Dosimetric Comparison of Pencil-Beam Scanning and Photon-Based Radiation Therapy as a Boost in Carcinoma of Cervix

Manoj K. Sharma, MD1; Eugen B. Hug, MD2; Manindra Bhushan, MS3; Dennis Mah, PhD2; Dominic Maes, MS2; Munish Gairola, MD1; Surender K. Sharma, MD1; Girigesh Yadav, PhD3; Manoj Pal, MD1; Deepika Chauhan, DNB4; Abhinav Dewan, DNB1; Inderjit Kaur, DNB1; Sarthak Tandon, DNB1; Swarupa Mitra, MD1

1Department of Radiation Oncology, Rajiv Gandhi Cancer Institute and Research Centre, New Delhi, India
2ProCure Proton Therapy Center, Somerset, NJ, USA
3Division of Medical Physics, Department of Radiation Oncology, Rajiv Gandhi Cancer Institute and Research Centre, New Delhi, India
4Department of Radiation Oncology, BLK Super Specialty Hospital, New Delhi, India

Abstract

**Purpose:** Brachytherapy is essential for local treatment in cervical carcinoma, but some patients are not suitable for it. Presently, for these patients, the authors prefer a boost by using intensity-modulated radiation therapy (IMRT). The authors evaluated the dosimetric comparison of proton-modulated radiation therapy versus IMRT and volumetric-modulated arc therapy (VMAT) as a boost to know whether protons can replace photons.

**Patients and Methods:** Five patients who received external beam radiation therapy to the pelvis by IMRT were reviewed. Three different plans were made, including pencil beam scanning (PBS), IMRT, and VMAT. The prescribed planning target volume (PTV) was 20 Gy in 4 fractions. The dose to 95% PTV (D95%), the conformity index, and the homogeneity index were evaluated for PTV. The Dmax, D2cc, and Dmean were evaluated for organs at risk along with the integral dose of normal tissue and organs at risk.

**Results:** The PTV coverage was optimal and homogeneous with modulated protons and photons. For PBS, coverage D95% was 20.01 ± 0.02 Gy (IMRT, 20.08 ± 0.06 Gy; VMAT, 20.1 ± 0.04 Gy). For the organs at risk, Dmax of the bladder for PBS was 21.05 ± 0.05 Gy (IMRT, 20.8 ± 0.21 Gy; VMAT, 21.65 ± 0.41 Gy) while the Dmax for the rectum for PBS was 21.04 ± 0.03 Gy (IMRT, 20.81 ± 0.12 Gy; VMAT, 21.66 ± 0.38 Gy). Integral dose to normal tissues in PBS was 14.17 ± 2.65 Gy (IMRT, 25.29 ± 6.35 Gy; VMAT, 25.24 ± 6.24 Gy).

**Conclusions:** Compared with photons, modulated protons provide comparable conformal plans. However, PBS reduces the integral dose to critical structures significantly compared with IMRT and VMAT. Although PBS may be a better alternative for such cases, further research is required to substantiate such findings.

**Keywords:** conformity index; homogeneity index; intensity-modulated radiation therapy; pencil beam scanning; volumetric-modulated arc therapy
Introduction

Intensity-modulated radiation therapy (IMRT) is frequently used to spare nearby organs at risk (OARs) to improve treatment quality. Lesser OAR doses reduce treatment-related complications [1]. Although there is increase in integral dose by IMRT, it has been found to be safe and tolerable for women with gynecological malignancies.

Volumetric-modulated arc therapy (VMAT) has emerged as an advanced technique after IMRT which uses machine parameters like dose rate, multileaf collimator motion, and gantry speed for optimizing a deliverable plan [2]. Arc technique delivers radiation with a higher dose rate, thus shortening the beam time and hence reducing the likelihood of intrafractional patient motion.

Proton beams, with their characteristic Bragg peak energy deposition, decrease the integral dose by removing exit dose and in general have demonstrated excellent dose conformity of the target region. It has been reported to further reduce radiation-induced toxicities and to facilitate dose escalation [3]. Recently, pencil beam scanning (PBS), also known as intensity-modulated proton therapy and spot scanning, has become more widespread as a more advanced technique to deliver proton radiation therapy. The PBS technique uses magnetic fields to steer specific spots of different intensities or weights to optimize target coverage while respecting normal tissue dose constraints.

