Determination of vascular refilling volume in haemodialysis

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During ultrafiltration (UF) inadequate vascular refilling leads to hypovolaemia which can cause intradialytic hypotension. The nature of refilling is poorly understood, and refilling volume is not a measurable parameter, so far. Recently, we developed a simple and easy method to determine absolute blood volume during routine haemodialysis sessions (1). Knowledge of absolute blood volume allows now the calculation of vascular refilling volume.

Method:

Absolute blood volume (aBV) was measured by indicator dilution using a relative blood volume monitor (BVM) incorporated in the dialysis machine (1):

- An on-line infusate bolus was administered immediately after the beginning of the dialysis session before ultrafiltration was started.
- 240 mL of ultra-pure dialysate were infused as post-dilution by the bolus function of a commercial dialysis machine (5008, FMC).
- The resulting increase in relative blood volume (RBVpost-RBVpre) was measured by the BVM.
- Absolute blood volume was calculated as:

$$\text{absolute blood volume (in mL)} = \frac{\text{bolus volume (240 mL) x 100 \%}}{\text{increase in relative blood volume in \%}}$$

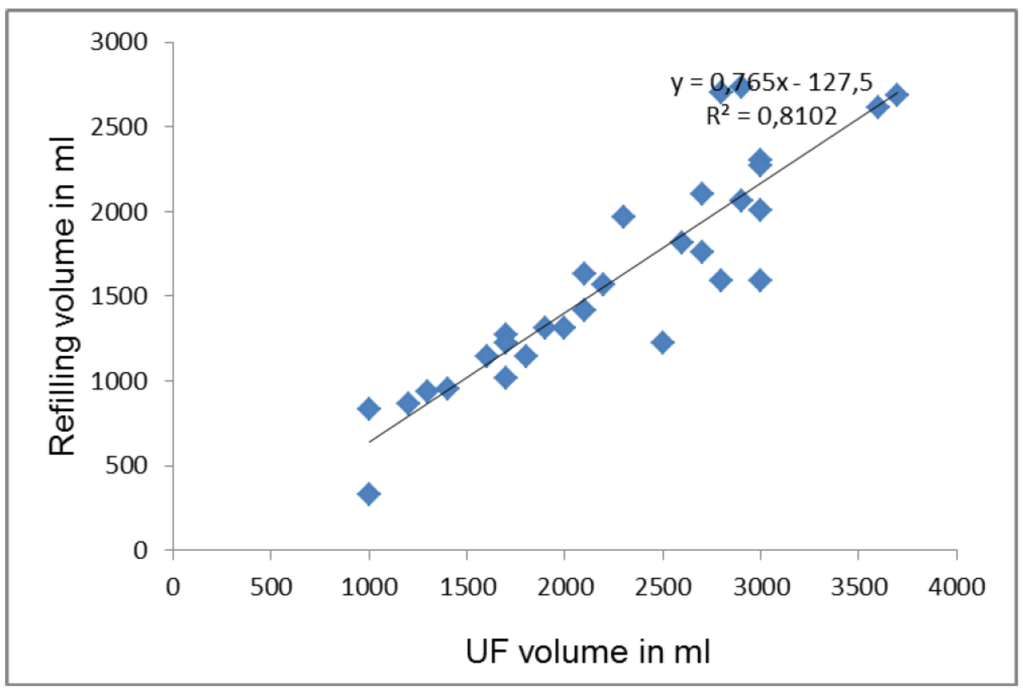
Blood volume at dialysis end is given as:

$$aBV_{end} = aBV_{beginning} \times RBV_{end} \text{ in \%}/100$$

Assuming a steady-state hematocrit distribution model, refilling volume can be calculated as:

$$\text{Refilling volume} = \text{UF volume} - (aBV_{beginning} - aBV_{end})$$

The refilling/UF ratio strongly correlated with the UF volume



Results:

The study was done in **30 stable haemodialysis patients** to determine the absolute blood volume with the described method (1). Before treatment, actual volume overload was estimated by bioimpedance analysis using the body composition monitor (FMC, Bad Homburg, Germany).

