Application Fields and Innovative Technologies

Semi-Automated Echogenicity and Texture Feature Extraction from Quantitative Ultrasound Imaging on Suprahyoid Muscles for Swallowing using fine-tuned MedSAM2 M.S.W. Chan, E. Kwong, W.Y.S. Lam, Y.P. Zheng, C.K.W. Ng, J.C.F. Yu. *Gerontechnology* 25(s)

Purpose Age-related decline in swallowing muscle morphology is highly associated with dysphagia [1-3]. Quantitative ultrasound of the suprahyoid muscles—specifically metrics of mean echogenicity and texture radiomics—is a promising, bedside biomarker but requires laborious manual segmentation [4-5]. We evaluated whether a fine-tuned MedSAM2 model [6], a state-of-the-art foundation model for medical image segmentation, is a possible tool to automate this quantitative data extraction process to reflect muscle morphological changes due to ageing. **Method** We annotated 100 ultrasound images from healthy young adults, healthy older adults, and "possible sarcopenia" patients (based on the Asian Working Group for Sarcopenia 2019 criteria [2]) as ground truth. The suprahyoid muscles, including geniohyoid, mylohyoid and anterior digastric bellies, were annotated in one muscle group. A medical-specific, pre-trained, tiny variant of weighting points with hierarchical vision transformer (hiera) was selected as the backbone for MedSAM2 fine-tuning. The images and annotated masks were used to fine-tune the MedSAM2 model for 50 epochs. Finetuning was performed using Pytorch using Apple MPS framework on MacBook Pro with M4 Max GPU. Images were normalized to 8-bit RGB images for processing. Masks were pre-processed as single-channel binary masks. Dice coefficient and intersection of union (IoU) were determined to evaluate the model. A separate set of 45 unannotated images from 15 subjects was further inferred automatically; masks were filtered with an Otsu-based confidence threshold (0.7) [7]. Mean model confidence achieved 0.683. Human review removed 15 images with deviant ROIs, leaving 30 images from 12 subjects. Mean echogenicity and selected texture features (autocorrelation from Gray Level Co-occurrence Matrix (GLCM), with offset settings of 1 pixel distance and averaged angles and first-order entropy) were extracted from each ROI using PyRadiomics [8]. Values obtained from multiple images of the same subject were averaged. Group differences across the subjects were assessed using the Kruskal-Wallis test with Dunn's test for post-hoc comparisons. **Results and Discussion** The fine-tuned model achieved a Dice coefficient of 0.859 and an intersection over union (IoU) of 0.755 on the validation data. Preliminary automated analysis distinguished the possible sarcopenic group from healthy young adults in metrics of echogenicity (H=7.423, p=0.024, η^2=0.602), autocorrelation ($H = 8.346$, $p = 0.015$, η^2=0.705), and first-order entropy ($H = 7.423$, $p = 0.024$, η^2=0.602). The model is under refinement, and further results from the improved model will be presented. This study demonstrated the feasibility of extracting quantified muscle morphological changes by deploying a clinically compatible, semi-automated pipeline. Human oversight ensures the model-predicted values are valid. This approach streamlines quantitative dysphagia assessment and empowers frontline clinicians to perform ultrasound-assisted diagnosis with greater confidence, and serves as a stepping stone for building reliable automated segmentation models. Clinically, clinicians could utilize the automated segmentation model to reduce tedious manual annotation work and achieve real-time diagnostics. Caregivers at home may use wearable devices deployed with the distilled automated model to identify risks, promoting timely intervention for patients with dysphagia.

Key References

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