OXYGEN EXTRACTION RATIO (OER): A POSSIBLE PARAMETER TO MEASURE CARDIOVASCULAR (CV) STRESS IN HAEMODIALYSIS (HD).

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Introduction

○ Hemodialysis treatment may cause peripheral tissue hypoxia not routinely evaluated

○ Intra-HD hypoxia (*Arterial* Oxygen saturation, SaO_2, <90%), automatically detected with dedicated sensors, has been reported to associate with increased morbidity and mortality.

○ The Oxygen extraction ratio (OER, n.v 20%-25%), obtained with the measurement of SaO_2 and Central Venous Oxygen Saturation ($SvcO_2$), is routinely employed in ICU to quantify tissue hypoxic stress. Theoretically more sensitive than SaO_2, OER increments may indicate parenchymal hypoperfusion and inadequate adaptation to hypoxia (Figure 1).

Aims

We aimed to evaluate if OER:
a. increased significantly during HD sessions;
b. was different between long (HD_{Long}) and short (HD_{Short}) HD intervals;
c. was differently affected by Isolated UF (iUF) or Isolated Diffusion (iD).

Fig. 1

Under normal conditions tissue extract about 20-25% of the oxygen from the blood. In pathological conditions tissue oxygen need increase and extracting oxygen becomes higher.

Methods

We enrolled 20 clinically stable patients on HD since >6 months , with Central Venous Catheter.
We contemporarily sampled arterial SO_2 (by capillary oxymeter) and $ScvO_2$ (by blood gas analysis) to calculate the OER basally, 15', 30', 60', 120' and end of HD_{Long}.
In 10 of them (group A), OER was re-measured in the following two HD_{Short} sessions.
In the other 10 (group B), OER was re-measured during the first hour of the first and second HD_{Short} performed by applying iUF or iD respectively.
During each HD, UF rate was kept at<10 ml/kg/h and symptoms were recorded.

Results

Clinical and biochemical features are reported in Tab.1.

In the HD_{Long} session, OER increased within 30' (post hoc test p<.05) and then progressively up to the end of HD, by 38%. Mean basal OER of HD_{Long} (34,4±7), HD_{Short1} (33,8±7) and HD_{Short2} (34,2±7) were not different (Tab.2).
In the two HD_{Short} sessions, OER changes overlapped (no statistical difference) with those in HD_{Long} (Fig.2).

