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INTRODUCTION

Radiotherapy is one of the primary methods of treating cancer patients. The first step in preparing a treatment plan in radiotherapy involves contouring anatomical structures. Manually defining organs at risk is a time-consuming process that requires significant experience from the operator. The availability of reliable AI-supported software tools would be highly beneficial, as it could greatly improve the radiotherapy workflow and reduce the time needed for segmentation. The aim of this study is to present specific cases where the clinical use of AI requires technician intervention or even replacement by manual contouring.

METHODS AND MATERIALS

A deep learning-based autocontouring system (syngo.via RT Image Suite VB40, Siemens Healthineers, Forchheim, Germany) was used to delineate anatomical structures in all patients. Contours were reviewed for 150 patients treated in the chest, head and neck, and pelvic regions. The operator visually identified and recorded any contouring inaccuracies based on professional experience. For each region, structures that consistently posed challenges for automatic contouring were identified, and specific anomalous cases were described.

RESULTS

In all patients immobilized using a vacuum mattress, the mattress was not delineated. Similarly, the head and neck immobilization mask was not identified in any of the patients where it was used.

In the chest region, the most common issue was the presence of fluid in the lungs. Altered lung tissue was often incorrectly contoured despite clearly visible boundaries.

In the head and neck region, the main issue involved delineation of the larynx. Additionally, lung fragments visible on the CT scan were not marked. (Fig.1.)

In the pelvic region, the system failed to contour the cauda equina and portions of the spinal cord when its length was less than 10 cm. (Fig.2.)

Any anatomical anomalies (e.g., missing kidney, abdominal or inguinal hernia, or bones destroyed by disease) resulted in incorrect boundary detection or misplacement of the structures (e.g., the tumor volume was contoured as the urinary bladder). (Fig.3.)

Despite the use of Dual Energy and IMAR during CT imaging, metallic elements continued to pose problems for automatic contouring and were delineated inaccurately. (Fig.4.)

DISCUSSION

The difficulty in contouring the larynx observed in this study is also reported in the literature [1]. It is believed that the lack of standardized larynx boundaries and the anatomical complexity of this small structure make its automatic segmentation on CT particularly challenging. Poor visibility of the structure's boundaries may also contribute to this issue.

Similar explanations apply to the problems with delineating immobilization devices such as vacuum mattresses and head masks. Adjusting grayscale settings did not resolve the issue, and the only viable solution was manual contouring.

Another challenge involves atypical patient anatomy. While structures may be well-defined, their unusual location or shape can confuse the system. A potential solution would be to collect and use such cases to train the system, thereby improving its performance. Although this is time-consuming and labor-intensive, it enhances system accuracy. However, extremely atypical cases—such as the presence of a hernia or metallic implants—may continue to be problematic.

Many studies evaluate the accuracy of automatic contouring using metrics such as the Dice coefficient [2, 3]. Values above 0.7 are generally considered acceptable. However, in radiotherapy, this criterion may not be appropriate for certain structures like the spinal cord. If a region of spinal cord is missed during contouring, the delivered dose might exceed safe levels without detection. Therefore, such a situation is usually avoided by determining the spinal cord based on the fusion of CT and MRI examinations. The use of the Dice coefficient and determining its limit value for assessing the correctness of contouring should always be well thought out. Considering the complexity of the issue, the use of mathematical apparatus was abandoned in this work and a qualitative assessment of the operation of the automatic contouring system was made. The correctness of the system's determination of structures was assessed visually based on the assessment of an experienced technician.

