THE IMPACT OF HAEMODIALYSIS ARTERIOVENOUS FISTULA ON HAEMODYNAMIC PARAMETERS OF THE CARDIOVASCULAR SYSTEM

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Background

Satisfactory vascular access flow (Qa) of an arteriovenous fistula (AVF) is necessary for haemodialysis (HD) adequacy. Aim of the present study was to further our understanding of haemodynamic modifications induced by the AVF on the cardiovascular system of HD patients (FIGURE 1). Main objective was to calculate using real data in what way an AVF influences the load of the left ventricle (LLV).

Figure 1

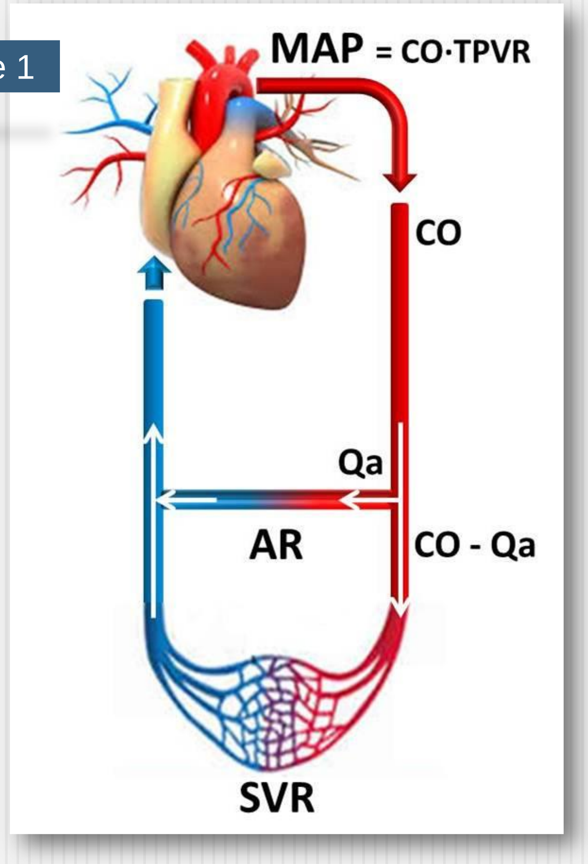


Table 1. Demographic, clinical and haemodynamic data of the 86 patients enrolled into the study (data are reported for both the entire cohort and for their categorization into lower and upper arm AVFs).

	All (no. 86)	Lower arm (no. 56)	Upper arm (no. 30)	P
Age (years)	61.0(11.0)	58.6(9.4)	63.4(11.9)	0.453*
Gender (males) (%)	53.8	57.2	50.4	0.142#
Diabetes mellitus (%)	15.6	15.5	15.7	0.876#
Dialysis duration (months)	59.6(22.9)	65.0(18.4)	54.2(21.9)	<0.0001**
Haemoglobin (g/dl)	11.6(1.3)	11.2(1.7)	12.0(2.1)	0.654*
AVF vintage (months)	74.4(65.4)	79.8(62.6)	69.0(65.7)	<0.0001**
MAP (mmHg)	92.7(13.9)	92.0(15.1)	93.4(12.4)	0.320**
HR (beats/min)	72.7(9.5)	71.2(11.5)	74.2(8.4)	0.540**
CO (l/min)	6.3(1.3)	5.7(1.0)	6.8(1.0)	<0.0001*
Qa (l/min)	1.3(0.6)	0.9(0.3)	1.6(0.4)	<0.0001**
LLV (watt)	1.3(0.6)	1.0(0.3)	1.6(0.4)	<0.0001*
CPR	0.2(0.3)	0.1(0.1)	0.3(0.1)	<0.0001**
LLV_{AVF} (% of LLV)	19.7(3.1)	15.8(3.2)	23.5(4.0)	<0.0001*
TPVR (mmHg·min/l)	14.9(3.2)	16.1(4.2)	13.7(3.2)	<0.0001*
AR (mmHg·min/l)	80.3(24.6)	102.2(21.8)	58.3(15.9)	<0.0001**
SVR (mmHg·min/l)	18.6(4.1)	19.2(5.3)	17.9(5.1)	<0.0001**

Continuous variables are expressed as mean(SD) while categorical data as percentages. *Student's t-test for unpaired data; ** Mann-Whitney U-test; #χ^2 test

Methods

All HD patients treated in our Dialysis Unit and bearing an AVF were enrolled into the present observational cross-sectional study. Fifty-six patients bore a lower arm AVF and 30 an upper arm AVF (TABLE). Qa and cardiac output (CO) were measured by means of the ultrasound dilution Transonic Hemodialysis Monitor HD02 (Transonic Systems Incorporated, Ithaca, NY, USA). Mean arterial pressure (MAP) was calculated; total peripheral vascular resistance (TPVR) was calculated as MAP/CO; resistance of AVF (AR) and systemic vascular resistance (SVR) are connected in parallel and were respectively calculated as AR = MAP/Qa and SVR = MAP/(CO - Qa). LLV was calculated on the principle of a simple physical model: LLV (watt) = TPVR·CO^2. The latter was computationally divided into the part spent to run Qa through the AVF (LLV_{AVF}) and that part ensuring the flow (CO – Qa) through the vascular system. The data of the 86 AVFs were analyzed by categorizing them into lower and upper arm AVFs.

