Adaptive MR-Guided Stereotactic Radiotherapy Boost for gynaecological cancer; EMBRACE-II Dose Constraints vs UK SABR Consortium 2019 Guidelines
Curative treatment for locally advanced cervical cancer is chemo-radiation with a combination of external beam radiotherapy (EBRT) and brachytherapy boost[1]. This combination can also be applied in endometrial, vulval, vaginal or recurrent gynaecological cancers. However, brachytherapy is not always feasible due to patient factors, including refusal, or, more commonly, technical challenges such as tumour extent, fibrosis or poor access.

Adaptive MR-Guided Stereotactic Radiotherapy Boost for Gynecological Cancer; EMBRACE-II Dose Constraints vs UK SABR Consortium 2019 Guidelines

Ebison Chinherende, Derya Yucel, Gemma Eminowicz
genesiscare.com/uk

Background

Curative treatment for locally advanced cervical cancer is chemo-radiation with a combination of external beam radiotherapy (EBRT) and brachytherapy boost[1]. This combination can also be applied in other gynaecological cancers undergoing chemoradiation. However, brachytherapy is not always feasible due to patient factors, including refusal, or, more commonly, technical challenges such as tumour extent, fibrosis or poor access. Unfortunately, historical external beam radiotherapy (EBRT) boosts are associated with poorer survival than brachytherapy[2].

MR-Guided stereotactic ablative radiotherapy (SABR) adapts dose to daily anatomical variations, with superior soft tissue contrast, continuous intrafraction tracking, reduced PTV margins and allows for dose escalation. This therefore could provide an effective alternative in patients unable to undergo standard of care brachytherapy.

Dose to organs at risk (OARs) limit the radiation dose that can be delivered and therefore mandatory and optimum OAR dose constraints are applied at planning to minimise toxicity risk. For brachytherapy, the EMBRACE-II guidance[3] is applied (max dose to 2cc (D2Ccc) but for SABR the 2019 UK SABR consortium[4] guidelines (UKSC-19) are applied.

Objectives

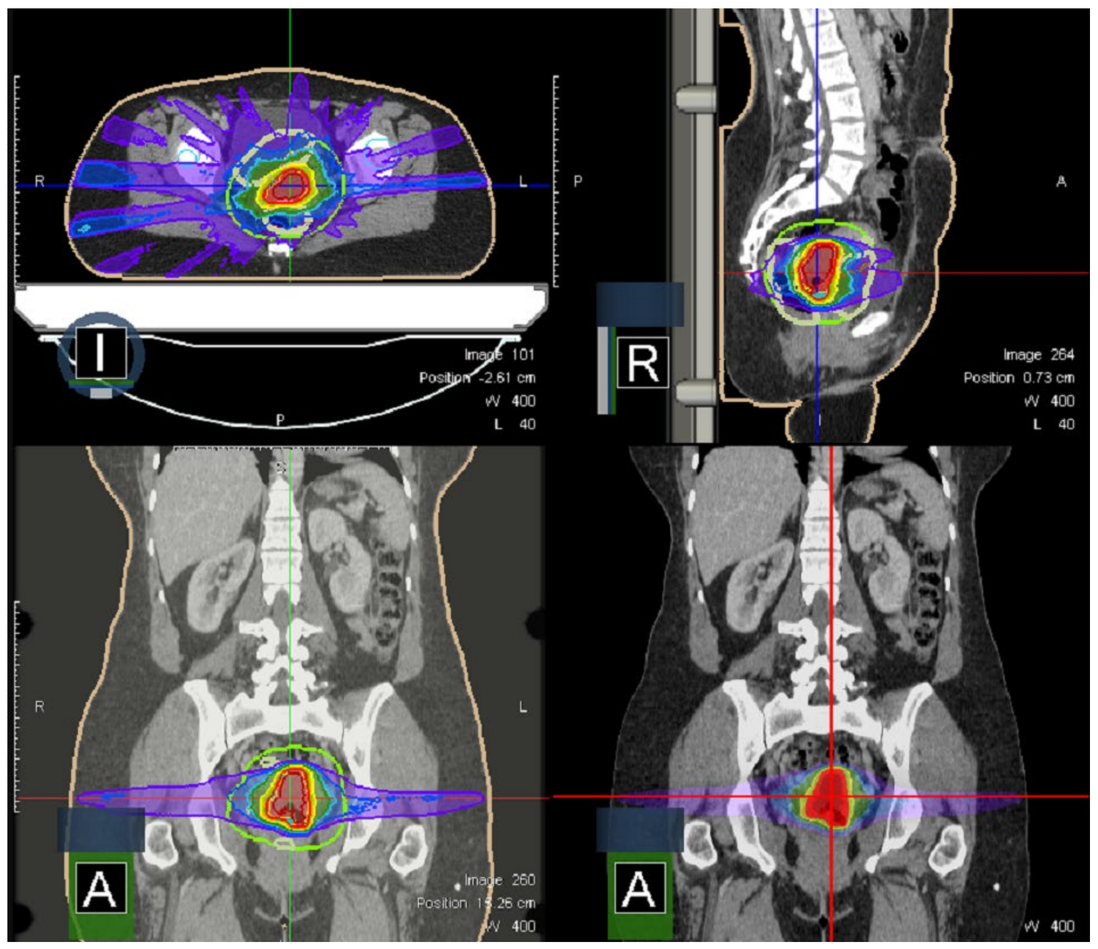
This dosimetric study aims to deliver a comparable biologically equivalent radiotherapy dose ($\alpha/\beta=10$) to brachytherapy and establish optimal OAR dose constraints for radiobiological calculations (RBE) using 2019 SABR Consortium (UKSC-19) versus EMBRACE-II guidelines.