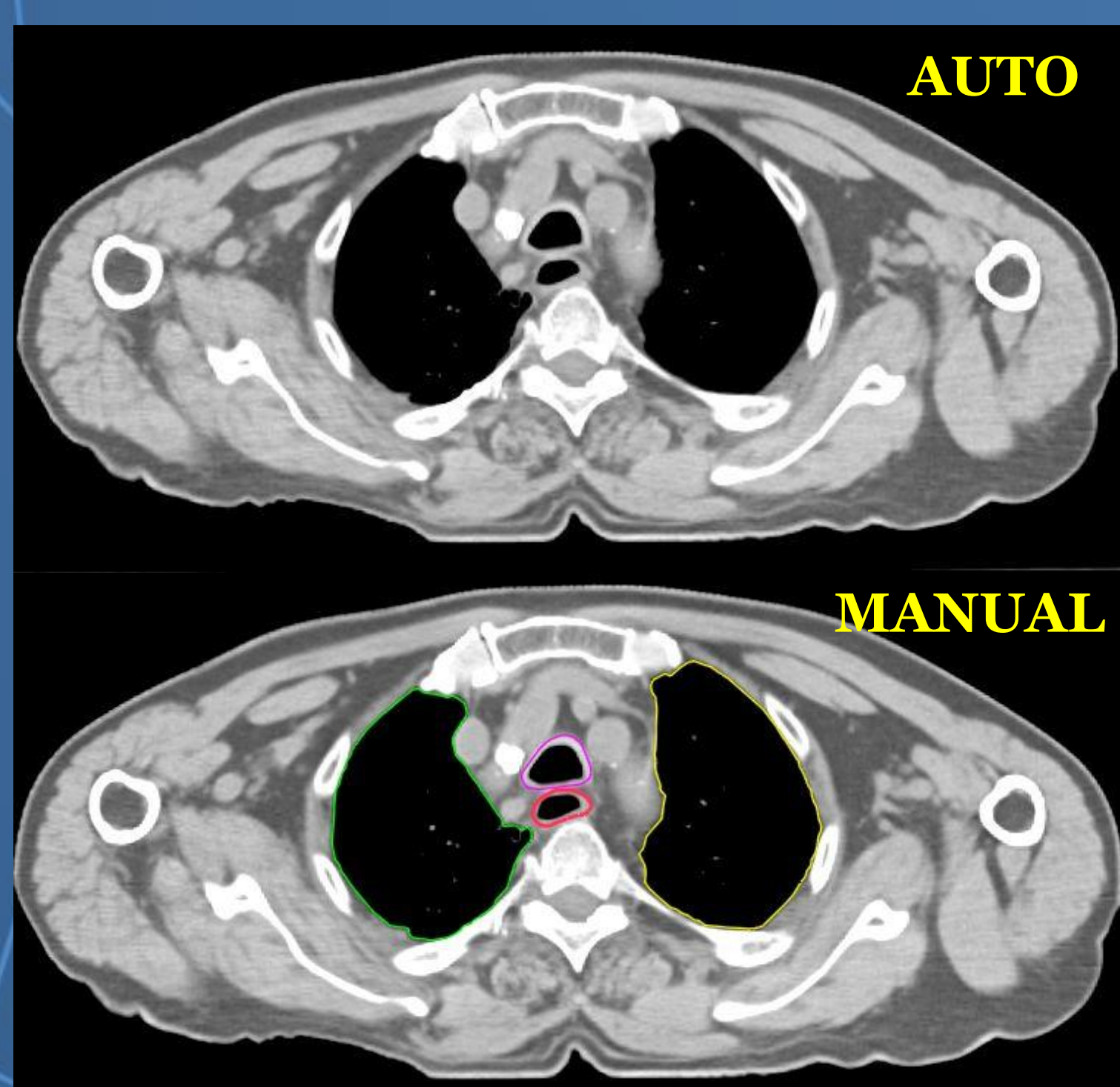


Fig.1. Lack of contours of the larynx, esophagus and lungs in the head and neck region.

