Influence of different instructions on vertical ground reaction forces during drop landings

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INTRODUCTION

Sudden decelerating motion, such as landing from a jump, is reportedly one of most common causes of noncontact injuries in competitive sports [1]. In order to analyze motor control strategies related to injury risk factors and prevention, variations of typical kinetic charcteristics must be assessable. Vertical ground reaction forces (VGRFs), measured while subjects pass drop landing series, demonstrate reliable parameters like peak and valley (Fig.1) [2]. When designing studies into landing tasks, we have to make sure that measured differences are related to injury and not influenced by other factors like task instruction. The purpose of this study was to investigate whether different instructions influence vertical ground reaction forces during drop landings in female dancers.

METHODS

Ten female dancers (17.8±0.5 years; 55.6±7.5 kgf; 167± 6cm) volunteered in this study. The participants were asked to execute three drop-landing series (3x 10 trials) with different instructions barefooted from a height of 40 cm down to a force plate (Zebris, Germany, 2560 sensors, sampling rate of 100 Hz) of 51x81 cm. 1. instruction: bipedal drop-landing without any add on (i-none); 2. instruction: bipedal drop-landing as soft as possible (i-soft); 3. instruction: bipedal drop-landing, achieving straight stand as fast as possible (i-fast). Each subject first passed drop-landing with i-none followed by i-soft and i-fast in a randomized order. VGRF was measured during drop landing.

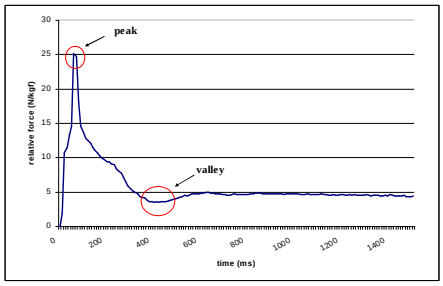

Figure 1: Example for a force-time-curve of one leg during drop-landing

Fig.1 shows a typical force-time.curve of drop-landing. Those curves were analyzed with respect on differences of forces and related times of peak and valley (Fpeak, Fvalley; Tpeak, Tvalley) between i-none, i-soft and i-fast. In order to be able to compare force values of the individuals, VGRFs were normalized by body mass and averaged over test series for each subject. Statistics were computed using an ANOVA with repeated measures followed by post hoc paired t-tests.

RESULTS AND DISCUSSION

Results were shown in Table 1. Normalized Fpeak were significantly lower for i-soft compared with i-none (right: p=.005; left: p=.008) and i-fast (right: p= .001; left: p=.006). Fvalley did not differ significantly between i-none and i-soft, but demonstrated significant differences between i-soft and i-fast (right: p=.011; left: p=.022) and between i-none and i-fast for the left leg (p=.016)

Tpeak showed only differences between instructions concerning the right leg, occured significantly earlier in i-none than in i-soft (p=.001). Tvalley demonstrates decreased values in i-fast and increased values in i-soft compared with i-none. These differences became statistically significant concerning the right leg (soft-none: p=.000; soft-fast: p=.000; none-fast: p=.034) as well as the left one (soft-none: p=.001; soft-fast: p=.000; none-fast: p=.042).

In summary it seems to be that i-soft causes lower force peaks and longer landing durations, operationalized by a lately occurring valley in force-time-curves, in comparison to the other instructions. I-fast shows oppositional effects like higher peaks and early occurring valleys with lower force values.

CONCLUSIONS

The experimental findings indicate that different instructions on drop landings seem to influence motor control strategies measurable in the VGRFs. Future studies have to keep this in mind when designing testing sessions related to injuries.

REFERENCES

1. Shimokochi Y, et al. *Journal of Athletic Training.* **44**:33-38, 2009.
2. Koplin S, et al., *Isocin Exerc Sci.* **16**[3]:200, 2008.

Table 1: Survey of all parameters of the three instructions

parameter	Fpeak right		Fpeak left		Fvalley right		Fvalley left		tpeak right		tpeak left		tvalley right		tvalley left	
	N/kgf		N/kgf		N/kgf		N/kgf		ms		ms		ms		ms	
instruction	mean	Sd	mean	Sd	mean	Sd	mean	Sd	mean	Sd	mean	Sd	mean	Sd	mean	Sd
none	22,0	5,5	18,9	5,5	3,4	0,8	3,1	0,8	60,7	14,0	68,4	15,7	503,4	129,2	496,6	95,0
soft	15,7	2,7	14,6	4,7	3,7	0,5	3,2	0,7	81,3	8,5	100,5	48,5	703,8	130,4	670,0	116,7
fast	21,4	5,0	20,7	5,2	2,5	0,7	2,2	0,8	69,7	18,1	71,1	17,1	376,6	70,2	380,0	76,0