Knowledge of absolute blood volume allows now the additional calculation of vascular refilling volume.

Absolute blood volume was

6.50 ± 1.70 L at the beginning and **5.84 ± 1.61 L** at the end of dialysis session.

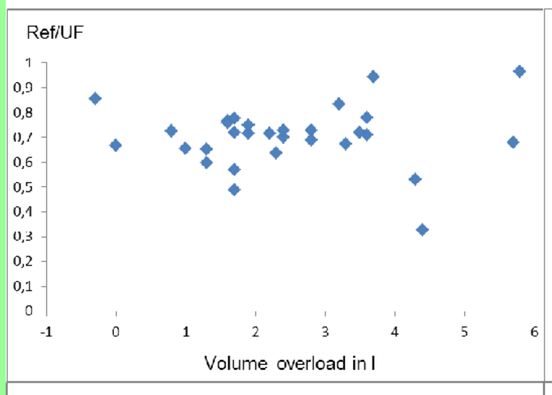
Mean ultrafiltration was **2.27 ± 0.74 L** per dialysis session.

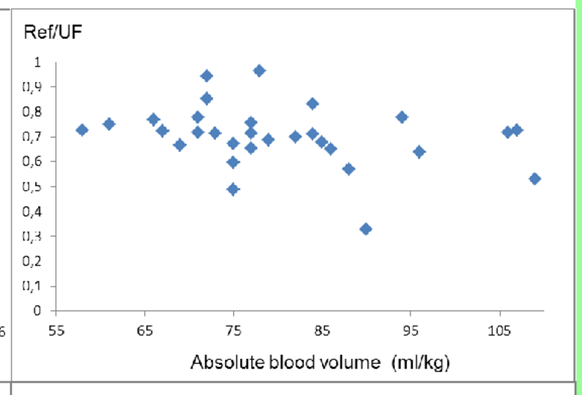
The calculated **refilling volume** amounted to **1.61 ± 0.63 L** .

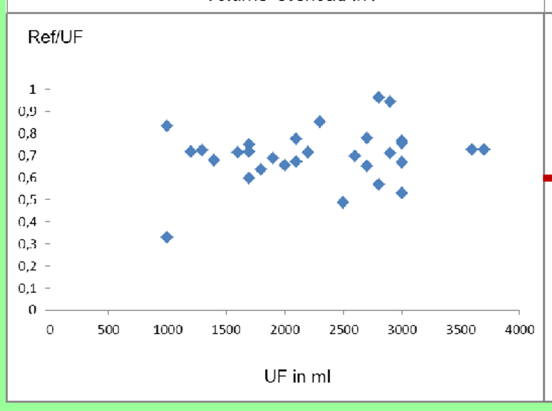
The **refilling/UF ratio** was **70 ± 12 %**

and appeared to be a relatively stable parameter (coefficient of variation 17 %).

There were no correlations with fluid overload measured by bioimpedance, or absolute blood volume (normalized for body mass at dry weight in mL/kg), and nor with the amount of UF volume:







Refilling volume seems to depend only on the UF volume.

Refilling volume amounts about 70 % of UF volume.

IN CONCLUSION, this is the first study which quantifies vascular refilling volume in chronic haemodialysis patients in clinical setting.

The refilling volumes seemed to depend on the UF volume only, and were relatively uniform in stable chronic haemodialysis patients. Our data cannot confirm the previous assumption that the refilling volume depends on fluid overload, possibly because of moderate volume excess in our study population.

The applied method to determine absolute blood volume is a new and promising tool to investigate the vascular refilling process in haemodialysis. Further studies in this matter will contribute to a better understanding of the nature of refilling, and prevent imbalances between ultrafiltration and vascular refilling.

1. Kron J, Schneditz D, Leimbach T, Aign S, Kron S: A simple and feasible method to determine absolute blood volume in hemodialysis patients in clinical practice. Blood Purif 2014; 38: 180-187.

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