this study demonstrates the clinical feasibility of implementing TRS-492 for HDR cervical brachytherapy. The transition enhances dosimetric accuracy and international consistency, with minimal disruption to clinical workflow, supporting its broader adoption in modern radiotherapy centers.

References:

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Dosimetry in Brachytherapy – An International Code of Practice for Secondary Standards Dosimetry Laboratories and Hospitals, Technical Reports Series No. 492, IAEA, Vienna (2023).
- [2] Bidmead AM, Sander T.; IPEM Working Party. Phys Med Biol. 2010 Jun 7;55(11):3145-59 (2010).

ENHANCING CERVICAL BRACHYTHERAPY WITH CT ANGIOGRAPHY AND MRI

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Imaging has transformed brachytherapy for cervical cancer into a precise and reliable treatment modality. Since 2005, three-dimensional imaging techniques, particularly Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), have become the clinical standard for treatment planning [1]. CT provides accurate applicator and source localization essential for dose optimization, while MRI's superior soft-tissue contrast enables tailored radiation delivery to the high-risk clinical target volume (HR-CTV) and enhanced sparing of organs at risk (OARs) [1]. Our center adopted CT-guided brachytherapy in 2016 and MRI-guided brachytherapy in 2020, resulting in improved treatment precision and patient outcomes through dedicated multidisciplinary collaboration.

Recently, Computed Tomography Angiography (CTAG) has been introduced as an innovative adjunct to guide interstitial needle insertion during combined intracavitary and interstitial brachytherapy. CTAG provides detailed visualization of the uterine artery and its branches, enabling needle placement that avoids vascular injury. Our clinical experience with 44 patients using CTAG-guided needle insertion showed no arterial punctures or hemorrhagic complications, supporting its safety and feasibility [2]. These findings align with established evidence from uterine artery embolization procedures, which demonstrate CTAG's effectiveness in vascular mapping and risk reduction during invasive pelvic interventions [3,4].

While ultrasound guidance offers the advantage of real-time needle visualization without ionizing radiation, its limited availability and operator dependency restrict widespread clinical adoption [5]. In contrast, CTAG involves additional radiation exposure but delivers critical anatomical detail that outweighs potential long-term risks in this setting.

Combining MRI for precise dose planning with CTAG for safe needle insertion represents a comprehensive and synergistic approach in cervical cancer brachytherapy. This integrated imaging strategy enhances both safety and treatment efficacy by improving tumor targeting while minimizing complications. Successful implementation requires multidisciplinary teamwork among radiation oncologists, medical physicists, and radiologists, along with advances in image registration and planning software.

Future research should focus on prospective comparative studies between CTAG and ultrasound-guided needle insertion, development of contrast alternatives for patients with iodine contraindications, and further integration of artificial intelligence to optimize needle trajectory planning based on multi-modality imaging.

In conclusion, the combined use of MRI and CT Angiography is a promising innovation that elevates the standard of care in interstitial brachytherapy for cervical cancer by enhancing precision, safety, and clinical outcomes.

References

[1] A.T. Kirsch-Mangu, D.C. Pop, A. Tipcu, A.I. Andries, G.I. Pasca, Z. Fekete, A. Roman, A. Irimie, C. Ordeanu, *Diagnostics* 14, 1267 (2024).

- [2] L. Fokdal, A. Sturdza, R. Mazeron, et al., *Radiother. Oncol.* 120, 434 (2016).
- [3] T. Sullivan, J.H. Yacoub, M.M. Harkenrider, et al., *Radiographics* 38, 932 (2018).
- [4] M.Á. Vázquez-Barragán, J.R. Ariztegui-Andrade, J.P. Montemayor-Lozano, et al., *Eur. J. Anat.* 26, 551 (2022).
- [5] R. Pötter, K. Tanderup, C. Kirisits, et al., *Clin. Transl. Radiat. Oncol.* 11, 48 (2018).

Abstract template for :Feasibility and dosimetric impact of intensity-modulated radiotherapy for cervical cancer patients in Nepal: A retrospective analysis

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Purpose: Cervical cancer remains a significant health burden in Nepal, with 2169 new cases and 1313 deaths recorded in 2022¹. This study evaluates the feasibility of implementing step-and-shoot IMRT for cervical cancer treatment in a resource-limited setting, comparing its dosimetric outcomes and practical implementation challenges with the currently used 3D-CRT technique.

Methods: Retrospective IMRT plans were created for ten stage II cervical cancer patients treated at a major cancer center in Nepal, prescribed 50 Gy in 25 fractions, and compared to clinically implemented 3D-CRT plans to assess dosimetric differences. Mean doses to organs at risk (bladder and rectum) were evaluated, and statistical analysis was performed using the Wilcoxon Signed Rank Test, with a significance level set at 0.05. The time required to create each plan was recorded.

Results: The dosimetric analysis revealed that IMRT provided superior dose conformity and better sparing of organs at risk (OARs) compared to 3D-CRT. Specifically, IMRT allowed for a statistically significant reduction of the mean doses to the bladder and rectum while maintaining adequate target volume coverage. However, planning IMRT cases took approximately twice as long as 3D-CRT (mean 65 minutes versus 31 minutes).

Conclusion: This study demonstrates the feasibility of implementing IMRT in a Nepalese setting, showcasing its potential to improve treatment precision and reduce radiation exposure to critical organs compared to 3D-CRT. Although IMRT requires more extensive planning and delivery time, its superior dosimetric outcomes could profoundly improve cervical cancer care in Nepal. This underscores the importance of continued research and investment in advanced radiotherapy techniques within resource-limited settings.