

Rectal Spacer Quality and Rectal Dose Sparing in Prostate SABR: Evidence From a Prospective Clinical Trial

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ABSTRACT

Rectal spacers are commonly used in prostate SABR to reduce rectal dose, but the clinical utility of spacer quality as a planning-oriented quality assurance (QA) metric remains unclear. We retrospectively analyzed 110 prostate SABR cases from the multi-institutional prospective POTEN-C trial. Spacer quality was assessed using a clinically assigned spacer quality score (SQS) based on the minimum prostate–rectum separation on planning imaging. Rectal dosimetric endpoints, including rectal hotspot dose (D0.03cc) and high-dose volume metrics, were evaluated in relation to SQS. Higher SQS was associated with improved rectal dosimetry, including lower rectal hotspot dose and reduced high-dose rectal exposure. Associations with early gastrointestinal quality-of-life (GI QoL) were weak overall, but patients with SQS = 0 showed a markedly higher rate of early GI QoL decline. These findings support SQS as a simple and practical planning QA metric for anticipating achievable rectal dose sparing in routine prostate SABR.

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INTRODUCTION

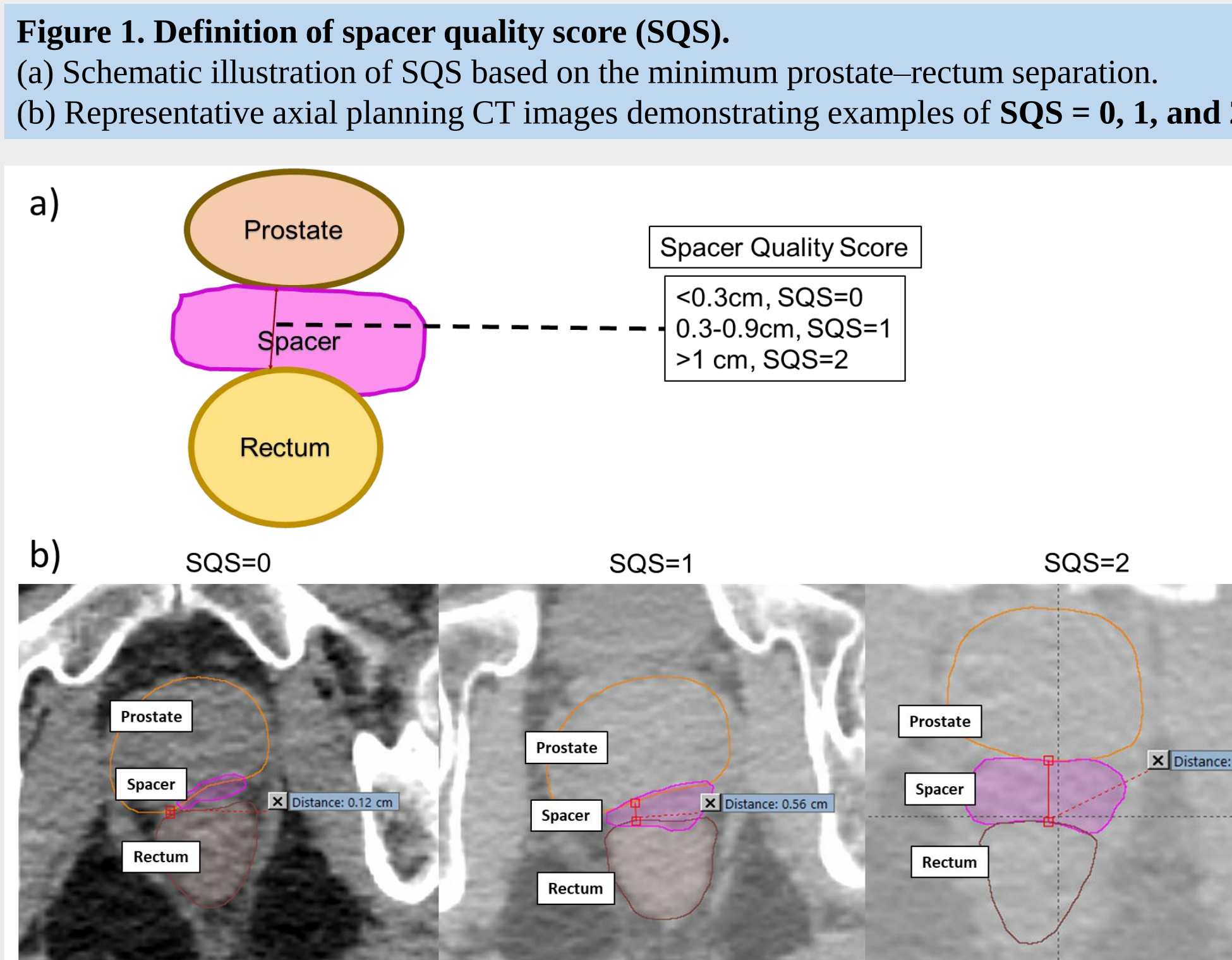
- Rectal spacers are widely used in prostate SABR to increase prostate–rectum separation and reduce rectal dose.
 - While spacer presence has been well studied, **spacer quality** is less commonly incorporated into routine planning QA.
 - A simple geometric assessment of spacer quality may help identify cases with limited achievable rectal sparing.
- Purpose**
To evaluate whether a clinically assigned **spacer quality score (SQS)** predicts rectal dose sparing and can serve as a practical **planning-oriented QA metric** in routine prostate SABR.

