

# Are current margins in locally advanced cervical cancers treated by tomotherapy appropriate?

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## INTRODUCTION

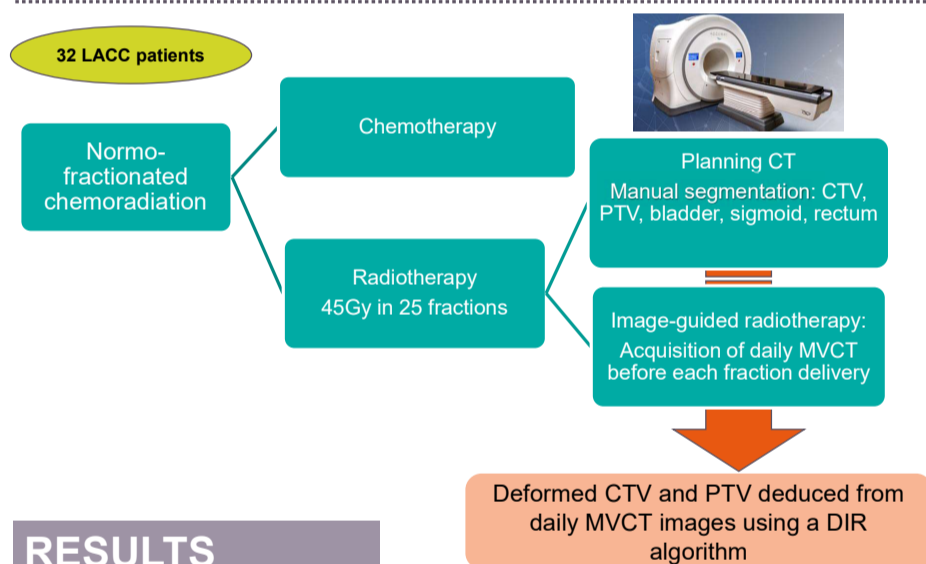
Margins applied to pelvic lymph nodes clinical target volume (CTV\_N) and to primary tumor clinical target volume (CTV\_T) to generate their respective Planning Target Volumes (PTV\_N and PTV\_T) vary widely between institutions in locally advanced cervical cancers (LACC). In our center, isotropic 7 and 10 mm margins are considered for normo-fractionated image-guided treatments to deduce PTVs from CTV\_N and CTV\_T respectively. The aim of this work was to assess the validity of these margins for Tomotherapy treatments using a Deformable Image Registration (DIR) algorithm.

## MATERIALS & METHODS

- Monocentric cohort of **32 patients**
- **Planning CT and 25 MVCT** acquired for image guidance purposes retrieved for each patient
- **CTV, PTV, bladder, rectum and sigmoid** contoured on the planning CT (pCT) by a radiation oncologist
- Application of a **DIR algorithm** based on three intensity metrics (normalized cross-correlation, mutual information and a third metric based on local discrete wavelet transform that allows recovery of geometric information) on the planning CT considering each daily MVCT, **resulting in deformed CT, CTV, PTV (dCT, dCTV, dPTV) for each patient and fraction.**
- **DIR algorithm validation:**
  - **Six patients** selected from the entire cohort (subcohort 1)
  - Delineation of the CTV (CTV<sub>man</sub>) and PTV (PTV<sub>man</sub>) on 5 MVCT (one per week of treatment)
  - Evaluation metrics: **Dice Similarity Coefficient (DSC):** dCTV/dPTV vs CTV<sub>man</sub>/PTV<sub>man</sub>

$$DSC_{CTV} = \frac{2(CTV_{man} \cap dCTV)}{CTV_{man} + dCTV} \quad DSC_{PTV} = \frac{2(PTV_{man} \cap dPTV)}{PTV_{man} + dPTV}$$
- **Inter-fractional motion impact – quantitative analysis:**
  - 32 patients: **Percentage of the deformed CTV outside PTV – evaluation for each fraction**

$$V_{dCTVoutPTV} = \frac{100}{dCTV} [(PTV \cup dCTV) - PTV]$$
- **Investigation of the potential of reducing clinical margins:**
  - Sub-cohort of **6 patients** (subcohort 1)
  - Application of isotropic margins to the CTV\_N (4mm, 5mm) to generate different PTV\_N and six non-isotropic margins to the planning CTV\_T (Table 1): assessment of the percentage of the deformed CTV outside the new generated PTV



