Biomechanics for Landing Instruction of a Box Horse Exercise

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INTRODUCTION

Generally, it seems that almost all children prefer physical education class in elementary school stage. For children it is said that physical exercise itself is play as well as training is essential to their normal growth and normal development. For example Jean Jacques Rousseau (1712-78), a French philosopher, wrote in his book Emile ou de l'Education (1762) that by returning to natural state, man is both good and happy, and that physical exercise has stimulating effect both in mind and body of children. Taking into consideration that physical education utilizes a basic physical exercise including such as working about, running around and jumping up and down, physical education class will have some function to provide a lot of opportunities meeting to satisfy their physical needs in instinct.

A box horse exercise is one of the suitable exercises, which develops their organ and motor ability. And also, as one of educational materials in physical education class of elementary school, a box horse exercise makes up a challenging spirit to get over some obstacles. Especially in Japan, it is usual that a box horse exercise is compulsory for all children from elementary school to junior high school. In spite of the fact that children vault a box horse with joy, serious accidents have occured in landing phase as usual. However so far, little has been reported pertaining to scientific analysis of safety landing in a box horse exercise. Therefore scientific data of safety instruction, especially focused to landing skill for a box horse exercise are needed to be analyzed with biomechanical techniques in order to prevent children from getting some

serious injuries at a box horse exercise in physical education class of elementary school.

The purpose of this study was to investigate the influence of instruction in a box horse exercise on landing impulse absorbing ability and landing motion for elementary school children attending physical education class.

METHOD

The subjects were 22 boys and 18 girls, mean weight was 34.7 kg, in the fifth grade of Jyuichiya elementary school in Kanazawa, Japan. Each subject performed a vaulting exercise over a box horse after 5 meter running approach. The subjects were instructed to land as soft and quickly as possible. Landing motion when the subject vaulted a 70 cm tall box horse on to the ground was filmed with 16 mm high speed camera positioned at 17 m from the subject and operated 100 fps and also horizontal and vertical ground reaction force curves were obtained from force plate simultaneously. The films taken in this experiment were analyzed with NAC motion analyzer with digitizer. Measuring by force plate, Peak Force to Weight (P.F./W.), Peak Force Time (P.F.Time), Forward Force (FW.F.) and polar surve were obtained. Stick picture, and angular variance of hip, knee and ankle joints were analyzed from 16 mm films. As mentioned above, this kind of experiment was done before and after a three week physical education class of a box horse exercise.

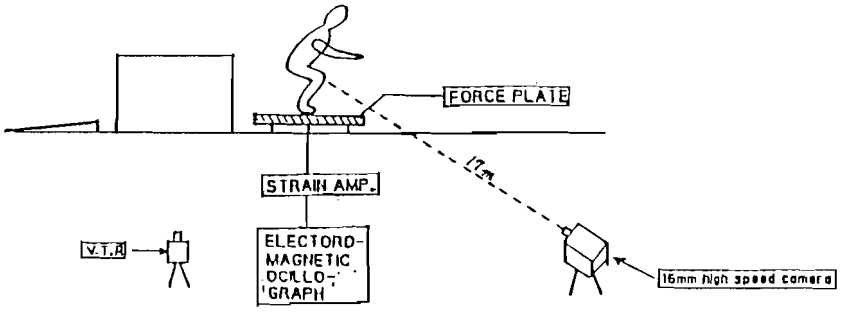

Fig. 1 Schematic diagram of experiment for a box horse exercise.

RESULTS AND DISCUSSION

Landing absorbing ability data are presented in Table 1. P.F./W. was 4.02, P.F. Time was 0.044 sec and FW.F. was 29.6 kg before physical education class, and P.F./W. was 3.04 P.F. Time was 0.075 sec and F.W.F. was 16.4 kg after physical education class respectively. P.F./W. and FW.F. decreased significantly ($p<0.01$) and P.F. Time increased significantly ($p<0.05$) as a result of instructions. This result shows that children can absorb more a landing impulse in their whole body and taking a long time after physical education class. As children had enough time to practice a landing softly in physical education class, absorbing ability seems to be enhanced.

TABLE 1

Mean values and standard deviations before and after physical education class of an elementary school

Test	Item	P.F/W	P.F. Time (sec)	FW force (kg)
before	M	4.02	0.044	29.6
	SD	0.97**	0.015*	9.0**
after	M	3.04	0.075	16.4
	SD	1.18	0.080	6.6

*: P<.05 **:P<.01

Polar curves of horizontal and vertical directions in landing phase before and after physical education class are shown in Figure 2. Both horizontal and vertical forces decreased after physical education class.

