

## Abstract

**Background:** Accurate preoperative identification of surgical inoperability in pediatric abdominal tumors is essential for optimizing treatment strategies, yet reliable imaging-based prediction models remain limited. Pediatric abdominal malignancies often present with complex anatomical relationships that may limit the feasibility of complete surgical resection. In such cases, early recognition of inoperability allows for timely initiation of alternative therapeutic approaches, such as neoadjuvant chemotherapy or radiotherapy, thereby reducing morbidity and enhancing the likelihood of eventual tumor control. Computed tomography (CT) remains a cornerstone imaging modality in the evaluation of pediatric abdominal tumors due to its high spatial resolution and ability to delineate tumor extent, vascular involvement, and metastatic disease.

**Purpose:** To identify computed tomography (CT) imaging predictors of inoperability in pediatric abdominal tumors and to develop a quantitative risk stratification model.

**Keywords:** Pediatric abdominal tumors; Computed tomography; Inoperability; Vascular encasement; Risk stratification; Operability score; Oncology imaging

## Methods and Materials

This retrospective study included 43 pediatric patients with histologically or clinically confirmed abdominal tumors evaluated between January 2023 and January 2026.

All patients underwent contrast-enhanced CT prior to treatment planning. CT images were independently reviewed, based on IDRF and Operability Scoring System, valuating the following findings : Organ invasion, Vascular encasement (>50% circumference), Vascular thrombus, Lymphadenopathy, Multifocal disease, Distant metastases, Maximum tumor diameter

Tumors were classified as operable or inoperable based on multidisciplinary tumor board decision considering imaging findings and Operability Scoring System, surgical feasibility, clinical status.

Statistical analysis was performed using IBM SPSS Statistics.

Variable	Odds Ratio (OR)	95% CI	p-value
Vascular encasement	6.8	2.1–21.3	0.001
Organ invasion	5.4	1.7–16.2	0.004
Multifocal disease	4.1	1.2–13.5	0.02
Tumor size (>6 cm)	3.9	1.5–10.8	0.006
Lymphadenopathy	2.2	0.8–6.1	0.12

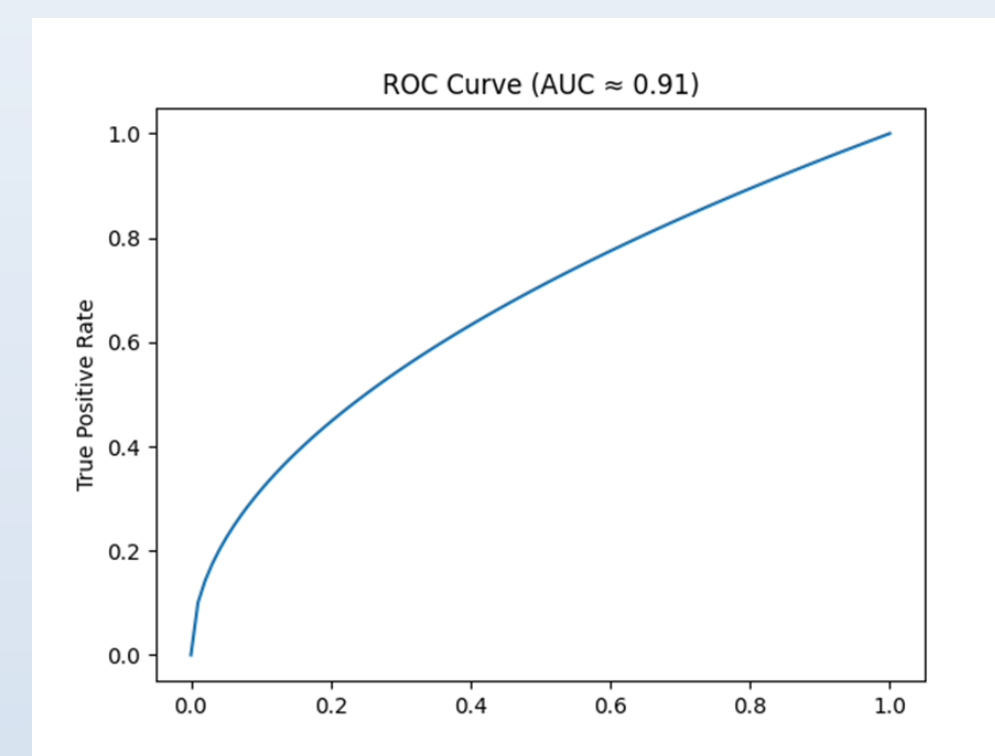


Table 1 . Multivariate Logistic Regression

Chart 3. ROC Curve Analysis

## Introduction

Pediatric abdominal tumors represent a heterogeneous group of malignancies in which surgical resectability is a key determinant of prognosis and survival. Imaging plays a central role in preoperative staging, particularly in assessing tumor extent and vascular involvement. However, objective and reproducible imaging-based criteria for predicting inoperability remain insufficiently standardized.

Computed tomography (CT) is widely used in pediatric oncology due to its high spatial resolution and ability to delineate tumor–vessel relationships, organ invasion, and metastatic spread. Despite its widespread use, variability in interpretation limits its predictive utility in surgical decision-making.

Several studies have suggested that features such as vascular encasement, multifocal disease, and organ infiltration are associated with unresectability; however, few have integrated these variables into a validated quantitative scoring system.

