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Original research article

Immobilization versus no immobilization for pelvic external beam radiotherapy

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ABSTRACT

Aim: To identify the most reproducible technique of patient positioning and immobilization during pelvic radiotherapy.

Background: Radiotherapy plays an important role in the treatment of pelvic malignancies. Errors in positioning of patient are an integral component of treatment. The present study compares two methods of immobilization with no immobilization with an aim of identifying the most reproducible method.

Materials and methods: 65 consecutive patients receiving pelvic external beam radiotherapy were retrospectively analyzed. 30, 21 and 14 patients were treated with no-immobilization with a leg separator, whole body vacuum bag cushion (VBC) and six point aquaplast immobilization system, respectively. The systematic error, random error and the planning target volume (PTV) margins were calculated for all the three techniques and statistically analyzed.

Results: The systematic errors were the highest in the VBC and random errors were the highest in the aquaplast group. Both systematic and random errors were the lowest in patients treated with no-immobilization. 3D Systematic error (mm, mean ± 1SD) was 4.31 ± 3.84, 3.39 ± 1.71 and 2.42 ± 0.97 for VBC, aquaplast and no-immobilization, respectively. 3D random error (mm, 1SD) was 2.96, 3.59 and 1.39 for VBC, aquaplast and no-immobilization, respectively. The differences were statistically significant between all the three groups. The calculated PTV margins were the smallest for the no-immobilization technique with 4.56, 4.69 and 4.59 mm, respectively, in *x*, *y* and *z* axes, respectively.

Conclusions: Among the three techniques, no-immobilization technique with leg separator was the most reproducible technique with the smallest PTV margins. For obvious reasons, this technique is the least time consuming and most economically viable in developing countries.

Abbreviations: 3DCRT, three dimensional conformal radiotherapy; IMRT, intensity modulated radiotherapy; VBC, vacuum bag cushion; EPID, electronic portal imaging device; CBCT, cone beam computed tomography; PTV, planning target volume; CTV, clinical target volume; SD, standard deviation; TE, total error.

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1. Background

Pelvic external beam radiotherapy plays an integral part in the management of gynaecologic, genitourinary and gastrointestinal malignancies. Carcinoma of uterine cervix, endometrium, rectum and prostate are the most common pelvic malignancies treated in radiation oncology departments of developing countries like India.[1] Three dimensional conformal radiotherapy (3DCRT) is the minimum standard of care, although higher technologies like intensity modulated radiotherapy (IMRT) are a recommended standard in the treatment of carcinoma prostate and postoperative cases.

Variation in the patient positioning is a major problem during radiotherapy for pelvic malignancies. Higher patient setup errors will compel Radiation oncologist to give a larger planning target volume (PTV) margins, i.e. irradiate more normal tissues. Smaller PTV margins may lead to potential geographic miss of the target volume and, hence, may lead to recurrence.[2]

Several patient positioning and immobilizing techniques are being practiced in our country in the radiotherapy for the pelvis.[3,4] With huge workload in most of the radiotherapy centres in India, frequent onboard image verifications with EPID (electronic portal imaging device) or kv-CBCT (kilovoltage cone beam computed tomography) is not feasible in most of the centres. Hence it is ideal to adapt to most favourable, less time consuming and most economically viable technique for patient positioning with maximum reproducibility. There are conflicting pieces of evidence and lack of consensus as to the ideal method of patient immobilization for pelvic radiotherapy.[4–6] Therefore, in the present study we compare two most commonly utilized modalities of patient immobilization, namely whole body vacuum bag cushion (VBC) and six-point pelvic aquaplast system with no immobilization with a leg separator.

2. Aim

The aim of the present study is to identify the most appropriate patient positioning technique for treatment of pelvic malignancies. The objective of the present study is to quantify systematic error, random error and planning target volume for each of the techniques of patient positioning by periodic EPID imaging and derive the most optimal technique of patient positioning in external beam radiotherapy for pelvic malignancies.

3. Materials and methods

3.1. Sample collection and sample size

After Institutional ethical clearance, a retrospective observational study was started. On assuming 'between group variance' of 1 mm, and 'within group variance' of 2 mm and an effect size of 30%, 80% power and 2-sided alpha error of 5%, the required number of instances (readings) would be 523. We therefore accrued 65 consecutive patients receiving pelvic external beam radiotherapy (radical or palliative intent) on Elekta synergy linear accelerator (Elekta®) from January 2016 to October 2016 into the present study.

3.2. Patient positioning and immobilization

All patients underwent computed tomographic scan for radiotherapy planning. All the patients were positioned in a supine position with hands above the head or akimbo on the chest based on the patient comfort. And for all the patients the AIO base plate (all in one base plate) was fixed on the CT couch as well as on the treatment couch. This base plate helps in indexer level marking by means of positioning indicators in all the three systems, namely: VBC, aquaplast and no-immobilization. The details of three different patient positioning techniques are as follows:

3.3. Patient positioning using vacuum bag cushion (VBC)

Whole body VBCs (Orfit Industries®) are nylon mattress filled with tiny polyurethane beads. Patient is made to lie down in a supine position. A comfortable cradle is formed around to conform to the body contours of the patient by using a vacuum pump for 10 min. After the VBC achieved the desirable firm consistency, the self sealing quick release valve was used to seal the mattress (Fig. 1A). The laser marks are placed on the VBC, corresponding to indexer and on the patient's body for daily setup reproducibility. The mattress was labelled and used throughout the treatment.

3.4. Six point aquaplast immobilization system

Six point aquaplast immobilization system (Orfit Industries®) used in the present study has a thigh separator with a knee rest. Patient is immobilized in a supine position with the knee rest. The lateral 4 clamps of the aquaplast were fixed to the carbon fibre AIO base plate and medial two clamps were fixed to the thigh separator. The laser marks were placed both on the patient's body and on the aquaplast. The upper and the lower borders of the cast were also marked on the patient body. Corresponding indexer levels were marked to match the patient's position. (Fig. 1B).

3.5. No immobilization

All the patients in this category were simulated in a supine position on a flat surface with a pillow or a comfortable headrest under the head. Flat zero degree sponge was fixed over the AIO base plate. A leg separator was held by the patient in between the ankle joints. Laser isocentre markings were placed directly on the patient's body (Fig. 1C).

3.6. Image acquisition and processing

All patients were positioned on the day of treatment and the laser markings representing simulation centres were matched. Couch shifts were given to match the treatment isocentre as per the data obtained from the treatment planning system. EPID images were acquired in 2 axes viz., antero-posterior and lateral direction. The images were