Institutional Review of Ovoid Surface Dose and Physician Variation In HDR Brachytherapy: A Step Toward Vaginal Dose De-Escalation

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ABSTRACT

EMBRACE II emphasizes minimizing vaginal mucosal dose in locally advanced cervical cancer brachytherapy. Beyond the traditional organs at risk (bladder, rectum, sigmoid), vaginal mucosa dose has gained attention due to late toxicities such as vaginal stenosis, which affect sexual function and quality of life. This study examines the relationship between vaginal dose, HR-CTV coverage, and inter-fraction variability from physician contouring.

We retrospectively evaluated 170 fractions (44 patients) treated with EBRT followed by HDR tandem and ovoid brachytherapy. Vaginal dose was measured at the left and right ovoid surfaces as a percentage of prescription dose and assessed against HR-CTV D90% and ovoid size. Inter-fraction variability was compared between fractions contoured by multiple physicians (151/170) versus a single physician (19/170).

Some fractions showed high vaginal doses (>150% Rx) despite lower HR-CTV D90%, indicating that added ovoid loading did not improve coverage. Vaginal dose generally decreased with larger ovoids. The multiple physician group showed greater variability: 1.9 fold higher HR-CTV volume variation, 17.6% higher vaginal dose, and 35.0% higher dose standard deviation.

Vaginal dose can be safely reduced without compromising HR-CTV coverage, supporting the feasibility of EMBRACE II de-escalation. Inter-fraction variability, especially from multiple physicians, drives excess vaginal dose, underscoring the need for standardized contouring and physician continuity to minimize unnecessary mucosal dose and improve outcomes.

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INTRODUCTION

The **2018 EMBRACE II study** came with recommendations to **de-escalate vaginal dose during the treatment of locally advanced cervical cancer** using tandem and ovoid applicators [1]. Historically, the organs at risk (OARs) considered during intracavitary brachytherapy planning included the bladder, rectum, sigmoid, and small bowel. In recent years, however, **dose to the vaginal mucosa** has become widely discussed as a distinct planning concern, driven by **late toxicities**, most notably **vaginal stenosis**, but also dryness, telangiectasia, shortening, and dyspareunia, that can persist for years after treatment and meaningfully degrade sexual function and quality of life [2].

Despite these recommendations**, the absence of a single, strongly enforced vaginal OAR dose limit leaves substantial room for planning heterogeneity among physicians and physicists**. This variability is compounded upstream by inter-physician differences in target and normal-tissue contouring, which propagate into inter-fraction differences in achievable coverage and source loading. The present work investigates the interplay between vaginal dose, HR-CTV coverage, and inter-fraction variability attributable to physician contouring, with the goal of clarifying where reproducible dose de-escalation is feasible without sacrificing tumor coverage—supporting the broader project aim of limiting ovoid and ring loading in tandem-and-ovoid brachytherapy to preserve post-treatment quality of life.

METHODS AND MATERIALS

We retrospectively evaluated **170 fractions** (**44 patients**) treated with EBRT followed by HDR brachytherapy using tandem and ovoid applicators. Vaginal dose was measured at the surface of the left and right ovoids as a percentage of prescription dose. Metrics assessed included **vaginal dose relative to HR-CTV D90%** to evaluate dose de-escalation affects on target coverage, as well as **ovoid size correlations with vaginal dose**. To assess inter-fraction variability, patients were grouped by contouring consistency: multiple physicians across fractions (151/170) versus a single physician (19/170), and differences in vaginal dose and HR-CTV volumes were analyzed.

RESULTS

Higher vaginal doses (>150% Rx) occurred in some fractions despite lower HR-CTV D90%, suggesting **increased ovoid loading did not improve target coverage.** Vaginal dose also trended inversely with ovoid size, generally decreasing as larger ovoids were used, consistent with the greater source to mucosa distance afforded by larger applicators**. Inter-fraction variability was higher in patients contoured by multiple physicians**, with 1.9-fold greater HR-CTV volume variation**, 17.6% higher (mean) vaginal dose**, and 35.0% higher dose standard deviation. These findings indicate **contouring variability may lead to unnecessary vaginal dose** exposure.

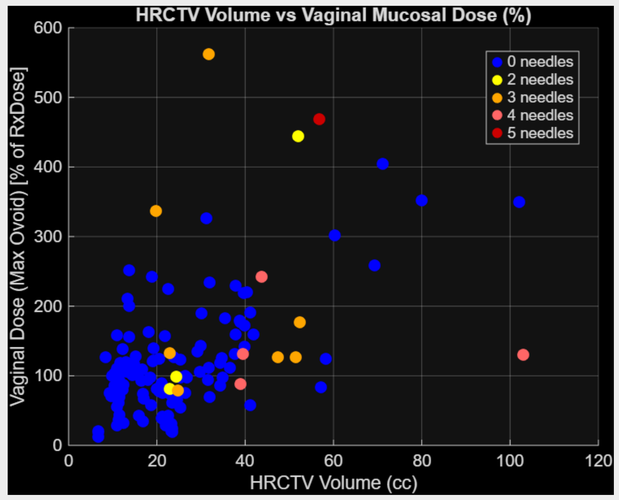

Figure 1. This data shows a small correlation between the size of our target and increase in the vaginal dose. Some data points are highlighted in hotter colors for interstitial cases which may have more complicated HR-CTVs, giving the data some context.

