



Patient Frailty as a Predictor of Outcomes Following Preoperative Embolization for Skull Base Meningioma Resection



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INTRODUCTION

Pre-operative embolization is frequently used for skull base meningiomas to decrease intraoperative bleeding, improve surgical visibility, and facilitate maximal safe resection. However, the impact of patient frailty on embolization efficacy, perioperative safety, and long-term outcomes has not been well defined. The modified Frailty Index (mFI-5) provides a standardized measure to stratify patients by physiologic reserve.

AIMS

To assess how frailty impacts embolization performance, perioperative safety, functional outcomes, and long-term symptom burden in skull base meningioma patients, and to evaluate its predictive value for complications and discharge disposition.

METHODS

We retrospectively reviewed 35 patients who underwent pre-operative embolization followed by surgical resection for skull base meningiomas. Patients were stratified into low frailty (mFI-5 <2, n=28) and high frailty (mFI-5 ≥2, n=7). Demographic, tumor features, and embolization parameters were compared using Mann-Whitney U and Kruskal-Wallis tests. Outcomes included peri- and postoperative complications, ICU admission and length of stay (LOS), functional outcomes measured by modified Rankin Scale (mRS), and discharge disposition. Symptom burden was assessed preoperatively and at 3, 6, and 12 months. Predictive ability of mFI-5 for rehabilitation discharge, prolonged ICU stay (≥7 days), and poor functional outcome (mRS ≥3) was assessed using ROC analysis.

RESULTS

Patient Demographics and Baseline Characteristics by Frailty Level

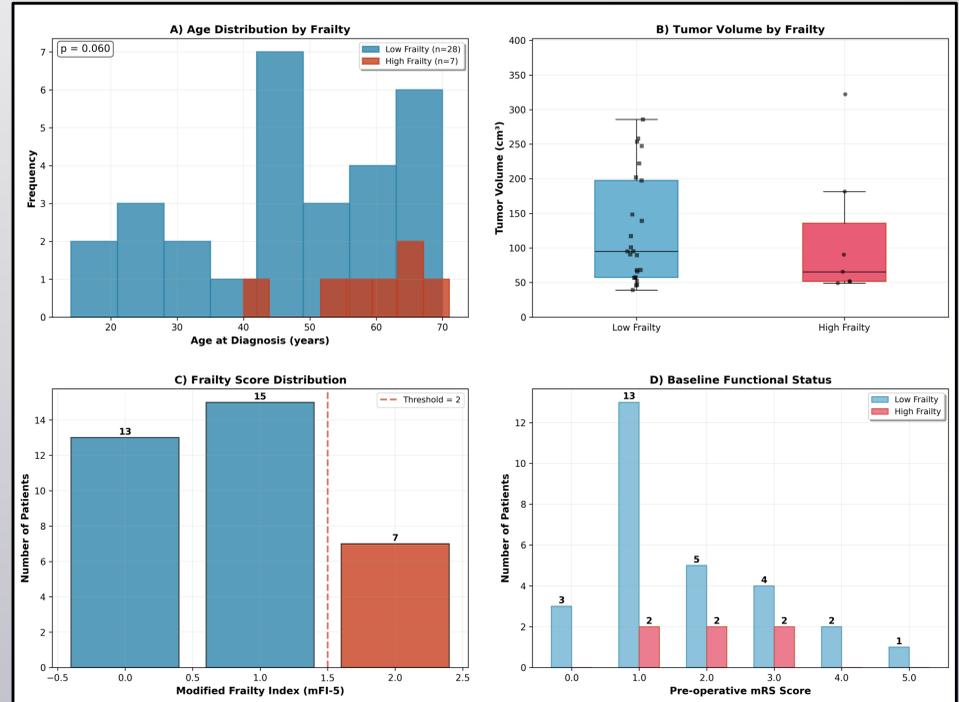


Figure 1: High-frailty patients were nonsignificant older (59.4 vs 47.0 years, p=0.060) with similar BMI, tumor volume (115.9 vs 124.0 cm³, p=0.450), and WHO grade. Baseline function was minimally different in the high-frailty cohort (mRS 2.0 vs 1.7, p=0.400).

Embolization & Clinical Outcomes

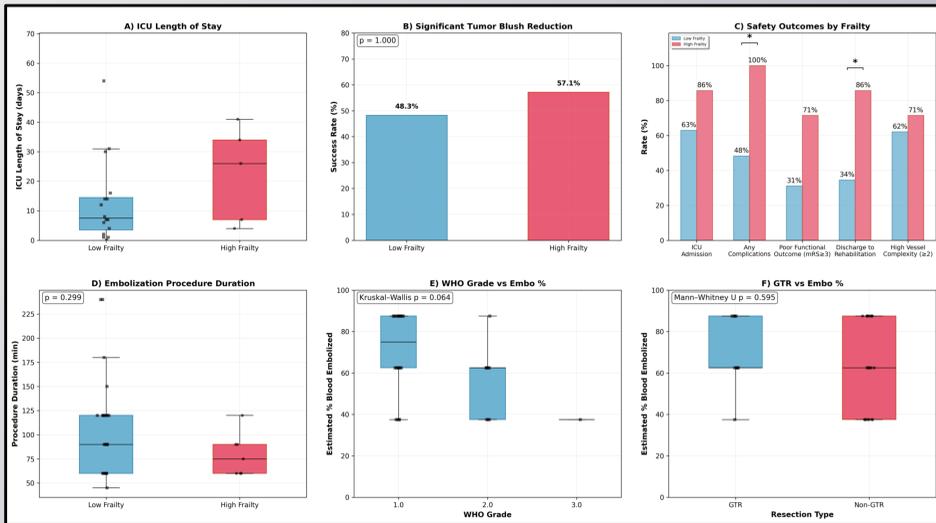


Figure 3: Embolization characteristics were comparable: procedure duration (79.3 vs 103.9 min, p=0.300) and significant tumor blush reduction (57.1% vs 46.7%, p=0.690). Degree of embolization did not differ by WHO grade (p=0.064) or resection type (gross total vs non-gross total; p=0.595). Safety and resource utilization diverged by frailty. High-frailty patients had more ICU admissions (85.7% vs 63.0%, p=0.380), longer ICU LOS (22.4 vs 12.9 days, p=0.250), and significantly higher complication rates (100% vs 48.3%, p=0.030). Discharge to rehabilitation was more frequent with high frailty (85.7% vs 34.5%, p=0.030), and poor functional status at discharge (mRS ≥3) was more common (71.4% vs 31.0%, p=0.080).

