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Purpose: to investigate the dose reduction to organs at risk (OARs) and the improvement of conformity index (CI) in HDR treatments with intracavitary versus combined intracavitary/interstitial (IC/IS) applicators. To identify the correlation of dose to OARs with CI.

Method: Planning MRI or CT images for fifteen patients treated with IC or IC/IS brachytherapy applicators were obtained. For each patient, one structure set (GTV, HR-CTV and OARs) was delineated and two treatment planning scenarios were modeled for both IC and IC/IS applicators using Oncentra Brachy v.4.5.3. Each IC and IC/IS treatment plan was optimized to reach an equivalent dose to the D90 of HR-CTV while consistent with GEC-ESTRO guidelines for D2cc to OAR (bladder, rectum, and sigmoid). CI, defined as the quotient of treatment volume receiving 90% or more of the prescribed radiation dose, and the HR-CTV volume was computed for each treatment plan. Paired t-tests were used to identify significant differences between IC and IC/IS treatment plans with respect to OAR doses and CI, while Spearman correlation coefficients were used to assess correlations between OAR sparing and CI.

Treatment planning: For each patient we used the original treatment plan that was delivered, then we created on the same imaging data set and on the same structure set a mock up plan with IC only or IC/IS. In cases where interstitial needles were not placed at the time of applicator insertion, needle/dwell positions were virtually modeled based on ovoid position and patient anatomy. CI= TV of D90(cc)/HR-CTV(cc). Hybrid plans= IC/IS applicators plans, TnO= Tandom and ovoid's IC applicator plans.

Results: Mean volumes of HR-CTV were 29.7 (range 10.4 to 52.3) cc. Mean doses to D2cc volumes were 15.9% lower for bladder ($p<0.01$); 15.3% lower for rectum($p<0.01$);

and 10.0% lower for sigmoid ($p<0.01$) with IC/IS plans. Mean CI for IC and IC/IS plans were 2.95 (range 1.90 to 4.5) and 2.44 (range 1.9 to 3.3) respectively and demonstrated significant improvement for IC/IS plans ($p<0.05$). CI improvement demonstrated inverse correlation with D2cc dose reduction for bladder ($p<0.05$), rectum ($p<0.05$), and sigmoid ($p<0.05$).

Fig 1: Improved conformity index is strongly associated with reduction of dose to OARs. $rs = 0.81786$, p (2-tailed) = 0.0002.

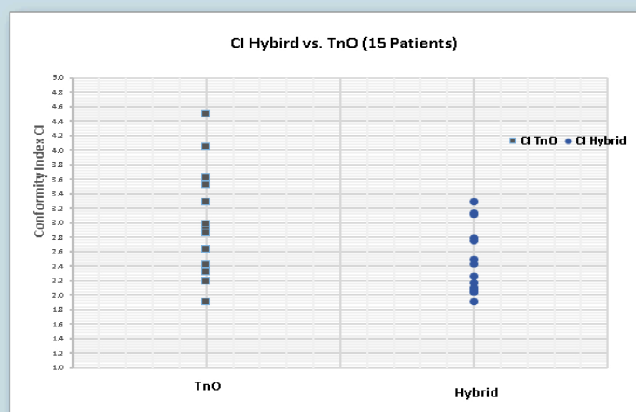


Fig 2: Improved conformity index is correlated with dose reduction to rectum. $rs = -0.83571$, p (2-tailed) = 0.0001

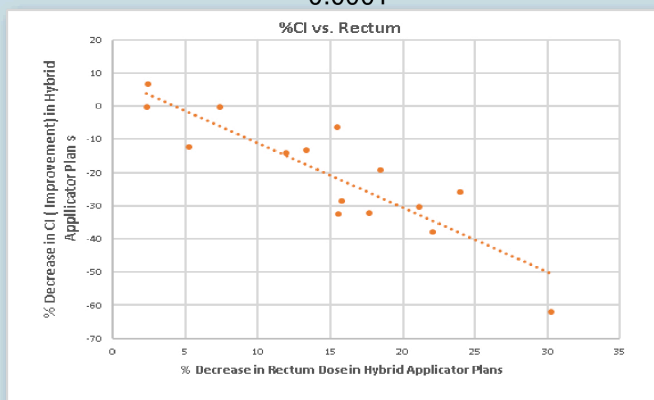


Fig 3: Improved conformity index is correlated with dose reduction to sigmoid colon. $rs = -0.78929$, p (2-tailed) = 0.00047

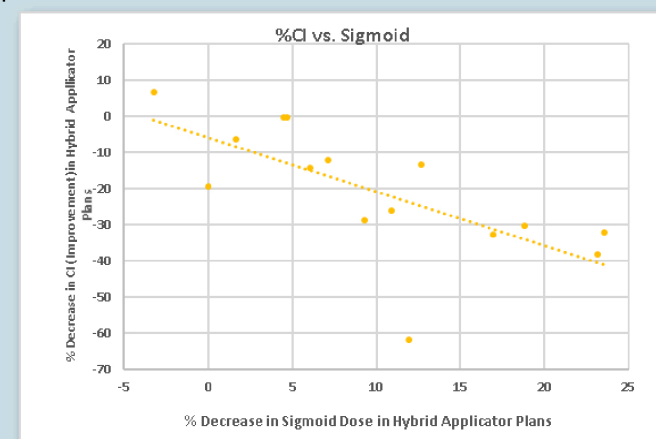
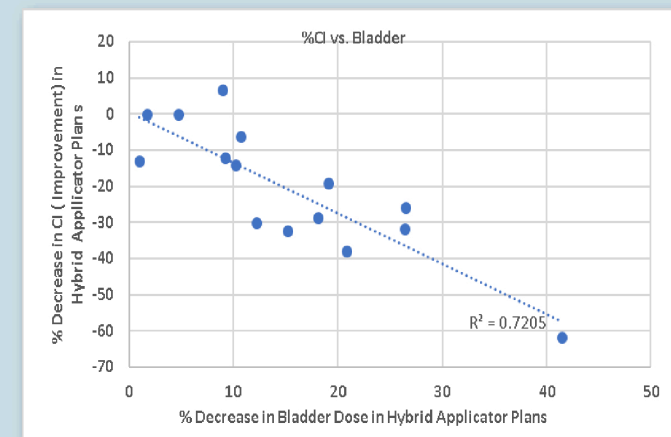


Fig 4: Improved conformity index is correlated with dose reduction to bladder $rs = -0.80357$, p (2-tailed) = 0.00031



Significance & Conclusion: Clinicians use high risk CTV volume as a predictor for the potential dose reduction to OARs with use of hybrid applicators (combined IC /IS), other than the HR-CTV volume, little data is available to guide clinicians as to predict relative OAR dose reductions with use of combined IC/IS vs IC applicators and tumor/target volume characteristics that correlate with greatest benefit. We proved that for a range of HR-CTV volumes, dose reduction to OARs with the use of IC/IS applicators does not depend on HR-CTV volume only. We proved that the improved conformity index and relative dose reduction OARs are strongly correlated regardless of HR-CTV volume. We aim to expand the study by increasing the number of patients and testing other correlations between OARs dose reduction, HR-CTV, and dosimetric parameters to come up with a predictor assist the clinicians in making the decision of using combined IC/IS. For an equivalent prescribed radiation dose, IC/IS applicators are associated with significant reductions in D2cc doses to rectum, sigmoid, and bladder. Significantly improved CI in IC/IS plans is associated with greater dose reductions to bladder, rectum, and sigmoid with use of IC/IS applicators.