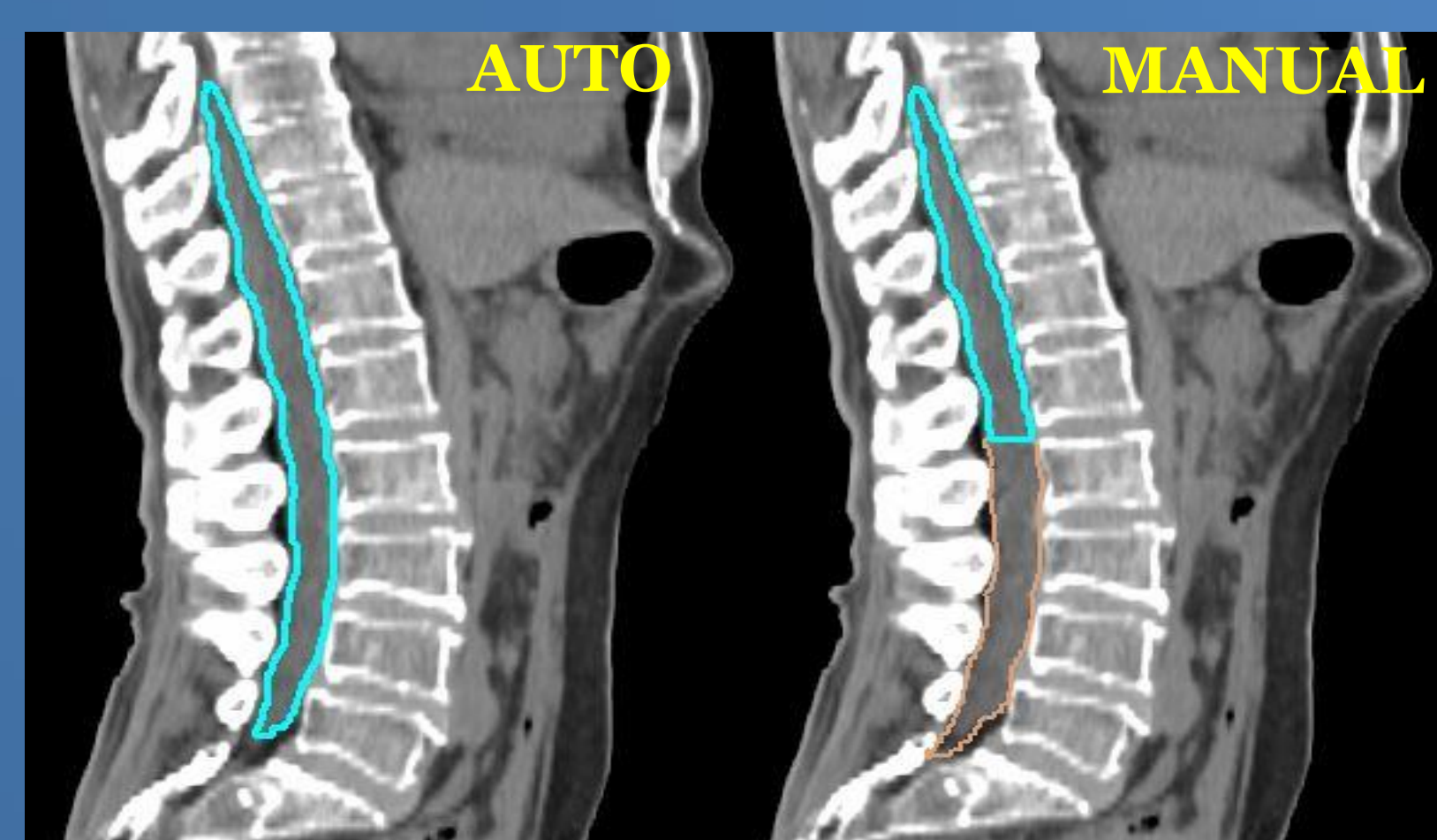


Fig. 2. Invalid delineation of the cauda equina .



Fig.3. Autocontouring for pelvic region in a case of a sarcoma tumor - the tumor volume was contoured as the urinary bladder .

