

FOOT TYPE CLASSIFICATION USING FUZZY LOGIC

Mehrdad Anbarian^{1,2}, Paul Allard¹, Nader Farahpour², Sébastien Hinse¹, Clarice Tanaka³

¹Kinesiology Department, University of Montreal, Quebec, Canada,

²Physical Education Department, Bu-Ali Sina University, Hamadan, Iran,

³Department of Physical Therapy, Speech Therapy and Occupational Therapy, University of São Paulo, Brazil,
e-mail: mehrdad.anbarian@umontreal.ca

INTRODUCTION

Foot type classification methods are still controversial in the literature [1]. The difficulty lies in part in the different means of assessing foot disorders such as visual inspection, foot print, radiography, etc. and with the number of parameters to characterize foot morphology. Consequently, foot classification is often based on parameters related to a specifically pathology rather using a single set of angles for all pathologies [2]. The aim of this study was to determine if fuzzy logic (FL) can be applied to classify five foot types using only two geometric parameters and determine its performance.

METHODS

An experienced podiatrist clinically categorized 321 feet into 4 pathological groups, namely, pes planus (n=52), pronation (n=80), pes cavus (n=115) and supination (n=48) and an able-bodied group (n=26).

A digital camera was used to capture two black and white images taken from the postero-anterior and medial views of feet while weight-bearing. Camera-subject distance was fixed at approximately 1.7 meter. The pictures were then processed by a numerical filter where the grey levels were transformed into a color-coded image highlighting muscle and bone prominences. This process facilitated the measurement of two foot parameters. These are the rearfoot and Djian-Annonier angles (Figure 1). In the literature, rearfoot angle is used to describe subtalar joint position while Djian-Annonier is described medial height arch.

The fuzzy logic toolbox in MATLAB was used to develop the classification model. The above two parameters were introduced in the FL model. For estimating the relative accuracy of the classification method, Kappa statistics were applied by comparing the result of the FL classification with that of the clinical sorting.

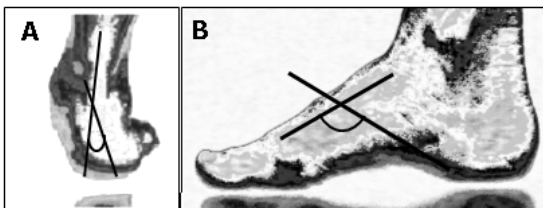


Figure 1: A) Rearfoot and B) Djian-Annonier angles.

RESULTS AND DISCUSSION

The FL technique was successful in classifying 88.8% of all able-bodied and pathological feet. The lowest success rate was found for the able-bodied group (69.2%) as compared to a mean success rate of 93.7% for all pathologies groups (Figure 2). Misclassification of 5 of the 26 feet as pes cavus in the able-bodied group reduced the performance of the FL technique. The misclassification could be related to lower difference value of the rearfoot angle. In the able-bodied group it was 1° greater than in the pes cavus group while it ranged from 7.4° to 10.3° for other pathologies.

A Kappa value of 0.89 was obtained with the FL classification method when compared to the podiatrist's classification. To our knowledge no one has yet reported a classification in which both able-bodied and pathological feet were presented. Furthermore, previous studies were limited to parameters related to a single pathology.

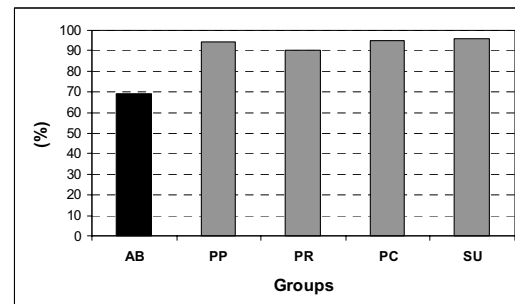


Figure 2: Classification results for able-bodied (AB), pes planus (PP), pronation (PR), pes cavus (PC) and supination (SU) groups.

CONCLUSIONS

The fuzzy logic method was able to classify the five foot types using only two geometrical parameters with high accuracy.

REFERENCES

1. Saltzman CL, et al. *Arch Phys Med Rehabil*, **76**, 45-49, 1995.
2. Rzeghi M and Batt ME. *Gait and posture*, **15**, 282- 291, 2002.