Symptom Evolution Analysis by Frailty Level

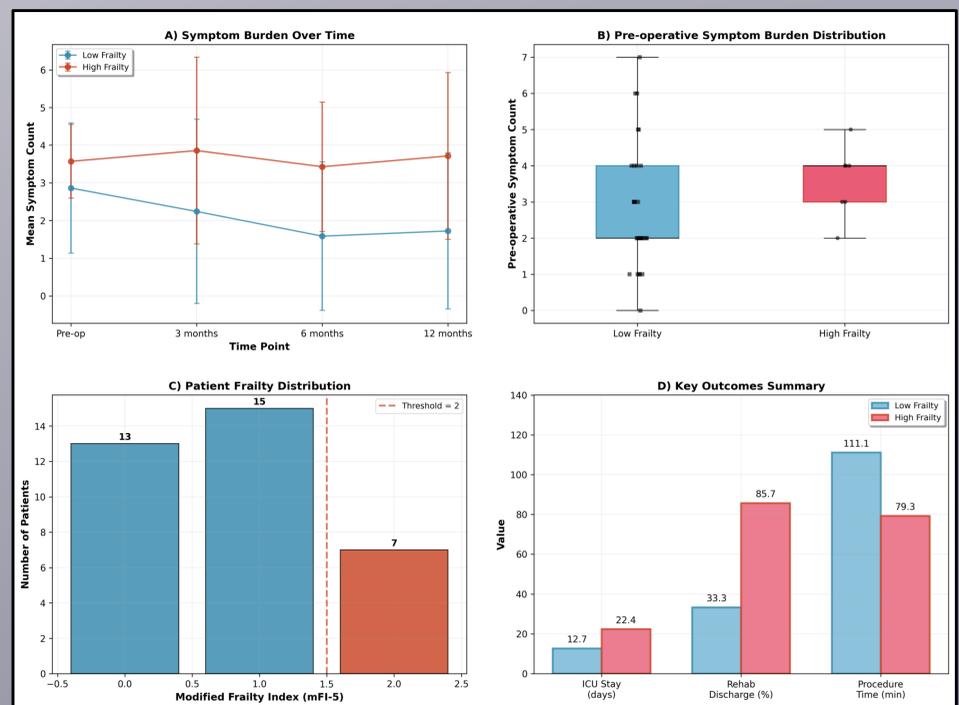


Figure 2: Longitudinally, symptom burden remained higher in the high-frailty group. Pre-operative counts were similar (3.6 vs 2.8, p=0.130), but differences were significant at 6 months (3.4 vs 1.5, p=0.020) and 12 months (3.7 vs 1.7, p=0.030). Low-frailty patients improved over time; high-frailty patients showed persistent or increasing burden. mFI-5 demonstrated prognostic value.

ROC Curves (mFI-5) for Key Outcomes

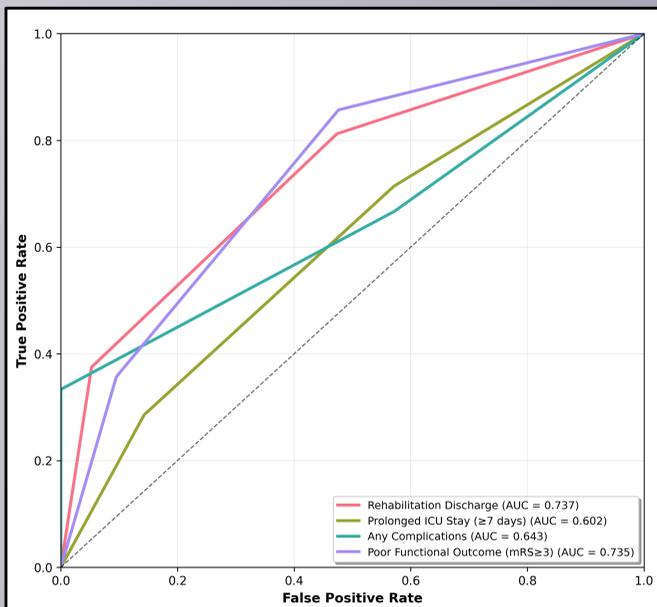


Figure 4: AUC 0.737 for rehabilitation discharge, 0.735 for poor functional outcome, and 0.602 for prolonged ICU stay.

Conclusion

Frailty is a significant determinant of perioperative safety and functional outcomes in patients undergoing preoperative embolization for resection of skull base meningiomas. Although the technical performance of preoperative embolization was not affected by frailty, high-frailty patients experienced higher complication rates, longer ICU stays, more frequent discharge to rehabilitation, and persistent postoperative symptom burden. ROC analysis demonstrated that frailty reliably predicts poor outcomes, supporting its use as a preoperative risk stratification tool. Integrating frailty assessment into clinical decision-making may improve patient counseling, guide perioperative planning and management, and improve postoperative resource allocation to optimize patient outcomes.

