Computerised analysis of lymph nodes increases agreement among investigators

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Cancer represents a substantial burden – not only on the affected patients themselves, but also on our healthcare systems and the general population. The lymphatic system plays a central role in metastatic cancerous processes, as lymph nodes are often among the first regions of the human body to be affected by carcinoma.

The software application Definiens LymphExpert™ supports radiologists in the assessment of tumour progression and patients' response to treatment by determining changes in the size of lymph nodes. To validate the software against manual human measurements, a clinical study was conducted in cooperation with the University Hospital of Munich/Grosshadern. The study's objective was to assess whether semi-automated analysis could be comparable to a purely manual assessment by human readers. The study was supported by Peter Herzog, MD, and Sonja Kirchhoff, MD, University Hospital of Munich/Grosshadern.

The study

In order to cover a reasonable range of biological diversity, CT data (axial images of 3mm slice thickness and a reconstruction increment of 2mm) of 50 patients (37 males, 13 females) with an age-range between 20 and 87 years were selected for the study.

Nineteen subjects were lymphoma patients, while the remaining 31 patients' primary cancer sites were liver, lung, breast and others. A total of 294 lymph nodes from different areas were analysed, with the longest diameters ranging from 10mm to 110mm.

The clinical study was based on RECIST 1.0 criteria (Response Evaluation Criteria In Solid Tumors), which specifies that the longest diameter of a single lesion is to be measured in an axial slice. Two experienced radiologists measured the RECIST diameter of each lymph node twice: once manually, using a workstation certified for clinical use, and then using the software application, Definiens LymphExpert.

Results of the study

The clinical study's first objective was to check whether the segmentation results obtained by the software are acceptable for an experienced clinical user. In this study 86% of the results were found to be acceptable by both investigators.

The second aspect of the study compared the manual measurements to the results provided by Definiens LymphExpert. The outcome is depicted in the form of Bland-Altman diagrams (see Figures 1 and 2).

In Figure 1, each circle represents a lymph node. Its x-coordinate is given by the average of the corresponding manual diameter measurements of both radiologists. Its y-coordinate is given by the difference of these measurements.

Semi-automatic diameter quantifications are plotted analogously in Figure 2. The green lines indicate the ± interval of the doubled standard deviation with respect to the mean (indicated by the black line).

Figures 1 and 2 show that the computer-aided quantification of the lymph nodes according to RECIST criteria is comparable to the manual measurements. When using Definiens LymphExpert, the agreement between both investigators even increased, shown by the decrease of the standard deviation of the measurement differences from 2.34 mm to 1.15 mm (see Table 1).

