Recurrent neural network models for the automated detection of acute myocardial infarction on echocardiography

Ryosuke. Muraki, Keiko. Sugimoto, Kunihiko.Sugimoto, Akira. Yamada, Eiichi. Watanabe,
Kuniaki.Saito, Hiroshi. Fujita, Atsushi. Teramoto.

Abstract— **Currently, myocardial infarction is a disease caused by lifestyle diseases such as diabetes and high blood pressure, which can lead to sudden death and chronic heart failure. Echocardiography is mentioned as a non-invasive examination of myocardial infarction that can assess heart function, wall motion and complications in real time. It can also assess wall motion abnormality a finding of myocardial infarction and is widely used for cardiology. However, abnormal wall motion is difficult to distinguish from normal myocardium depending on the extent and severity of the motion, which can lead to prognosis and risk of fatal complications. In this study, we focused on development of an automated detection method for myocardial infarction using artificial intelligence in echocardiography. As a preliminary study, we developed an automated classification method using convolutional neural network (CNN) and recurrent neural network （RNN）. Moreover, we compared the classification accuracy in three different RNN models.**

Clinical Relevance— **This method supports the rapid detection of acute myocardial infarction and can lead to accurate treatment and improved prognosis.**

I. INTRODUCTION

The acute myocardial infarction is caused by lifestyle-related diseases and may cause sudden death or chronic heart failure, and early detection is essential. Echocardiography is mentioned as an examination of acute myocardial infarction. It's noninvasive modality for early diagnosis and evaluating abnormal wall motion in patients with myocardial infarction. However, the abnormal wall motion is difficult to distinguish depending on the range and the severity. Missing of this finding leads to a fatal complication, so high accuracy is required. In this study, we aimed to develop an automated classification scheme of acute myocardial infarction using convolutional neural network (CNN) and recurrent neural network (RNN) in echocardiography [1] [2] [3].

II. METHODS

We collected 103 cases with no symptoms and 99 cases with myocardial infarction and selected two types of views: a short-axis image of the level of the papillary muscle （pm）

A. Teramoto is with the Graduate School of Health Sciences, Fujita Health University, 1-98 Dengakugakubo, Toyoake-city, Aichi 470-1192 Japan, (phone: +81-562-93-9872; e-mail: teramoto@fujita-hu.ac.jp).

and a left ventricular axis image （lx） as input data. These images were given to the CNN architecture for feature extraction. The extracted features were then given to the simple RNN, long short-term memory (LSTM), and gated recurrent unit (GRU) to classify case with no symptoms or having a myocardial infarction.
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III. RESULTS

We calculated classification accuracy using 5-fold cross validation. As a result, the classification accuracies of lx image using simple RNN, LSTM, GRU were 85.1%, 88.2% and 90.0% respectively. As for pm image, the classification accuracies using simple RNN, LSTM, GRU were 86.7%, 87.1% and 89.1% respectively.

IV. DISCUSSION & CONCLUSION

We developed automated classification scheme of acute myocardial infarction using CNN and RNN in echocardiography. GRU showed the highest classification accuracy for pm and lx images. These results suggested that proposed method can detect acute myocardial infarction with high accuracy, confirming the effectiveness of our method.

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REFERENCES

[1] I. Sutskever, G. E. Hinton, G. Taylor. "The recurrent temporal restricted Boltzmann machine," Proceedings of the 21st International Conference on Neural Information Processing Systems, pp.1601-1608, 2020.

[2] S. Hochreiter and J. Schmidhuber. ″Long short-term memory″, Neural Computing, Vol. 9, Issue. 8, pp.1735−1780, Nov. 1997.

[3] K. Cho, B. Van Merrienboer, C. Gulcehre, D. Bahdanau, F. Bougares, H. Schwenk, Y. Bengio. "Learning Phrase Representations using RNN Encoder-Decoder for Statistical Machine Translation", Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing, pp.1724-1734, Oct, 2014.