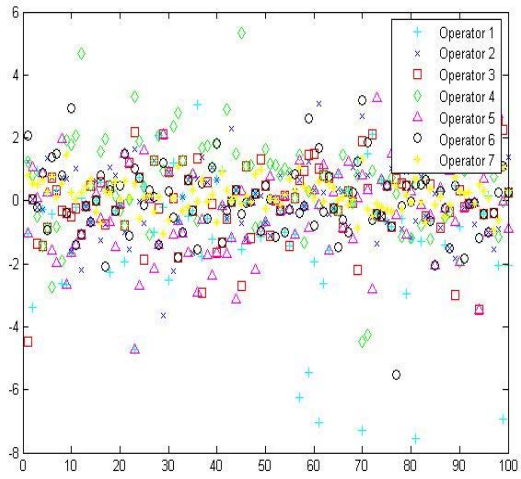

Conclusion: Our DIR-QA platform demonstrated inter- and intra-operator variability on the order of one voxel (1mm by 1mm by 2.5mm). Machine-generated feature points can serve as a measure of the quality of deformable image registration.

EP-1902

Impact of image quality on DIR performances: results from a multi-institutional study

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Purpose or Objective: To investigate the accuracy and robustness, against image noise and artifacts (typical of CBCT images), of various commercial algorithms for deformable image registration (DIR), to propagate regions of interest (ROIs) in computational phantoms based on patient images. This work is part of an Italian multi-institutional study.

Material and Methods: Thirteen institutions with six available commercial solutions provided data to assess the agreement of DIR-propagated ROIs with automatically drown ROIs considered as ground-truth for the comparison. The DIR algorithms were tested on real patient data from three different anatomical districts: head and neck, thorax and pelvis. For each dataset, two specific Deformation Vector Fields (DVFs) were applied to the reference data set (CTref) using the ImSimQA software. To each one of these datasets two different level of noise and capping artifacts were applied to simulate CBCT images (fig.1, panel a -b) . Every center had to perform DIR between CTref, two deformed CTs and four CBCT for each anatomical district. The different software used in this study were: VelocityAI, Mirada, MIM, RayStation, ABAS, SmartAdapt. A four way ANOVA was performed to identify major predictors of DIR performances followed by a post hoc Sceffè test for analyzing intergroup differences; the logit transform of the Jaccard Conformity Index (JCI) was used as metric.

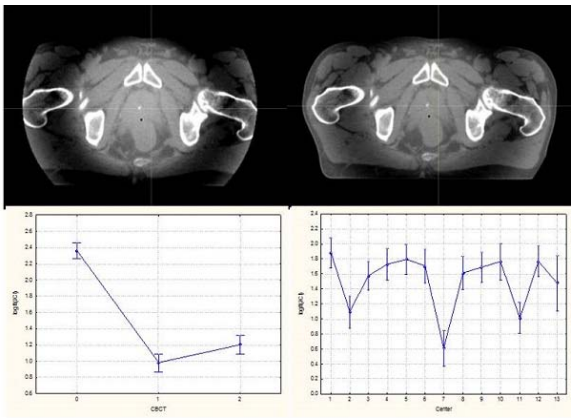

Fig. 1. Examples of the two simulated CBCT images. (panel "a" and "b") JCI values against image quality (panel c): "0" states for "clear" CT images, and CBCT "1" and "2" for the two CBCT version of the deformed images. DIR performances of the different centers (panel "d").

Results: More than 2000 DIR-mapped ROIs were analyzed, and many results were carried out. We report only the most relevant results for clinical applications. The ANOVA test states that the differences in DIR performances are not statistically significant between the head and neck and prostate cases, while lung case shows a significant difference; they depend from the strength of the deformation; and they are very sensitive to image quality (capping artifacts and noise) (Fig1 panel c). There is statistical evidence that the center #7 performs worst then the others with significant differences respect all the other centers except the number #2 and #11 (fig1, panel d).

Conclusion: This work illustrates the effect of image noise to DIR performances in some clinical scenarios with well-known DVFs. Some clinical issues (like ART or Dose Accumulation) need accurate and robust DIR software. This work put in evidence the presence of an important inter-software variability (in terms of JCI parameter), and the need of accurate system commissioning and quality control about the robustness of some commercial system against image quality. Regarding the results in fig1, panel c, the worst scenario (CBCT2) the DIR performances appear slightly better than in CBCT1: what does it mean? Probably the results are very sensitive to image quality but there is a threshold in image degradation above which adding noise or artifacts doesn't impact on DIR algorithms. This finding suggests the opportunity to test other situations to tune at a finest level noise and artifacts.

EP-1903

Application of the Enhanced ChainMail algorithm with inter-element rotation in adaptive radiotherapy

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Purpose or Objective: In adaptive radiotherapy positioning uncertainties, due to e.g. tissue deformations in the course of fractionated therapy, can result in a dose delivery that strongly deviates from the planned dose. Especially with regard to particle therapy, it is therefore important to quantify such deviations and to evaluate the need for