

Impact of Provider/Patient Positions on CPR Quality During Rescue Sledge Resuscitation on Inclined Terrain: A Controlled Manikin Study

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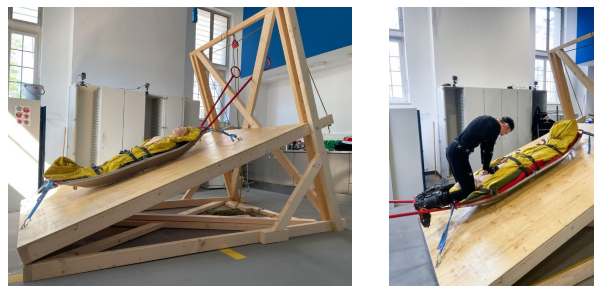
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INTRODUCTION

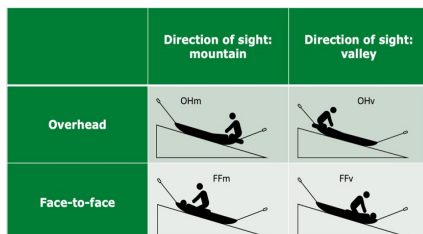
Providing high-quality cardiopulmonary resuscitation (CPR) during alpine rescue on inclined terrain is challenging. This study evaluated the effect of rescuer position on CPR quality during simulated sledge transport.

METHODS

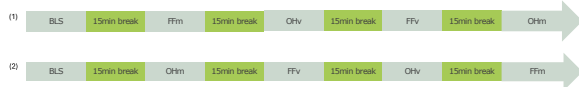
In a controlled manikin study, 43 trained mountain rescuers performed two-minute compression-only CPR in four positions on a 20° inclined rescue sledge: face-to-face mountain (FFm), face-to-face valley (FFv), overhead mountain (OHm), and overhead valley (OHv). Standard basic life support (BLS) on flat ground served as reference. Compression depth (CCD), rate (CCR), recoil, no-flow time (NFT), and variability were recorded. Participants also rated exertion, quality, and stability.



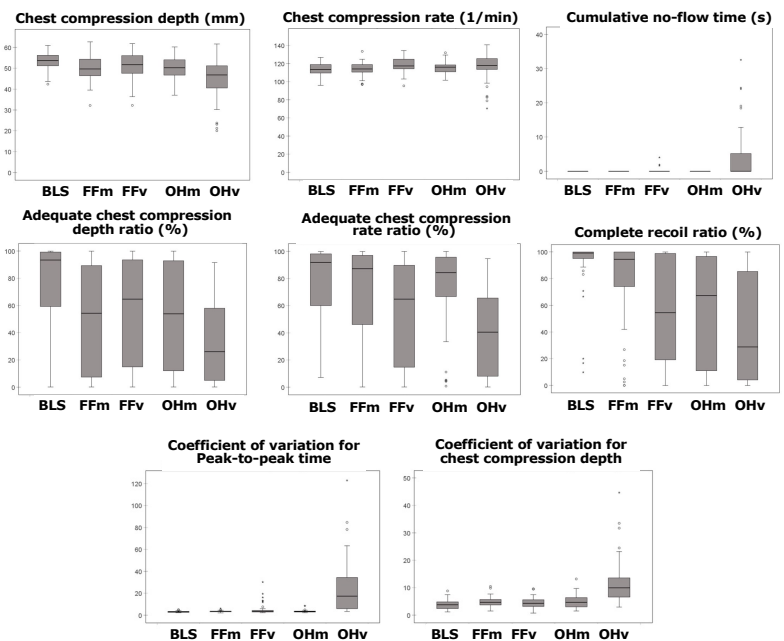
A



B



n=43	BLS	FFm	FFv	OHm	OHv	F	df1, df2	p	η^2
CCD (mm)	53.28 ± 4.28	49.91 ± 5.67*	50.91 ± 6.72*	49.98 ± 6.01*	44.64 ± 10.12*	13.86	2.51, 105.47	<0.001	.25
CCDr	0.76 ± 0.33	0.49 ± 0.40*	0.55 ± 0.38	0.53 ± 0.39	0.33 ± 0.30*	9.89	4, 168	<0.001	.19
CCR (1/min)	113.12 ± 6.48	113.75 ± 7.67	119.36 ± 8.33*	115.23 ± 7.02*	115.91 ± 14.99	6.34	1.75, 73.56	<0.001	.13
CCRr	0.79 ± 0.25	0.71 ± 0.31	0.52 ± 0.38*	0.73 ± 0.30	0.39 ± 0.32*	22.56	4, 168	<0.001	.35
NFT (s)	0.00 ± 0.00	0.00 ± 0.00	0.18 ± 0.72	0.00 ± 0.00	4.31 ± 7.81				
CREr	0.91 ± 0.22	0.78 ± 0.34	0.58 ± 0.40*	0.56 ± 0.40*	0.40 ± 0.39*	15.83	4, 168	<0.001	.27
CV CCD (%)	3.94 ± 1.88	4.90 ± 1.82	4.51 ± 1.97	4.96 ± 2.53	12.28 ± 8.83*	26.87	1.32, 55.33	<0.001	.91
CV peak-to-peak time (%)	3.16 ± 0.58	3.44 ± 0.71	5.43 ± 5.48	3.52 ± 1.25*	24.54 ± 25.14*	29.21	1.08, 45.34	<0.001	.41



RESULTS

Position had a significant effect on compression depth ($F = 13.86$, $p < 0.001$). CCD was highest in BLS (53.3 ± 4.3 mm) and comparable in FFv (50.9 ± 6.7 mm, $p = 0.36$), but lower in FFm (49.9 ± 5.7 mm, $p < 0.05$), OHm (50.0 ± 6.0 mm, $p < 0.05$), and OHv (44.6 ± 10.1 mm, $p < 0.001$). Adequate depth ratio (CCDr) was higher in BLS (0.76 ± 0.33) than FFm (0.49 ± 0.40 , $p < 0.05$) and OHv (0.33 ± 0.30 , $p < 0.01$). Mean CCR remained within 100–120/min across all conditions, but the correct rate ratio (CCRr) declined in valley-facing positions (BLS 0.79 ± 0.25 vs. OHv 0.39 ± 0.32 , $p < 0.001$). Complete recoil (CREr) was more frequent in BLS (0.91 ± 0.22) and FFm (0.78 ± 0.34) compared to other positions ($p < 0.05$). NFT occurred only in valley-facing conditions (FFv 0.18 ± 0.72 s; OHv 4.3 ± 7.8 s). Subjectively, FFm was rated highest for quality (7.3 ± 1.3) and stability (7.3 ± 1.6), while OHv was most exhausting (8.5 ± 1.4) and lowest in perceived quality (2.6 ± 1.8 ; $p < 0.001$).

CONCLUSION

CPR quality is reduced on an inclined rescue sledge compared with flat-ground BLS. Mountain-facing positions, particularly FFm, maintain compression performance more effectively than valley-facing orientations. These findings support position-specific recommendations for alpine resuscitation training and practice.