Double-scattering (DS) proton therapy and PBS are 2 modes of delivering proton therapy. A 3-dimensional (3D) treatment planning technique is used in DS to design a conformal radiation dose distribution. Individualized compensators, along with apertures, are used to shape the distal edge of the beam and to limit the perimeter of radiation field, respectively [4, 5]. The PBS technique uses inverse planned fields for optimization. Two distinct approaches have identified. Planning can be optimized per field for a single-field uniform dose or multiple-field optimization may be used in which the fields are simultaneously optimized. In general, single-field uniform dose fields are considered to be more robust than multiple-field optimization. In both cases, individually weighted spots with different energies are used to achieve a desired proton beam distribution. In other words, DS and PBS are analogous to 3D conformal radiation therapy and IMRT of photon therapy, respectively. Because of the ability to modulate intensity in the beam direction in PBS, an optimal plan can be achieved with fewer fields. Although, 5 to 10 beam fields are required for IMRT, PBS uses only 2 to 4 beam fields; in contrast, VMAT shows constant rotation of beam fields to achieve similar dose coverage.

The standard of care of cervical cancer is external beam radiation therapy and brachytherapy, as a primary treatment. For acceptable local control, an adequate biological equivalent dose is needed; however, there are currently significant variations in dose concepts, dose prescription, and documentation worldwide. Most patients undergo brachytherapy. Different external beam radiation therapy techniques used as boost for those patients in lieu of brachytherapy have yielded generally inferior results due to inadequate dose coverage of tumor. More than 45% of patients undergoing 3D conformal radiation therapy boost developed recurrence within 2.5 years, and 75% of the recurrences were thought to originate centrally, inside the tumor volume [6].

Recent advancements in radiation technology, including IMRT, VMAT, and PBS, facilitate opportunities of tumor dose escalation and/or reduction of the radiation to normal tissues, thereby increasing the likelihood of local control and overall survival. On the basis of this background, the authors conducted a dosimetric study comparing PBS with IMRT and VMAT to determine the specific advantage of one treatment modality compared with the others.

Patients and Methods

Patient Selection

Five patients with histologic proven carcinoma of the cervix underwent combined chemoradiation as their definitive treatment. Initially, patients received 50.4 Gy in 28 fractions at a dose of 1.8 Gy per fraction. For a variety of reasons, the patients were unable to receive brachytherapy. For these patients, a stereotactic body radiation therapy boost was given. The dose prescription was 20 Gy in 4 fractions. The boost target area included the gross tumor volume plus a 1-cm margin. For proton beams, this margin is typically larger than required for a 3.5% uncertainty range, but it was chosen for consistency between the photon and proton plans.

For purposes of this dosimetric comparison, the plans for those 5 patients were retrospectively replanned using proton PBS techniques. For proton plans, a generic relative biological effectiveness (RBE) of 1.1 was assumed, and all doses are listed in Gy (for photons) or Gy (RBE) (for protons). The study approval was acquired from an institutional review board.
Patient Simulation and Planning

Orfit casts (Orfit Industries, Wijnegem, Belgium) were made to immobilize the patients and 3-mm slice thickness planning scans were acquired in supine position with full bladder. The bladder, rectum, bowel, and femoral heads were delineated as OARs according to the Radiation Therapy Oncology Group Guidelines [7].

Proton beam plans were generated on a RayStation treatment planning system (version 4.7, Raysearch, Stockholm, Sweden). Two opposed lateral beams were individually optimized (single-field uniform dose) using inverse planning. Plans were generated for an IBA Proteus Plus system (IBA Proteus Plus, Ion Beam Applications, Louvain-La-Neuve, Belgium) using a universal nozzle. No range shifter was used due to the large (>10 cm) depth of the target [8–10].

One limitation of proton beams is that they are potentially sensitive to changes in range due to transient changes in bowel filling. While the opposed parallel pair geometry should help offset this uncertainty, the authors estimated variability by forcing the density of the bowel in the field to 0.5 g/cm³, which is a first-order estimate of the potential range of the different scenarios.

Photon plans were designed on the Varian Eclipse Treatment Planning System, version 11.0 (Varian Medical System Inc, Palo Alto, California), with 6-MV flattening filter free photon beams from a Varian True Beam equipped with high definition multileaf collimator.

