

## **ATTENUATION OF GROUND REACTION FORCES IN SALTO DISMOUNTS FROM THE BALANCE BEAM**

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### **INTRODUCTION**

Epidemiological studies have documented the incidence of injuries in female gymnasts. In comparison to other sports, the incidence of injury in gymnastics is high. One epidemiological study prompted the author to state "...women's gymnastics should be recognized as a hazardous sport" (Snook, p. 242). To understand the etiology of injury, researchers (e.g., Caine, Cochrane, Caine & Zemper, 1989; Clark & Buckley, 1980; Garrick & Requa, 1980; Garrick & Requa, 1978; Lindner & Caine, 1990; Lowry & Leveau, 1982; Martin, Yesalis, Foster & Albright, 1987; Pettrone & Ricciadelli, 1987; Sands, 1985; Sands, Newman, Harner, Paulos & Shultz, 1987; Snook, 1979; Splain & Rolnick, 1984; Vergouwen, 1986; Weiker, 1985; Zaricznyj, Shattuck, Mast, Robertson & Delia, 1980) have identified injuries by sites, types, and/or events (floor exercise, uneven bars, vault, and balance beam). Dismounts, considered an element of all events, have drawn attention as an injury mechanism. Studies have shown the dismount, especially when gymnasts attempt to "stick" their landing, to be a major component of the incidence of injury. The purpose of this study was to determine and compare the ground reaction forces (medial-lateral, anterior-posterior, and vertical) in sticking and rolling out of front and back salto dismounts from the balance beam. It was the belief of the authors that, by appropriately using a forward or backward roll out of a salto dismount, ground reaction forces could be attenuated and possibly reduce the incidence of overuse injuries.

### **METHODS**

The recruitment of subjects for this study was in accord with the policies of the University Committee on Research Involving Human Subjects at Michigan State University. Potential subjects were identified through coaches at youth gymnastics clubs. After completing informed consent forms, subjects were invited to campus to receive a medical screening administered by a sports medicine physician. Those passing the medical screening were permitted to participate in the dismount phase of this study. An initial study (Brown, Witten, Espinoza, Witten, Wilson, Wisner, Weise & Learman, in press) of these subjects was conducted on the ground reaction forces associated with sticking and rolling out of roundoff and barani dismounts from the balance beam. Ground reaction forces of salto dismounts from six subjects, ranging in age from 131 to 184 months and in skill level from 7 to 10, provided the data for the current study.

After warming up, subjects practiced dismounting onto a specially designed gymnastics mat that was adhered via double-sided carpet tape to an AMTI force platform. This mat was surrounded by and isolated from other matting of the same material. Subsequently, subjects were asked to perform two types of salto dismounts (front and back) from the balance beam and to complete each type with two different styles of landing (stick and roll out). If a subject had a force records from both styles of landing for the front and/or back salto, their data was included for further analysis.

## RESULTS

Ground reaction forces were recorded for both styles of dismount for four subjects in the back salto, two subjects in the front salto, and two subjects in the cartwheel back salto. Table 1 contains a summary of the ground reaction forces normalized in units of body weight. The results indicate that, by rolling out of the landing, vertical ground reaction forces (force component with the greatest magnitude) are substantially reduced for all types of salto dismounts that were investigated. Mixed results were obtained for medial-lateral and anterior-posterior ground reaction forces.

Table 1 Average Maximum Ground Reaction Force in Units of Body Weight

Ground Reaction Force:		medial-lateral*		anterior-posterior*		vertical*	
Style of Landing:		stick	roll	stick	roll	stick	roll
Type of Dismount:	back salto (n=4)	2.33	3.01	2.44	2.16	9.09	8.40
	cartwheel back salto (n=2)	0.42	0.73	2.99	1.99	9.41	7.55
	front salto (n=2)	0.80	0.32	1.23	0.74	12.83	9.41

\*Absolute value used.

## CONCLUSION

The results of this study, in combination with the findings of a previous investigation (Brown, Witten, Espinoza, Witten, Wilson, Wisner, Weise & Learman, in press) of ground reaction forces in sticking and rolling out of roundoff and barani dismounts from the balance beam, support the authors' contention that ground reaction forces could be attenuated and possibly reduce the incidence of overuse injuries in female gymnasts.

## REFERENCES

Brown, E. W., Witten, W. A., Espinoza, D. M., Witten, C. X., Wilson, D. J., Wisner, D. M., Weise, M., & Learman, J. (in press). Attenuation of ground reaction forces in dismounts from the balance beam. In T. Bauer (Ed.), *Proceedings of the XIII Symposium of the International Society of Biomechanics in Sport*. Thunder Bay, Ontario, Canada: Lakehead University.

Caine, D., Cochrane, B., Caine, C., & Zemper, E. (1989). An epidemiologic investigation of injuries affecting young competitive female gymnasts. *The American Journal of Sports Medicine*, 17(6), 811-820.

- Clark, K. S., & Buckley, W. E. (1980). Women's injuries in collegiate sports. *The American Journal of Sports Medicine*, 8(3), 187-191.
- Garrick, J. G., & Requa, R. K. (1980). Epidemiology of women's gymnastics injuries. *The American Journal of Sports Medicine*, 8(4), 261-264.
- Garrick, J. G., & Requa, R. K. (1978). Girls sport injuries in high school athletes. *The Journal of the American Medical Association*, 239(21), 2245-2248.
- Lindner, K. J., & Caine, D. J. (1990). Injury patterns of female competitive club gymnasts. *Canadian Journal of Sports Science*, 15(4), 254-261.
- Lowry, C. B., & Leveau, B. F. (1982). A retrospective study of gymnastics injuries to competitors and noncompetitors in private clubs. *The American Journal of Sports Medicine*, 10(4), 237-239.
- Martin, R. K., Yesalis, C. E., Foster, D., & Albright, J. P. (1987). Sports injuries at the 1985 Junior Olympics- An epidemiologic analysis. *The American Journal of Sports Medicine*, 15(6), 603-608.
- Pettrone, F. A., & Ricciadelli, E. (1987). Gymnastics injuries: The Virginia experience 1982-1983. *The American Journal of Sports Medicine*, 15(1), 59-62.
- Sands, B. (1985). Injury data NCAA female gymnastics 1983-84 - Data reveals potential patterns. *Technique*, 4(2), 7-8.
- Sands, W. A., Newman, A. P., Harner, C., Paulos, L. E., & Schultz, B. B. (1987). A two year study of injury in collegiate women's gymnastics. *Technique*, 7(3), 4-10.
- Snook, G. A. (1979). Injuries in women's gymnastics - A 5-year study. *The American Journal of Sports Medicine*, 7(4), 242-244.
- Splain, S. H., & Rolnick, A. (1984). Sports injuries at a nonscholarship university. *The Physician and Sportsmedicine*, 12(7), 55-56, 58-60.
- Vergouwen, P. (1986). Epidemiologie van blessures bij toptunsters. *Geneeskunde en Sports*, 18(2), 27-28.
- Weiker, G. G. (1985). Injuries in club gymnastics. *The Physician and Sportsmedicine*, 13(4), 63-66.
- Zaricznyj, B., Shattuck, L. J., Mast, T. A., Robertson, R. V., & Delia, G. (1980). Sports-related injuries in school-age children. *The American Journal of Sports Medicine*, 8(3), 187-191.

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