B|BRAUN
SHARING EXPERTISE

Oscillometric assessment of vascular stiffness as a predictor of cardiovascular mortality in patients on maintenance hemodialysis

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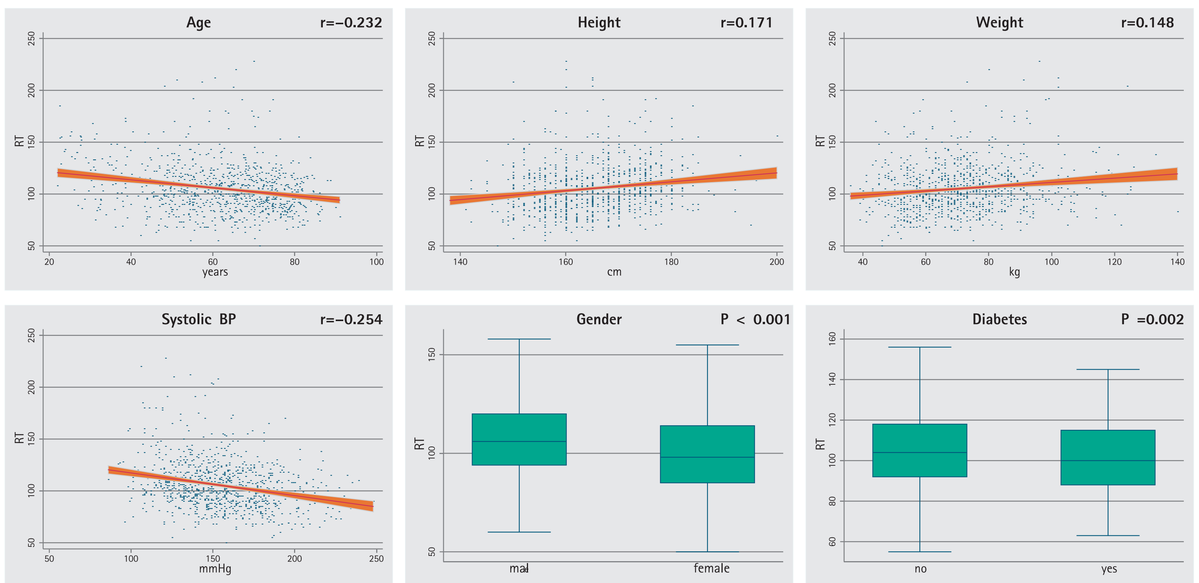
Background and aim

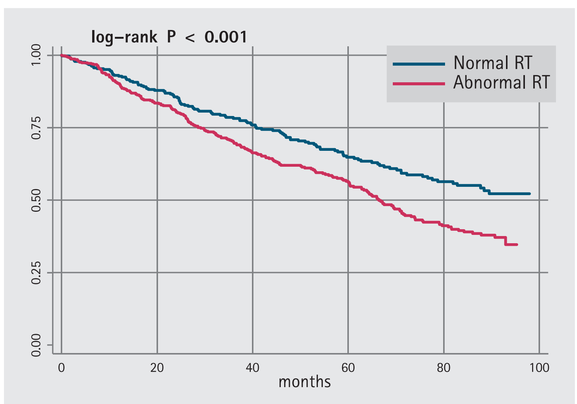
- Arterial stiffness, assessed by pulse wave velocity (PWV) is a strong and independent predictor of cardiovascular (CV) mortality in patients on maintenance hemodialysis.
- The standard method measuring PWV is applanation tonometry; however, this technic is cumbersome and requires well trained personal.
- The Arteriograph is an oscillometric device developed for assessment of vascular stiffness: pulse pressure waves are detected in a simple upper arm cuff during complete occlusion of the brachial artery. Both the primary and the reflective pressure waves are detected, and wave reflection time (RT) is calculated.
- PWV is derived from the estimated aortic length and reflection time. Aortic length is estimated from the jugulum-symphysis distance measured by the operator.
- The aim of this study was to evaluate the predictive value arterial stiffness measured by the oscillometric method on mortality.

	All patients	Alive or non-CV death	CV death	p
N (%)	925	566 (61.2%)	359 (38.8%)	
Male gender (%)	51.7%	53.0%	49.6%	NS
Diabetes (%)	**30.4%**	**25.7%**	**37.9%**	**<0.001**
Age (year)	**61.5 ± 14.4**	**58.6 ± 15.0**	**66.2 ± 12.1**	**<0.001**
BMI (kg/m²)	26.3 ± 5.4	26.3 ± 5.5	26.3 ± 5.1	NS
Ca (mmol/l)	2.30 ± 0.21	2.30 ± 0.20	2.30 ± 0.21	NS
P (mmol/l)	1.53 ± 0.49	1.54 ± 0.48	1.51 ± 0.51	NS
Dialysis vintage (months)	30.3 (iqr 45.3)	30.2 (iqr 47.8)	30.6 (iqr 44.0)	NS
Follow-up time (months)	37.4 (iqr 55.1)	30.2 (iqr 47.8)	30.6 (iqr 44.0)	NS
Systolic BP (mmHg)	154 ± 27	153 ± 27	156 ± 29	NS
Diastolic BP (mmHg)	85 ± 14	85 ± 14	84 ± 15	NS
PWV (m/s)	10.0 ± 2.35	9.93 ± 0.10	10.1 ± 0.12	NS
RT (msec)	105 ± 24	106 ± 22	104 ± 25	NS

