学位論文審査結果の要旨

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（学位論文審査結果の要旨）

Prediction of Pulmonary to Systemic Flow Ratio in Patients With Congenital Heart Disease Using Deep Learning-Based Analysis of Chest Radiographs

【主論文審査結果の要旨】

著者らは論文において下記の内容を述べている。

Importance: Chest radiography is a useful noninvasive modality to evaluate pulmonary blood flow status in patients with congenital heart disease. However, the predictive value of chest radiography is limited by the subjective and qualitive nature of the interpretation. Recently, deep learning has been used to analyze various images, but it has not been applied to analyzing chest radiographs in such patients.

Objective: To develop and validate a quantitative method to predict the pulmonary to systemic flow ratio from chest radiographs using deep learning.

Design, setting, and participants: This retrospective observational study included 1031 cardiac catheterizations performed for 657 patients from January 1, 2005, to April 30, 2019, at a tertiary center. Catheterizations

without the Fick-derived pulmonary to systemic flow ratio or chest radiography performed within 1 month before catheterization were excluded. Seventy-eight patients (100 catheterizations) were randomly assigned for evaluation. A deep learning model that predicts the pulmonary to systemic flow ratio from chest radiographs was developed using the method of transfer learning.

Main outcomes and measures: Whether the model can predict the pulmonary to systemic flow ratio from chest radiographs was evaluated using the intraclass correlation coefficient and Bland-Altman analysis. The diagnostic concordance rate was compared with 3 certified pediatric cardiologists. The diagnostic performance for a high pulmonary to systemic flow ratio of 2.0 or more was evaluated using cross tabulation and a receiver operating characteristic curve.

Results: The study included 1031 catheterizations in 657 patients (522 males [51%]; median age, 3.4 years [interquartile range, 1.2-8.6 years]), in whom the mean (SD) Fick-derived pulmonary to systemic flow ratio was 1.43 (0.95). Diagnosis included congenital heart disease in 1008 catheterizations (98%). The intraclass correlation coefficient for the Fick-derived and deep learning-derived pulmonary to systemic flow ratio was 0.68, the log-transformed bias was 0.02, and the log-transformed precision was 0.12. The diagnostic concordance rate of the deep learning model was significantly higher than that of the experts (correctly classified 64 of 100 vs 49 of 100 chest radiographs; P = .02 [McNemar test]). For detecting a high pulmonary to systemic flow ratio, the sensitivity of the deep learning model was 0.47, the specificity was 0.95, and the area under the receiver operating curve was 0.88.

Conclusions and relevance: The present investigation demonstrated that deep learning-based analysis of chest radiographs predicted the pulmonary to systemic flow ratio in patients with congenital heart disease. These findings suggest that the deep learning-based approach may confer an objective and quantitative evaluation of chest radiographs in the congenital heart disease clinic.

胸部 X 線写真から血行動態指標を定量的かつ客観的に評価可能であり、その診断能が臨床医を上回る可能性があることを示した論文であり、学術上極めて有益であり、学位論文として価値あるものと認めた。

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