The IMRT plans for sliding window delivery were produced using a direct aperture optimization algorithm that translates intensity maps into deliverable apertures. The IMRT plans were generated using 9 coplanar gantry angles at 0°, 40°, 80°, 120°, 160°, 200°, 240°, 280°, and 320° to keep the collimator angle at 0°. A progressive resolution optimization algorithm was used for the VMAT planning process, which makes changes to dynamic variables, such as MLC speed, dose rate, and gantry speed, and uses iterations in multiresolution levels. The VMAT plans were generated using dual arcs starting from 181° to 179° with a collimator angle of 30° and an counterclockwise angle from 179° to 181° with a collimator angle of 330°.

Evaluation Parameters

All plans were normalized to meet the specification that 95% volume of the planning target volume (PTV) should be covered by 100% of the dose prescription of 20 Gy or 20 Gy (RBE) for the proton plans. Average dose-volume histograms were generated to evaluate target and OAR doses. A maximum point receiving more than 110% of prescribed dose was considered a hot spot.

Parameters of D95%, D98%, D2%, D<93%, and D>110% were analyzed for PTV coverage. Conformity index (CI) and homogeneity index (HI) were calculated using following formulas [11, 12]:

\[
CI = \frac{V_{RI}}{TV}
\]

where \(V_{RI}\) is the reference isodose volume and \(TV\) is the target volume.

\[
HI = \frac{D_2}{D_{98}}
\]

where \(HI\) is the dose at volume \(D_x = D_{100-x}\). Maximum dose (\(D_{max}\)), dose to 2 cm³ volume (\(D_{2cc}\)), and mean dose (\(D_{mean}\)) were evaluated for the bladder and rectum. Mean doses (\(D_{mean}\)) were noted for femoral heads. Both quantitative and qualitative analyses were performed for all parameters.

Integral Dose

Integral dose to any organ was defined as a product of organ volume and mean dose received by the organ [13]:

\[
\text{Integral Dose (Normal Tissue)} = (\text{Body - PTV}) \times \text{Mean Dose}
\]

\[
\text{Integral Dose (Organ)} = \text{Organ Volume} \times \text{Mean Dose}
\]

Statistical Analysis

Data were analyzed by applying the standard statistical tests using SPSS Statistics 22.0 (SPSS Inc, Chicago, Illinois). A nonparametric Kruskal-Wallis test was used for comparison of means between each plan. A \(P\) value <.05 was considered statistically significant.
Results

Target Volume Coverage

The average volume of PTV in the present study was $134.94 \pm 34.44 \text{ cm}^3$. D$_{95\%}$ reported was $20.08 \pm 0.06 \text{ Gy}$, $20.1 \pm 0.04 \text{ Gy}$, and $20.01 \pm 0.02 \text{ Gy}$ (RBE) for IMRT, VMAT, and PBS, respectively. A significant difference was observed in PTV coverage ($D_{95\%}$) for PBS compared with VMAT ($p = 0.029$). No significant change was seen in PTV coverage between IMRT and VMAT. However, $P$ value ($P = 0.019$) of PBS was significant if we compared all the modalities together, giving PBS an edge over IMRT and VMAT (Tables 1, 2, and 3).

Among all the modalities, PBS showed the most homogeneous dose distribution with a significant $P$ value ($P = 0.001$). The HI values were $1.05 \pm 0.01$, $1.06 \pm 0.02$, and $0.97 \pm 0.01$ for IMRT, VMAT, and PBS, respectively. The HI between IMRT and VMAT was not significantly different. There was no difference in CI among the 3 modalities. However, IMRT compared favorably to VMAT in conformality ($P = 0.006$).

Bladder

The dose distributions evaluated for bladder in each plan were within tolerance. The $D_{\text{max}}$ was $20.8 \pm 0.21 \text{ Gy}$, $21.65 \pm 0.41 \text{ Gy}$, and $21.05 \pm 0.05 \text{ Gy}$ (RBE) for IMRT, VMAT, and PBS, respectively. The maximum dose to bladder was significantly lower for PBS and IMRT when compared with VMAT. But no difference was observed between PBS and IMRT.

The $D_{\text{occ}}$ was $20.57 \pm 0.3 \text{ Gy}$, $20.83 \pm 0.2 \text{ Gy}$, and $20.72 \pm 0.28 \text{ Gy}$ (RBE) for IMRT, VMAT, and PBS, respectively, whereas the $D_{\text{mean}}$ reported was $8.48 \pm 4.44 \text{ Gy}$, $8.51 \pm 4.26 \text{ Gy}$, and $6.31 \pm 2.81 \text{ Gy}$ (RBE) for IMRT, VMAT, and PBS, respectively.

