

Purpose

- Adaptive radiation therapy treatments on the Elekta Unity MR-linac last up to **40 minutes** without respiratory gating and more than **60 minutes** with gating.
- These prolonged treatment times are driven by Unity's **online adaptive workflow**, low nominal dose rate (425 MU/min), and lack of VMAT functionality.
- Treatment times can be reduced by modifying Monaco planning parameters to decrease the number of monitor units per fraction (MU/Fx) and plan optimization time.
- However, these modifications also affect plan quality.
- The purpose of this study was to **evaluate the impact of Monaco planning parameters on MU/Fx, plan quality, and plan optimization time** for Elekta Unity liver SBRT plans.

Methods

- 10** previously treated liver SBRT Unity patients were **replanned by modifying one planning parameter at a time**. The evaluated parameter values are shown in Table 1.
- Impacts on treatment time were assessed by recording the **MU/Fx, plan optimization time, and estimated delivery time**.
- Impacts on plan quality were assessed by calculating the **conformality and gradient indices**, and by observing compliance with **dosimetric and hotspot constraints**.

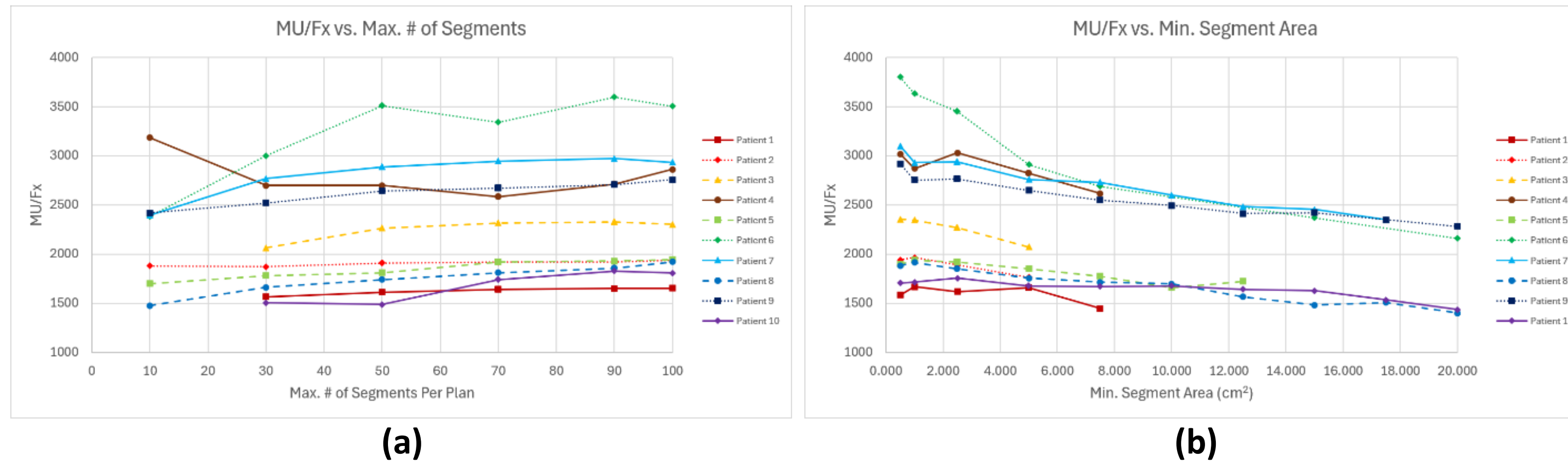


Figure 1. Variation in the number of MU/Fx with (a) maximum number of segments per plan and (b) minimum segment area. Missing data points indicate plans that were clinically unacceptable due to one or more of the following: conformity index > 1.6, gradient index > 9.0, and/or unmet dosimetric/hotspot constraints.