Angular variance of hip, knee and ankle joints before and after physical education class are shown in Figure 3 and Figure 4. The minimum hip, knee and ankle joints angle appeared immediately after landing before physical education class, late at landing after physical education class, respectively. These results indicated that deep and long time flexion of hip, knee and ankle joints are important for absorbing a landing impulse.

Polar curves of a skilled boy and an unskilled boy are shown in Figure 5. FW.F of a skilled boy was smaller than that of an unskilled boy. This result indicated that absorbing forward force might be important for safety and stationary landing of a box horse exercise.

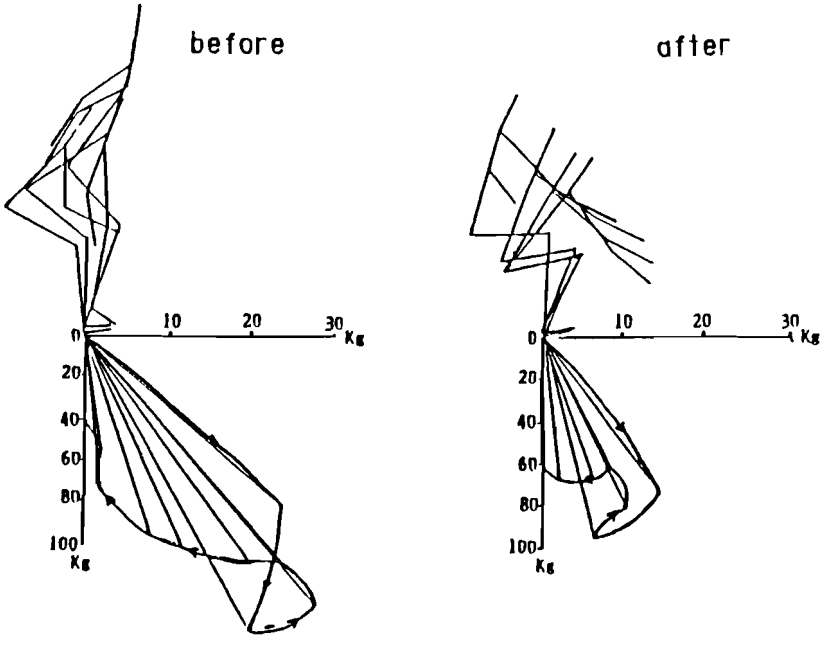

Fig. 2 Polar curves of horizontal and vertical directions in landing phase before and after physical education class of an elementary school.

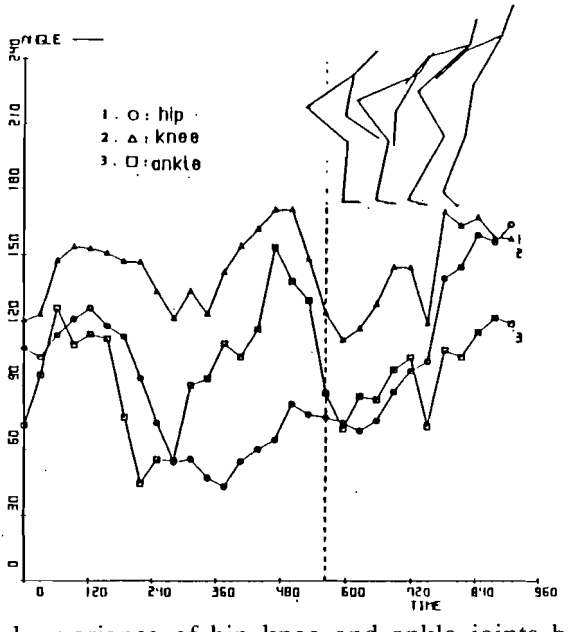

Fig. 3 Angular variance of hip knee and ankle joints before physical education class.

