

# Otsu and Chan-Vese methods compared in thyroid active volume segmentation with Monte Carlo generated SPECT

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## Background

The Otsu method and the Chan-Vese model are proven to perform well in determining organ volumes; this study aimed to compare their performance regarding segmentation of active thyroid gland volumes, by varying the parameters: gland volume, activity concentration, activity concentration heterogeneity and background activity concentration.

## Materials and Methods

Computed tomography was performed on three playdough thyroid phantoms (20, 35 and 50 ml). Image data were separated into playdough and water, based on Hounsfield values. Sixty single photon emission computed tomography (SPECT) projections were simulated by Monte Carlo method with Technetium-99m. Linear combinations of SPECT images were made, generating 12 volume and background combinations: each with both homogeneous thyroid activity concentration and three hotspots of different relative activity concentrations (48 SPECT volumes in total). The relative background levels chosen were 5%, 10%, 15% and 20% of phantom activity concentration and hotspot activities 100% (homogeneous case) 150%, 200% and 250%. Poisson noise (coefficient of variation of 0.8 at a 20% background level, scattering excluded) was added before Monte Carlo based SPECT reconstruction by the Sahlgrenska Academy reconstruction code (SARec). Otsu's threshold selection method and the Chan-Vese model for active contours without edges were applied for segmentation; the results were evaluated concerning relative volume, mean absolute error and standard deviation per thyroid volume, as well as dice similarity coefficient.

## Results

Both methods segment the images well and deviate similarly from true volumes. They both slightly overestimate small volumes and underestimate large ones. Different background levels affect the two methods similarly as well. However, Chan-Vese deviates less and paired t-testing showed significant difference between distributions of dice similarity coefficients ( $p < 0,01$ ).

## Conclusions

Our investigations indicate that Chan-Vese performs better and is slightly more robust, albeit more challenging to implement and use clinically, than Otsu. There is a trade-off between performance and user-friendliness.