

GAIT ANALYSIS OF THE NORMAL AND ACL DEFICIENT PATIENTS AFTER LIGAMENT RECONSTRUCTION SURGERY

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INTRODUCTION: Anterior cruciate ligament (ACL) injury of the knee is common in sports. A serious ACL injury leads to ligament reconstruction surgery. In order to evaluate result of surgery or optimize the rehabilitation process, a knee condition must be objectively identified. The purpose of this study is, therefore, to numerically indicate and classify knee condition of patients via the chaos analysis. Lyapunov exponents (LyEs) were used for the comparison of the normal and the patients.

METHODS: This study carried out walking on a treadmill for 13 subjects (8 healthy subjects, 5 ACL deficient patients) and sagittal kinematic data of the right lower extremity were collected by using two video recorders. Prior to videotaping, reflective markers were placed on the skin surfaces of greater trochanter, lateral femoral condyle and lateral malleolus of the right lower extremity. Subjects were asked to walk on the treadmill at self-selected speed while kinematic data were collected at 50 Hz. The recorded gait patterns were digitized and then coordinated by using the direct linear transformation. The knee angle data time series were analyzed using chaos analysis method, which is based on the structural characteristic of a time series embedded in an appropriately constructed state space (Dingwell, 2000). To properly reconstruct a state space, it was necessary to calculate an appropriate time delay and embedding dimension for investigated time series. Time delays were calculated from the first minimum of the average mutual information function. The estimation of the embedding dimensions was carried out using the global false nearest neighbor algorithm. After determining the embedded dimension, a strange attractor was reconstructed. Through the attractor analysis, the estimation of knee condition can be conducted by calculating the largest LyE using Wolf algorithm. The results were classified according to knee conditions.

RESULTS & DISCUSSION: The results figured out the difference between healthy subject and patient. As the knee condition became worse, LyE became larger.

Subjects		Lyapunov exponent
Healthy subjects	Normal walking	0.107(± 0.0078)
	Abnormal walking	0.139(± 0.0167)
ACL deficient patients		0.123(± 0.0247)

CONCLUSION: This study suggested an analysis method of the severity of injury and the level of recovery. The proposed method can be used to develop diagnosis system and help patients' effective treatment.

REFERENCES:

Dingwell, J.B., and Cusumano, J.P. (2000). Nonlinear time series analysis of normal and pathological human walking. *Journal of CHAOS*, 10(4) 848-863.

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