Automated Three-dimensional Psoas Analysis is Superior to Two-dimensional Analysis to Predict Sarcopenia and can be Used to Predict Discharge Disposition in Trauma Patients

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Background

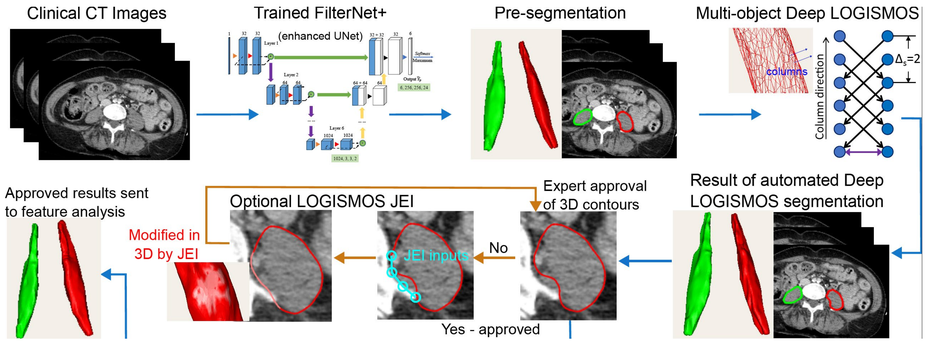
- Sarcopenia is an independent risk factor for morbidity and mortality. While maybe techniques and scoring systems have been produced to assess sarcopenia, a ubiquitous and accurate means for its identification is lacking.
- CT imaging is routinely used to evaluate surgical patients. Classically, sarcopenia is calculated with a single slice of a CT image looking at the psoas muscle around the level of L3. This often requires manual tracing of the psoas by the user.
- A 3D analysis of the entire psoas muscle to assess for sarcopenia, looking at density and volume. These were automated analysis using a proprietary software.
- These measurements were then used to predict discharge disposition following a trauma admission.

Methods

- Psoas muscles from 317 patients were segmented in whole body CT scans by a proprietary LOGISMOS (Layered Optimal Graph Image Segmentation for Multiple Objects and Surfaces) software.
- Psoas muscles were separately analyzed in 2D using a single slice analysis at L3 level to produce total psoas area (TPA) and in 3D to generate total psoas volume (TPV).
- 2D and 3D radiomic features (RF) were extracted for TPA and TPV using PyRadiomics package quantifying sarcopenia severity.
- Patient information included patient characteristics (PC), injury severity score (SS), time in ICU (TII) and time until discharge (TUD).
- Random forest classifier was trained to predict clinical outcome of discharge home without assist (181 Y / 136 N) and prediction performance assessed using 5-fold-cross-validation. Different input feature combination of radiomic features and patient information were tested.
- Prediction correctness (mean ± standard deviation) and combined F1-score (1 is best) were calculated to compare performance of different prediction models.

Methods Continued

Deep LOGISMOS Analysis of Left and Right Psoas Muscle Segmentation for CT.



Results

	Patient-specific features used in respective prediction models					
Predicting patient home discharge without assist	**RF only**	**RF+PC**	**RF+SS**	**RF+PC+SS**	**RF+PC+SS+TII**	**RF+PC+SS+TII+TUD**
3D prediction correctness [mean±stdev %]	**57±2**	**60±3**	**64±4**	**65±3**	**67±4**	**74±3**
2D prediction correctness [mean±stdev %]	**56±6**	**55±2**	**59±3**	**62±5**	**64±4**	**72±5**
3D F1-score	**0.644**	**0.672**	**0.702**	**0.718**	**0.728**	**0.772**
2D F1-score	**0.63**	**0.624**	**0.647**	**0.672**	**0.697**	**0.762**

Table Legend: Radiomic Features (RF), Patient Characteristics (PC), Injury Severity Score (SS), Time In ICU (TII) and Time Until Discharge (TUD)

Discussion

- The highest prediction correctness of 74% was achieved with all available patient information combined with 3D radiomic features.
- Increasing the quantity of patient features consistently allowed for improved predictions of outcomes in the random forest classifier
- When comparing the prediction value of 2D vs. 3D RFs in the tested prediction models, 3D psoas muscle analyses and associated 3D radiomic features consistently and statistically significantly outperformed that of 2D analyses and 2D radiomic features ($p<0.01$ for both correctness and F1 score comparisons).

Conclusions

- Sarcopenia is an independent risk factor for adverse outcomes and increased length of stay in trauma patients. The 3D volumetric and density analysis is a reliable way to evaluate for sarcopenia in patients with a CT scan.
- 3D volumetric and density analysis outperformed the standard 2D measurements utilized in sarcopenia assessments.
- Automation using LOGISMOS can decrease the both the labor needed and inter-user variability needed to quickly and accurately use prediction models.
- LOGISMOS can help produce an automated intelligence system to predict patient outcomes in the clinical setting.
- Further studies to predict morbidity, identify patients who would benefit from prehabilitation, and improve hospital reimbursement based on value-based care will need to be completed.