CORRELATIONS BETWEEN EXPERTS' SCORING AND BIOMECHANICAL ASSESSMENT IN BALLET MOVEMENT

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The purpose of this study was to investigate the relationship between assessment of ballet movement by experts and biomechanical variables. Releve point movement was recorded by a video camcorder (Sony, Japan) for the expert assessment. Eight infrared cameras (Qualisys, Sweden) and two force plates (Kistler, Switzerland) were used for biomechanical analysis. A High reliability in score for flexibility and assistance among three judges was found. Based on the analysis of correlations, flexibility and ROM were positively correlated as the subject who performed wider motion at the ankle achieved higher sores in flexibility from the judges. Negative correlations were found between the judges' scores in assistance and ankle joint power as well as their scores in balance and COP on the left side. Development of objective and reliable scoring standards in ballet based on the understanding of body movements supported by the verification of scientific method is needed.

KEY WORDS: Releve, Biomechanics, Range of Motion(ROM), Correlation.

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INTRODUCTION: Assessment of ballet performance is not consistent because of our subjective viewpoints on movements. The importance of the assessing standard being established through scientific method based on biomechanical analysis is recognized since the current method of assessment in ballet is based on subjective viewpoints and the experience of the judges. The legitimacy of the judges is being questioned by several studies (Kang, 2011; Moon, Oh, 2012; Ahn, Oh, 2007). Donna Krasnow and Chatfield (2009) assessed the relationship between body parts, connectivity, movement of joints and capacity of locomotion in order to establish the standard criteria of evaluation. They suggested flexibility, balance and energy as the main factors for assessment. Through aesthetic elements are involved, a more quantitative assessment, such as evaluating biomechanical technique, can be applied to understanding the principle in ballet movement (Kwon, 2001). A study suggested that the biomechanical method for assessing the accuracy and efficiency of movements could be used (Chung, 1998). Therefore, the purpose of this study was to investigate whether biomechanical variables could be used as the standard for assessment in ballet performance with the scores of experts in flexibility, assistance and balance being among the assessment factors.

METHODS: Fifteen subjects who majored in ballet were recruited for participation in the study (height: 160.86±4.18 cm, mass: 48.42±4.11 kg, age: 21.13±1.06 years, experience: 7.3±1.4 year). 1) Experts' Assessment: A video camcorder (Sony HXR-MC2000, Japan) was installed to record the frontal movement at 60 f/s.

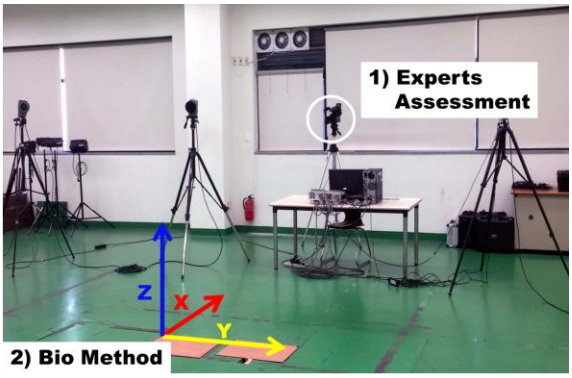

Figure 1: Experimental setup for experts' assessment and biomechanics test

Three judges each having over 15 years of judging experience assessed the subjects' abilities in flexibility, assistance and balance based on a video tape using index of 1~5 (higher index indicates better performance). For the experts' assessment, a maximum of 20 points for each ability, or 60 points in total, was used. 2) Biomechanical Assessment: Participants wore a leotard and toe shoes and performed Releve, on two force plates at a sampling of 1000Hz (Kislter, Switzerland). Eight infrared high speed cameras at a sampling of 100Hz were used to capture the motion of the lower extremity. Body segment was modeled by using Visual3D(C-motion, USA) filtered with Butterworth 2nd order low-pass filter at 6Hz as a cut off frequency (Lin, Su, & Wu, 2005). Information from 10 trials was collected and averaged for the analysis. Correlation coefficient analysis was performed to investigate the relationship between the experts' qualitative assessment and the quantitative biomechanics assessment. The SPSS version 19.0(IBM, USA) was used for statistical analysis at an alpha level of .05.

RESULTS: Cronbach's correlation coefficients indicated the reliability among the three judges' scores in flexibility, assistance, and balance. The results showed the highest reliability in flexibility (0.884) followed by assistance (0.571) and balance (0.387). There was low reliability among the judges' scores in balance (Table 1).

Table 1: Reliability among the judge's scores

	Judge1	Judge2	Judge3	Cronbach alpha
Flexibility	7.9(3.3)	12.8(3.0)	9.4(2.4)	.884
Assistance	10.5(3.2)	11.8(2.2)	9.7(2.8)	.571
Balance	10.9(3.6)	11.7(2.5)	9.9(1.6)	.387

Figure 2 shows correlations between the range of motion (ROM) of ankle, knee, and hip joints and the experts' scores in flexibility. The results show that increased ROM at the ankle has a positive correlation with higher scores in flexibility (Right: R= 0.71, P=0.003, Left: R= 0.63, P=0.012).

