

MRI Radiomics Correlate with Clinical Outcomes of Peripheral Venous Malformations Following Percutaneous Sclerotherapy

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Background

- Venous malformations (VMs) are congenital slow-flow dilated venous channels that comprise two-thirds of all congenital vascular malformations.
- VMs can arise in any part of the body and affect patients of any age and gender.
- VMs can range anywhere from small, superficial lesions to extensive, deeply penetrating lesions that cause significant pain and disfigurement.
- Image-guided percutaneous sclerotherapy (PS) is the standard first-line treatment for most VMs.
- Magnetic resonance imaging (MRI) has been established as the gold standard for the diagnosis and follow-up of VMs.
- Few studies have investigated the precise relationships between quantitative MRI evaluation (mainly lesion volume) and treatment response after PS.

Objectives

To study the changes in MRI radiomic features (including lesion volume and signal intensity) in patients with peripheral extremity VMs treated using PS.

Materials and Methods

- Our vascular anomalies database was searched for patients with peripheral extremity VMs who were treated by image-guided percutaneous sclerotherapy and had completed their treatment plan, and clinical and imaging follow-up between 2005-2022.
- VMs were manually segmented on pre- and post-treatment T2-weighted (T2-WI) MRI using 3D Slicer software to assess the changes in lesion volume and signal intensity (SI).
- To account for signal parameter differences between pre- and post-treatment T2-WI, a histogram equalization technique was applied for precise and true calculation of SI change after PS.
- Treatment response was categorized as 0 = worse or unchanged, and 1 = improvement based on clinical evolution after treatment.
- Clinical outcome assessment was also scored on a 7-point scale, ranging from -3 (worst deterioration) to +3 (maximum improvement), based on patient's perception of symptoms change.
- Spearman's rank correlation coefficient (ρ) and Paired t-test (t) were used for statistical analysis.

Results

- Eighty-one patients (mean age: 20±14 years; 47 females) with peripheral upper (23 lesions) and lower (58) extremity VMs underwent 125 percutaneous sclerotherapy procedures (range: 1-6). Different sclerosants were used: anhydrous alcohol (52 sessions), foamed bleomycin (38) and foamed sotradecol (35).
- Most patients (77) reported clinical improvement following sclerotherapy, including mild (8 patients), moderate (22), and significant (47) improvement.
- There was a statistically significant difference in VM mean **volume** variation between the **success and failure groups** (-9.4 cm³ ± 23.6 vs. 21.2 cm³ ± 20.2, **P = .04**). However, the difference in mean SI variation was not significant between the **two groups** (-128 ± 163 vs. -22.6 ± 91.4, **P = .06**).

