

Toxicity and Clinical Outcomes Following Brachytherapy Using 3-D Dosimetric Planning in Patients with Cervical Cancer: An Institutional Experience

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INTRODUCTION

- Cervical cancer is the most common gynecological cancer worldwide.¹
- The standard of care for locally advanced cervical cancer (LACC) includes primary chemoradiation, brachytherapy, and external-beam radiotherapy.²
- Brachytherapy (BT) involves the targeted delivery of radiation to the cervix (**Fig 1**). However, radiation can be toxic to surrounding structures, most commonly affecting the gynecological, genitourinary, and gastrointestinal systems.³
- Historically, brachytherapy was planned using a 2-D approach, which had limitations in accuracy and increased toxicity to the adjacent bowel and bladder. 3-D planning using CT or MRI has been shown to have improved dose precision and reduced toxicity.⁴
- This study aims to evaluate toxicity and clinical outcomes for patients treated at our institution utilizing this method, contributing to existing literature and assessing institutional results.

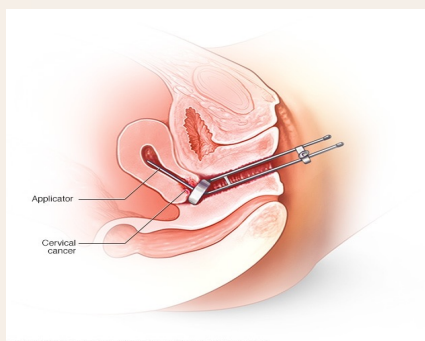


Figure 1: Intracavitary Brachytherapy

METHODS

- This single-institution, retrospective study included 31 patients with LACC treated between 2012 and 2019 with pelvic EBRT and high-dose-rate (HDR) brachytherapy using 3-D planning.
- Radiation therapy was delivered via 3-D conformal or intensity-modulated techniques, with HDR brachytherapy using an Iridium-192 source.
- Oncologic outcomes assessed included local, regional, and distant recurrence-free survival, progression-free survival, and overall survival.
- Acute and chronic GI, GU, and GYN toxicities were graded using CTCAE v4.0, with clinically significant toxicities defined as grade ≥ 2 .

RESULTS

Table 1: Patient and treatment characteristics

Characteristic	N = 31 ¹
Age	54 (30-84)
Follow-up (years)	3.2 (0.1-10.6)
Treatment year	2012-2019
Grade	
1	2 (6.5%)
2	13 (42%)
3	11 (35%)
Unknown	5 (16%)
Histology	
Adeno	5 (16%)
Mixed	1 (3.2%)
Squamous	25 (81%)
FIGO stage	
IB	8 (26%)
II	13 (42%)
IIIA	2 (6.5%)
IIIB	7 (23%)
IIIC1	0 (0%)
IVA	1 (3.2%)
Para-aortic node involvement	
Yes	4 (13%)
No	27 (87%)
Pelvic EBRT dose (Gy)	45.0 (30.0-50.4)
Pelvic EBRT fractions	25 (23-32)
Cervix brachytherapy dose (Gy)	30.0 (18.0-36.0)
Cervix brachytherapy fractions	5 (3-6)
Total EQD2 (Gy)	84.3 (64.9-95.8)
Receipt of chemotherapy	
Yes	29 (94%)
No	1 (3.2%)
Unknown	1 (3.2%)

¹Data presented as n (%) or median (range)

Table 1: Demographics and tumor characteristics of patients who underwent brachytherapy for cervical cancer. Details of radiation treatments.

Table 2: Acute and chronic grade ≥ 2 toxicities

Toxicity	n (%)
All acute toxicity	8 (26%)
Acute gastrointestinal toxicity	2 (6.5%)
Acute genitourinary toxicity	2 (6.5%)
Acute gynecologic toxicity	6 (19%)
All late toxicity	10 (32%)
Late gastrointestinal toxicity	7 (23%)
Late genitourinary toxicity	3 (9.7%)
Late gynecologic toxicity	1 (3.2%)

Table 2: Acute and chronic toxicities grade ≥ 2 following radiation therapy graded according to Common Terminology Criteria for Adverse Events v4.0.

Table 3: Oncological outcomes

Outcome	Median (years)	1-year	2-year	3-year	4-year	5-year
Local recurrence free survival	Not met	96.6%	93.0%	93.0%	87.5%	87.5%
Regional recurrence free survival	Not met	96.4%	92.7%	92.7%	87.3%	87.3%
Distant metastasis free survival	Not met	82.7%	71.6%	67.4%	67.4%	67.4%
Progression free survival	5.1	76.7%	66.2%	55.2%	55.2%	51.0%
Overall survival	5.1	93.4%	79.6%	65.1%	60.8%	52.1%

Table 3: Clinical outcomes after radiation therapy, calculated from start of radiotherapy.

CONCLUSION

- Brachytherapy remains an integral part of definitive radiotherapy for LACC, delivering high doses of radiation to the tumor while sparing surrounding tissue and improving survival outcomes.
- Despite its effectiveness, brachytherapy can be accompanied by significant toxicity which can appear both in acute and chronic time frames. Pelvic brachytherapy commonly affects the gastrointestinal, genitourinary, and gynecological systems.
- The transition from 2-D to 3-D dosimetric planning has been shown to improve survival rates and decrease radiotherapy-related toxicity by enhancing dose precision and tumor targeting.
- Our study showed a favorable local and regional control of about 90% at 5 years pointing to the effectiveness of pelvic RT and BT which address locoregional disease. Many patients (around 30%) however developed metastatic disease which signifies a potential window of benefit of systemic therapy.
- The use of 3-D brachytherapy planning resulted in lower toxicity and comparable clinical outcomes, supporting its continued use. While limited by sample size and follow-up duration, this study contributes to existing evidence on the safety and efficacy of 3-D planning, emphasizing the need for larger studies to confirm its benefits.

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