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Advancement of the Technology in Radiation Oncology

Rahat Hadi* and Ajeet Kumar Gandhi

Department of Radiation Oncology, Dr. Ram Manohar Lohia Institute of Medical Sciences, India

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Today, approximately 120 years after the discovery of X-Ray, November 8, 1895 by German physicist Wilhelm Conrad Röntgen, radiation therapy has taken a gaint leap and has become not only very advanced and sophisticated but also precise and conformal. The holy grail of radiation treatment remains the same: effective dose to the tumor and minimal dose to the organ at risks. This has been made possible by better imaging modalities available to us today. In fact, one thing that has revolutionized the entire radiation treatment is imaging. Moving from the era of fluoroscopy, computerized Tomography (CT) scan and Magnetic Resonance Imaging (MRI), we are moving towards functional imaging and subsequently moving from Clinical Target Volume (CTV) to Biological Target Volume (BTV). A number of biological pathways including hypoxia, proliferation etc are being targeted and forming the concept of subsets of Planning Target Volume (PTV) inside the PTV. Imaging as a part of radiation treatment planning right from the target delineation to treatment delivery has made us more confident in delivering doses that we intend to deliver. Coming to advances in teletherapy, Intensity Modulated Radiation Therapy (IMRT) has become the standard of care for most of the treatment sites in the present era. Flattening filter free (triple F) beams has given us unique advantage of using unflattened beams to deliver IMRT in quicker time. While tomotherapy or helical tomotherapy and cyberknife have enabled magnafield irradiation and stereotactic treatments respectively with more ease, at the same time newer innovations are also being explored. Vero stereotactic body radiation therapy (SBRT) is such an innovation from Brainlab which has a movable gantry and enables SBRT delivery with more flexibility. Electromagnetic field tracking with calypso system and respiratory gating with Real time Position Management (RPM) are new tools for effective management of motion. View Ray incorporates Co-60 based IMRT with real time MRI guidance and heralds a new approach in precise delivery of radiation. The advancement in technology has also increased the cost of the treatment by many folds and one way to circumvent this is by indigenous design of the equipments. Integrated IGRT unit (G Ray), Bhabhatron-II and Karknidon (Ir-192 after loader) are indigenous solution from panacea and is already being used at some of the centres in India and abroad. Particle beam therapy notably proton beam radiotherapy with its advantage of Bragg peak is the future of radiation treatment. Advancement in proton beam therapy including intensity modulated treatment, on-board imaging, motion management etc are on way. Imaging has also brought a paradigm shift in the use of brachytherapy practice. Ultrasound guided catheter insertion for gynecological and prostate cancers have made interstitial brachytherapy more tolerable. Image guidance has also made possible the use of interstitial brachytherapy to other unexplored sites like liver, lung, brain etc. Miniaturized x-ray source inserted in to flexible catheter (electronic brachytherapy) has enabled the use of brachytherapy for superficial tumors and also for breast and gynecological malignancies. Advanced dose calculation algorithms which takes in to account applicator material, patient in homogeneities, tissue air interface etc are now commercially available (ACUROS: VARIAN) and may be equivalent to advanced dose calculation algorithms like Monte Carlo. Real time planning of High Dose Rate (HDR) (Vitesse: Varian) and Low Dose Rate (LDR) (Veriseed: Varian) brachytherapy provides real time guidance on needle positioning and conformality of plan and enables pre/intra and post-operative planning. Integrated brachytherapy units with insertion of implant, imaging and treatment delivery in the same room not only reduces overall treatment time but also improves accuracy of planning and is more comfortable for the patient. It is sure that better imaging, further technological advancements in design of Linear Accelerators (LINACs), advanced and faster dose calculation algorithms and radiobiological modeling for plan evaluation would further bring us in to a new era of radiation oncology in the time to come.

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****Correspondence:***

Rahat Hadi, Department of Radiation Oncology, Dr. Ram Manohar Lohia Institute of Medical Sciences, India; E-mail: drrahathadi@yahoo.co.in

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