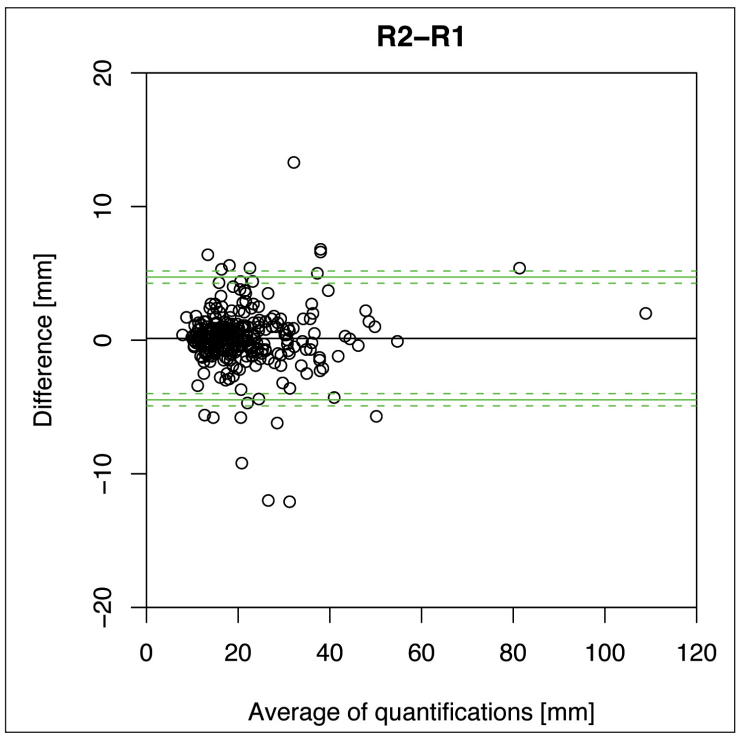


Fig 1: Bland-Altman diagram presenting the difference between the two readers' manual RECIST diameter measurements.

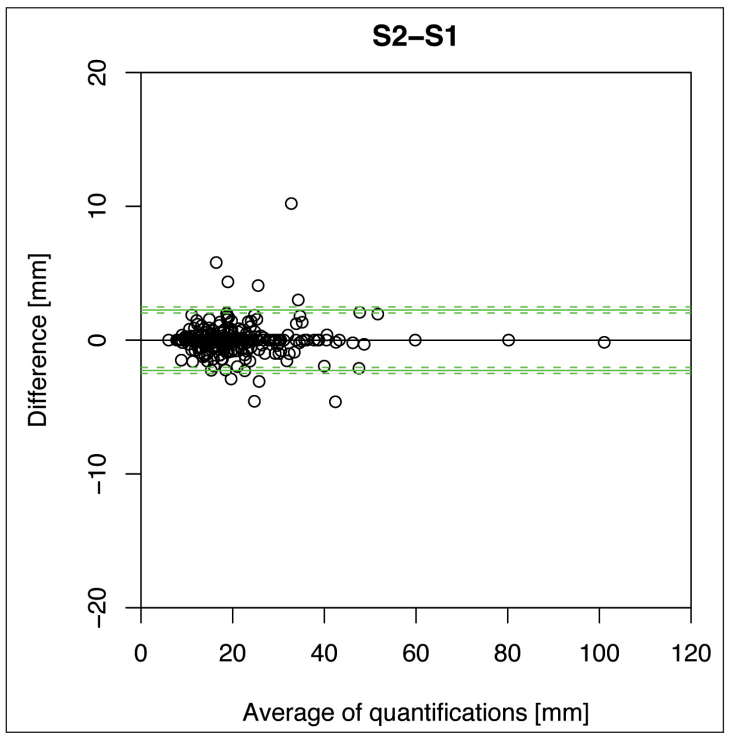
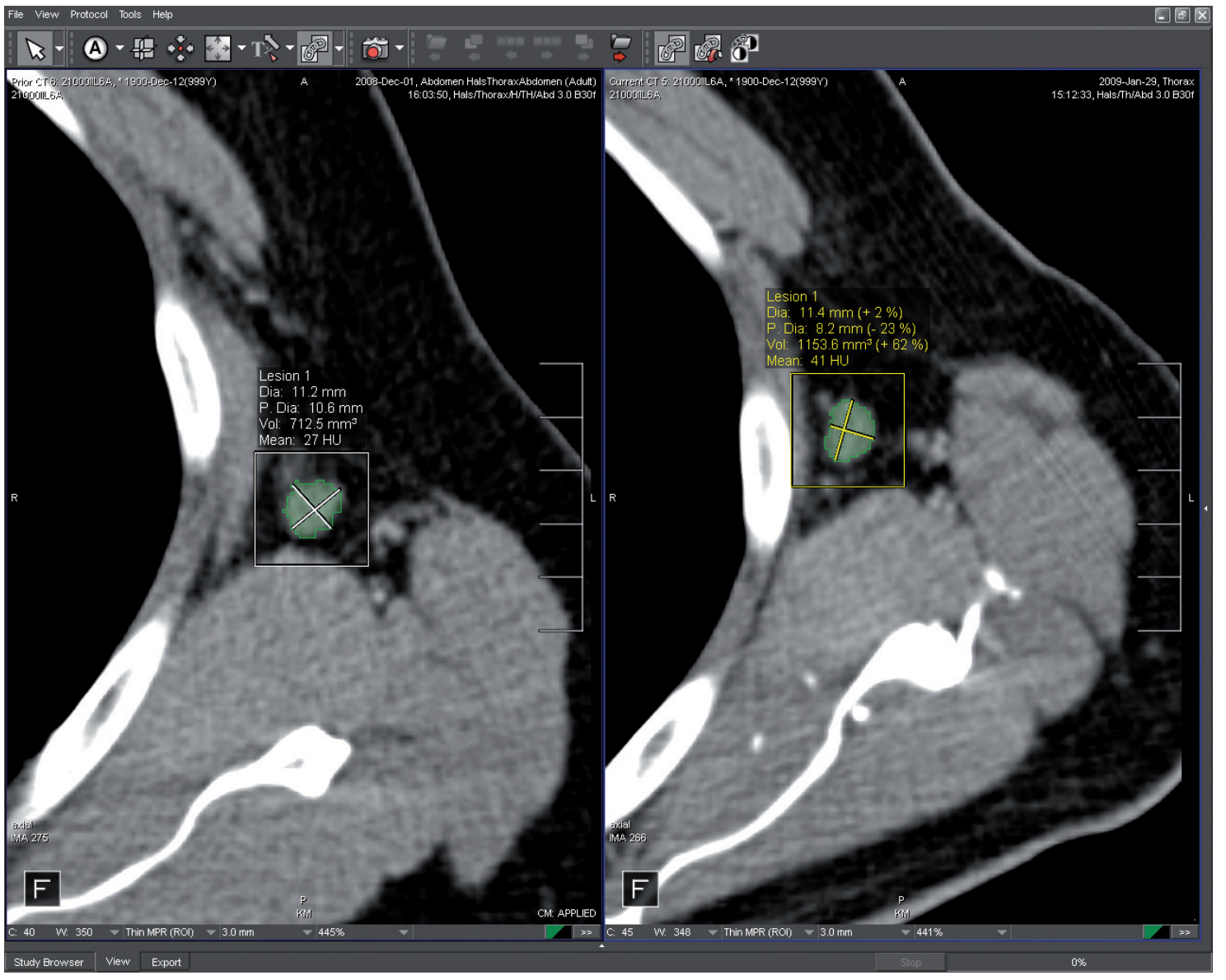