### Table 1. Dosimetric parameters for target volume and organs at risk.

| Structure | Parameter | Planning modality | $P$ value |
|-----------|-----------|-------------------|-----------|
|           |           | IMRT 6FFF (Gy)    | VMAT 6FFF (Gy) | PBS (Gy [RBE]) | IMRT vs VMAT | VMAT vs PBS | IMRT vs PBS | All |
| PTV       | $D_{95\%}$ | $20.08 \pm 0.06$ | $20.1 \pm 0.04$ | $20.01 \pm 0.02$ (RBE) | .514 | .029 | .097 | .019 |
|           | CI        | $0.92 \pm 0.02$  | $0.89 \pm 0.03$  | $0.87 \pm 0.04$  | .006 | .503 | .077 | .107 |
|           | HI        | $1.05 \pm 0.01$  | $1.06 \pm 0.02$  | $0.97 \pm 0.01$  | .187 | .001 | .001 | .001 |
| Bladder   | $D_{\text{max}}$ | $20.8 \pm 0.21$ | $21.65 \pm 0.41$ | $21.05 \pm 0.05$ (RBE) | .018 | .024 | .056 | .001 |
|           | $D_{\text{occ}}$ | $20.57 \pm 0.3$ | $20.83 \pm 0.2$ | $20.88 \pm 0.06$ (RBE) | .077 | .573 | .106 | .091 |
|           | $D_{\text{mean}}$ | $8.48 \pm 4.44$ | $8.51 \pm 4.26$ | $6.31 \pm 2.81$ (RBE) | .885 | .134 | .163 | .605 |
| Rectum    | $D_{\text{max}}$ | $20.81 \pm 0.12$ | $21.66 \pm 0.38$ | $21.04 \pm 0.03$ (RBE) | .004 | .017 | .012 | .001 |
|           | $D_{\text{occ}}$ | $20.5 \pm 0.26$ | $20.43 \pm 0.38$ | $20.72 \pm 0.28$ (RBE) | .438 | .239 | .325 | .347 |
|           | $D_{\text{mean}}$ | $10.8 \pm 3.43$ | $10.78 \pm 2.87$ | $9.19 \pm 2.62$ (RBE) | .948 | .046 | .093 | .633 |
| RFH       | $D_{\text{mean}}$ | $3.53 \pm 1.41$ | $2.78 \pm 1.04$ | $3.6 \pm 1.94$ (RBE) | .016 | .42 | .946 | .645 |
| LFH       | $D_{\text{mean}}$ | $3.97 \pm 2.08$ | $3.79 \pm 2.14$ | $3.92 \pm 2.13$ (RBE) | .337 | .905 | .963 | .99 |

### Table 2. Comparison of the integral dose.

| Structure | Planning modality | $P$ value |
|-----------|-------------------|-----------|
|           | IMRT 6FFF (Gy)    | VMAT 6FFF (Gy) | PBS (Gy [RBE]) | IMRT vs VMAT | VMAT vs PBS | IMRT vs PBS | All |
| Normal tissue | $25.29 \pm 6.35$ | $25.24 \pm 6.24$ | $14.17 \pm 2.65$ | .712 | .008 | .008 | .009 |
| Bladder    | $1.74 \pm 0.99$  | $1.71 \pm 0.91$  | $1.18 \pm 0.52$  | .627 | .083 | .101 | .512 |
| Rectum     | $0.62 \pm 0.17$  | $0.64 \pm 0.21$  | $0.53 \pm 0.16$  | .508 | .025 | .039 | .621 |
| Right femoral head | $0.31 \pm 0.16$ | $0.23 \pm 0.11$ | $0.31 \pm 0.21$ | .04 | .516 | .952 | .728 |
| Left femoral head | $0.31 \pm 0.14$ | $0.28 \pm 0.11$ | $0.30 \pm 0.19$ | .215 | .861 | .975 | .926 |

### Abbreviations:
- IMRT: intensity-modulated radiation therapy; 6FFF: 6-MV flattening filter free; VMAT: volumetric arc therapy; PBS: pencil beam scanning; PTV: planning target volume; $D_{95\%}$: dose to 95%; Gy: Gray; RBE: relative biological effectiveness; CI: conformity index; HI: homogeneity index; $D_{\text{max}}$: maximum dose; $D_{\text{occ}}$: dose to 2 cm$^3$ volume; $D_{\text{mean}}$: mean dose; LFH: left femur head; RFH: right femur head.

