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Original article

Decision analysis model evaluating the cost of a temporary hydrogel rectal spacer before prostate radiation therapy to reduce the incidence of rectal complications

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Abstract

Purpose: We conducted a decision analysis to evaluate the cost effectiveness of a newly Food and Drug Administration approved rectal spacer gel (SpaceOAR, Augmenix) for the reduction of rectal toxicity of prostate radiation therapy (RT).

Methods: A decision tree model (TreeAge Pro) was used to compare the strategy of pretherapy placement of a spacing hydrogel before RT to RT alone. The model compared costs associated with rectal complications because of rectal toxicity over a 10-year period across 3 different RT modalities. Rectal toxicity rates were estimated from studies on conformal RT dose escalation, high-dose stereotactic body radiotherapy (SBRT) and low-dose SBRT. Rectal toxicity reduction rates (baseline reduction 70%) were estimated from recently published 15 month data using a rectal spacer. Direct and indirect cost estimates for established grades of rectal toxicity were based on national and institutional costs. Reduction in short-term complications were assumed to carry forward to a reduction in long-term toxicity. One-way and two-way sensitivity analyses were performed.

Results: The overall standard management cost for conformal RT was $3,428 vs. $3,946 with rectal spacer for an incremental cost of $518 over 10 years. A 1-way sensitivity analyses showed the breakeven cost of spacer at $2,332 or a breakeven overall risk reduction of 86% at a cost of $2,850. For high-dose SBRT, spacer was immediately cost effective with a savings of $2,640 and breakeven risk reduction at 36%. However, 2-way spacer cost to risk reduction sensitivity analyses were performed.

Conclusion: The use of a rectal spacer for conformal RT results in a marginal cost increase with a significant reduction in rectal toxicity assuming recently published 15 month rectal toxicity reduction is maintained over 10 years. For high-dose SBRT it was cost effective. Further studies would be necessary to validate the long-term benefits of rectal spacers.

Keywords: Prostate cancer; Radiation therapy; Radiation proctitis; Rectal spacer

1. Introduction

Thirty-three percent of men with incident cancer in the United States will receive a diagnosis of prostate cancer [1]. This results in over 200,000 new diagnoses a year leading to an estimated care cost of $11.85 billion [1,2]. A standard treatment option for clinically localized prostate cancer is external beam radiation therapy (RT). This is most commonly delivered using image-guided conformal radiation therapy (CRT) techniques such as 3-dimensional CRT, stereotactic body radiotherapy (SBRT), or intensity-modulated radiation therapy (IMRT). Initial studies of CRT showed higher doses (78 vs. 70 Gy) resulted in lower rates of biochemical recurrence and clinical failure with higher rates of lower gastrointestinal (GI) complications [3]. Historically, rectal toxicity has been the dose-limiting factor in prostate radiation [4,5]. Rectal complications of radiotherapy can cause serious morbidity to patients and require costly interventions to manage [6–10]. In the modern era of heath care cost consciousness,

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interventions that can decrease cost or improve the side effect profile of radiation are particularly important [11,12].

To reduce rectal toxicity a variety of methods of organ displacement have been implemented. Biodegradable balloons, injection of collagen, and injection of dissolvable hydrogels have been attempted in patients before delivery of ionizing radiation [13–16]. Initial cadaveric studies showed that injection of a hydrogel spacer (SpaceOAR, Augmenix Inc., Waltham MA) was able to achieve an average separation of 12.5 mm between the prostate and the rectum [16], resulting in a reduction of the percentage of the rectum receiving radiation from 25% to 59% [17–19]. Mariados et al. [20] recently published 15 month findings regarding use of the SpaceOAR system. Patients who received preradiation injection of the rectal spacer experienced significantly lower incidence and severity of long-term (greater than 3 mo) rectal complications compared with standard management. Although there were no significant differences observed in the rates of early rectal toxicity with the exception of significantly fewer patients experiencing acute rectal pain, an absence of grade 2 or greater long-term rectal toxicity was encouraging [20]. This approach has been shown feasible in patients who had prior radiotherapy and were undergoing salvage brachytherapy as well [21].

