

Kinetics and kinematics of wrestling during tackle defending between Greco-Roman and freestyle: an implication of the knee and ankle joint injury prevention

希羅式與自由式摔角於防禦擒抱之力動學與運動學：應用於膝關節與踝關節傷害預防

Tsong-Rong Jang¹, Sheng-Chang Chen², Yang-Chieh Fu², Tsung-Jung Ho^{3,4}, and Tung-Wu Lu^{2*}

¹Athletics Department and Graduate School, National Taiwan Sport University, Taichung, Taiwan

²Institute of Biomedical Engineering, National Taiwan University, Taipei, Taiwan

³College of Chinese Medicine, China Medical University, Taichung, Taiwan

⁴Chinese Medicine Department, China Medical University Beigang Hospital, Taiwan

Email: twlu@ntu.edu.tw

摘要

本研究將使用動作分析技術來研究希羅式與自由式摔角擒抱動作之生物力學，並且透過人體數學模型計算可獲得下肢的運動學、力動學資料。如此可觀測動作之整體性及下肢關節間相互之影響。如此將能夠找出摔角擒抱之動作特徵，更進一步幫助選手提升其技術，並藉由下肢其他關節的協同動作分散膝關節的受力，降低比賽與練習時的受傷機率與傷害程度，延長選手的比賽生命。

關鍵字: 角力、希羅式、自由式、膝關節、生物力學、動作分析

INTRODUCTION

Wrestling is one of the oldest and popular competitive sports in the world, however, studies on it is still not very clear. There are two types of wrestling runs internationally, namely Greco-Roman (GR) style and freestyle (FS). GR style does not allow attacking lower extremities but FS style is free to attack. Most studies have been focused on affects of rapid weight gain/loss and injury epidemiology (Choma et al., 1998), and only few discuss biomechanics and physiology of wrestlers (Grindstaff & Potach, 2006). The purposes of the current study were to apply movement analysis and inverse dynamics on wrestling study, and to investigate the preliminary injury mechanism by kinematics analysis during tackle defensive movement. And the different kinematics pattern and injury mechanism between GR and FS style were also investigated. Therefore, there were some hypotheses: (1) FS had higher adduction of the knee and inversion of the ankle, which implied higher risk of injury, (2) lateral attack had shorter resist time both in GR and FS style, which indicate higher risk of injury than frontal attack because of rapid loss of

balance. Hence, the purpose of the study was to investigate to investigate possible injury mechanism of during defensive movement among GR and FS college wrestlers.

MATERIALS AND METHODS

Eighteen male college wrestlers were recruited from the wrestling team of National Taiwan Sport University (170.7±6.55 cm and 73.67±10.66 kg). A motion capture system consisted by six state-of-art ultra-high-resolution infrared video cameras (VICON 512, Oxford Metrics, Oxford, U.K.) was used to collection kinematic data at 120 Hz. Two AMTI force platforms (Mass., U.S.A.) were used to collect ground reaction force on both feet of the wrestler at 1080 Hz. Force platform signals were synchronized with video data by data VICON work station. The participant defended tackle attack from the front, left and right of the participant. A three-dimensional model of the human locomotor system (T.-W. Lu & O'Connor, 1998) was used to analyze the collected lower limb data in this study. The trajectories of the center of pressure (COP), maximum and minimum values of three dimensional

knee and ankle joint angles were outputted for statistical analysis. Statistic analysis was performed by SPSS[®] Statistics software (SPSS Inc., 11.0.1). Differences between styles of three attack direction were tested by 2-tailed independent t-test, and the significant level was set at $\alpha = .05$.

RESULTS

The results shows that there is no significant difference between styles and directions, lateral attack generally had longer resisting time than front attack. In addition, FS style had longer resisting time than GR style. For the COP trajectories, they did not consist among all participants. Generally FS had smaller sway area of the COP, anterior-posterior, and medial-lateral excursion than GR.

For the kinematics data, comparing GR and FS style defending frontal attack, we found that the left knee minimum rotation value and right knee maximum rotation values on the transverse plane showed significant differences ($P < 0.05$), and the p value of right knee minimum rotation was close to significant level ($p = 0.057$). There was no significant difference of right and left attack between GR and FS style. When comparing front attack with lateral attack in GR style, the right knee maximum rotation on transverse plane was significantly different when receiving both left and right attack ($p < 0.05$), and the left ankle flexion peak angles in the sagittal plane movement was significantly different ($p < 0.05$). When comparing same situation in FS, right knee maximum adduction has significant difference ($p = 0.05$) during left attack defense, and minimum left dorsi-flexion at the ankle and maximum right internal rotation at right knee were significantly different during right attack defense ($p < 0.05$).

DISCUSSION AND CONCLUSIONS

The joint kinematics did not show significant difference especially on the frontal plane movement of the knee and ankle, the ankle joint had approximately 15

degrees inversion, and the knee joint has approximately 20 degrees, both in GR and FS defending. These were quite large joint angles especially on the knee, and which might imply higher risk of ankle and knee ligament injuries.

For COP, FS styles had less sway area and excursion on all direction. This would be obvious because GR style player begins competition at standing position and FS player starts with trunk forward flexes, which means at a higher center of mass (COM) position than FS style.

It was hypothesized that there was higher adduction of the knee and inversion of the ankle in FS wrestling, and had shorter resist time during lateral attack both in GR and FS styles. Kinematic results did not fully support the first hypothesis since there was no significant difference between GR and FS. Movement duration, although there was no significant difference, did not seem to support the second hypothesis. However, according to the results, the hypotheses were not supported in this study, because of many factors, such as skin movement artifacts of the lower extremities, difficulty to mimic real motion in laboratory, small area of force plates etc.

Results indicated that wrestlers potentially had higher risk of ligament injuries of the knee and ankle which consisted with literature. It is suggested that proper training program should be conduct to increase lower extremity muscle strengths and powers to prevent injuries during practices and games.

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