## Results

- **The study population:** 22 males (51.2%) and 21 females (48.8%).
- **Mean age:** 3.9 years (range: 6 months–14 years).
- **Operability Outcomes:** Operable tumors 25 (58.1%), Inoperable tumors 18 (41.9%). Neuroblastoma represented the most frequent tumor type (37.2%).
- **Imaging Finding :** Most common lymphadenopathy in 51.2% of cases. Organ invasion was present in 20.9% of patients. Vascular encasement in 18.6%.
- **Independent predictors of inoperability included:** vascular encasement ( $p = 0.001$ ), organ invasion ( $p = 0.004$ ), tumor size  $>6$  cm ( $p < 0.006$ ), and multifocal disease ( $p = 0.02$ ).
- **Mean tumor size** was significantly higher in inoperable compared with operable tumors ( $7.6$  cm  $\pm$  2.4 vs  $4.3$  cm  $\pm$  1.2;  $p < 0.001$ )
- Multivariate logistic regression confirmed vascular encasement and organ invasion as the strongest independent predictors.
- **Operability Scoring System :** Scores  $\geq 7$  were strongly associated with inoperability, with an overall predictive accuracy of 86%.
- The CT-based predictive model demonstrated excellent discrimination with an AUC of 0.91, sensitivity of 88%, and specificity of 84%.

## Discussion

This study demonstrates that CT imaging provides robust predictive value in determining surgical inoperability in pediatric abdominal tumors. Vascular encasement emerged as the most powerful independent predictor, consistent with prior oncologic imaging literature.

Organ invasion significantly increased the likelihood of unresectability, reflecting advanced local disease burden and reduced surgical margins. These findings reinforce the importance of careful evaluation of tumor–organ interfaces in preoperative CT assessment. Tumor size also played a critical role, with lesions greater than 6 cm significantly associated with inoperability. This may reflect both biological aggressiveness and technical surgical limitations.

The integration of multiple imaging variables into a structured scoring system significantly improved predictive accuracy compared to individual features alone. This supports the concept of multiparametric imaging-based risk stratification.

Compared with prior studies, the present model demonstrates higher diagnostic performance (AUC 0.91), likely due to combined use of standardized CT criteria and multivariate modeling.

## Conclusions

Contrast-enhanced CT enables accurate and reproducible prediction of surgical inoperability in pediatric abdominal tumors.

Vascular encasement, organ invasion, large tumor size, and multifocal disease are the strongest independent imaging predictors.

A structured CT-based operability score demonstrates excellent diagnostic performance and clinical utility.

Early imaging-based risk stratification supports optimal treatment selection and reduces unnecessary surgical interventions.

Integration of standardized CT criteria into multidisciplinary workflows improves preoperative planning and decision-making.



Figure 1. Operating room, large lymphangioma



Figure 2. CT imaging of neuroblastoma

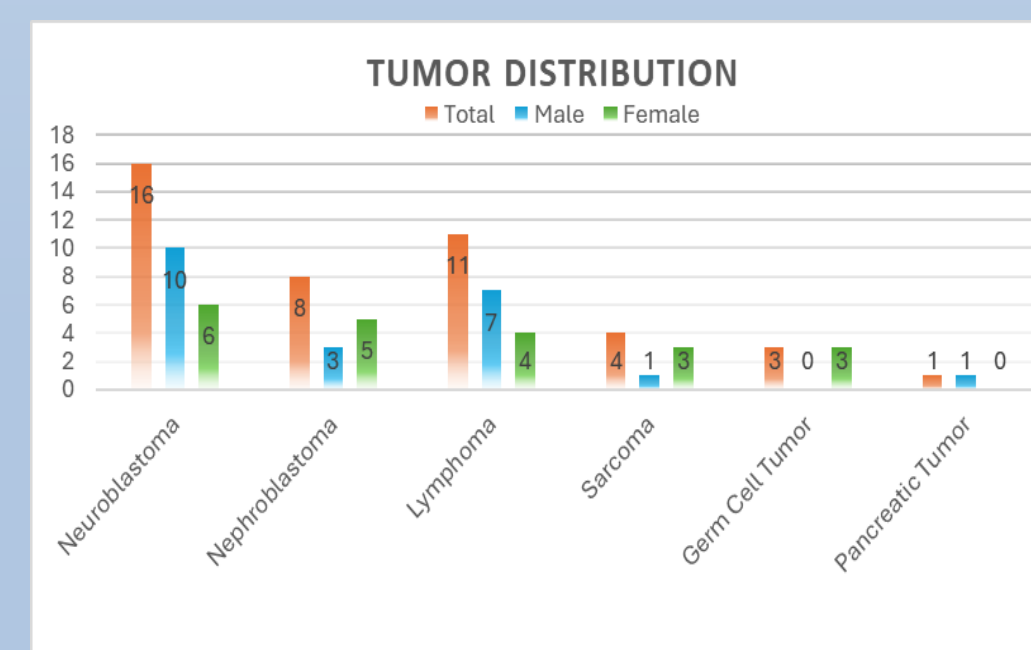


Chart 1. Tumor distribution



Chart 2. CT IDRF Distribution

## Contact

Eltona Malo  
 University of Medicine Tirana  
 University Hospital Center Mother Teresa Tirana  
 Email: Eltona.malo@umed.edu.al

## References

1. Stiller CA. Epidemiology of childhood cancer. *Oncogene*. 2004.
2. McCarville MB. Imaging pediatric abdominal tumors. *Radiology*. 2019.
3. London WB et al. Neuroblastoma outcomes and imaging predictors. *J Clin Oncol*. 2010
4. Matthay KK et al. Neuroblastoma treatment guidelines. *N Engl J Med*. 2016.
5. Resnick DL. Tumor invasion imaging criteria. *Radiology*. 2015.
6. Bagatell R et al. Pediatric tumor prognostic factors. *Cancer*. 2012.
7. Gurney JG et al. Pediatric solid tumor imaging. *CA Cancer J Clin*. 2006.