### Abbreviations:
- IMRT: intensity-modulated radiation therapy; 6FFF: 6-MV flattening filter free; VMAT: volumetric arc therapy; PBS: pencil beam scanning; PTV: planning target volume; $D_{95\%}$: dose to 95%; Gy: Gray; RBE: relative biological effectiveness; CI: conformity index; HI: homogeneity index; $D_{\text{max}}$: maximum dose; $D_{\text{occ}}$: dose to 2 cm$^3$ volume; $D_{\text{mean}}$: mean dose; LFH: left femur head; RFH: right femur head.

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respectively. The $D_{2cc}$ did not differ significantly among the modalities. The $D_{\text{mean}}$ remained lower for PBS; however, it was not statistically significant.

**Rectum**

Maximum dose received by rectum was $20.81 \pm 0.12 \text{ Gy}$, $21.66 \pm 0.38 \text{ Gy}$, and $21.04 \pm 0.03 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively. Plan analysis revealed significant difference ($P = .001$) for maximum doses. The VMAT delivered significantly higher doses compared with IMRT ($P = .004$) and PBS ($P = .017$). Dose maximum was comparable between IMRT and PBS.

The $D_{2cc}$ reported was $20.5 \pm 0.26 \text{ Gy}$, $20.43 \pm 0.38 \text{ Gy}$, and $20.72 \pm 0.03 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively and thus was similar between the modalities. The $D_{\text{mean}}$ reported was $10.8 \pm 3.43 \text{ Gy}$, $10.78 \pm 2.87 \text{ Gy}$, and $9.19 \pm 2.62 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively, revealing a significantly reduced mean dose $D_{\text{mean}}$ for PBS compared with VMAT.

**Femoral Heads**

The mean dose to the right femur was $3.5 \pm 1.41 \text{ Gy}$, $2.8 \pm 1.04 \text{ Gy}$, and $3.6 \pm 1.94 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively, hence offering lower mean dose for IMRT than VMAT plans while remaining a similar for PBS. The mean dose to the left femur was $3.97 \pm 2.08 \text{ Gy}$, $3.79 \pm 2.14 \text{ Gy}$, and $3.92 \pm 2.13 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively. No significant changes were detected.

**Integral Dose**

The doses to the normal tissues were $25.29 \pm 6.35 \text{ Gy}$, $25.24 \pm 6.24 \text{ Gy}$, and $14.17 \pm 2.65 \text{ Gy (RBE)}$ for IMRT, VMAT, and PBS, respectively. Use of PBS ($P = .008$) resulted in a significantly reduced integral dose compared with IMRT and VMAT.

Integral dose to the rectum was significantly lower for PBS compared with IMRT and VMAT. Overall, there was a relatively small difference among all 3 modalities. However, the integral dose to the bladder remained significantly unchanged. The integral dose to the femoral head was lower for IMRT, but it did not result in any significant difference between the treatment techniques (Figures 1, 2, and 3).

**Discussion**

In clinical practice, the RBE of protons is generally accepted as 1.1. At present, there is insufficient clinical evidence to propose different RBE values specific to individual human tissues or dose/fractionation. The average RBE at mid-spread-out Bragg peak is 1.2 and 1.1 for in vitro and in vivo, respectively. There is an inherent probability of increased dose deposition at the terminal few millimeters of the spread-out Bragg peak, and the RBE at this region is reported to be potentially as high as 1.7 in vitro and in silico. There is increasing research that hot spots should be considered in proton planning [14]. Although there is uncertainty about the universal application of and Gy (RBE) of 1.1 of protons, there are presently no clinical studies that would provide indication to the contrary, that is, to provide sufficient evidence whether a patient is overdosed or underdosed with this value [15].