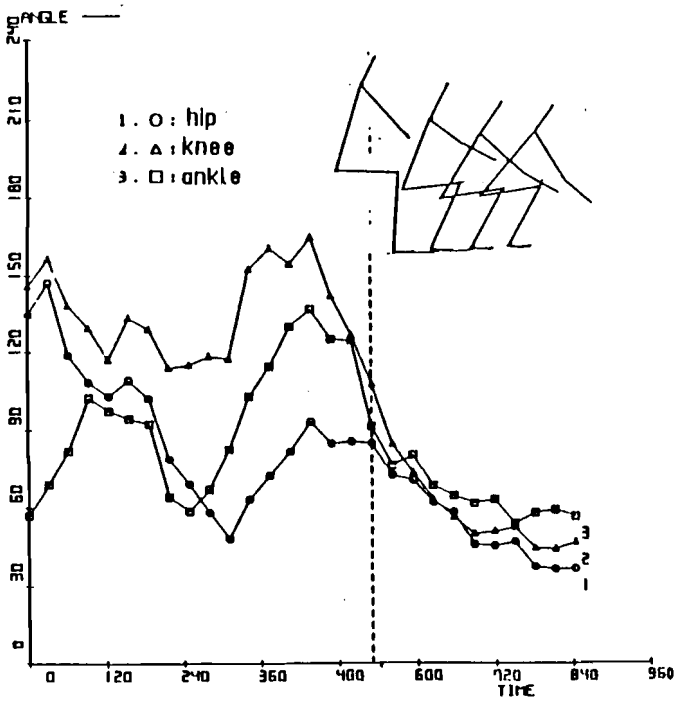

Fig. 4 Angular variance of hip, knee and ankle joints after physical education class.

Stick picture of landing motion before and after physical education class is shown in Figure 6. Three obvious different motions appeared after physical education class, i.e. 1) Erecting the upper body was found immediately after touching a box horse. 2) Deep flexion of hip and knee joints was found at landing. 3) Raising arm forward was found at landing. Erecting the upper body after touching a box horse seems to be useful to absorb a forward force inclining body after landing. Advice of «Look forward» may be effective to make erect the upper body after touching a box horse.

Deep flexion of hip and knee joints at landing may absorb a landing impulse. Raising arm forward at landing may keep his balance, and when children fall forward, it may help to touch hand to floor immediately.

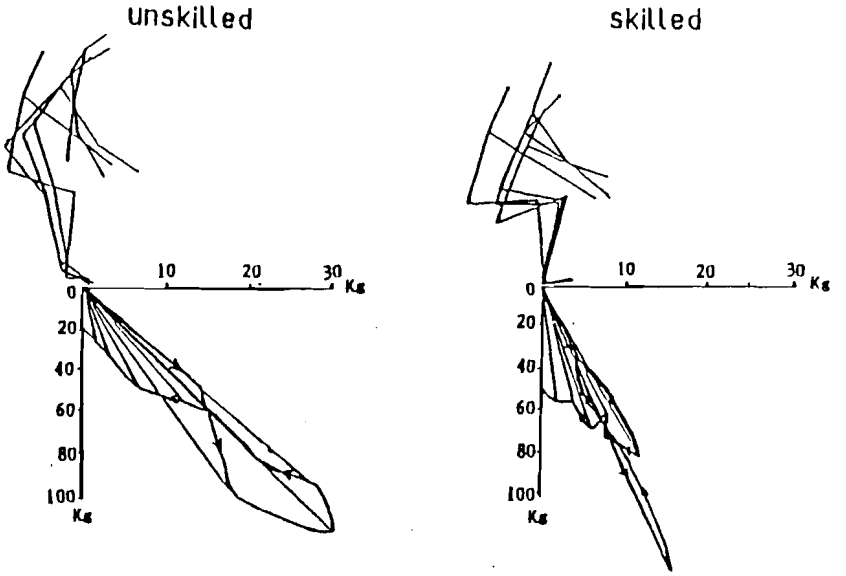

Fig. 5 Polar curves of a skilled boy and an unskilled boy in landing phase.

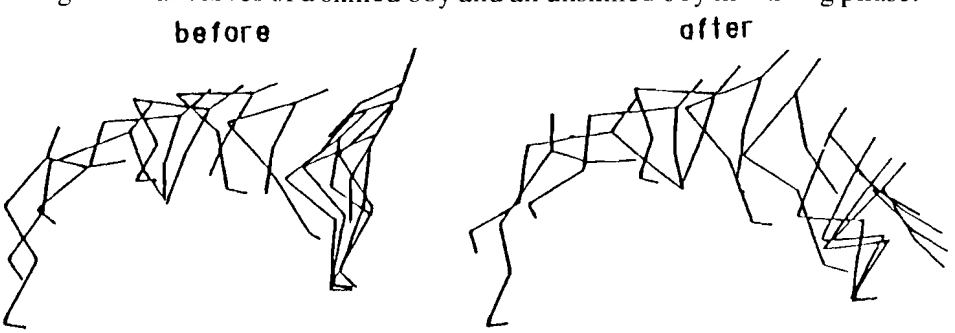

Fig. 6 Stick picture of landing mortion before and after physical education class.

CONCLUSION

In this study, the following general conclusions could be made:

1. Absorbing forward force may be important for safety and stationary landing of a box horse exercise.
2. Erecting the upper body after touching a box horse, deep flexion of hip and knee joints and raising arm forward at landing may be needed for absorbing forward force.

REFERENCES

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2. The new Oxford illustrated dictionary, vl. 2:1477, Oxford University Press, 1978.