During the first hour of the HD_{Short1} session with iUF, the increment of OER from basal was not significant, at variance with the significant increase recorded during the HD_{Short2} with iD (Tab. 2). Importantly, all HD sessions were asymptomatic with no change (ANOVA = n.s.) in blood pressure (either systolic or diastolic) nor of heart rate. During sessions, no significant change was evident for capillary SO_2 (average 98±1 %), while $ScvO_2$ progressively decreased, thus allowing to refer the recorded O_2 consumption to peripheral extraction and not to other possible causes of systemic SO_2 reduction.
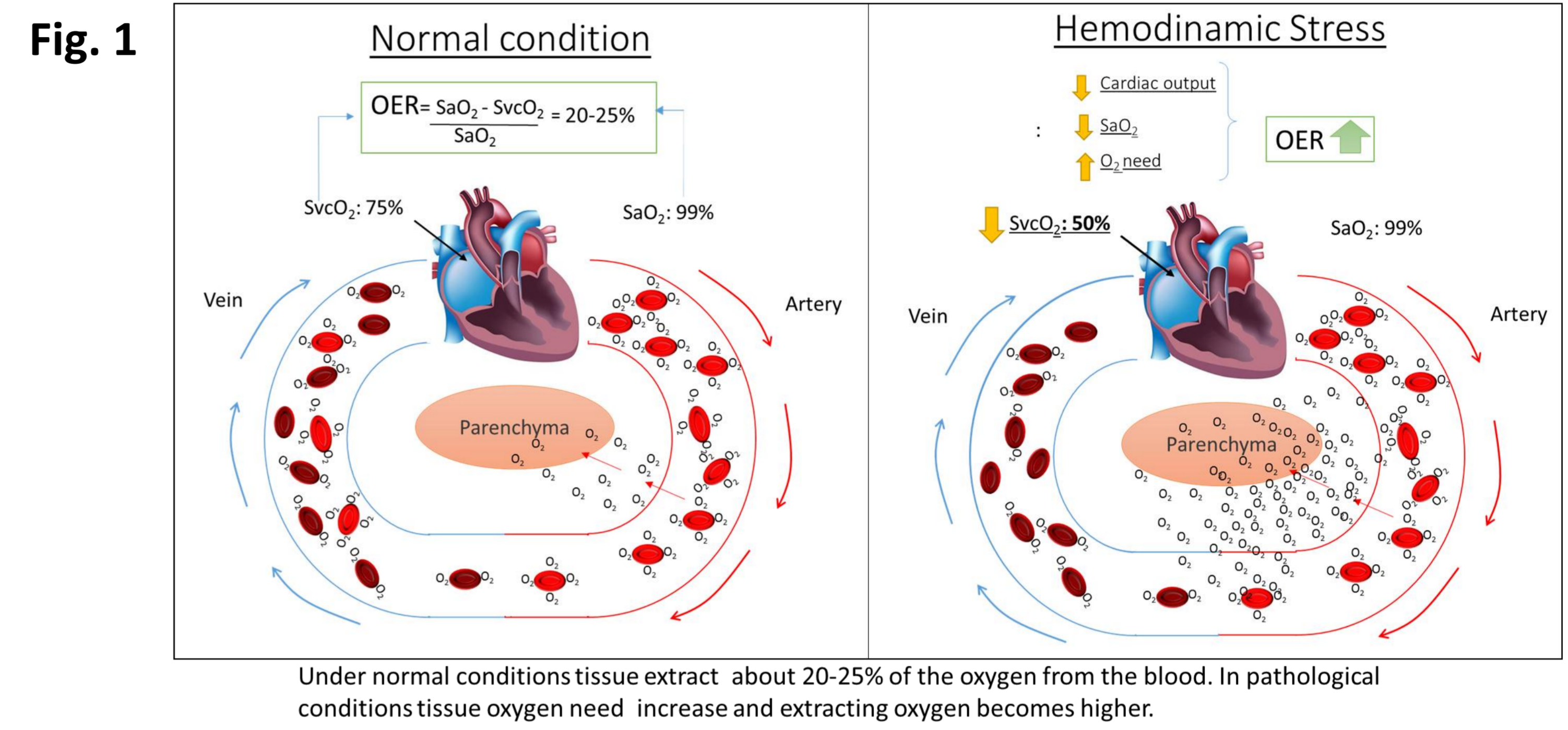
Tab. 1, Patients characterisitics (mean ± SD)	
N.	20
Men/Females; N (%)	8 (40)/12 (60)
Age, yr	75±13
HD Vintage, yr	3,7±3,3
BMI, Kg/m²	25,1±5,6
Comorbidity; N (%)	12 (60)
ACS, N (%)	2 (10)
Peripheral ischemia, N (%)	3 (15)
Cerebral ischemia, N (%)	0
Diabetes, N (%)	7 (35)
Hb, g/dl	10,3±1,2
Calcium, mg/dl	8,5±0,4
Phosphate, mg/dl	5,2±1,2
PTH, pg/ml	338±154
ALP, UI/L	84±26

HD, type	Paz. (n)	Basale	15'	30'	60'	120'	End HD	Anova
HD_{Long}	20	34,4±7	39,0±7	40,0±8*	40,7±6#	42,5±8°	46,9±6^	.0001
HD_{Short1}	10	33,8±7	40,2±8*	41,3±6#	42,4±5#	42,0±7#	45,9±8°	.004
HD_{Short2}	10	34,2±7	40,6±9	42,2±7*	42,0±8*	42,9±10*	45,9±7°	.003
HD_{Short}, iUF	10	33,0±6	35,9±7	36,6±6	37,5±7			n.s
HD_{Short}, iD	20	32,4±6	37,6±6	38,8±5*	38,4±7			.04