METHODS AND MATERIALS

- Methods and Materials**
- Study cohort:** 110 prostate SABR cases retrospectively analyzed from the multi-institutional prospective **POTEN-C** clinical trial.
 - Spacer quality assessment:** A clinically assigned **spacer quality score (SQS)** was derived from the minimum prostate–rectum separation on planning imaging.
 - SQS definition:**
 - **SQS = 0:** < 0.3 cm
 - **SQS = 1:** 0.3–0.9 cm
 - **SQS = 2:** ≥ 1.0 cm
 - Dosimetric endpoints:** Rectal hotspot dose (**D0.03cc**) and high-dose rectal volume metrics were extracted from treatment plans.
 - Analysis:** Associations between SQS and rectal dosimetric endpoints were evaluated to determine whether spacer quality predicts achievable rectal dose sparing. Exploratory analyses also examined relationships between SQS, rectal dose metrics, and early bowel-related quality-of-life (QoL) outcomes.

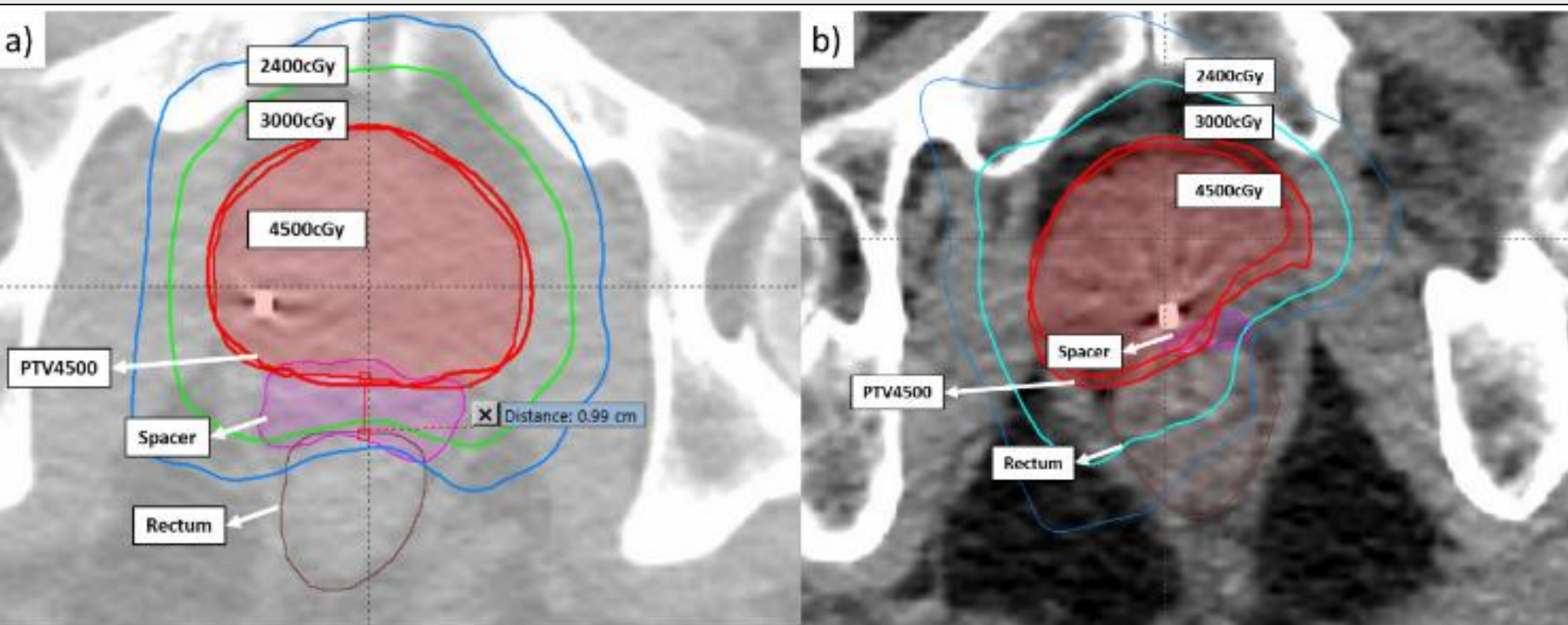
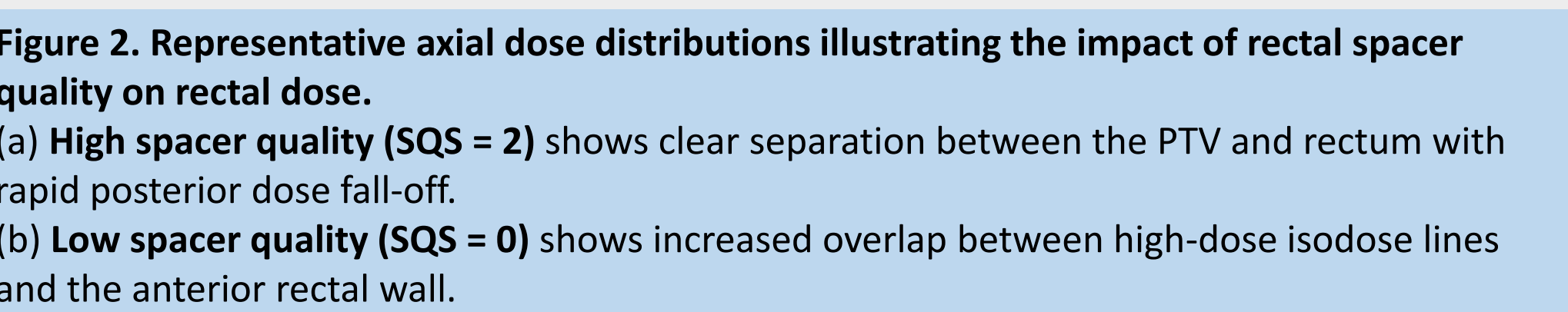
RESULTS

- 1. Definition of spacer quality score**
Spacer quality was quantified using the minimum prostate–rectum separation measured on planning imaging. As shown in **Figure 1**, SQS provides a simple three-level geometric classification of spacer quality:
- SQS = 0:** < 0.3 cm
 - SQS = 1:** 0.3–0.9 cm
 - SQS = 2:** ≥ 1.0 cm
- This metric is routinely assessable on planning imaging and can be formalized as an objective planning QA tool.



- 2. Higher spacer quality was associated with improved rectal dosimetry**
Higher SQS was strongly associated with improved rectal dose sparing. Representative dose distributions are shown in **Figure 2**. Cases with **high spacer quality (SQS = 2)** demonstrated clear separation between the PTV and rectum with steep posterior dose fall-off, whereas **low spacer quality (SQS = 0)** showed increased overlap between high-dose isodose lines and the anterior rectal wall.
- Consistent with these visual findings, **Table 1** shows that higher SQS was associated with lower rectal dose across multiple clinically relevant DVH endpoints. The strongest associations were observed for **rectal hotspot dose** and **high-dose rectal metrics**, supporting SQS as a practical predictor of achievable rectal dose sparing.
- Figure 2 caption**
Figure 2. Representative axial dose distributions illustrating the impact of rectal spacer quality on rectal dose.
- (a) **High spacer quality (SQS = 2)** shows clear separation between the PTV and rectum with rapid posterior dose fall-off.
- (b) **Low spacer quality (SQS = 0)** shows increased overlap between high-dose isodose lines and the anterior rectal wall.

