Hemorheology in Kidney Transplantation: A role in cardiovascular risk?

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INTRODUCTION

Hemorheology is the study of flow properties of blood and its elements.

Flow properties are among the main determinants of a proper tissue perfusion and their alterations play significant role in disease processes through endothelium damage and subsequent fibrosis with progression to end-organ injury. Hemorheology focuses on the study of **blood viscosity** and **deformability of** its main component, **the erythrocyte**.

Chronic Kidney Disease (CKD) bears an increased incidence of *Cardiovascular (CV) disease*; patients with **end stage renal disease (ESRD)** undergoing dialysis present a CV risk of death 10-20 fold higher than the general population. Traditional risk factors are insufficient to explain the enourmous burden of CV disease in ESRD patients.

Kidney transplantation (KT) represents the therapy of choice for ESRD; it results in a better quality of life, lowers the incidence of CV complications and improves the overall survival when compared to dialysis. Nevertheless, CV risk remains higher when compared to general population, and still represents the first cause of death in this group of patients.

Many alterations in the hemorheologic profile have been described in ESRD patients (rise in whole blood viscosity and plasma viscosity, lower erythrocyte deformability). From literature hemodialysis (HD) and medical therapy supporting CKD do not improve hemorheologic defects.
Even though alterations in KT hemorheologic parameters could theoretically be involved in the microcirculatory system alterations leading to progression of chronic kidney damage, *literature does not support definitive data on the hemorheologic profile of KT recipients.*

OBJECTIVES

Aim of our study is to characterize the **hemorheologic profile of KT recipients**, and to compare these data with our own data in healthy volunteers and patients undergoing HD.

MATHERIALS and METHODS

We considered the **following groups**:
- n. **47** healthy volunteers **(control)**
- n. **90** uremic patients undergoing intermittent **HD**, with data obtained **before** and **after** the dialytic session
- n. **108** kidney transplant recipients (**KT**)

For each group, we evaluated the following hemorheologic parameters *(with measurements involving whole blood corrected for 40% Ht):*

- **Plasma viscosity (ηP)** (shear rate 300 Hz)
- **Whole blood viscosity** measured at **low** (1 Hz) **shear rate: hS1** (simulates behaviour of the blood fluid in big vessels)
- **Whole blood viscosity** measured at **high** (200 Hz) **shear rate: hS200** (simulates behaviour of the blood fluid in small vessels and microcirculation)
- **Erythrocyte aggregation index: EAI** (express the tendency to rouleax formation in the low-flux areas)
- **Flow limit: to** [measured through the Casson regression model] (represents the minimum strenght to be applied to the blood fluid in order to it starting to flow)
- **Erythrocyte deformability (ED)**: evaluated with the **Taylor factor (Tk)**

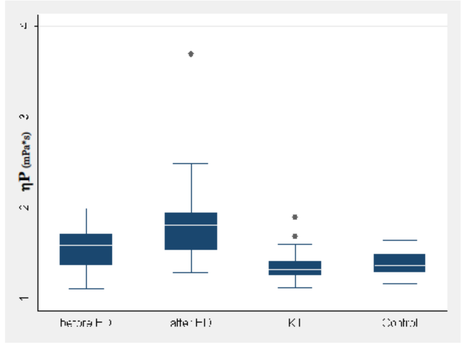
$$1-(hP/hS200)0.4/Ht$$

- **Viscous-elastic behaviour of blood**: using an oscillating scheme we evaluate the fluid response to a determined and increasing strain, through the **G'** parameter (**elastic module**)

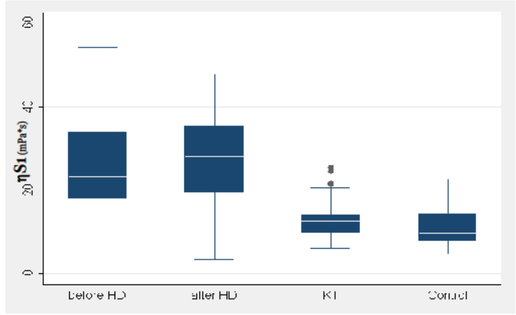
All measurements were performed with the **Haake Rotovisco RV20 Rheometer**, a coaxial cylinder viscosimeter (measurment system CV 100 Couette type, ZB 15 sensor, Haake, Germany), using a sample blood volume of 1600 µl, at 37°C and following recommendation from ICHS (International Comittee for Standardization in Hematology).

Statystical analysis was performed with Stata 11 software, using the Kruskal-Wallis test.