Results

Applying Embrace-II constraints achieves a 14.5% (40.3Gy vs 35.2Gy mean) and 2.3% (42.8Gy vs 41.8Gy mean) increase in D98% CTV and D90% PTVhigh coverage respectively, whilst reducing treatment time by 9.8%. Mean PTV coverage was improved by 3.6% for D90% (80.2Gy vs 77.4Gy) and 7.8% for D98% (26.7 vs 24.7Gy). Dmax was also increased by 2.1% (mean 53.6Gy range 51.3-55.3, vs 52.5Gy range 50.4-55.5)

Mean	EMBRACE-II Dose Constraints	UKSC-19 Dose Constraints
D98% CTV EQD2(Gy)	40.3	35.18
D98% PTVhigh EQD2 (Gy)	36.6	36.13
D98% PTV EQD2 (Gy)	26.65	24.73
D90% CTV Cum EQD2 (Gy)	94.2	89.36
D90% PTVhigh EQD2 (Gy)	42.8	41.84
D90% PTVhigh Cum EQD2 (Gy)	87.50	86.18
D90% PTV Cum EQD2 (Gy)	80.20	77.4
Px Dose Spillage	1.05	1.06
Estimated Delivery Time (min)	10.2	11.31
Global D-Max (Gy)	53.6	52.52

Mean plan stats after optimizing using EMBRACE-II vs 2019 UK SABR Consortium Dose Constraints. A total of 8 Cases were optimized using similar objectives.



Methods

8 cases were retrospectively planned. High risk clinical target volume (entire cervix, residual tumour and grey zones, HRCTV) and OARs (rectum, bladder, bowel, femoral heads and sacral nerves where applicable) were outlined. A 3mm CTV to planning target volume (PTV) margin was applied. Prescription to PTV was 30Gy (boost CTV to 35Gy) in 5 fractions. OARs constraints were calculated for both UKSC_19 and EMBRACE-II guidelines and plans were created and compared applying these constraints. No OAR recovery was assumed.

