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Two-year results of transabdominal ultrasound-guided brachytherapy for cervical cancer

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ABSTRACT

PURPOSE: To report the preliminary results of transabdominal ultrasound (TAUS)–guided brachytherapy (BT) in cervical cancer.

METHODS AND MATERIALS: Twenty-nine patients with cervical cancer Stage IB–IVA according to The International Federation of Gynecology and Obstetrics staging were treated by radical radiotherapy from February 2012 to December 2012. Treatment was composed of WPRT to 50 Gy in 25 fractions and central shielding after 44 Gy in combination with TAUS-guided BT to optimize the total dose (equivalent dose of 2 Gy [EQD2]) to the minimal dose at cervical points (in EQD2 concepts) defined by TAUS ≥80 Gy while maintaining low doses to the ICRU report no. 38 bladder and rectal points. The treatment results and toxicity profiles were reported.

RESULTS: At median followup time of 19 months (range, 17–27), the local control and disease-free survival rates were 93.1% and 86.2%, respectively. One episode of Grade 3 vaginal toxicity was observed in this followup period. The mean applied doses to cervix, bladder, and rectal points were 82.6, 72.5, and 75 Gy, respectively. TAUS-guided planning reduced bladder (defined as >80 Gy in EQD2) and rectal overdose (defined as >75 Gy in EQD2) in 44.9% and 34.5% of patients, respectively.

CONCLUSION: The 2-year results demonstrate that TAUS-guided BT is feasible and associated with excellent tumor control/toxicity rates in cervical cancer.

Keywords: Cervical cancer; Brachytherapy; Transabdominal ultrasound (TAUS)

Introduction

Cervical cancer is one of the most common gynecologic cancers in Asia. In Northern Thailand, the incidence rate of cervical cancer was 22.7 per 100,000 in 2005 (1).

In patients who are categorized inoperable, a combination of whole pelvic radiation therapy (WPRT) and brachytherapy (BT) is commonly used. High-dose-rate (HDR) intracavitary brachytherapy (ICBT) is used to escalate the dose to the tumor or cervix to total doses of minimum 80 Gy at Point A. The point-based approach according to Manchester system is extensively applied and works with orthogonal x-rays for calculation and prescription of ICBT (2, 3).

In this context, Point A is the major critical point for dose specification of conventional ICBT and is rigidly calculated ignoring the specific tumor anatomy or volume in each individual patient. However, this may cause underdosage to the target volume and/or overdosage to organs at risk (OARs) (4–6). In contrast to conventional planning, the utilization of image-guided brachytherapy (IGBT) with MRI and/or CT is increasingly described in the recent literature and shows a clear benefit of volume-based IGBT to significantly improve treatment results in terms of dose escalation to high-risk clinical target volume >80 Gy and reduction of treatment-related morbidity (7–12).

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In addition to CT and MRI, ultrasound (US) technology already plays an important role in BT and may also serve as an additional method for IGBT treatment planning. Application of US guidance during BT for cervical cancer has been used extensively in the past to reduce the complications, especially from uterine perforation that have been reported to occur in 3–10% of applications (13, 14). The use of US in BT planning for cervical cancer is in clinical practice and documented in a few publications. The largest study by Van Dyk *et al.* (15, 16) reports very promising first results and treatment-related toxicities.

Based on these published data, we performed a study using a portable US device that was installed in January 2012. The aim was to analyze the use of portable US in multiple places, BT theater, loading room, and to evaluate the early results of transabdominal ultrasound (TAUS)–guided BT planning and treatment in cervical cancer in the Faculty of Medicine, Chiang Mai University.

Methods and materials

After approval by institutional review board, patients with histologically verified cervical cancer were enrolled. The inclusion criteria were cervical cancer Stage IB–IVA according to The International Federation of Gynecology and Obstetrics (FIGO) classification, biopsy-proven squamous cell carcinoma or adenocarcinoma of cervix, no uncontrolled medical condition, age 18–70 years, no previous surgery or radiotherapy, and signed informed consent. The treatment method included a combination of WPRT and concurrent platinum-based chemotherapy with HDR ICBT and is described in the next section.

External beam radiation therapy

WPRT with 6 or 10 MV photons was applied to treat the primary tumor and pelvic lymph nodes to the dose of 50 Gy in 25 fractions and with central shielding (after 44 Gy) in cN0 stages. A parametrial boost (additional dose of 6 Gy in three fractions) was performed in the case of advanced parametrial or pelvic sidewall involvement.

Concurrent chemoradiation

When concurrent chemotherapy was indicated (e.g., squamous cell carcinoma), either cisplatin (40 mg/m^2; maximum dose = 70 mg) or carboplatin (area under the curve = 2; maximum dose = 200 mg) was prescribed in weekly schedule. Laboratory investigations (complete blood count, blood urea nitrogen, and serum creatinine) were evaluated before consideration of chemotherapy. In cisplatin regimen, chemotherapy was performed when creatinine clearance was more than 50 mL/min and stopped when it was less than 30 mL/min. In carboplatin regimen, it was stopped when creatinine clearance was less than 30 mL/min.

Brachytherapy

HDR ICBT was used in all patients. Four applications with 6.5–7 Gy per fraction were applied, and TAUS was used to guide and plan all fractions. The first ICBT application was usually scheduled after the fourth week of WPRT. Standard tandem/ovoid or CT/MRI applicators were used. A Foley catheter was placed in the bladder and filled with 7 cm^3 of diluted contrast media. A normal saline solution 150–200 cm^3 was added into the bladder to enhance US visibility of uterus and OARs and maintain reproducible bladder geometry. The vagina was packed with gauze to stabilize the applicator. The WPRT was interrupted for each day of HDR BT insertion. Three steps of TAUS (BK Medical Flex Focus 400, Analogic Ultrasound, Boston, MA) were performed by the radiation oncologist. Primarily, TAUS was used during the BT application to prevent uterine perforation. The uterine tandem was identified, and the relationship to the uterus was evaluated. In the second step, patients were transferred to the loading room and adjusted to supine position with their legs relaxed on the flat table. The rectal probe was inserted to identify the anterior rectal wall. Then, TAUS was performed again for each application to verify the position of applicator. The tandem and uterus were also defined in this step. In the third step, the tandem was used as reference, and, at the level of cervical os and 2 cm superiorly, the distances from tandem to the uterine wall in anterior and posterior directions were measured by TAUS in sagittal view. At the level of cervical os, the measurements of the distances from the tandem to the lateral walls were also evaluated. These measurements were performed as described by Van Dyk and Bernshaw (17).

After these three steps, orthogonal radiographs were taken to start the planning process. The TAUS-measured distances from the tandem to the uterine wall were used to define the following cervical points (Fig. 1):

L1 = the distance from tandem to posterior wall of uterus at the level of cervical os

L2 = the distance from tandem to anterior wall of uterus at the level of cervical os

L3 = the distance from tandem to posterior wall of uterus at the level of 2 cm superior to the cervical os along the tandem

L4 = the distance from tandem to anterior wall of uterus at the level of 2 cm superior to the cervical os along the tandem

A1 = the distance from tandem to right lateral wall of cervix at the level of cervical os

A2 = the distance from tandem to left lateral wall of cervix at the level of cervical os