Other particle therapies, like carbon ion, are increasingly used in advance cervical cancers. One such study by Kato et al [16] showed a 5-year local control rate of 79% in stage IIIIB by dose escalation (68.8 to 72.8 GyE) to the tumor and favorable local control in stage IVA. The better results were ascribed to superior dose distribution and radiobiological advantages of carbon ion.
With PBS, there is high conformality between the prescription isodose line and the target, which leads to improved sparing of normal tissue compared with IMRT/VMAT and DS. However, PBS has challenges and limitations due to potential interplay effects between the scanning beam and organ motion. In DS, the interplay effects are less likely to change due to the moving target, making DS in some cases a more robust alternative for mobile targets. But in both techniques, there are
opportunities to escalate the tumor dose and, simultaneously, deliver low dose to normal structures. This difference compared with photons is the basis for clinical research and proton application [17]. However, the results from the present study are merely suggestive for the advantages of dose escalation by PBS. Further studies are warranted to arrive at a conclusion.

The PBS results are better in target coverage because of the additional degrees of freedom in weighted individual spots and the absence of an exit dose in the optimization. The IMRT approach delivers dose in the exit path of the beam, and VMAT gives a lower dose wash to the surrounding volume. Therefore, PBS provides the highest homogeneous dose coverage as well as conformal dose distribution. The CI improved compared with IMRT, but overall it is statistically insignificant ($P = .107$).

The primary specification of the treatment-planning concept is to have optimum coverage as the planning priority. This was also confirmed with 2 studies by Weber et al [18, 19]. They reported that CI was similar irrespective of target volume when proton and photons were compared.

Contribution of lower dose increases due to rotational motion in VMAT resulted in higher maximum point dose and dose to 2 cm$^3$ volume of the bladder compared with IMRT and PBS. The same was true for the rectum. Simultaneously, PBS provided better conformity of the target leading to lower mean doses. However, it was not statistically significant.

Figure 3. Box-whisker plot distribution for (A) D95, (B) overall integral dose, (C) bladder 2 cm$^3$, and (D) rectum 2 cm$^3$ for intensity-modulated radiation therapy, volumetric arc therapy, and pencil beam scanning, respectively.
As for the bilateral femoral heads, the doses were lower with VMAT plans. This can be explained by a lower number of total monitor units, causing lower scattering and lower peripheral doses [20]. The mean dose of the femoral heads should improve with PBS, but in the present study, the authors used 2 opposing lateral proton beams, which negated the dosimetric advantage of protons for this OAR. This beam approach reflects how patients are currently being treated, but it may not be optimal. This was the reason for the \( P \) values not being significant when comparing all modalities together.

The present study demonstrates the clear advantage of PBS over IMRT and VMAT \( (P = 0.009) \) in terms of a lower integral dose to the normal tissues. This should translate into lower risk of developing secondary malignancies [21].

The benefit of a low integral dose can be of great importance in potentially curable cases of cervical cancers, especially in younger patients. A second distinct advantage of PBS can be in larger cervical tumor volumes, where lower integral dose in general can result in reduced dose to pelvic bones, thus decreasing irradiation of bone marrow. Reduced bone marrow suppression by radiation can lead to lesser hematological complications. This effect might not be present in smaller target volumes as it can be seen in our study, having higher doses to the femurs due to bilateral proton beams.

With lower doses to the OARs, one of the potential benefits of proton beam therapy can be decreased second primary incidence rate. According to 2 studies by Schneider et al [22, 23], there was a decrease in incidence of secondary cancers by a factor of 2.0 if spot-scanned proton therapy was used compared with IMRT. It was unclear whether the secondary malignancy risks were potentially increased by passively scattered protons related to increased neutron scatter or if the net result would be a decreased risk due to a low integral dose to normal tissues [24]. Chung et al [25] reported that proton therapy is not associated with increased risk of posttreatment malignancies.

The cohort of patients selected for this study was small in number. Subsequent studies would require a higher sample size to confirm these initial results. The clinical relevance of this dosimetric study is still to be evaluated. Due to the limited literature on direct comparisons between proton and photon dosimetric distribution, we still need to evaluate whether photon OAR constraints can be applied to a proton plan evaluation. The next step would be to evaluate the observed effects on larger target volumes to better understand the effects on integral doses.

**Conclusion**

Proton therapy is an evolving technique for treating patients worldwide. The physical and radiobiological parameters of proton could be advantageous in comparison of photons. The present study compared both modalities, and the authors found improvements for certain situations for protons over photons. At present, proton therapy is only used for the treatment of cervix cancer in a few proton centers worldwide. Therefore, the question of the dosimetric benefits of proton beam therapy translating into clinically relevant results presently remains unanswered and will require further studies.

**ADDITIONAL INFORMATION AND DECLARATIONS**

**Conflict of Interest:** The authors have no conflicts of interest to declare.

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