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A Novel Approach to Evaluate the Prostate Pelvis Lymph Node Setup Margin

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ABSTRACT

Current techniques for assessing setup margins in prostate and PLN radiation treatments rely on manual, time-consuming workflows. A novel automated workflow approach was developed to evaluate three clinical sites with different immobilization methods. A total of 30 patients, ten from each site, were randomly selected. One planning CT and 7 CBCTs for each patient were analyzed using this method. This study revealed that PLN setup margins vary significantly among patients, but there is no statistically significant difference between the immobilization methods.

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INTRODUCTION

- Different pelvic LN margins and immobilization methods are currently used at each site in our institution; the effectiveness of immobilization for reducing PTV margins needs to be investigated.
- Current techniques for assessing setup margins in prostate and PLN radiation treatments rely on manual, time-consuming workflows.

AIM

A novel automated workflow approach was developed to evaluate three clinical sites with different immobilization methods.

METHODS AND MATERIALS

- A total of 30 patients, ten from each site, were randomly selected. Each site used different immobilization methods: a foot strap, an alpha cradle from the knee to the feet, and a vacuum bag from the pelvis to the feet.
- One planning CT and 7 CBCTs for each patient were imported into MIM software. A MIM automated workflow was developed to automate the process.
- Rigid registration was performed between the CBCT and CT, aligning the pelvic bones.
- The PLN structure was copied from CT to CBCT and expanded to 15 structures with an increased margin ranging from 1mm to 15mm.
- The CBCT was manually shifted to align with the fiducials, and the PLN structure was copied to the CBCT again, which intersected with the 15 expansion structures. The intersection volume of less than 0.1 cc was defined as full PLN coverage in this study.
- The smallest margin corresponding to the intersection volumes greater than 0.1 cc was recorded for each CBCT.
- The margins were analyzed for each patient and each site using the Mann-Whitney U test to evaluate differences between sites.

RESULTS

- The smallest margin required to cover PLN varies among patients, ranging from 2.9±1.4mm to 10.1±2.5mm.
- The mean and standard deviation of the margins are 5.5±2.3mm, 5.7±3.1mm, and 5.5±2.5mm, respectively, for three sites.
- P-value is 0.8713, 0.9899, and 0.858 between foot strap and vacuum bag, foot strap and alpha cradle, vacuum bag and alpha cradle, respectively.

Table 1: Patient immobilization and PLN margins for three sites

Clinical Sites	PTV_LN margin (mm)	Immobilization Method
1	12	Foot strap
2	5-7	Vacuum bag from pelvis to feet
3	7	Alpha cradle from Knee to feet

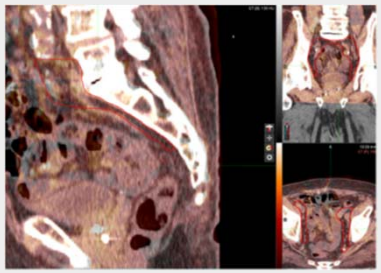

Figure 1: The PLN structure (red) was copied from CT to CBCT when the bony structure was aligned.

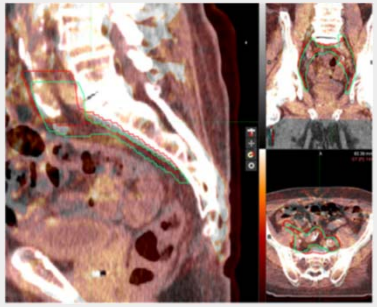

Figure 2: The PLN structure (green) was copied to CBCT again when fiducials were aligned.

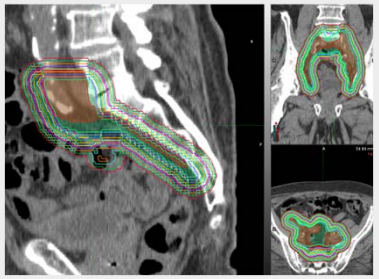

Figure 3: 15 PTV structures were created from green PLN.

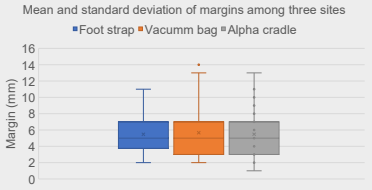

Figure 4: Compare the margins among different immobilization groups

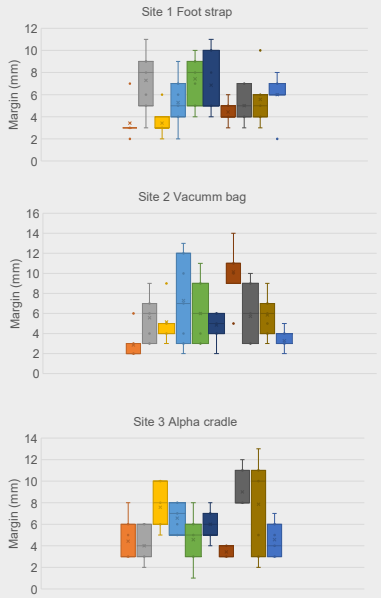

Figure 5: Compare the mean and standard deviation of the margins for 10 patients at each site.

DISCUSSIONS

- Study assumes the sacrum is rigid; the pelvic LN moves with the sacrum and the deformation is minimal.
- The PLN setup margin variation among the patients could be related to the bladder and rectum filling and will be studied further.
- Site 1 reduced the PLN margin from 12mm to 8mm based on the results.
- Alpha cradle and vacuum bag didn't improve PLN setup accuracy compared to the foot strap. There is a potential to reduce the immobilization cost for site 2 and site 3.

CONCLUSIONS

This novel approach revealed that PLN setup margins vary significantly among patients, but there is no statistical difference between the different immobilization methods.

REFERENCES

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2. E.A. Marnouche, etc. "Evaluation of margins in pelvic lymph nodes and prostate radiotherapy and the impact of bladder and rectum on prostate position", Cancer/Radiothérapie' 25 (2021) 161-168