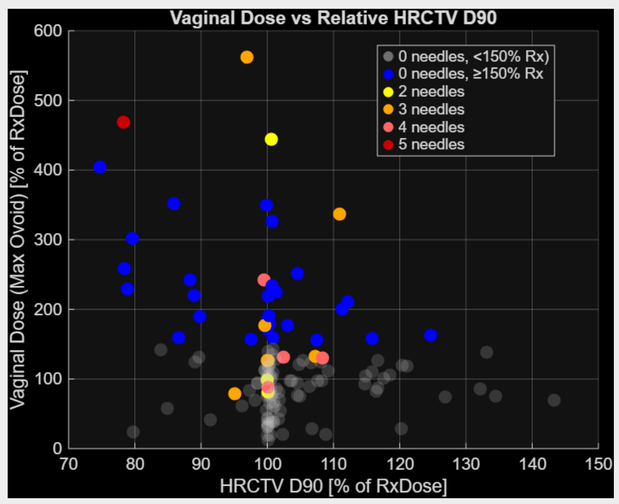

Figure 2. As you increase target coverage, the expectation is you may also increase vaginal dose. However, this data exposes that increasing ovoid loading and vaginal dose does not result in better target coverage.

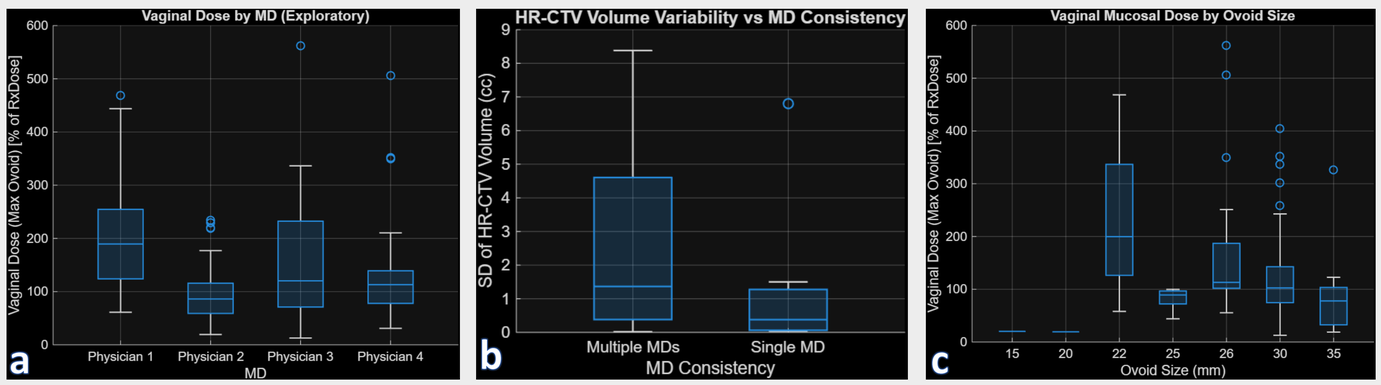

Figure 3. Originally the data in these tables were just exploratory and not the focus of the research, but some interesting correlations were found. (a.) Shows the difference in variability in vaginal dose as given by each of our four gyn physicians. (b.) This data shows the much larger variability in standard deviation of HR-CTV volumes when multiple physicians are involved in the contouring through a brachy course. (c.) This shows a general correlation that as ovoid size is increased, there is a decrease in vaginal dose.

DISCUSSION

These results reinforce the EMBRACE II premise that vaginal dose de-escalation is achievable without sacrificing target coverage [1]. The observation that some fractions delivered >150% Rx to the vaginal surface while achieving lower HR-CTV D90% is particularly informative: it demonstrates that **heavier ovoid loading does not reliably improve coverage** and may simply raise mucosal dose unnecessarily. This aligns with prior work showing that shifting loading away from the ovoids and ring, toward the tandem and needles, reduces vaginal point doses while maintaining the HR-CTV D90 ≥ 85 Gy EQD2 objective [2]. The inverse relationship between ovoid size and vaginal dose further supports applicator selection as a practical lever for de-escalation. Because higher vaginal point doses are significantly associated with grade ≥2 vaginal stenosis, reducing this avoidable exposure has direct implications for late toxicity and quality of life [3].

Patients managed by multiple physicians across fractions experienced markedly greater HR-CTV volume variation and correspondingly higher and more variable vaginal dose, implicating inter-observer contouring differences, rather than true inter-fraction anatomic change, as a modifiable source of excess dose.

Limitations include this study's use of single institution, retrospective design and the modest single physician subgroup (19/170).

CONCLUSIONS

This analysis confirms that vaginal dose can be safely reduced during tandem and ovoid HDR brachytherapy without compromising HR-CTV coverage, supporting the feasibility of the EMBRACE II de-escalation recommendations in routine practice [1]. High vaginal doses were often delivered without any corresponding coverage benefit, and larger ovoids were associated with lower mucosal dose, together highlighting straightforward, clinically deployable pathways to limit vaginal mucosal exposure.

Inter-fraction variability, particularly from multiple contouring physicians, emerged as a significant contributor to excess vaginal dose. Standardizing contouring practices and maintaining physician continuity across fractions therefore represent high impact interventions to minimize unnecessary mucosal dose. Implementing these measures clinically should reduce avoidable vaginal toxicity and help preserve sexual function and quality of life for women following treatment for locally advanced cervical cancer.

REFERENCES

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