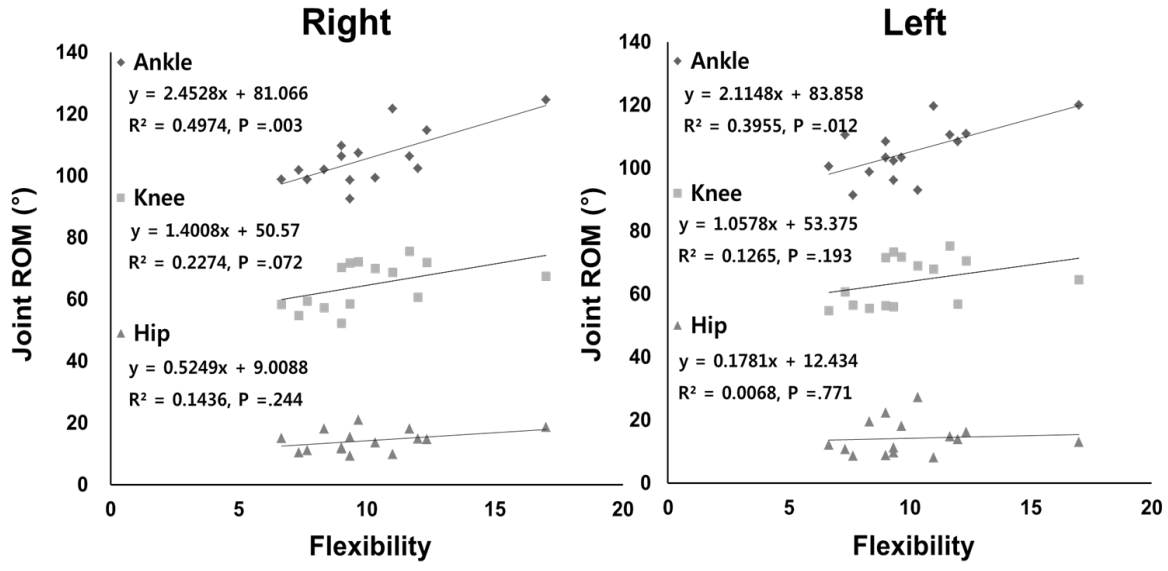

Figure 2: Correlations between ROM of each joints and experts' scores in flexibility

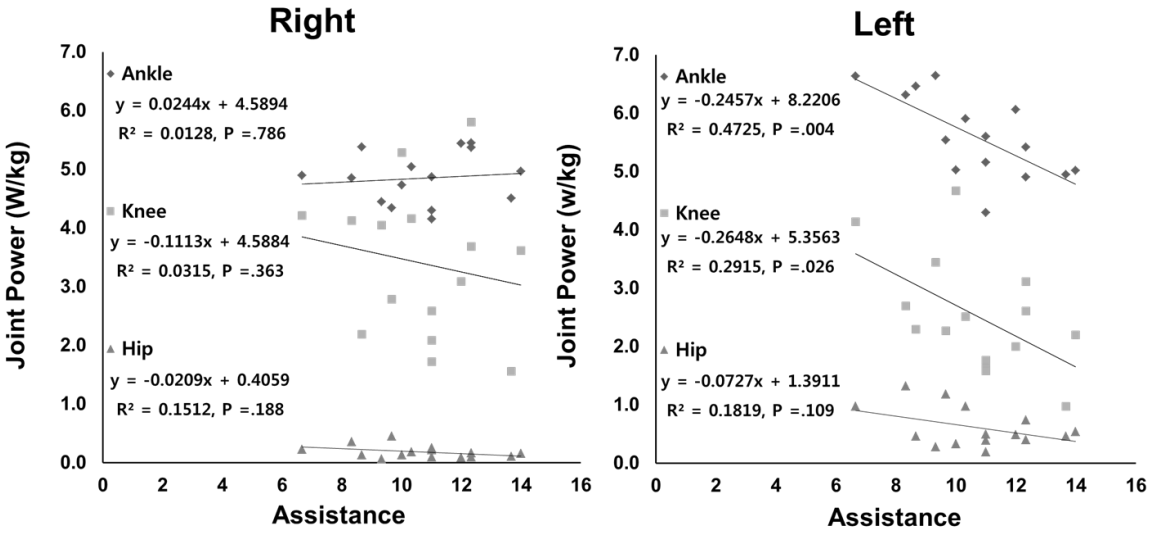

Figure 3: Correlations of joint power and experts' score in assistance

Figure 3 shows correlations between joint power and the experts' scores in assistance. The results show that decreased joint power at the ankle and knee has correlated with higher scores in assistance by the experts (left ankle: R= -0.69, P=0.004, left knee: R= -0.54, P=0.026).