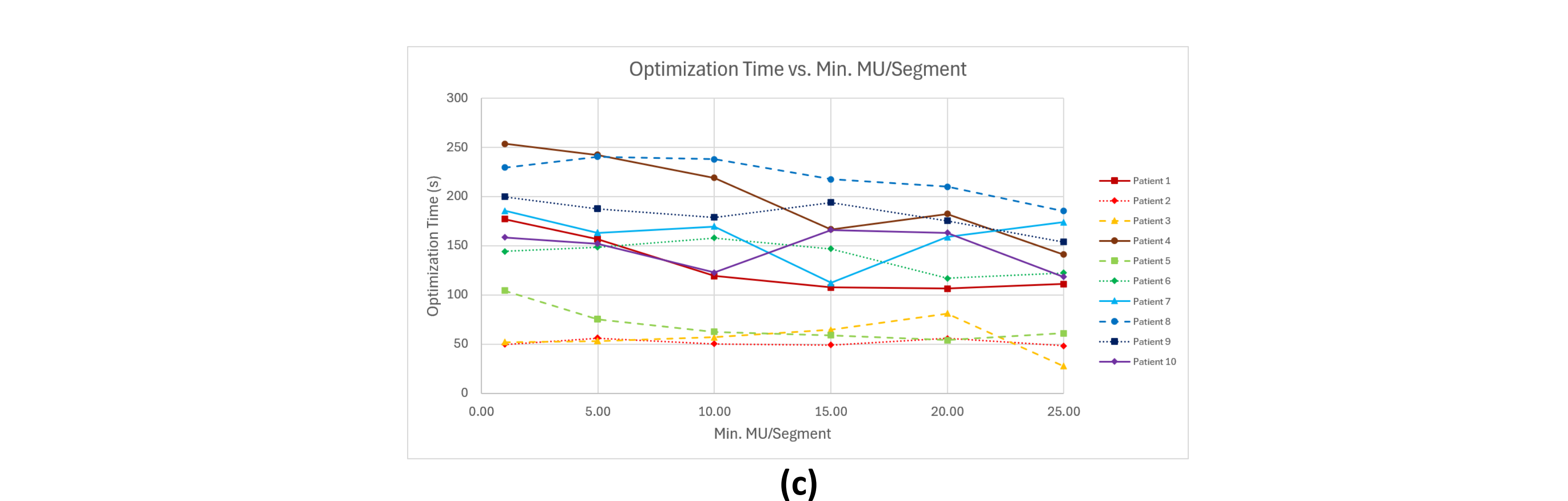
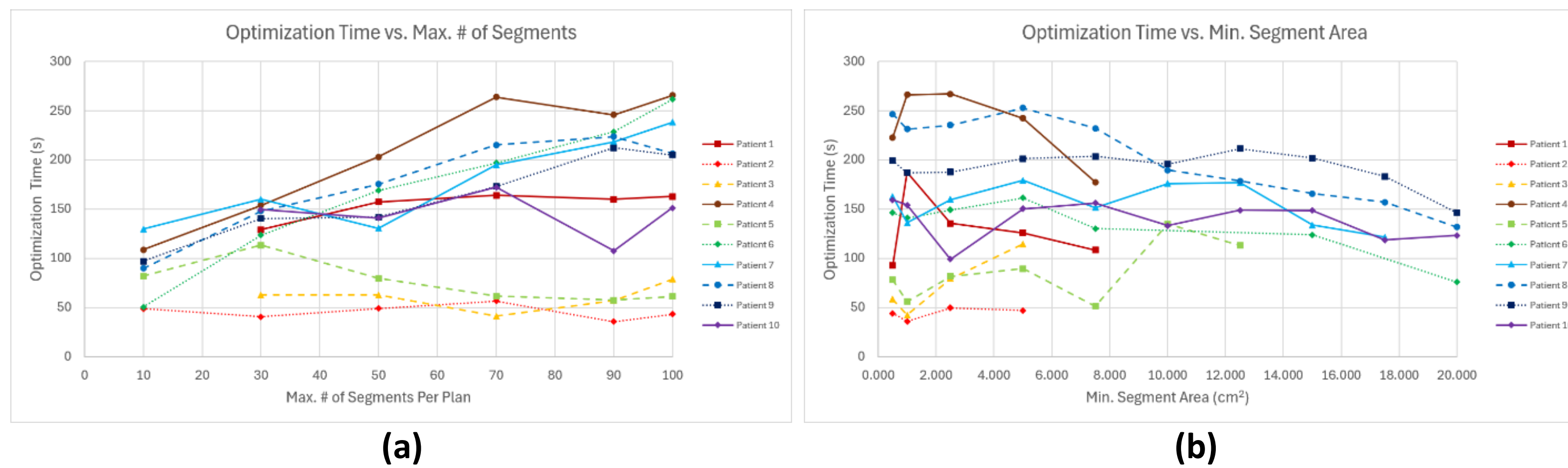


