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요류측정술의 해석: 인공지능을 이용한 응용

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Background and Objectives: Uroflowmetry (UFM) is a non-invasive, economical, and useful test that can predict indirectly the function of bladder and urethra in patients with lower urinary tract symptoms. We develop a program that automatically interprets the results of UFM using machine learning algorithm, a field of artificial intelligence (AI).

Materials and Methods: Since Sep. 2018, results of UFM more than 150 ml of voided volume were included prospectively. By accessing an internet-based reading program, three urologists independently labeled UFM results as normal, borderline, or abnormal. The majority decision was made if the readings of the three experts were inconsistent. The different readings of all three urologists were excluded from the final analysis. Among all the data, 80% are randomly selected as training set to train the machine learning algorithm to get a model predicting the diagnostics result, and the rest as validation set to evaluate the accuracy/performance of the model. Using parameters such as age, gender, voided volume, maximal flow rate (Qmax), time to Qmax, average flow rate (Qavg), flow time, delay time, and post void residual, the AI algorithms, learned through supervised machine learning, was developed to be interpreted in the three groups: normal, borderline, or abnormal. The accuracy of the developed algorithm model was validated with sensitivity and specificity using the validation set.

Results and Conclusion: After excluding 898 cases with voided volume less than 150 ml, 1574 cases (male 1031, female 543) were finally included. The male results were labeled as normal in 521 cases (50.5%) and abnormal in 232 cases (22.4%), with unanimous read rates in 51.4%. For female, 420 (77.3%) was normal and 60 (11.0%) was abnormal with 70.5% unanimous rates. Model performance improved gradually as the number of available factors increased. The prediction algorithm showed the best accuracy when using the combination of four parameters: voided volume, Qmax, time to Qmax and Qavg. The prediction accuracy was 94.2% in males and 94.5% in females. In conclusion, when machine learning was used to predict the reading of the UFM results, the prediction accuracy was the highest when using four parameters such as voided volume, Qmax, time to max, and Qavg, and the prediction accuracy was 94.3%.

Keywords: Machine learning, Uroflowmetry, Automatic interpretation