Superior	Inferior	Lateral	Anterior / Posterior	Structure Name
15	5	10	15	PTV_T_1
10	10	10	15	PTV_T_2 (Gustave Roussy margins)
10	5	10	10	PTV_T_3
15	5	10	10	PTV_T_4
10	5	10	15	PTV_T_5
10	10	10	10	PTV_T_6

DSC objective > 0.8  
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## RESULTS

- **DIR algorithm validation (Figure 1):**
  - CTV: mean±std = 0.68 ± 0.06 (Manually contoured CTV on MVCT were different from the planning CTV, this may explain the low values of DSC)
  - PTV: mean±std = 0.81 ± 0.03
- **Interfractional motion impact – margins used in clinical routine (10 mm on CTV\_T and 7 mm on CTV\_N) (Figure 2):**
  - 30/32 patients had on average less than 1% of the CTV outside the PTV
  - Among these 30 patients, one fraction for two patients presented more than 5% of the CTV outside the PTV: 5.9% and 8.1%
  - 2/32 patients showed lower target volume coverage in comparison with other patients, with mean values of 1.5% and 1.4% of the CTV outside the target volume
- **Interfractional motion impact with margin reduction: mean CTV outside PTV (%)**
  - Reduction of margins of CTV\_N was inadequate for all six patients: results in non-coverage of the CTV\_N of at least 10%
  - Only one PTV\_T (margins: 10mm superior, 10 mm inferior, 10mm lateral left and right, 15mm anterior and posterior) had less than 5% of the CTV\_T outside the PTV\_T,
  - No statistical difference between PTV\_T\_1 and PTV\_T\_2 (margins: 15mm superior, 5 mm inferior, 10mm lateral left and right, 15mm anterior and posterior)

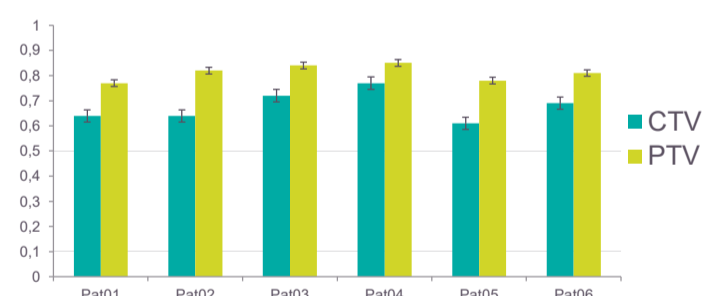


Fig. 1: DSC between deformed and manually contoured target volumes on a subcohort of six patients

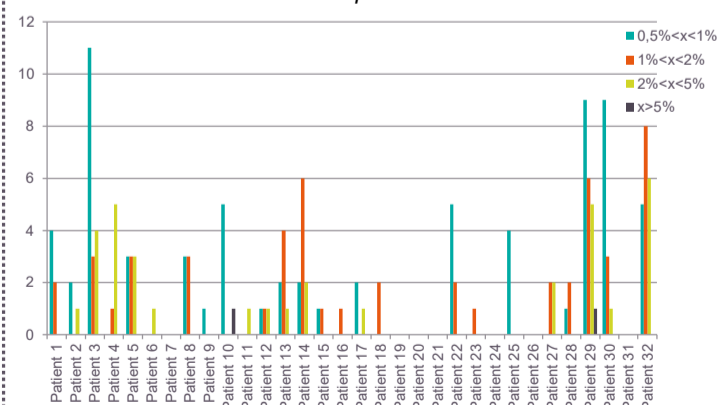


Fig. 2: Number of fractions with x % of the CTV outside the PTV per patient

## CONCLUSION

A larger subcohort is needed to evaluate performances of the DIR algorithm. Based on the evaluated version, our data suggest that current clinical margin recommendations are appropriate if applied without treatment adaptation. Reduction below 7mm on CTV\_N should not be recommended.