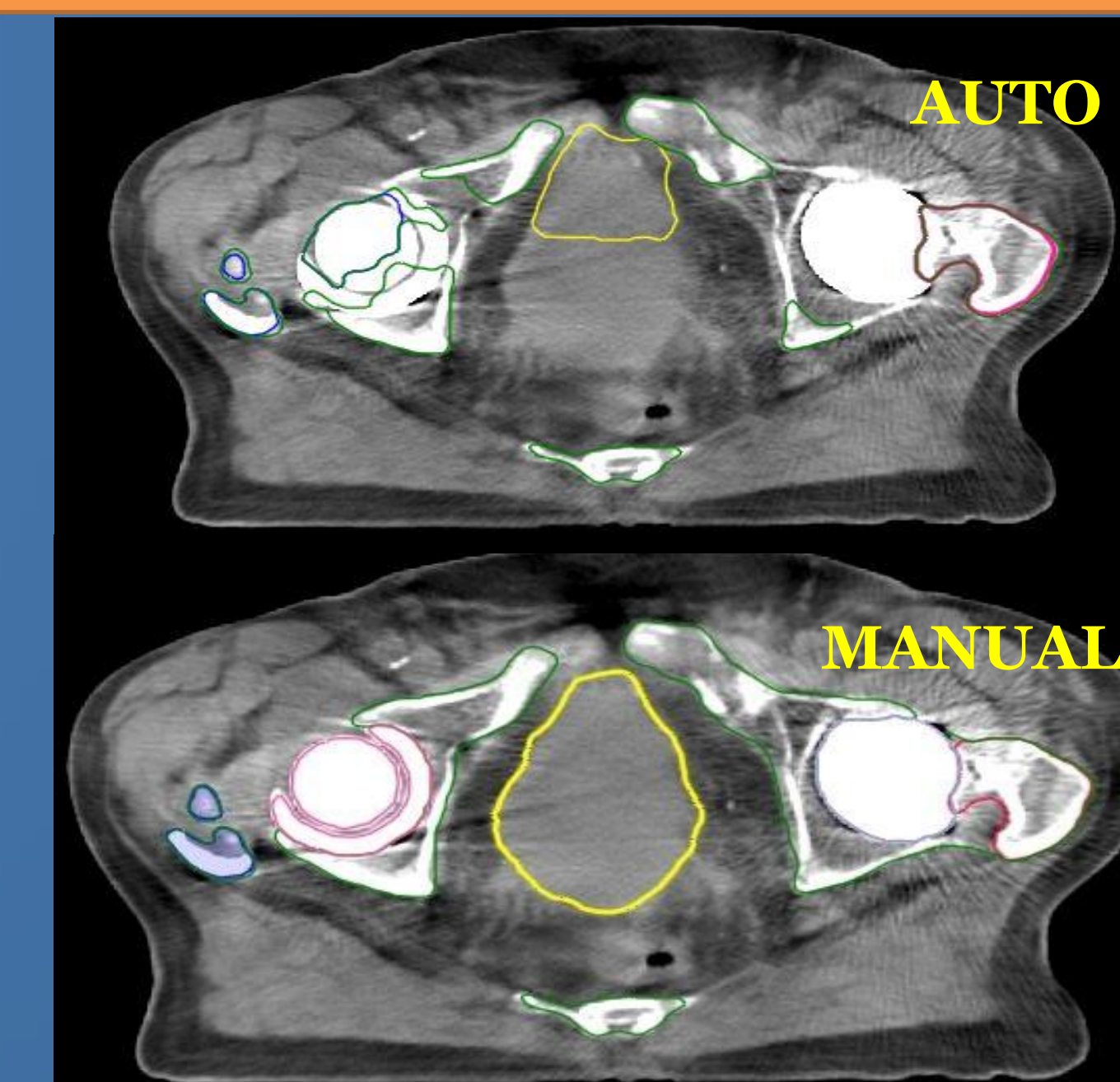


Fig. 4. Incorrect segmentation of OARs for a patient with a femoral head endoprosthesis.

CONCLUSIONS

The use of automatic contouring systems in clinical practice is highly advantageous and significantly accelerates the workflow. These systems must be continually improved by expanding their training databases with atypical cases—a task that, although demanding, is far less time-consuming than manual contouring alone. However, reliance on automatic systems does not eliminate the need to verify the accuracy of the generated contours. Furthermore, there are still cases in which structures are either not contoured or contoured incorrectly, necessitating manual intervention.

REFERENCES

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