Correlates of reflection time



Kaplan–Meier estimates for CV mortality



Determination of RT cut-off pointsbased on body height

Height tertiles	Abnormal RT
< 160 cm	< 102 msec
160 - 170 cm	< 107 msec
> 170 cm	< 112 msec

Reflection time and mortality
Cox regression models

	All-cause motality	CV mortality
Abnormal RT	1.25 (1.05 – 1.48)	1.26 (1.02 – 1.58)
Age (+10 years)	1.42 (1.31 – 1.54)	1.49 (1.35 – 1.67)
Male gender	1.26 (1.05 – 1.52)	1.1 (0.88 – 1.39)

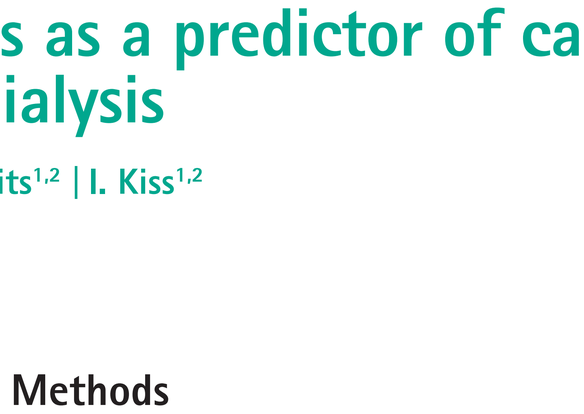
Other variables in the models: dialsis vintage, systolic and diastolic blood pressure

Methods

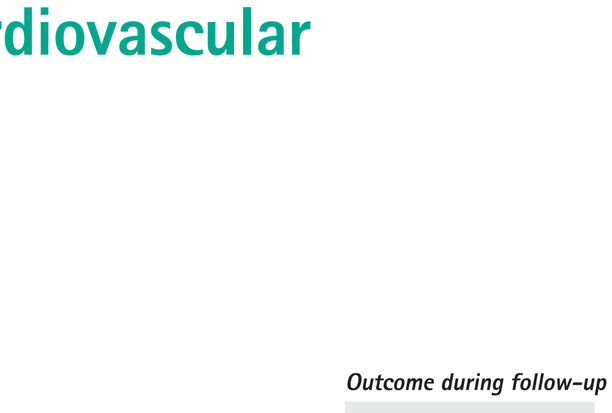
- Prospective cohort study
  - 18 dialysis centers in Hungary
  - patients on hemodialysis (HD) for more than 3 months
  - follow-up: 2005 - 2013
- Assessment of arterial stiffness using the Arteriograph instrument
  - parameters of interest: pulse wave velocity (PWV) and reflection time (RT)
- Demographical and laboratory data: dialysis patient registry
- Outcome: all-cause and cardiovascular mortality
- Statistics
  - data presented as mean ± SD or median (IQR, min-max) as appropriate
  - ROC analysis to determine cut-off values for defining abnormal RT based on body height
  - uni- and multivariate Cox proportional hazard models

Outcome during follow-up

PWV and CV mortality: no association was found



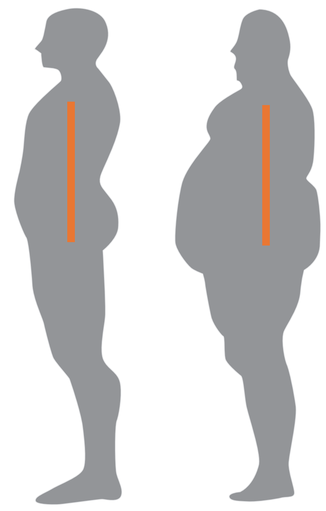
Kaplan–Meier estimates for all–cause mortality



Problems with PWV measurement using the oscillometric technic:

- Imprecise deremination of aortic length due to different body shape (height and weight are independent predictors of jugulum-symphysis distance).
- The anatomic location of the theoretic wave reflection site cannot be determined.

Alternative: reflection time (RT) can be accurately measured.



Correlates of abnormal reflection time

	Normal RT	Abnormal RT	p
N (%)	41%	59%	-
Male gender (%)	52.0	51.4	NS
Diabetes (%)	**25.5**	**33.8**	**0.015**
Age (years)	**58.3 ± 0.8**	**63.7 ± 0.5**	**<0.001**
Dialysis vintage (months)	31.9 (iqr 45.9)	27.9 (iqr 45.9)	0.065
BMI (kg/m²)	26.6 ± 0.3	26.1 ± 0.2	NS
Height (cm)	164 ± 0.5	165 ± 0.4	NS
Systolic BP (mmHg)	**148.5 ± 1.4**	**158 ± 1.2**	**<0.001**
Diastolic BP (mmHg)	**83.1 ± 0.7**	**85.5 ± 0.6**	**0.01**
Ca (mmol/l)	2.31 ± 0.02	2.29 ± 0.01	NS
P (mmol/l)	1.54 ± 0.05	1.52 ± 0.03	NS
Follow-up time (months)	**44.2 (iqr 62.9)**	**33.1 (iqr 51.1)**	**0.012**
All-cause mortality (%)	**55.2**	**69.6**	**<0.001**
CV mortality (%)	**32.4**	**43.1**	**<0.001**

Conclusions

- Oscillometric assessment of vascular stiffness might be able to predict mortality in hemodialysis patients.
- Measurement of reflection time is more reliable than pulse wave velocity using this method.
- Reflection time corrected for body height is an independent predictor of both all-cause and cardiovascular mortality in this population.

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