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Evaluation of gait abnormalities: a fuzzy classifier based on Statistical Gait Analysis

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AIM: There is a wide variety of subjects affected by gait abnormalities, e.g. elderly, orthopedic patients, post-stroke patients, patients suffering from multiple sclerosis, Parkinson's disease and diabetes. In some cases gait abnormalities may lead to an incremented fall risk. The purpose of this contribution is to describe a method that allows to assign a score to the gait quality of a patient, based on gait parameters obtained from a simplified protocol of instrumented gait analysis.

METHODS: The patient is equipped with foot-switches and knee goniometers and is asked to walk at his/her preferred speed for 2-3 minutes, in order to collect approximately 100-150 gait cycles. Carrying out the test requires less than 15 minutes, comprehensive of patient preparation and signal acquisition. Then, specific qualitative and quantitative gait parameters are extracted from the computerized analysis of the gait cycles: the percentage of atypical cycles, the heel contact and push-off duration, the instability of the knee, the knee angular velocity at initial contact, the cadence. The instability of the knee during gait is estimated from the dispersion of the goniometric curves recorded at each gait cycle, with respect to the average goniometric curve. The gait parameters are used as input variables of a fuzzy classifier: the value of each parameter is associated to a certain degree of membership to the class of "normal" or "abnormal" gait. The rules defined for the fuzzy classifier allow to assign a score to the gait quality of the patient.

RESULTS: As an example of classification, Fig. 1 reports the scores obtained on a population of 27 patients suffering from type 2 diabetes. Patients were tested before and after the completion of a program of adapted physical activity that lasted three months.

CONCLUSION: The objective evaluation of patient's gait abnormalities allows to design rehabilitation protocols focused on the specific needs of patients and obtain a quantitative follow-up documentation. The assignment of a synthetic score is a valuable tool in the validation of the efficacy of a specific therapeutic protocol and may be of help to forensic medical practitioners and assurance companies.

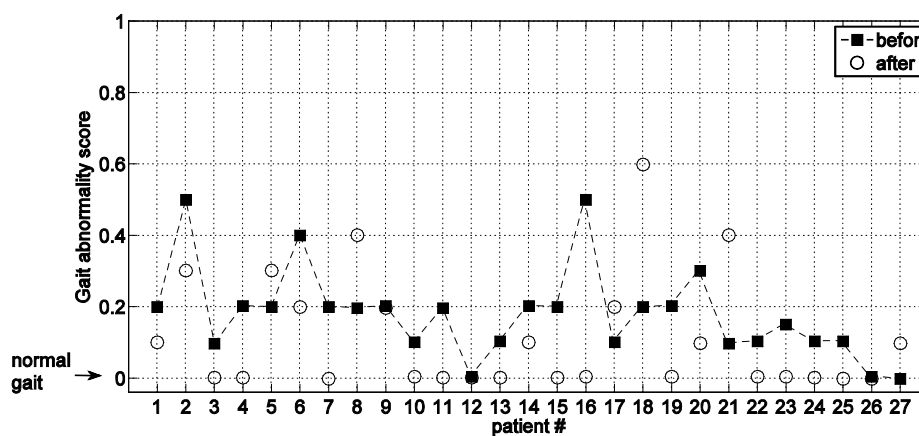


Figure 1: Population of type 2 diabetic patients: a gait abnormality score is assigned, to each patient, before and after the completion of a program of adapted physical activity.