# Classification of TI-RADS class-4 thyroid nodules based on shape and texture features from ultrasound images

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## INTRODUCTION

Classification of thyroid nodules could be helpful to the clinical diagnosis of thyroid cancer. Currently, clinical diagnosis of thyroid nodules is based on the thyroid imaging reporting and data system (TI-RADS), and depends on doctors' experience and knowledge[1,2].

## AIM

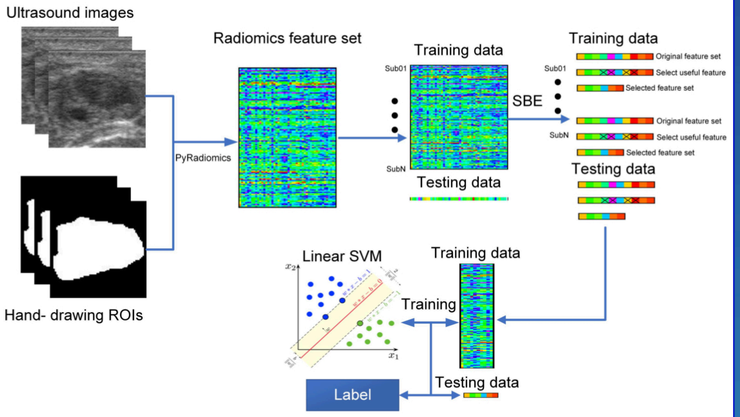
In this study, it was hypothesized that shape and texture features from ultrasound images could be helpful to the classification of thyroid nodules. And we chose to classify TI-RADS class-4 thyroid nodules which have malignant risk ranging from 5% to 80%[3].

## METHOD

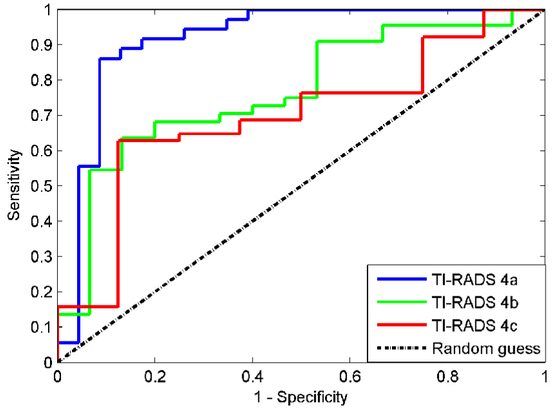
236 patients with TI-RADS class-4 thyroid nodules were enrolled and were classified into TI-RADS class-4a, 4b and 4c according to ultrasound-guided fine-needle aspiration biopsy results. One experienced doctor drew the region-of-interest for each nodule on the ultrasound images. Pyradiomics was used to extract shape features, texture features from relevant ultrasound images. The selected features were normalized to a range from 0 to 1. A ternary label with 1 for TI-RADS class-4a, 0 for TI-RADS class-4b and -1 for TI-RADS class-4c was used. Sequential backward elimination approach was used to select features from different categories. A linear support vector machine (SVM) classifier was configured and leave-one-out-cross-validation was used to evaluate the performance of the classifier with accuracy, sensitivity, specificity and receiver operating characteristic curve as evaluating metrics[4].

## RESULTS

Classification results demonstrated that the configured linear SVM could accurately classify class-4 thyroid nodules with a total classification accuracy of 84.75%. The accuracy for each of the sub-class was 88.89%, 86.67% and 62.5%, respectively.




*The framework of thyroid nodules diagnosis based on radiomics features and SVM.*




*ROC curves of the proposed linear SVM model.*

| Thyroid nodule type | Accuracy | Sensitivity | Specificity | AUC | *p* |
|---|---|---|---|---|---|
| TI-RADS 4a | 91.66% | 0.8661 | 0.9130 | 0.9155 | <0.001 |
| TI-RADS 4b | 86.66% | 0.6364 | 0.8667 | 0.7667 | <0.001 |
| TI-RADS 4c | 62.50% | 0.6275 | 0.8750 | 0.6961 | 0.005 |

*Prediction results of the proposed SVM for subjects with different types of thyroid nodules.*

## CONCLUSIONS

Shape and texture features in combination with fine-tuned machine learning models showed high accuracy in classification of TI-RADS class-4 thyroid nodules. The results demonstrated potential clinical application of radiomics features in the diagnosis of thyroid nodules.

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