Target dose metrics aimed for:

- D90% PTVhigh EQD2 ≥ 85Gy
- D90% PTV EQD2 ≥ 80Gy
- D90% CTV EQD2 ≥ 90Gy
- 1 cc max dose were kept under 52.5Gy

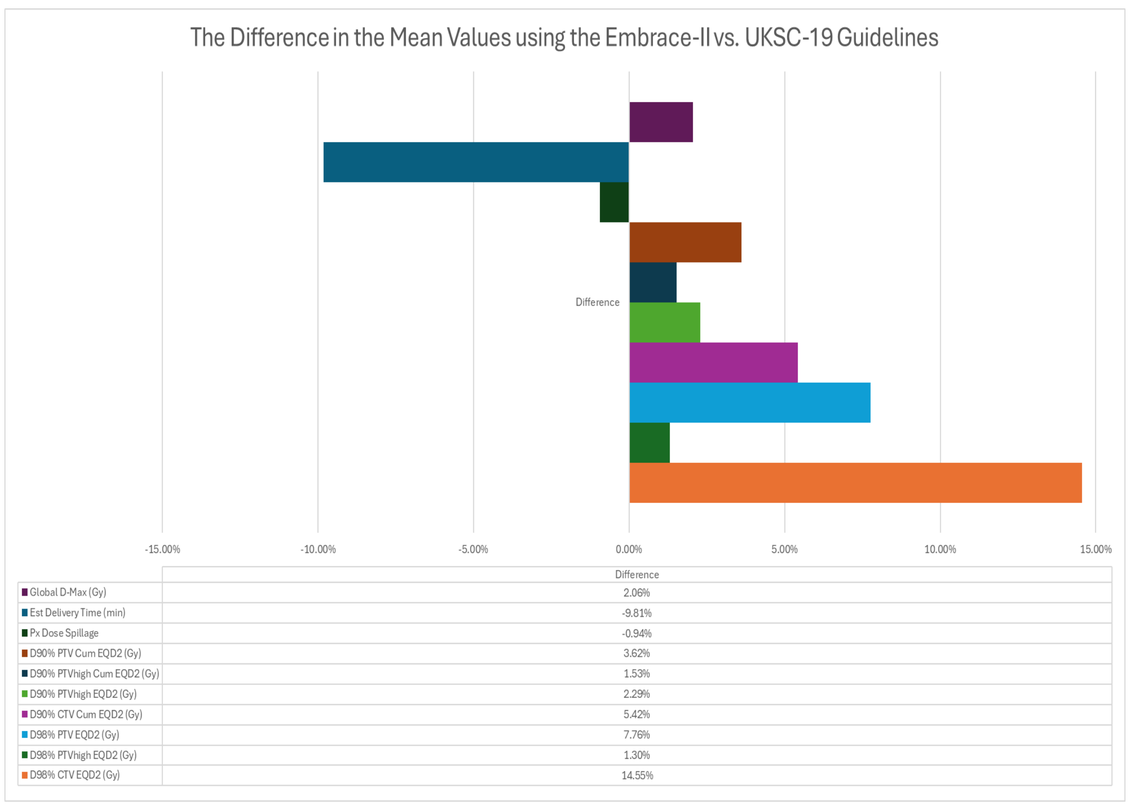


Figure: The chart illustrates the comparison of Embrace-II mean values with UKSC-19 plan values, thereby demonstrating a substantial enhancement in target coverage and a reduction in treatment delivery time.

Conclusion

MRgRT with both guidelines provides comparable dose delivery parameters to BT, with EMBRACE-II constraints allowing a higher coverage with less delivery time. This data supports the investigation of MRgRT in this setting due to the potential superior disease control prospects compared with other boost options

References:
1. Potter R, Tanderup K, Schmid MP, et al. MRI-guided adaptive brachytherapy in locally advanced cervical cancer (EMBRACE-I): a multicentre prospective cohort study. Lancet Oncol 2021; 22(4): 538-47
2. Eakin A, Wairiri L, Stadtlander W, et al. Identifying disparities in brachytherapy delivery for locally advanced cervical cancer. Brachytherapy 2023; 22(4): 461-7
3. EMBRACE collaborative. EMBRACE II protocol v15. 2015. https://www.embracestudy.dk/UserUpload/PublicDocuments/Docs/EMBRACE_II_title_page_and_total_protocol_v15_151015.pdf
4. SABRconsortium-guidelines-2019-v6.1.0.pdf. 2019. https://www.sabr.org.uk/wp-content/uploads/2019/04/SABRconsortium-guidelines-2019-v6.1.0.pdf

GenesisCare