A Fully Automated, Machine Learning-driven 3D Model Helps Predict Difficulty In Elective Splenectomy

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Background and significance

- **Laparoscopic** elective splenectomy (LS) is commonly performed for hematologic disorders
- However, there is a **size** threshold above which Open Splenectomy (OS) may offer superior clinical outcomes than a laparoscopic approach.
- The size threshold at which OS should be considered is **not clear**.
- Surgeons typically rely on **single-axis, CT-derived measurements** of spleen length to guide clinical decision-making.
- We developed and evaluated a **fully automated**, machine learning (**ML**) driven model that created **3D model** of the spleen and tested **anatomic features** that could predict **operative difficulty** in cases of splenomegaly.

Methods

- We performed a retrospective study of **42 consecutive patients** undergoing **elective** splenectomy with **available diagnostic imaging** (i.e., CT Abdomen/Pelvis with contrast)
- Including **38%** LS, **28%** male, and mean BMI of **26** kg/m².
- The workflow of our automated segmentation platform is demonstrated in ***Figure 1***.
- Derived features included
  - vertical height,
  - minimum and maximum diameters (mm),
  - cross-sectional areas (mm²) in axial, sagittal, and coronal planes,
  - surface area (mm²) and splenic volume (mL).
- Associations between ML-derived anatomic features and perioperative outcomes, including operative room **(OR) time** and estimated blood loss (**EBL**) were assessed with linear regression.

General Overview

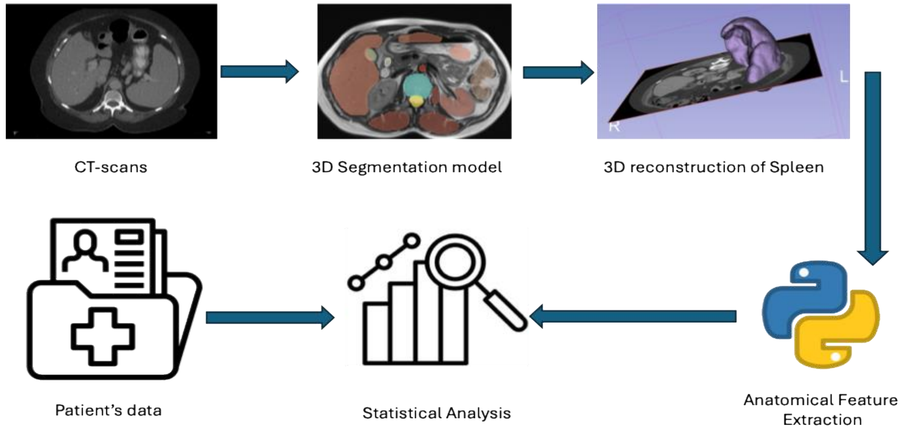

Fig.1: Automated ML-Driven Anatomical Feature Extraction workflow

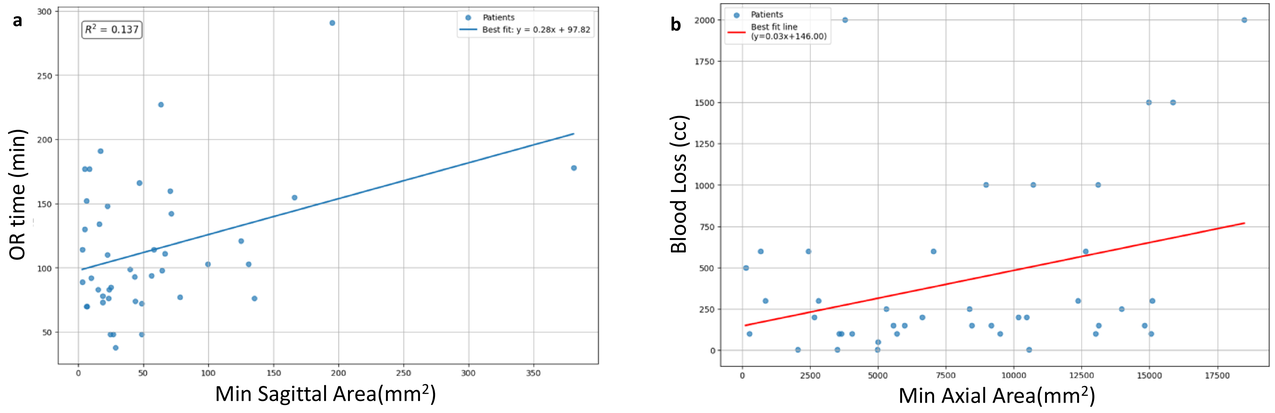

Fig.2 a) Scatter Plot and regression line for Surgery time and Minimum sagittal area.
b) Scatter Plot and regression line for Blood loss and Maximum axial area

Results

- We identified **weak** correlation between the **traditional** measure of **splenic length** and **OR time** or **EBL** (r = 0.14 for each).
- However, our ML-derived features, including **splenic cross-sectional area** and **splenic volume** showed improved association with EBL and OR time.
- Representative correlations and the segmentation workflow are provided (***Figure 2***).

Conclusion

- Our platform allows for **efficient**, **machine learning-driven** assessment of an individual's **splenic anatomy** based on routine preoperative imaging.
- Through this analysis, we have identified that multidimensional characteristics, including **cross sectional area** and **splenic volume**, may better predict **operative time** and **EBL** compared to the **traditional** measure of splenic length, alone.
- Incorporating these features into preoperative assessment may improve efficient planning for both LS and OS. Prospective validation in larger cohorts is warranted.

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