Fig 2: Bland-Altman diagram presenting the difference between the two readers' RECIST diameter assessments using Definiens LymphExpert.



Screenshot: Side-by-side comparison of analysed lymph nodes over time with Definiens LymphExpert.

Added value for clinicians

Determining how well and how fast patients respond to cancer therapy is essential for both patients and clinical physicians; the RECIST criteria were developed to help provide clinically-applicable information. Definiens LymphExpert demonstrated its efficiency in accurately quantifying RECIST criteria with acceptable results of 86% of the lymph nodes assessed. The accuracy achieved on the tested data was found to be comparable to manual diameter measurements.

The latest version of Definiens LymphExpert contains new features allowing for the users to manually edit detected contours of lymph nodes and also to include lymph nodes that could not be automatically analysed. The new functions will help radiologists to reconsider segmentation results, such as the 14% of lymph nodes in the comparative study that dropped out of the acceptable range.

Definiens LymphExpert supports clinical physicians in making essential decisions on tumour progression and patient response to therapy.

Please visit Definiens at ECR 2010, booth 606 (EXPO Gallery first level).

	R2-R1 [mm]	S2-S1 [mm]
mean	0.13	- 0.01
stdev	2.34	1.15

Table 1: Mean and standard deviation of the differences between manual (R2-R1) and semi-automatic (S2-S1) quantification
R1, R2: manual measurements of investigators 1 and 2, respectively
S1, S2: semi-automatic assessment of investigators 1 and 2, respectively