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aSi Electronic Portal Imaging Device for the Radiotherapy In Vivo Dosimetry

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Introduction. Following the EURATOM 97/43 recommendation, since 2000 is operative in Italy the D.L.vo 187/00 about the radioprotection of the patients undergone at medical radio exposition. In radiotherapy the number of Quality Controls increases as function of the treatment complexity and the workload is sometime responsible of their partial absence, that increases the dosimetric errors. Moreover in this field severe incidents have been recently reported by the international media. Opinion of many physicists is that a control during the treatment using a dedicated software for the in-vivo dosimetry (IVD) could strongly reduce the presence of dosimetric errors. This mean a major presence of physicists during the radiotherapy execution, where actually there is a general absence of this professional component. Moreover the IVD is one of the best ways to gain experience to prevent errors when introducing new radiotherapy techniques.
Methods. Actually amorphous Silicon Electronic Portal Devices (aSi EPIDs) associated at the linacs are used for imaging visual inspections and someone use them for the IVD that however supply estimations of the real delivered doses in patient. Indeed even the more complex (and time consuming) clinical IVD 3D-procedure, use the initial reference CT scans (used for the plan) to reconstruct the x-ray fluence to use in a second step for the re-computation of the dose in the same reference CT scans. Then if the patient's shape or setup are changed, the reconstructed fluence is not accurate and so the reconstructed doses. Only a wide-spread use of image guided radiation therapy could assure more accurate daily dose distributions, but also higher doses at normal tissues and time consuming. For these reasons the IVD must supply in real time useful warnings to activate quality controls to remove the causes of errors. The DISO Project, supported by INFN and the Università Cattolica S.C. developed software for the IVD using the aSi EPIDs of the linacs Varian, Elekta and Siemens, interfaced with the Record and Verify System of the Centre. An original calibration procedure of the aSi EPIDs was developed to use a generalized procedure based on a set of experimental data by different linacs.
Results In the recent years 20.000 IVD tests for 3D CRT, IMRT and VMAT treatments have been obtained in 8 Italian Centres participating at the DISO Project with software prototypes. On the basis of these results recently the BEST Medical Italy developed the SOFTDISO, a dedicated software for 3DCRT, IMRT and VMAT techniques. SOFTDISO supplies two tests (i) the ratio between the reconstructed dose at the isocenter point, and that planned for the patient by TPS with a tolerance level of 5%, (ii) a γ-analysis between a reference and a current EPID images acquired during the successive fractions, with $P\gamma < 1 \geq 90\%$ agreement (and acceptance criteria of 5% and 3 mm). The major causes of discrepancies were in general due to inadequate quality controls as : -patient setup, -occasional morphological changes, -systematic morphological changes, -attenuators on the beams (patient supports), -TPS implementation, - CT number implementation, -laser misalignment, -output dose variations, -partial missing of beam delivery during IMRT.
Conclusions: The SOFTDISO is able to supply in quasi real time the IVD tests based on the use of aSi EPID and the results confirm that even if about 15% of tests resulted out-tolerance levels, once removed the causes of the dose discrepancies, the mean values of the IVD indexes for each patient were within the tolerance levels. Moreover for the tests off-tolerance levels due to patient morphological changes, SOFTDISO is a useful tool for the adaptive radiotherapy strategy.

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