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RO-ILS CASE STUDY 19

WRONG VERTEBRAL BODY ALIGNMENT USING AUTO-REGISTRATION FOR SBRT

Introduction

Given the proximity and relatively similar shape of adjacent vertebral bodies, aligning them is prone to error. A prior RO-ILS publication discussed this topic,[1] shared additional case examples and highlighted a number of contributing factors that led to these clinically significant errors. This new case study reviews a recent near miss event and highlights continuing challenges with spine radiation treatments, including treatments using advanced imaging and technologies such as auto-registration software.

Event Description

- A patient was receiving SBRT to the lumbar spine.
- Therapists lined up the patient according to skin marks first, then performed a CBCT for alignment. The therapists and a physicist approved the alignment and called the radiation oncologist to the machine for review.
- The physician questioned if the alignment was off by a vertebral body. While the bony anatomy seemed well-aligned, the surrounding organs appeared different between the simulation CT and the CBCT.
- On further review, it was discovered that when the auto-registration software was used for alignment, the software aligned to the wrong vertebral body. A small field-of-view (FOV) was used for the auto-registration which focused on bony anatomy and did not focus on the surrounding organs.
- The alignment was corrected and the patient received treatment to the right location.
- Once the alignment was corrected, it was noted that although skin marks were used to align the patient initially, the table had to be moved 3.5 cm to align to the correct vertebral body.

Contributing Factors

- Small FOV
- Skin marks placed on mobile location, leading to discrepancy between skin marks and table position
- Default use of imaging software instead of clinical judgment
- No investigation of large table shift
- Confirmation bias

Lessons Learned/Mitigation Strategies

1. **Independent Review of Image Registration**
   When reviewing image registration for treatment guidance, it is important that each member of the team performs an independent review and not assume it has been done correctly by others. When possible, use orthogonal images in addition to CBCT to localize the target; the initial imaging technique is used for the alignment of the target and the second imaging technique is used for verification and minimal shifts if needed. The order of CBCT and orthogonal images may vary between practices but should be consistent within a practice.

2. **Selecting Appropriate Field-of-View**
   When treating the spine, a larger FOV may be needed to ensure the correct vertebral body is being targeted. The FOV should include other landmarks that staff members can independently use (e.g., from the iliac crest as a starting point) to optimize auto-registration software functionality. Although the vertebral bodies can appear very similar to each other, it is important to confirm that adjacent structures are also appropriate for the treatment location.

3. **Human Review of Software**
   Technology advancements have helped improve patient care immensely; however, staff must be cautious to not be lulled into complacency and overly rely on automation and the latest tools. Staff must execute safety fundamentals as attentive stewards of these powerful tools and fight potential confirmation bias. A thoughtful study of what failure modes exist using an American Association of Physicists in Medicine Task Group 100[2] approach can help identify challenges and consider mechanisms for optimizing automated work. As radiation oncology increasingly uses artificial intelligence software to facilitate the workflow, human confirmation of the work product is still required to catch errors.

4. **Discrepancy between Skin Marks and Table Position**
   When placing skin marks, mobile skin folds should be avoided. If mobile skin folds must be used, increased vigilance is needed when reviewing onboard imaging, to confirm the correct location is treated.

Conclusion

For anatomic reasons spinal radiation is a high-risk treatment location. This event highlights continued challenges with treating the correct vertebral body level. Beyond just increasing vigilance, facilities should consider applying standardization to processes. For example, a facility could standardize the imaging protocol for spine cases to include staff manually counting vertebral bodies or implement a checklist that includes items such the recommended large FOV. Thanks to the team approach and independent review by the attentive radiation oncologist, this error was caught before it reached the patient.

SAFETY CHECK

- What extra steps or safety checks are done at your facility for spinal radiation treatment?
- Is FOV standardized and how large is it when imaging for spinal treatment?
- How is an independent review of imaging encouraged and enforced to ensure the correct location is treated?
- When there is a discrepancy between skin marks and table position, what is your process to verify it? Is the process standardized and are there extra steps to reconcile the cause of the discrepancy?

References

1. RO-ILS Aggregate Report Q3Q4 – 2018 Report. https://www.astro.org/ASTRO/media/ASTRO/Patient%20Care%20and%20Research/PDFs/RO-ILS_Q3-Q4_2018_Report.pdf. Published 2018. Accessed May 21, 2024.
2. Huq MS, Fraass BA, Dunscombe PB, et al. The report of Task Group 100 of the AAPM: application of risk analysis methods to radiation therapy quality management. Med Phys. 2016 Jul;43(7):4209.