The use of a rectal spacer gel has the potential to allow delivery of high doses of radiation while reducing the incidence of clinically significant rectal toxicity. Rectal spacing interventions imply additional costs; however, expenses of therapy for rectal toxicity can be significant as well. We sought to analyze the use of SpaceOAR (Augmenix) before RT regarding cost efficacy for reducing rectal complications [20].

2. Methods

2.1. Model case

Our model patient was a men diagnosed with clinically localized prostate cancer, cT1 to cT2c, via prostate-specific antigen (PSA) screening or digital rectal examination, and with a life expectancy greater than 10 years. He had clinically significant cancer and did not meet low-risk criteria for active surveillance. This patient elected for curative-intent RT because of personal preference. This patient would not meet clinical parameters to require concomitant androgen deprivation therapy [22].

2.2. Rate assumptions

A decision tree model was constructed using TreeAge Pro (TreeAge Software, Inc., Williamstown, MA) comparing pre-RT use of hydrogel spacer to RT alone (Fig. 1). Rectal toxicity was defined by the Modified Radiation Therapy Oncology Group-Late Effects Normal Tissue (RTOG-LENT) scale as grade 1 to 4 shown in Table 1. Complications included in this model ranged from minor issues such as diarrhea to more severe complications such as fistula, perforation, and or life-threatening bleeding requiring surgical intervention. Interventions ranged from closer follow-up with expectant management to operative diversion for surgically-refractory recto-urethral fistula. Rates of each grade for CRT were obtained from dose-escalation studies of CRT performed at MD Anderson Cancer center [3]. Historical study rates of GI complications grade 2 or higher were seen in 26% of the patients receiving higher doses of radiation. For SBRT, representative studies [23–25] were used for rectal toxicity rates. In 1 case (high-dose SBRT), adverse events were defined in the literature by Common Terminology Criteria for Adverse Events (CTCAE) that required conversion to RTOG-LENT. In all cases where patient specific data was available (all CTCAE grade 3 complications) RTOG-LENT complication grades were assigned. This resulted in 5 of 6 patients being reassigned as RTOG-LENT grade 4. In the instance of CTCAE grade 2 complications patient level data was unpublished and 6 of 26 were assumed to be grade 3

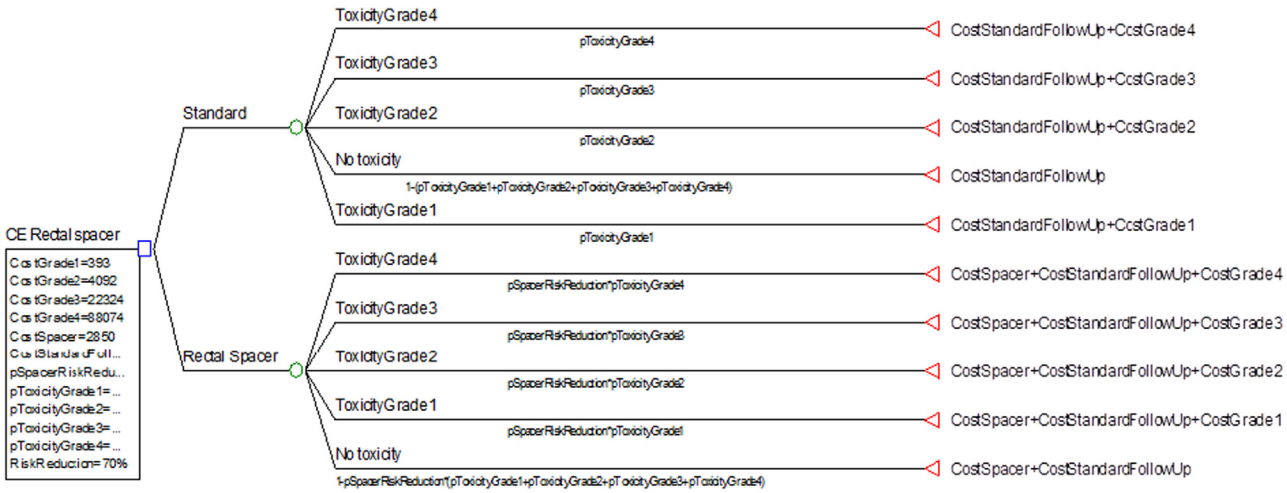

Fig.1. Decision Analysis Tree.