Figure 2

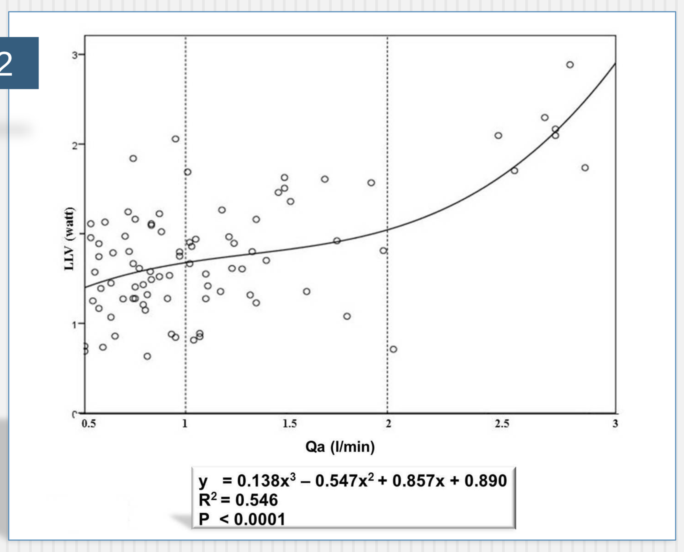


Figure 3

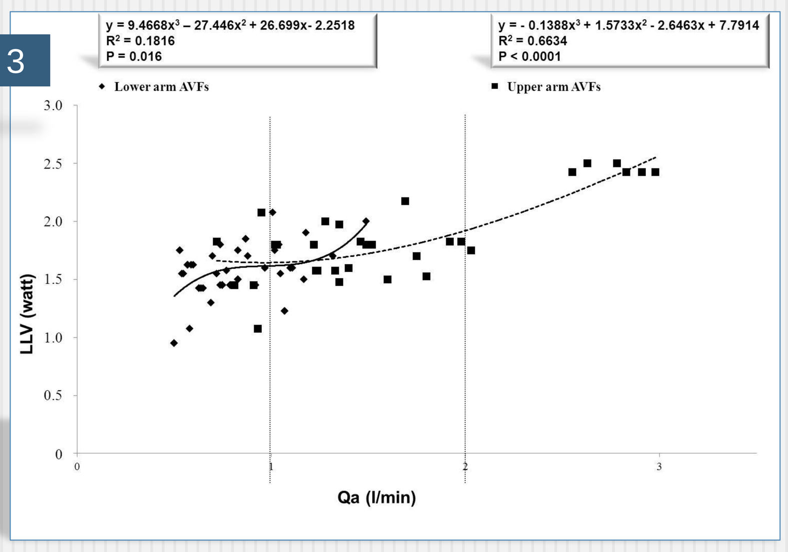
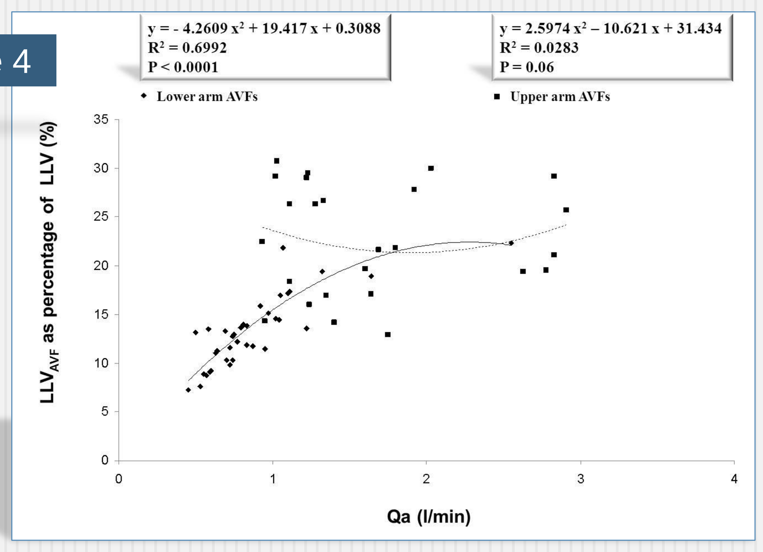


Figure 4



Results

Mean Qa, CO, MAP, TPVR, LLV and LLV_{AVF} of the 86 AVFs were respectively 1.3(0.6 SD) l/min, 6.3(1.3) l/min, 92.7(13.9) mmHg, 14.9(3.9) mmHg·min/l, 1.3(0.6) watt and 19.7(3.1) % of LLV. A statistically significant increase of Qa, CO, LLV and LLV_{AVF} and a statistically significant decrease of TPVR, AR and SVR of upper arm AVFs compared to lower arm AVFs was shown (TABLE). A third-order polynomial regression model best fitted the relationship between Qa and LLV for the entire cohort (R^2 0.546; $p < 0.0001$) (FIGURE 2) and for both lower (R^2 0.181; $p < 0.01$) and upper arm AVFs (R^2 0.663; $p < 0.0001$) (FIGURE 3). LLV_{AVF} calculated as % of LLV rose with increasing Qa according to a quadratic polynomial regression model, but only in lower arm AVFs. On the contrary, no statistically significant relationship was found between the two parameters in upper arm AVFs (FIGURE 4), even if mean LLV_{AVF} was statistically significantly higher in upper arm AVFs ($p < 0.0001$) (TABLE).

Conclusions

Our study describes using real data statistically significant haemodynamic modifications induced by an AVF on the cardiovascular system and shows for the first time that the relationship between Qa and LLV is complex and a third-order polynomial regression model best fits this relationship. Moreover, a quadratic polynomial regression model best fits the relationship between LLV_{AVF} and Qa, but only in lower arm AVFs.

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