Static and Dynamic Balance Function in Dialysis Patients

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Background. Falls in dialysis patients are common and cause significant morbidity and mortality. Multiple risk factors of falls have been identified, such as age, falling history, lower extremities weakness, balance problems, arthritis, orthostatic hypotension, and anemia. Computerized dynamic posturography (CDP) system, which can perform sensory organization test (SOT), limits of stability (LOS) and rhythmic weight shifting (RWS) tests, is widely used for evaluating balance problems in the elderly and various patient groups. Limited literature addressed the issue of balance function in dialysis patients. The aim of this study was to fill this gap.

Methods. Twenty-six patients receiving dialysis more than 3 months were enrolled. Twenty-six age-matched healthy volunteers were also recruited as control group. Each participant received anthropometric measurements, physical fitness (5-repetition sit-to-stand (STS), grip strength, sit-bend test and 6-minute walk test) and static and dynamic balance function tests on the CDP system.

Table 1: The demography of the control and patient groups

		Control Mean ± SD	Dialysis patient Mean ± SD	P-value
Gender	Male	7	8	
	Female	19	18	
Age (yr.)		48.7 ± 9.7	49.0 ± 10.8	0.9091
(Age range)		(28.8 ~ 61.6)	(28.9 ~ 68.2)	
Body height (cm)		160.3 ± 8.4	160.6 ± 8.4	0.8889
Body weight (kg)		61.0 ± 11.1	62.3 ± 14.5	0.7205
Body fat (%)		32.5 ± 3.9	32.8 ± 4.7	0.7635
BMI (kg/m^2)		23.6 ± 2.9	24.0 ± 4.4	0.7772
5-rep sit-to-stand (sec)		7.6 ± 1.5	10.5 ± 4.6	0.0031 **
Grip strength (kg)		23.4 ± 9.8	17.3 ± 10.2	0.0330 *
Sit bend (cm)		30.2 ± 9.7	24.7 ± 8.2	0.0369 *
6-min walk test (m)		597.9 ± 61.9	460.4 ± 98.9	<0.0001 ***
Albumin (g/dl)		--	3.72 ± 0.34	
Hb (g/dl)		--	10.1 ± 1.39	

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

Table 2: Mean values of the outcome measures from the sensory organization test (SOT) in the patient and control groups.

Test	Condition	Variables	Control Mean ± SD	Patient Mean ± SD	P-value
OT1	Eye open,	Equilibrium score	94.5 ± 1.3	92.8 ± 2.5	0.0102 *
	Stable surface	Strategy	97.7 ± 0.6	98.1 ± 1.3	0.1185
OT2	Eye closed,	Equilibrium score	92.9 ± 1.6	88.9 ± 4.8	0.0001 ***
	Stable surface	Strategy	96.9 ± 1.1	97.0 ± 2.1	0.4130
OT4	Eye open,	Equilibrium score	85.1 ± 4.0	72.6 ± 14.4	0.0002 ***
	Unstable surface	Strategy	88.6 ± 3.4	85.0 ± 5.1	0.0037 **
OT5	Eye closed,	Equilibrium score	69.3 ± 6.9	46.2 ± 24.5	<0.0001 ***
	Unstable surface	Strategy	81.9 ± 6.6	76.3 ± 6.7	0.0042 **
Composite equilibrium score			85.4 ± 2.5	75.1 ± 10.1	<0.0001 ***
Sensory analysis		Somatosensory ratio (SOT2/SOT1)	0.982 ± 0.015	0.958 ± 0.037	0.0099 **
		Visual ratio (SOT4/SOT1)	0.901 ± 0.042	0.780 ± 0.145	0.0004 ***
		Vestibular ratio (SOT5/SOT1)	0.733 ± 0.073	0.495 ± 0.260	<0.0001 ***

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

Table 3: Mean values of the outcome measures from the limit of stability (LOS) test in the patient and control groups.