Figure 2. Variation in the plan optimization time with (a) maximum number of segments per plan, (b) minimum segment area, and (c) minimum MU per segment. Missing data points indicate plans that were clinically unacceptable due to one or more of the following: conformity index > 1.6, gradient index > 9.0, and/or unmet dosimetric/hotspot constraints.

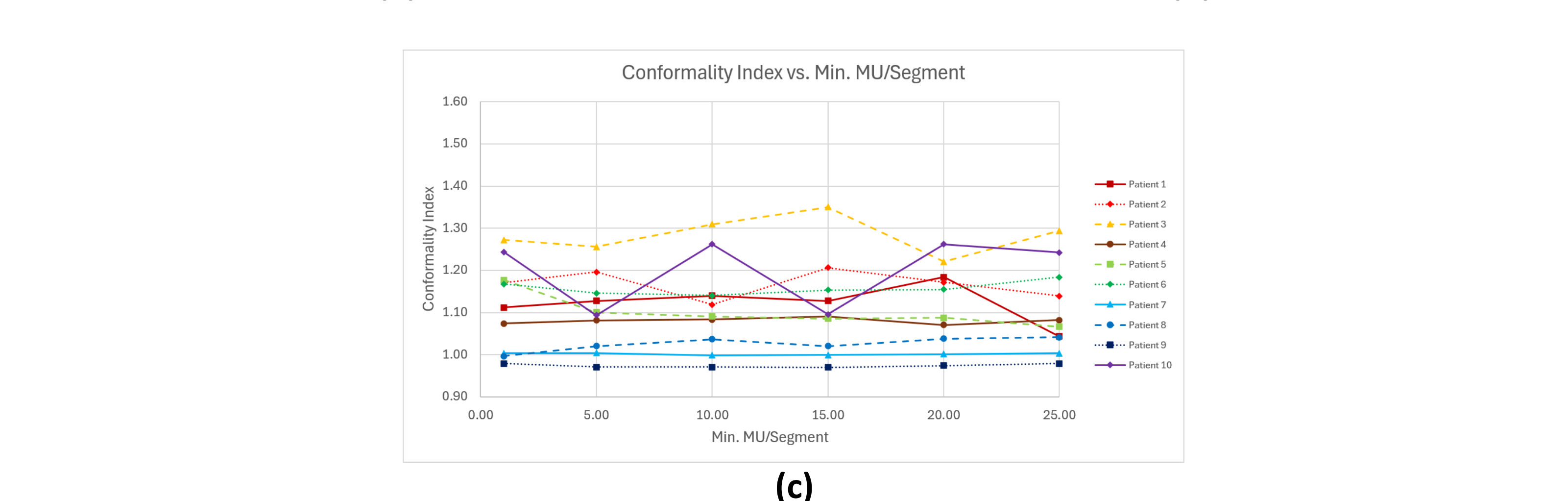
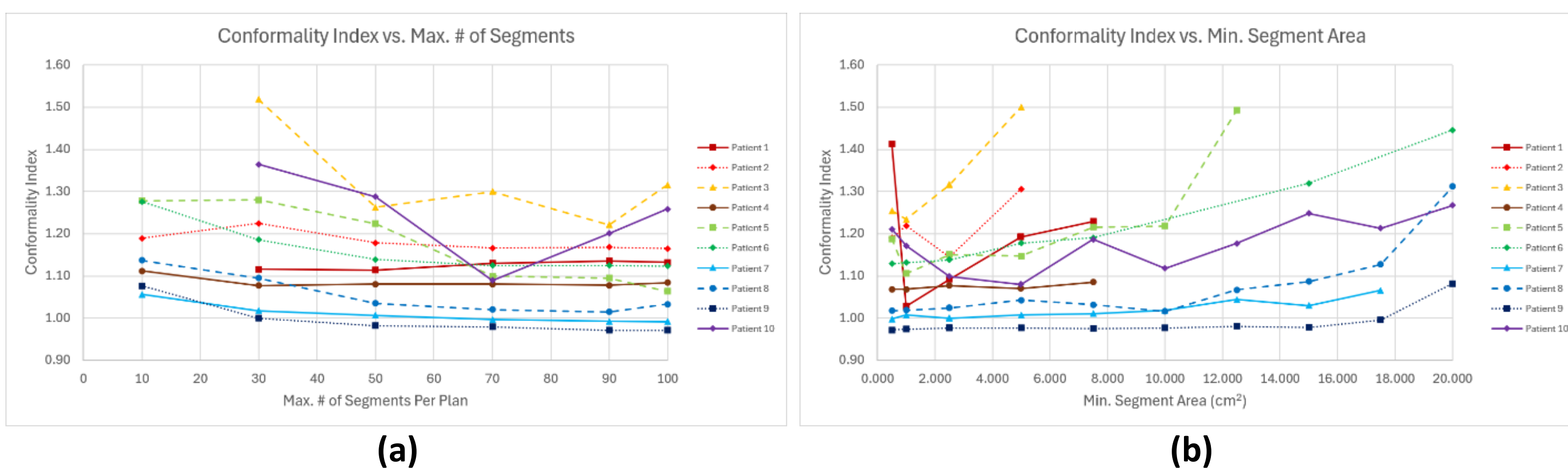


