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# Ultrasound use in gynecologic brachytherapy: Time to focus the beam

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**ABSTRACT** There is wide disparity in the practice of brachytherapy for cervical cancer around the world. Although select well-resourced centers advocate use of MRI for all insertions, planar X-ray imaging remains the most commonly used imaging modality to assess intracavitary implants, particularly where the burden of cervical cancer is high. Incorporating soft tissue imaging into brachytherapy programs has been shown to improve the technical accuracy of implants, which in turn has led to improved local control and decreased toxicity. These improvements have a positive effect on the quality of life of patients undergoing brachytherapy for cervical cancer. Finding an accessible soft tissue imaging modality is essential to enable these improvements to be available to all patients. A modality that has good soft tissue imaging capabilities, is widely available, portable, and economical, is needed. Ultrasound fulfils these requirements and offers the potential of soft tissue image guidance to a much wider brachytherapy community. Although use of ultrasound is the standard of care in brachytherapy for prostate cancer, it only seems to have limited uptake in gynecologic brachytherapy. This article reviews the role of ultrasound in gynecologic brachytherapy and highlights the potential applications for use in brachytherapy for cervical cancer. 

*Keywords:* Ultrasound; Gynecologic cancers; Cervical cancer; Brachytherapy

## Introduction

Brachytherapy is an integral part of radiotherapy treatment for locally advanced cervical cancer. It has been used for well over 100 years (1). Although other forms of radiotherapy evolved through innovation and advances in technology during the 20th century, brachytherapy techniques for cervical cancer remained largely static. The story of brachytherapy for cervical cancer is eloquently told by Erickson (2) in which she outlines the reasons for this lack of progress. Early dosimetry systems brought structure and standardization to gynecologic brachytherapy; but while other areas of radiotherapy progressed, gynecologic brachytherapy stalled within the confines of these dosimetric systems. Overtime, although there has been a growing awareness of the limitations of these standardized systems, the main drawback was the lack of use of modern imaging to appreciate and assess the individual nature of each women's anatomy and disease (3−12). The release of the Groupe Europeen de Curietherapie and European Society for Radiotherapy and Oncology recommendations for incorporating imaging, particularly MRI, into brachytherapy programs, is changing the way brachytherapy is being practiced (13−16). Traditional dosimetry systems consist of specific insertion techniques, applicators, prescribing and reporting, planning, and treatment methods; are all being challenged as soft tissue imaging is incorporated into practice. Sadozye and Reed (17) provide the next chapter to Erickson's unfinished tale in which they describe the use of modern imaging such as CT and MRI and the beneficial effects this use has on brachytherapy outcomes. These benefits include improvements in local control, overall survival, and very significant reductions in normal tissue

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toxicity (18−24). The chapter closes with Sadozye and Reed expressing hope that the uptake of image-based brachytherapy will be much better in the next 10 years than it has been in the previous decade. The most favored imaging modality for image-guided brachytherapy is MRI for its superior soft tissue definition, but uptake is largely hampered by cost and lack of access. CT is more accessible and so has seen greater uptake (25−31). Incorporating these imaging modalities into brachytherapy programs is largely restricted to well-resourced centers in both the first and developing world and remains elusive to many less well-resourced centers, particularly those in areas with a high burden of cervical cancer (32). The challenges of moving to 21st century image-guided brachytherapy treatment are faced by both the first and developing worlds in regard to resource procurement, resource allocation, and health care costs (25, 32). Challenges are also encountered in terms of the implementation of image guidance and the implications imaging has on the traditional practices of gynecologic brachytherapy (11, 25, 33, 34).

Ultrasound in gynecologic brachytherapy has featured from time to time over the years but has not found routine use and has tended to be overlooked in favor of more technically advanced imaging modalities. This article reviews the role of ultrasound in gynecologic brachytherapy and highlights the potential applications for use in brachytherapy for cervical cancer.

A search of the literature was performed in the bibliographic databases PubMed, Ovid Medline, and EMBASE using the keywords ‘‘ultrasound,’ ‘‘gynecology,’’ ‘‘brachytherapy,’’ ‘‘endometrial cancer,’’ and ‘‘cervix cancer’’ in various combinations, up to June 2014.

## Ultrasound use in brachytherapy to guide applicator placement

By far, the greatest use of ultrasound in gynecologic brachytherapy has been to guide applicator placement to avoid perforation, optimize the position within the uterine canal, and improve the technical quality of implants. Use of ultrasound to reposition a misplaced tandem was recognized as early as 1975 by Carson *et al.* (35). A number of prospective studies investigated the benefits of using ultrasound to guide applicator placement. Granai *et al.* (36) described applicator insertion ‘‘as blindly pushing a metal probe through an often distorted cervix to an unverifiable point.’’ They dispelled the prevailing thinking that ideal positioning of the intracavitary applicator is achieved using standard techniques of clinical palpation and X-ray confirmation. In a two-part study looking at ultrasound used during and after insertion, Granai *et al.* (36) found that 34% of the insertions were inadequate when assessed after insertion. This included frank perforations in 10% of the insertions. In the second part of the study, 72 of the 73 insertions assessed with intraoperative ultrasound were optimally placed. The single case in which ultrasound did not facilitate placement involved cancer of the cervical stump, for which adequate imaging was not possible. Granai *et al.* (36) found that ultrasound clearly visualized the procedure, allowing applicators to be positioned with confidence even in the most difficult cases. The immediate feedback from intraoperative ultrasound eliminated misplacements and thus the need for a second anesthesia to reposition the applicator. Rotmensch *et al.* (37) investigated the use of intraoperative ultrasound for applicator placement in 20 implants. Unsatisfactory placement was detected in nine implants (45%) including six (30%) perforations. These complications were unknown to the clinician inserting the applicators. Rotmensch *et al.* (37) concluded that use of intraoperative ultrasound was helpful when difficulty was encountered in the placement of the applicator. Potential complications could be identified early without resorting to more invasive corrective procedures. Corn *et al.* (38) investigated whether the inclusion of intraoperative ultrasound converted a more dangerous insertion into a procedure with relative safety, akin to that of a procedure not requiring ultrasound. A total of 143 implants were performed on 100 women. Ultrasound was used for 20 implants in patients with stenosis of the cervical os, radiation fibrosis, indeterminate orientation of the axis of the endometrial cavity, and previous perforation. There were five (3.5%) instances of perforation (with two occurring in the ultrasound subset). It was noted that these two cases were among the first cases planned with ultrasound, implying the presence of a learning curve. Corn *et al.* (38) found that use of ultrasound may compensate for the inherent risks of perforation harbored by patients with difficult anatomy. Mayr *et al.* (39) evaluated the outcome of ultrasound-guided applicator placement in retroverted uteri. Thirty three insertions were performed to dilate the cervical canal and reposition the uterus to anteversion. Ultrasound-guided anteversion of the applicator and uterus was achieved in all procedures with no evidence of perforation. Mayr *et al.* (39) concluded that use of ultrasound was feasible and resulted in acceptable outcomes and complication rates in a population at high risk for uterine perforation. The technical quality of implants has been shown to impact on clinical outcomes for patients (40). The studies discussed range from the 1990s to 2005; and although they all showed that use of ultrasound improved the technical quality of implants and contributed to a decrease in perforation, they have not had a widespread impact on practices to date.

## Rates of perforation detected with three-dimensional imaging

Although use of CT was being investigated for assessing dosimetry in intracavitary brachytherapy, some practitioners observed unexpected perforations of the uterus