Variables	Condition	Control Mean ± SD	Patient Mean ± SD	P-value
Reaction time (sec)	Forward	0.60 ± 0.16	0.96 ± 0.36	<0.0001 ***
	Backward	0.64 ± 0.19	0.78 ± 0.28	0.0758
	Right	0.61 ± 0.20	0.91 ± 0.44	0.0028 **
	Left	0.59 ± 0.17	0.87 ± 0.34	0.0006 ***
	Composite score	0.61 ± 0.15	0.88 ± 0.26	0.0001 ***
Movement Velocity (MVL) (°/sec)	Forward	4.88 ± 1.76	3.55 ± 1.39	0.0047 **
	Backward	3.73 ± 1.35	2.81 ± 1.12	0.0261 *
	Right	7.06 ± 2.81	4.87 ± 1.43	0.0038 ***
	Left	7.18 ± 2.79	4.96 ± 1.83	0.0007 ***
	Composite score	5.73 ± 1.86	4.06 ± 1.11	0.0011 **
Endpoint Excursions (EPE) (%)	Forward	73.4 ± 15.6	52.9 ± 18.9	0.0001 ***
	Backward	51.9 ± 12.3	44.4 ± 17.1	0.0522
	Right	90.4 ± 14.6	76.7 ± 20.2	0.0156 *
	Left	89.4 ± 16.0	78.2 ± 13.9	0.0057 **
	Composite score	76.4 ± 10.3	63.1 ± 12.3	0.0003 ***
Max Excursions (MXE) (%)	Forward	83.6 ± 11.2	68.8 ± 20.6	0.0038 **
	Backward	65.5 ± 13.9	58.8 ± 20.7	0.2484
	Right	101.7 ± 10.2	93.2 ± 12.1	0.0131 *
	Left	100.4 ± 11.0	93.5 ± 9.6	0.0168 *
	Composite score	87.5 ± 6.0	78.8 ± 10.0	0.0009 ***
Directional Control (DCL) (%)	Forward	84.5 ± 5.3	73.8 ± 18.3	0.0102 *
	Backward	67.7 ± 11.6	57.6 ± 21.1	0.0975
	Right	81.9 ± 5.8	74.9 ± 7.6	0.0005 ***
	Left	80.1 ± 6.2	76.2 ± 7.2	0.0576
	Composite score	78.7 ± 5.9	70.7 ± 11.1	0.0026 **

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

Table 4: Mean values of the outcome measures from the rhythmic weight shifting (RWS) test in the patient and control groups.

Direction	Variables	Condition	Control Mean ± SD	Patient Mean ± SD	P-value
Left and Right	Movement Velocity (MVL) (°/sec)	Slow	2.70 ± 0.38	2.85 ± 0.43	0.1860
		Medium	4.20 ± 0.49	4.26 ± 0.50	0.7621
		Fast	7.90 ± 1.56	8.22 ± 1.34	0.4638
	Directional Control (DCL) (%)	Slow	83.6 ± 4.85	80.0 ± 5.09	0.0023 **
		Medium	88.4 ± 3.15	84.9 ± 3.72	0.0009 ***
		Fast	90.8 ± 2.83	89.9 ± 3.67	0.4831
Forward and Backward	Movement Velocity (MVL) (°/sec)	Slow	1.86 ± 0.35	1.92 ± 0.44	0.5062
		Medium	2.71 ± 0.47	2.62 ± 0.44	0.5025
		Fast	4.78 ± 0.97	3.99 ± 1.27	0.0200 *
	Directional Control (DCL) (%)	Slow	79.9 ± 7.59	73.9 ± 12.67	0.1451
		Medium	81.2 ± 11.35	76.8 ± 11.18	0.0740
		Fast	83.9 ± 7.56	79.2 ± 12.33	0.2598

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

Results. There were no differences in height, weight, body fat and body mass index between groups. All the physical fitness parameters were significantly worse in the dialysis group. They also demonstrated worse performance in the balance tests, i.e. lower composite equilibrium score in SOT, lower composite score of reaction time, movement velocity, endpoint excursions in LOS test, and directional control in LOS and RWS tests. The composite equilibrium score of four SOT conditions was moderate correlated with 5-rep STS time (-0.41, P=0.04), grip strength (0.43, P=0.03), 6-min walk distance (0.55, P=0.004), and sit-bend length (0.50, P=0.01).

