Squat Ground Reaction Force on a Horizontal Squat Device, Free Weights, and Smith Machine

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Bed rest is an analog to spaceflight and advancement of exercise countermeasures is dependent on the development of exercise equipment that closely mimic actual upright exercise. The Horizontal Squat Device (HSD) was developed to allow a supine exerciser to perform squats that mimic upright squat exercise. **PURPOSE:** To compare vertical ground reaction force (GRFv) on the HSD with Free Weight (FW) or Smith Machine (SM) during squat exercise. **METHODS:** Subjects (3F, 3M) performed sets of squat exercise with increasing loads up to 1-repetition (rep) maximum. GRF data were collected and compared with previous GRF data for squat exercise performed with FW & SM. Loads on the HSD were adjusted to magnitudes comparable with FW & SM by subtracting the subject's body weight (BW). Peak GRFv for 45-, 55-, 64-, & 73-kg loads above BW were calculated. Percent (%) difference between HSD and the two upright conditions were computed. Effect size was calculated for the 45-kg load. **RESULTS:** Most subjects were unable to lift >45 kg on the HSD; however, 1 subject completed all loads. Anecdotal evidence suggested that most subjects' shoulders or back failed before their legs. The mean % difference are shown in Table 1. In the 45-kg condition, effect sizes were 0.37 & 0.83 ($p>0.05$) for HSD vs. FW and HSD vs. SM, respectively, indicating no differences between exercise modes.

Table 1. GRFv in BW ± SD at similar loads for HSD, FW, & SM.

Load (kg)	HSD (BW)	FW (BW)	SM (BW)	% Difference HSD vs. FW	% Difference HSD vs. SM
45	2.11±0.13	2.05±0.17	2.00±0.08	2.88%	5.35%
55	2.09*	2.15±0.12	2.18±0.08	2.83%	4.22%
64	2.30*	2.30±0.23	2.26±0.07	0.00%	1.75%
73	2.41*	2.45±0.19	2.51±0.16	1.65%	4.07%
			Mean:	1.84%	3.85%

*n=1

CONCLUSION: When BW was added to the target load, results indicated that vertical forces were similar to those in FW and SM exercise. The exercise prescription for the HSD should include a total external resistance equivalent to goal load plus subject BW. The HSD may be used as an analog to upright exercise in bed rest studies, but because most subjects were unable to lift >45 kg, it may be necessary to prescribe higher reps and lower loads to better target the leg musculature.