- Table 1 caption**
Table 1. Association between SQS and rectal DVH metrics.
- Linear regression coefficients (β) and p-values are shown for the relationship between SQS and rectal DVH endpoints. Negative β values indicate reduced rectal dose with higher spacer quality.



- 3. Spacer quality showed threshold-based relevance for early GI QoL**
Exploratory analyses demonstrated modest associations between rectal dose metrics and bowel-related QoL outcomes. Although SQS did not show a strong linear association with QoL overall, a clear threshold effect was observed:

Patients with very low spacer quality (SQS = 0) had a substantially higher frequency of early GI QoL decline than patients with SQS > 0. These findings suggest that SQS = 0 may serve as a clinical warning flag, indicating limited achievable rectal sparing and potentially higher early GI risk (**Table 2**).

DISCUSSION

- This study addresses a practical and underexplored QA question: how to assess rectal spacer placement using metrics already embedded in routine clinical planning workflows.
- Unlike prior studies that primarily compare **spacer presence versus absence**, this work evaluates **spacer quality** using a clinically assigned geometric score.
- Our results show that spacer quality translates into measurable rectal dosimetric benefit, making SQS a useful tool for **prospective planning QA**.
- From a practical standpoint, **very low spacer quality (SQS = 0; < 3 mm separation)** may identify cases in which achievable rectal sparing is constrained and closer planning review is warranted.
- Exploratory outcome analyses suggest possible threshold-based clinical relevance, although longer-term follow-up is needed to better define the relationship between spacer quality and toxicity or QoL outcomes.
- These findings also support future development of **automated planning QA tools**, including image- or LLM-assisted assessment of spacer geometry relative to the PTV and rectum.

CONCLUSIONS

A clinically assigned **spacer quality score (SQS)** provides a simple and practical **planning-oriented QA metric** in prostate SABR.

- Higher SQS is associated with improved rectal dosimetry, including lower rectal hotspot dose and reduced high-dose rectal exposure.
- Beyond confirming spacer presence, spacer quality assessment helps set realistic planning expectations and identify cases with limited achievable rectal sparing.

Take-home message:
Spacer quality, quantified by a simple geometric score, is a practical QA metric that predicts rectal dose sparing in prostate SABR.

REFERENCES

1. NB Desai, MR Folkert, A Leiker, et al. Prostate oncologic therapy while ensuring neurovascular conservation (POTEN-C): A phase II randomized controlled trial of stereotactic ablative body radiotherapy (SABR) with or without neurovascular sparing for erectile function preservation in localized prostate cancer
2. Craig E. Grossman, Michael R. Folkert, et al. Quality Metric to Assess Adequacy of Hydrogel Rectal Spacer Placement for Prostate Radiation Therapy and Association of Metric Score With Rectal Toxicity Outcomes, Advances in Radiation Oncology,

Table 2. Exploratory associations between SQS, rectal dose metrics, and QoL outcomes.
Exploratory analyses evaluating the associations among rectal DVH metrics, SQS, and 3-month bowel-related QoL outcomes.

Association between rectal DVH metrics and bowel QoL		
Rectum DVH metric	Association (Dose ↑ vs QoL ↓)	p-value
Dmax	Negative	0.15
Dmean	Negative	0.03
D0.03cc	Negative	0.15
D1.0cc	Negative	0.12
D2.0cc	Negative	0.06
D3.0cc	Negative	0.04
D10.0%	Negative	0.03
D20.0%	Negative	0.01
D50.0%	Negative	0.03
Association between SQS and GI QoL Drop		
SQS	GI QoL drop after 3 months	
0	100%	
1	17%	
2	23%	