Conclusions. Balance functions of dialysis patients were significantly impaired compared to age-matched controls. The composite equilibrium score was the best balance variable that related to all the physical fitness variables.
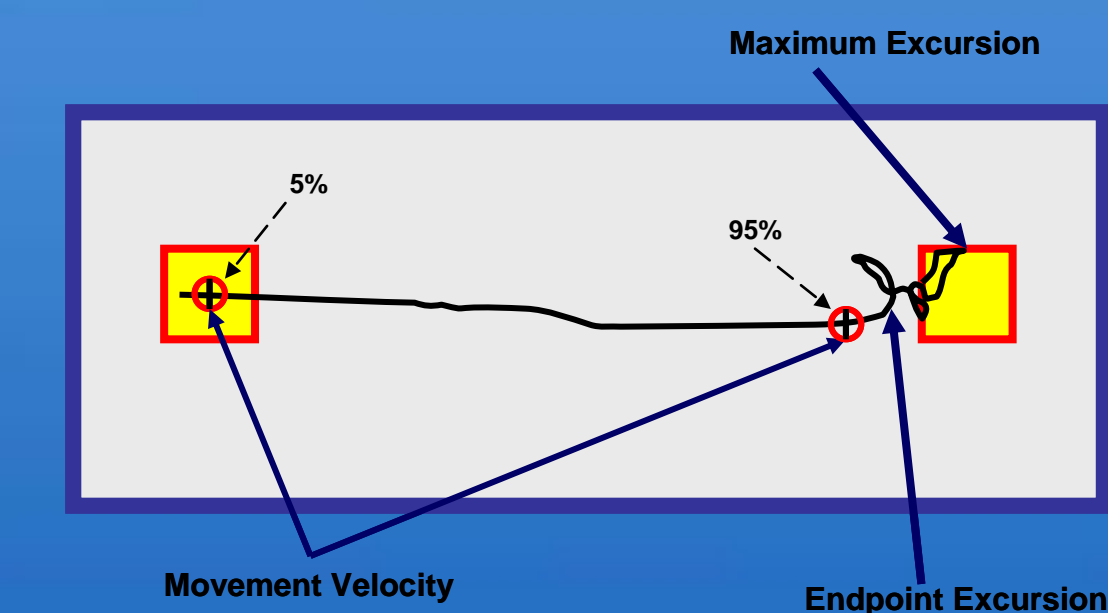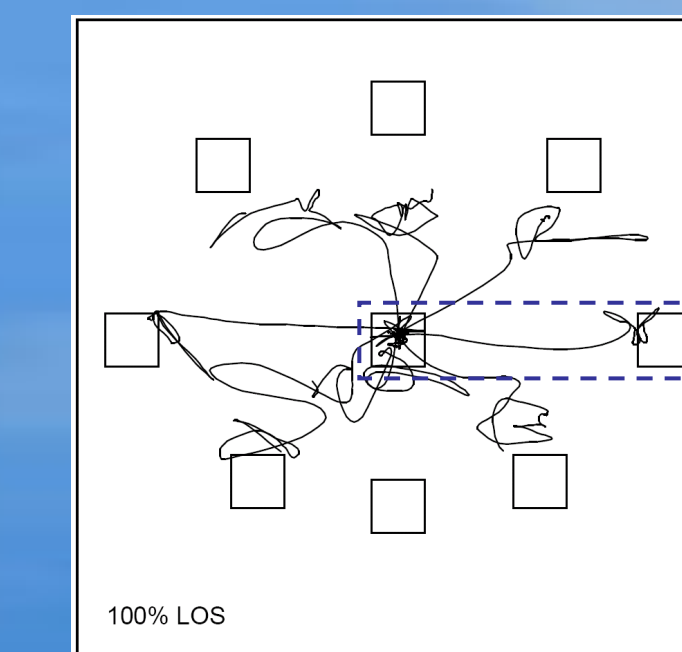
Figure 1: The diagrammatic representation of the outcome measures in the limit of stability (LOS) test. The movement velocity is defined as the average speed between 5% and 95% of COG movement in degrees per second. Endpoint excursion is the distance traveled by the COG on the primary attempt to reach the target. Maximum excursion is the furthest distance traveled by the COG during the trial.