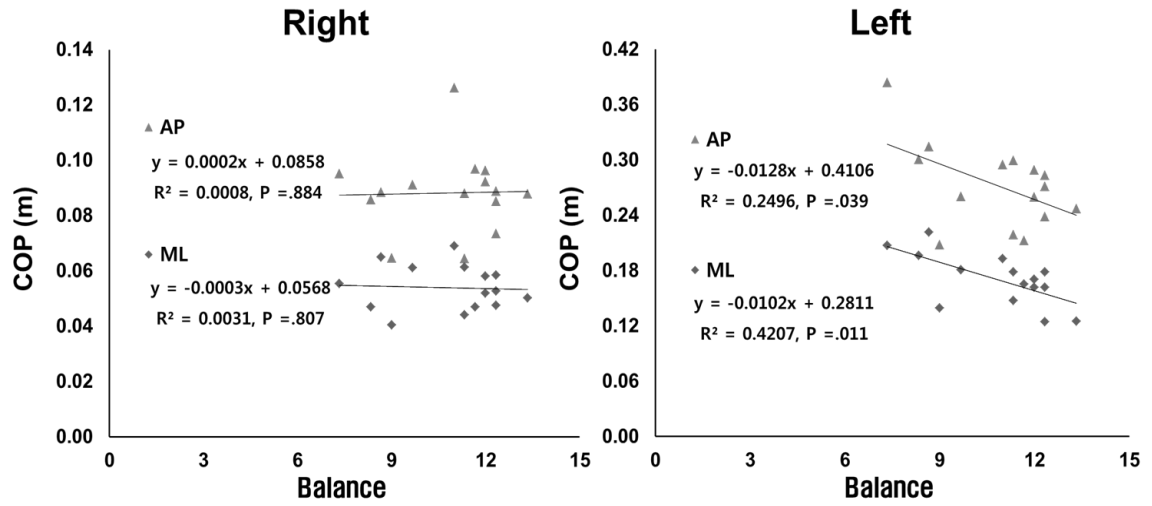

Figure 4: Correlations between COP and experts' scores in balance (AP: anteior-posterior direction, ML: medial-lateral direction)

Figure 4 shows correlations between variations in the center of pressure (COP) and experts' scores in balance. The results show that decreased range of COP, both in the anterior-posterior and medial-lateral directions has a correlation with higher scores in balance (AP direction: R= -0.50, P=0.039, ML direction: R= -0.65, P=0.011).

DISCUSSION: A previous study suggested that correlation coefficients between 0.9 and 0.5 are considered to be reliable levels. The reliability among the judges could be improved with a greater number of judges (Ahn, Oh, 2007). The results of this study are similar to the findings of previous studies as judges would assess ballet movements with a similar standard. On the other hand, the findings showed low reliability in balance among the judges in scores for balance. This is believed to because the judges assessed differently from each

other according to their subjective criteria gained from experience. Therefore, in order to evaluate the ability of balance in ballet objectively is required for the improvement of the reliability. Generally, dancers have a greater range of movement than that of averaged people. Dancers with a larger range of motion may face less restriction of movement. The relationship between judge's scores and ROM of joints shows positive correlations (Figure 2) as the subjects who performed with greater ROM obtained higher score from the judges. Joint power at the ankle on the left side is higher than that of right side (Figure 3) as dancers may rely more on left ankle compared with the right ankle during performance. However, it is also noted that the subjects who have lower joint power obtained higher scores in balance on the left ankle and knee (Figure 3). If a dancer shows a tendency to rely more on left leg the judges would evaluate lower scores on the ability of assistance during performance. This means that relatively high joint powers at the ankle and knee on the left would negatively influence the performance in assistance evaluated by the experts. Additionally, a smooth transition or optimal distribution in joint power between the joints of the lower extremity during movements would be evaluated through observation by the judges. Finally, there were negative correlations between COP and scores in balance by the experts. This indicates the judges give higher scores when movement s are performed with a small range of motion, and the less wobble there is, the higher score the judges give. Also, it was noted that judges assessed the subjects with higher scores when there was less range of COP in both AP and ML directions.

CONCLUSION: The reliability of judges' scores in flexibility and assistance was high because the same standard of assessment was used by all the judges. However, a lower reliability in balance was shown compared to the other two. It is believed that the viewpoints of the judges vary or their assessing standards are not fully objective when assessing performance. Based on the correlations between the experts' scores and biomechanical variables, a greater ROM of the lower joints during performance is associated with higher scores in flexibility by the judges. Also, appropriate distribution between joint powers in the lower body is related to a smaller path in the COP for balance, gaining a higher score. In conclusion, an objective measuring standard with high reliability should be developed for the judges' system of assessment in ballet. The development of objective criteria for ballet performance can be achieved through understanding the principles of human movement with assistance from a scientific method like biomechanical analysis.

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