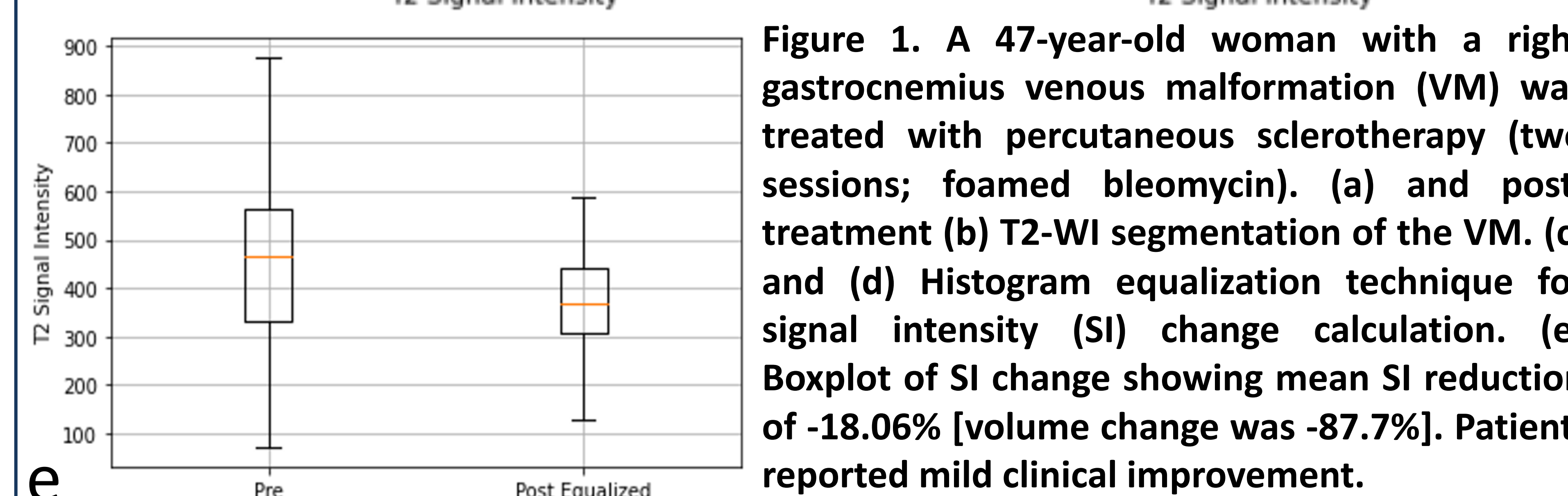
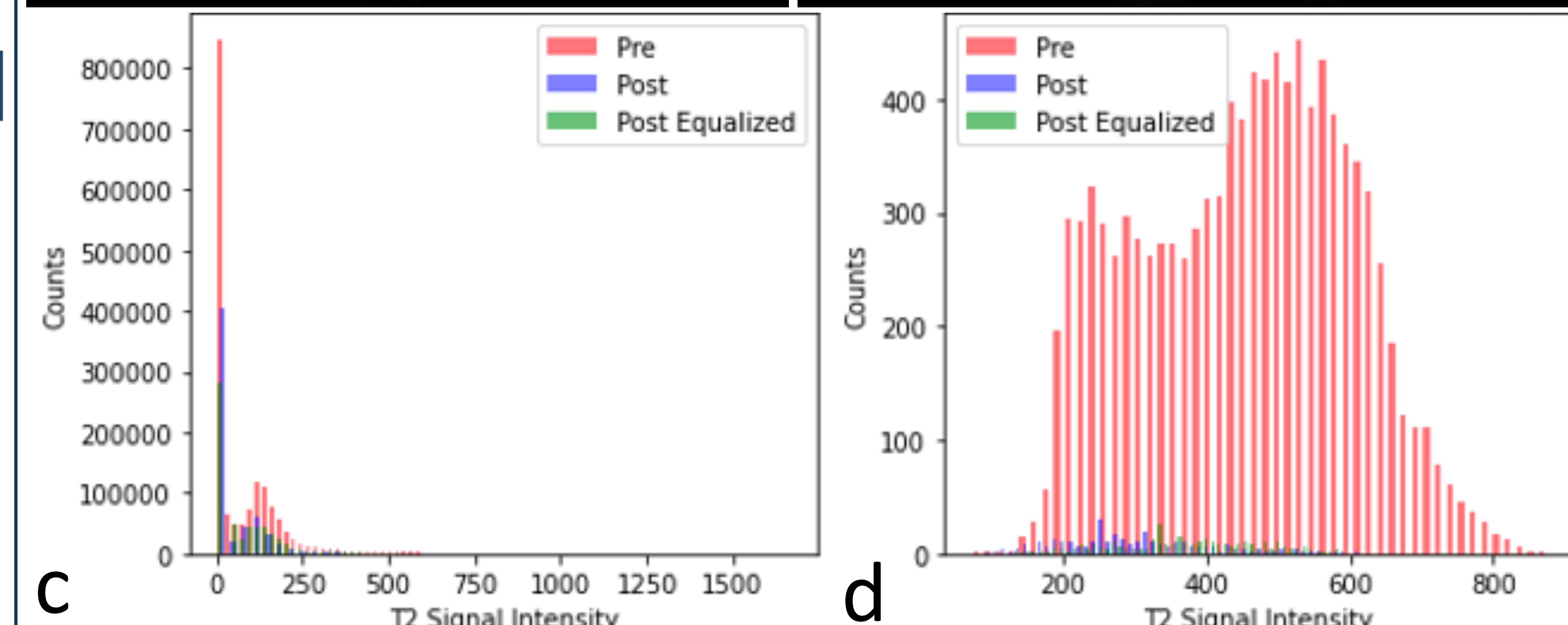
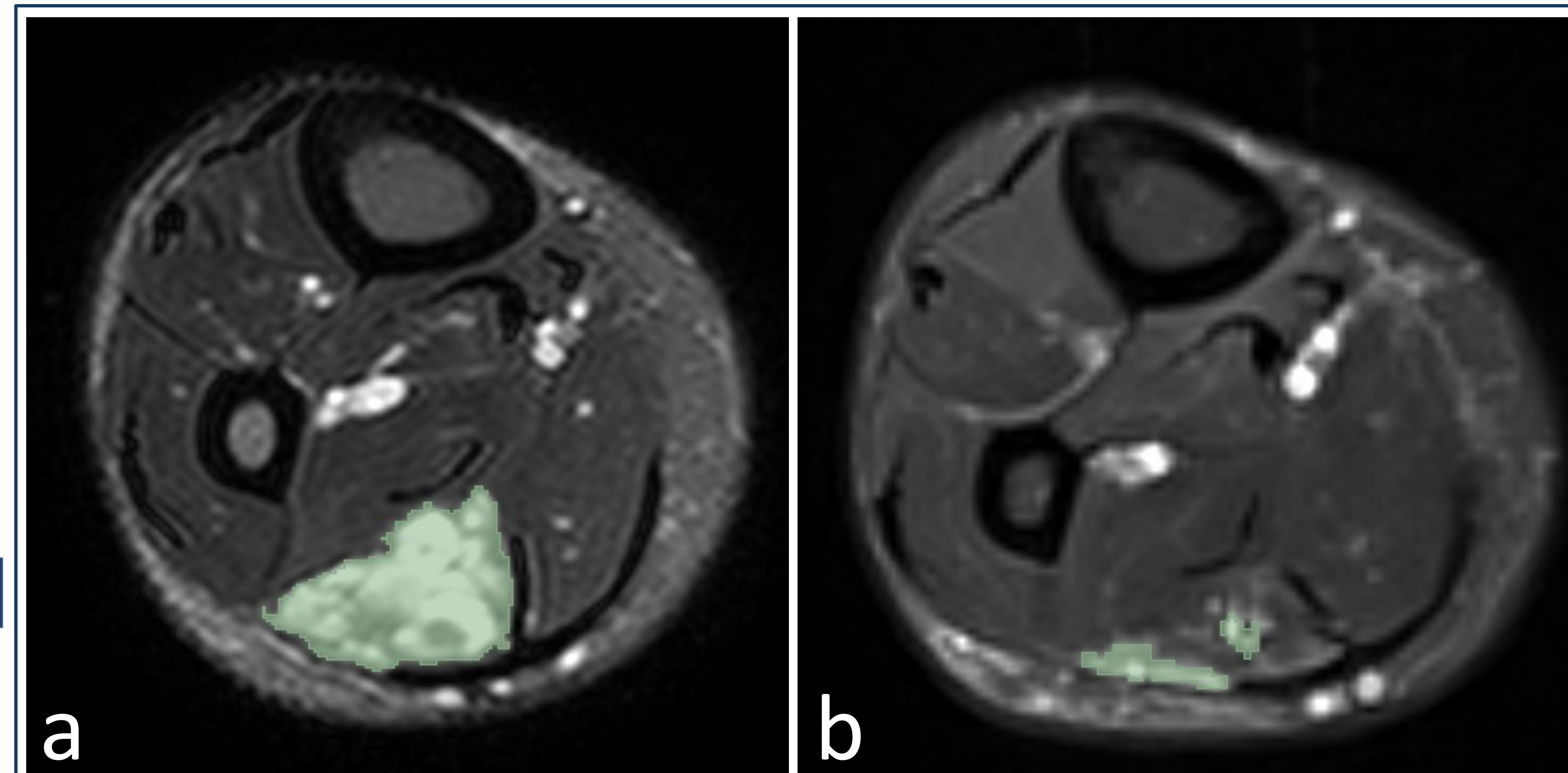


