Materials and Methods: T3/T4NO or N+ rectal adenocarcinoma patients (pts) were enrolled in an observational trial. Concomitant chemotherapy consisted of Oxaliplatin 100mg/m² on days -14, 0, +14, and 5-FU 200mg/m²/day from day -14 to the end of radiotherapy (day 0 is the start of radiotherapy). Radiotherapy consisted in the delivery of 41.4Gy in 18 fractions (fr) (2.3 Gy/fr) with Tomotherapy to the tumor and regional lymph-nodes (PTV) defined on CT/MRI imaging. After 9 fr, CT and MRI were repeated for the planning of the adaptive phase: PTVadapt was generated by adding a 5mm margin to the residual tumour visible on MRI images. In the last 6 fr, a boost of 3.0 Gy/fr (total dose: 45.6 Gy in 18 fr) was delivered to PTVtumor while concomitantly delivering 2.3 Gy/fr to PTV outside PTVtumor. Data regarding acute toxicity and outcome were analyzed.

Results: From September 2009 to April 2014, 50 pts completed the preoperative treatment and were evaluable. No G4 toxicity occurred: the G3 toxicity was gastrointestinal only: diarrhoea in 9/50 pts (18%), and proctitis in 2/50 (4%). Diarrhoea started before the adaptive phase in all cases and all affected patients were women. Two pts achieved complete response (cCR) and refused surgery, 1 pt was lost, 1 pt had early distant progression. Forty-six pts underwent surgery (43 R0, 3 R1): thirteen pts (28%) had pathological complete response (pCR); 22/46 (47%) showed TRG3 response: 13/46 (28%) and 6/46 (13%) had ≤5%, and 6-10% residual viable cells, respectively. Regarding the two patients with cCR who refused surgery, one is still cCR after 54 months while the other had local relapse and underwent transanal resection 1 year after treatment. Concerning treatment feasibility, two pts interrupted radiotherapy after 7 and 13 fr respectively, the remaining pts (48/50=96%) completed the treatment, and the median duration of RT was 25 days (22-36 days). 43/50 pts (86%) and 40/50 pts (80%) received the full dose of oxaliplatin and FU, respectively: 14% of pts received moderately reduced doses (60%-90%), and only two pts (4%) received less than 60% of the planned dose. Conclusions: This study confirms that adaptive boost strategy is feasible with an acceptable G3 toxicity rate and a very encouraging tumour response rate. The results suggest that there should still be room for further dose escalation with the aim of increasing pCR and/or cCR rates. The practical use of our 1.5 Tesla MRI/HDR treatment room makes it possible to perform position verifications and adaptive interventions during the process of BT to individualize the use of rectal probes and bladder fillings: we did interventions with respect to the OAR's, 4 times for deflation and then remove it before scanning and irradiation. Conclusions: Having a combined 1,5 T MRI/HDR treatment room makes it possible to perform position verifications and adaptive interventions that help to reduce uncertainties in brachytherapy and to deliver the prescribed dose as accurate as possible according to plan.