RESULTS

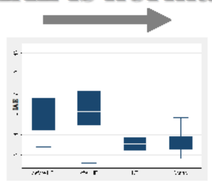


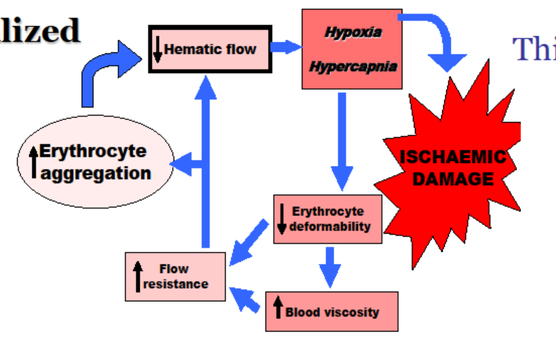
KT lowers hP towards normal levels compared to HD



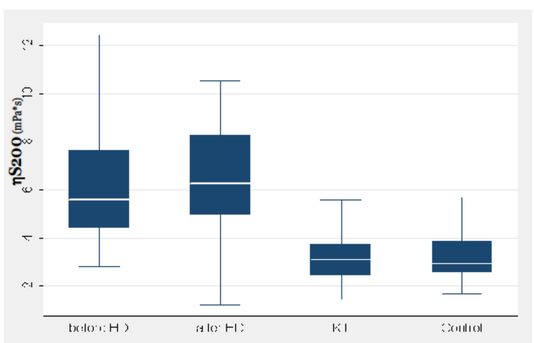
KT normalizes hS1 when compared to HD (before HD vs KT: p<0.0001)

IAE is normalized

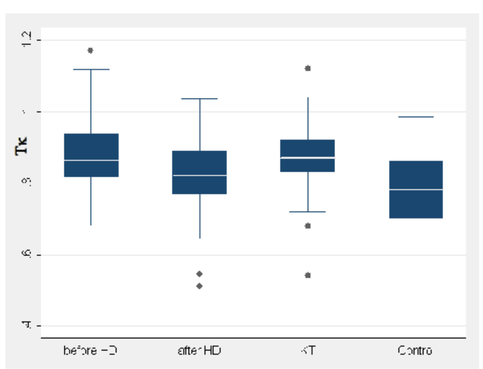




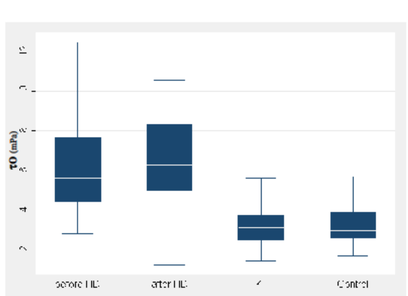
This acts against the **vicious circle** leading to **ischemic damage**



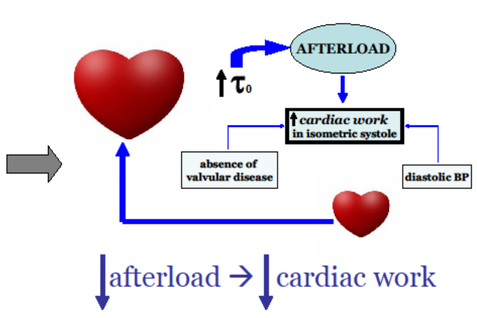
KT normalizes hS200 when compared to HD (before HD vs KT: p<0.0001)



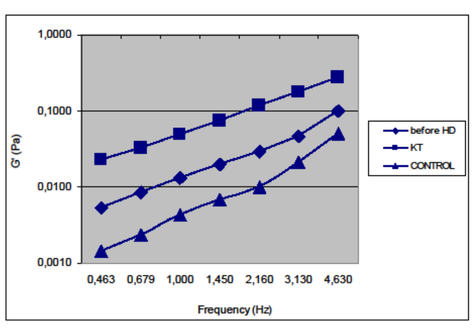
KT have higher Tk than HD and controls pointing to a **lower ED in KT recipients** (control vs KT p<0.0001)



KT normalizes τ0 (before HD vs KT: p<0.0001)



KT patients have higher G' than HD and controls



CONCLUSIONS

HD patients show *various alterations in hemorheologic profile*; this could support the ***extremely high incidence of CV complications*** in this group, involving *large vessels (ηS1), myocardial hypertrophy (τ0), small vessels and microcirculation (ηS200, Tk, EAI).*

KT *improves many of the hemorheologic alterations* found in HD, justifying a global ***reduction in CV risk***.

However **ED is still reduced (higher Tk and G')**. This parameter could act with detrimental injury at the microcirculatory level, damaging the endothelium and leading to a *progression of end-organ damage in KT patients.*

As a fact, the ***incidence of CV disease***, even if lower than in HD patients, ***remains higher in KT*** compared to controls; furthermore, the impaired ED could contribute to the progression of ***Interstitial Fibrosis/Tubular Atrophy (IFTA)***

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