Figure 1. A 47-year-old woman with a right gastrocnemius venous malformation (VM) was treated with percutaneous sclerotherapy (two sessions; foamed bleomycin). (a) and post-treatment (b) T2-WI segmentation of the VM. (c) and (d) Histogram equalization technique for signal intensity (SI) change calculation. (e) Boxplot of SI change showing mean SI reduction of -18.06% [volume change was -87.7%]. Patient-reported mild clinical improvement.

	Baseline	Follow-up	Change	P value
Volume (cm ³)	36.9 ± 49.5 (range: 0.8–230.0)	28.9 ± 40.5 (range: 0.1–211.5)	-7.9 ± 24.4 (range: -115.6–43.4)	.005
Signal intensity	525.4 ± 462.6 (range: 102.9–3002.6)	402.3 ± 405 (range: 58.5–2636.5)	-123.1 ± 161.9 (range: -672.6–444.5)	<.001

Table 1. Changes in calculated VMs volume and signal intensity.

	Volume change (cm ³)	Signal intensity change	P value
Therapeutic response	-.317 [95%CI: -0.505– -0.099]	–	.004
Children	-.364 [95%CI: -0.589– -0.087]	–	.009
Foot VMs	-.64 [95%CI: -0.909–0.005]	–	.046
VMs treated in one session	–	-.313 [95%CI: -0.547– -0.032]	.026
VMs treated with Sotradecol only	-.536 [95%CI: -0.813– -0.059]	–	.027
VMs treated with Bleomycin only	–	-.425 [95%CI: -0.725– 0.009]	.048

Table 2. Correlation analysis of radiomics with clinical and treatment details.

Conclusion

MRI radiomic features (such as changes in lesion volume and signal intensity) correlated with the clinical outcomes in patients with peripheral extremity venous malformations treated using percutaneous sclerotherapy.