Tab. 2, Mean values of OER. iUF = Isolated Ultrafiltration; iD: isolated diffusion; Bonferroni Post-hoc test vs Basale: *p<.05; # p<.005; ° p<.001; ^ p<.0001
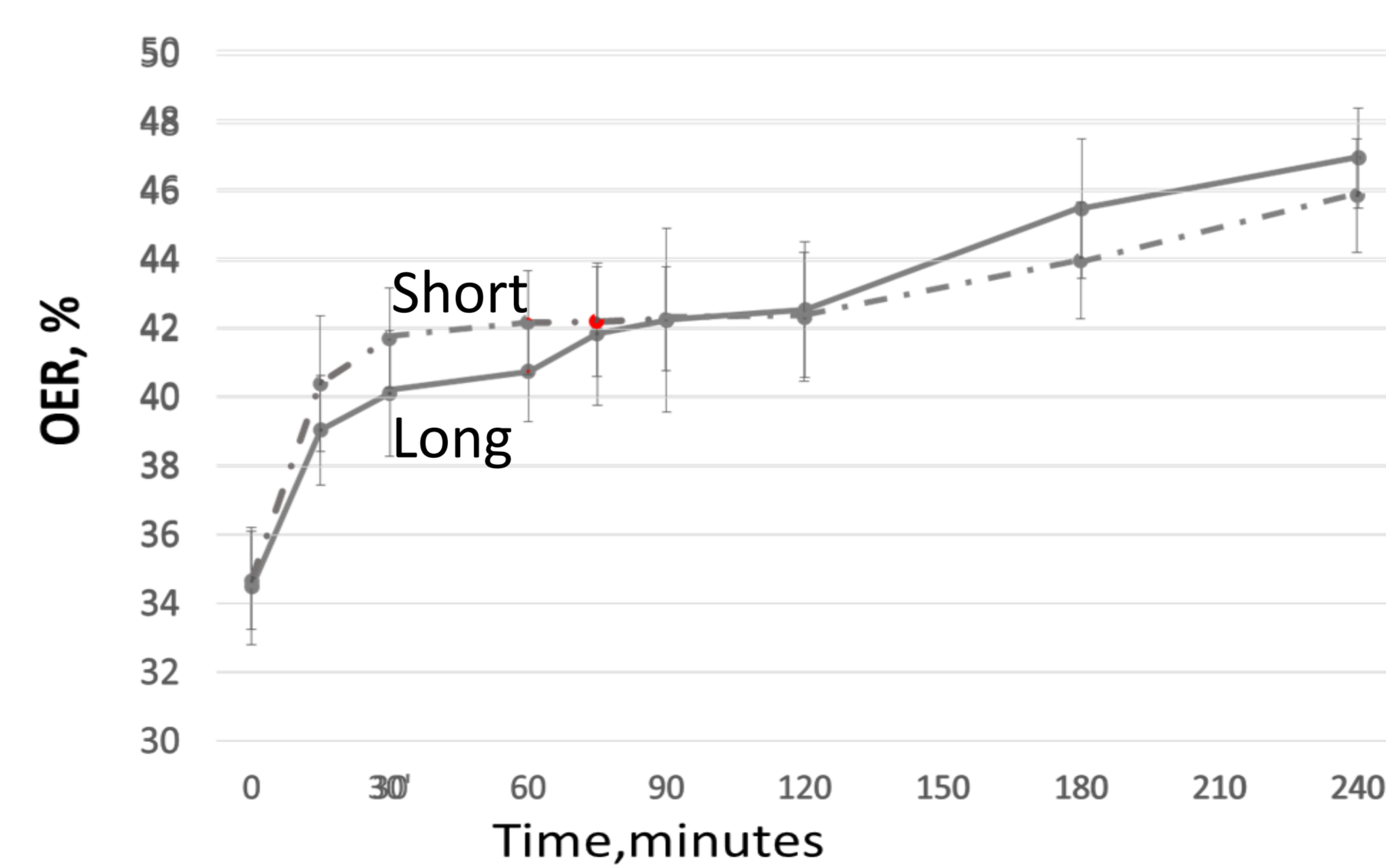

Fig. 2 OER trend during HD Short (median) vs Long interval

Discussion and Conclusions

a. Even asymptomatic HD sessions increase O_2 consumption in amounts that are measurable by OER;

b. HD intervals marginally modify the adaptive process to hypoxia;

c. iD affects this adaptive response possibly more than iUF.

Our results indicate that OER is a possible marker of HD stress, potentially useful in fragile patients.