Figure 3. Variation in the conformity index with (a) maximum number of segments per plan, (b) minimum segment area, and (c) minimum MU per segment. Missing data points indicate plans that were clinically unacceptable due to one or more of the following: conformity index > 1.6, gradient index > 9.0, and/or unmet dosimetric/hotspot constraints.

Results

Reduce MU/Fx by:

- Decreasing the **maximum number of segments** from 100 to 30 (**10.2 ± 4.8%**).
- Increasing the **minimum segment area** from 0.5 cm² to the PTV-based maximum value (**19.8 ± 9.9%**).
- Using **High fluence smoothing** (**6.5 ± 4.8%** in 8 of 10 patients).

Reduce Optimization Time by:

- Decreasing the **maximum number of segments** from 100 to 10 (**47.3 ± 29.0%**) for $V_{PTV} > 30 \text{ cm}^3$ only.
- Increasing the **minimum segment area** from 0.5 cm² to 20 cm² (**33.8 ± 12.5%**) for $V_{PTV} > 30 \text{ cm}^3$ only.
- Increasing the **minimum MU per segment** from 1 to 25 (**26.2 ± 15.8%**) for all V_{PTV} in this study.

Unacceptable plan quality caused by:

- Fewer than 30 segments (3 of 10 patients).
- Minimum segment area > 5 cm² ($V_{PTV} < 30 \text{ cm}^3$).
- Minimum segment area > 20 cm² ($V_{PTV} > 30 \text{ cm}^3$).
- Minimum segment width > 1.75 cm ($V_{PTV} < 16 \text{ cm}^3$).

Estimated Delivery Time (EDT) vs. MU/Fx:

- EDT = $0.1629 \cdot (\text{MU/Fx}) + 46.634$
- $R = 0.9098$
- $R^2 = 0.8278$

Conclusion

Lowers MU/Fx (and Estimated Delivery Time):

- Decreasing maximum number of segments
- Increasing minimum segment area
- Using High fluence smoothing

Lowers Optimization Time:

- Decreasing maximum number of segments
- Increasing minimum segment area
- Increasing minimum MU per segment

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Parameter	Tested Values
Max. # of Segments Per Plan	10, 30, 50, 70, 90, 100
Min. MU/Segment	1, 5, 10, 15, 20, 25
Min. Segment Width (cm)	0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00
Min. Segment Area (cm²)	0.5, 1.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0
Fluence Smoothing	Off, Low, Medium, High