DOPPLER ULTRASOUND: A POWERFUL TOOL FOR HEMODIALYSIS VASCULAR ACCESS

Maria Guedes Marques [1]; José Ibeas[2]; Carlos Botelho[1]; Joaquim Vallespín[2], Pedro Maia[1]; Pedro Ponce[3]

[1]Nephrocare Coimbra, Centro Acessos Vasculares, Coimbra, Portugal
[2]Hospital de Sabadell, Parc Tauli, Nefrologia, Barcelona, Espanha
[3]Nephrocare Lisboa, Centro Acessos Vasculares, Lisboa, Portugal

INTRODUCTION

- The most common cause of VA failure is thrombosis, due to flow limiting stenosis resulting from neointimal hyperplasia.
- Proper monitoring and surveillance improve overall success of VA care, and access blodd flow (Qa) is one of the most powerful predictors of VA failure.
- NKF-K/DOQI Guidelines:
  - VA should be monitored regularly for stenosis detection, and if detected, it should be treated with elective angioplasty or surgery prior to thrombosis.
  - DU as the preferred method for Qa surveillance (evidence A).
- According to data, DU correlates with other imaging modalities and with Thermodilution (TD) method.

DU limitations:
- operator dependence, expense of equipments, and impossibility to perform during hemodialysis.

TD limitations:
- line insulation changes, room temperature, and higher flows.

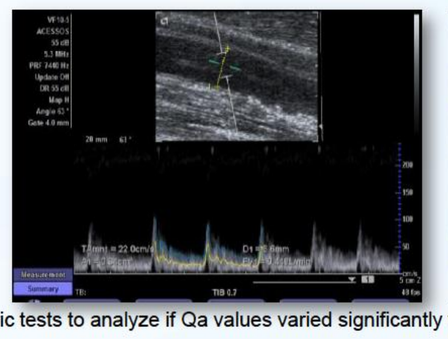
- Because not all access with stenosis are at risk for thrombosis , as well as, some access with high blood flow can suddenly stop, investigation of the more accurate technique of surveillance is essential and will have direct implications for patient care.

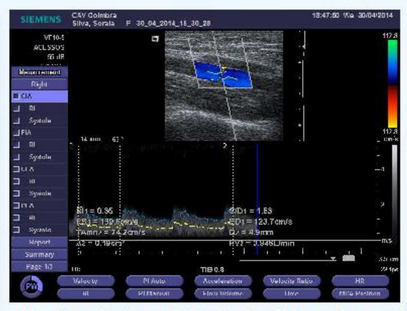
OBJECTIVES

- Evaluate the efficiency of Qa measurement with DU method in comparison to TD and find how VA-related parameters affect Qa values as a way to improve VA patency.

PATIENTS AND METHODS

- Transversal study in 40 patients under regular program of pos-dilutional on-line hemodiafiltration with 5008S Fresenius Medical Care® monitors.
- Patients selection based on different criteria as part of a surveillance program: Qa reduction, difficult puncture, analitical and clinical abnormalities.
- Ultrasonographic evaluation with Siemens Acuson X150 Ultrasound machine :
  - Morphologic
  - Hemodynamic
    - Humeral artery Qa → Qa (ml/min) = TMAV (cm/s) x D (cm) x 60.
- TD-Qa → blood temperature sensor BTM® (Blood Temperature Monitor).
- Demographic variables were recorded.





STATISTICAL ANALYSIS

SPSS 20.0 software for Windows (SPSS, Inc., Chicago, IL). Qas comparison and correlation with paired t-test and Pearson. Non parametric tests to analyze if Qa values varied significantly with other factors. Rejected null hypotheses if p-values < 0.05.

RESULTS

Table 1: Categorical variables

		Frequency (%)
Gender	Masculin	72,5
	Feminin	27,5
First VA status	First VA	67,5
	Not first VA	32,5
Previous interventions	Yes	20,0
	No	80,0
DU request motive	Qa reduction	22,5
	Difficult puncture	27,5
	Lab and/or pressure alterations	7,5
	Surveillance	32,5
	Clinical alterations	10,0
Type of VA	Radiocephalic AVF	32,5
	Humerocephalic AVF	40,0
	Humerobasilic AVF	10,0
	Humerobasilic AVG	7,5
	Proximal radiocephalic AVF	7,5
	Humerocommunicant AVF	2,5
Anastomosis	No alterations	92,5
	Hemodynamic meaning stenosis	5,0
	No hemodynamic meaning stenosis	2,5
Artery	No alterations	92,5
	Hemodynamic meaning stenosis	7,5
	No hemodynamic meaning stenosis	0,0
Vein	No alterations	30,0
	Hemodynamic meaning stenosis	37,5
	No hemodynamic meaning stenosis	22,5
	Central vein stenosis	10,0
Stenosis	No stenosis	20,0
	Hemodynamic meaning stenosis	55,0
	No hemodynamic meaning stenosis	25,0
Stenosis location	Anastomosis	6,3
	Artery	6,3
	Vein	81,3
	> one location	6,3
Prothesis	No PTFE	92,5
	No alterations	5,0
	Hemodynamic meaning stenosis	2,5
	No hemodynamic meaning stenosis	0,0
Nº stenosis	0	20,0
	1	65,0
	2	10,0
	3	5,0

Table 2: Continuous variables

	Mean	Median	Std. Dev.	Min	Max
Age (years)	64,50	65,00	13,68	32,00	84,00
Time of dialysis (months)	51,35	33,00	47,30	0,00	155,00
Time of vascular access (months)	47,60	34,00	42,11	2,00	154,00
Thermodilution Qa (ml/min)	1012,00	885,00	492,97	270,00	2000,00
Doppler Qa (ml/min)	1032,55	997,00	468,75	297,00	2230,00
Average venous pressure (mmHg)	208,50	200,00	31,64	139,00	272,00
Average arterial pressure (mmHg)	-182,20	-189,50	31,53	-226,00	-98,00
Recirculation (%)	11,65	11,00	3,12	6,00	20,00

Table 3: Comparation and correlation of TD and DU methods

	Mean	Median	Std. Dev.	Min	Max		Mean	P-value	Pearson	P-value
TD-Qa (ml/min)	1012	885	493	270	2000	Paired T Test	-20,5	,624	0,851	,000
DU-Qa (ml/min)	1033	997	469	297	2230					

Table 4: Kruskal Wallis and Mann-Whitney Test

	P-value	
	TD Qa (ml/min)	DU Qa (ml/min)
DU request motive	0,076	0,006
First VA	0,036	0,199
VA type	0,079	0,021
Time of VA (threshold 48 months)	0,112	0,061
Previous endovascular procedure	0,509	0,478
Venous pressure (threshold 200 mmHg)	0,203	0,155
Arterial pressure (threshold -185 mmHg)	0,028	0,015
Recirculation (threshold 10%)	0,145	0,266
Anastomosis characteristics	0,103	0,076
Artery characteristics	0,538	0,048
Vein characteristics	0,208	0,844
Presence of stenosis	0,039	0,038
Stenosis location	0,087	0,031
Stenosis hemodynamic meaning	0,290	0,935
Number of stenosis	0,012	0,034

DISCUSSION

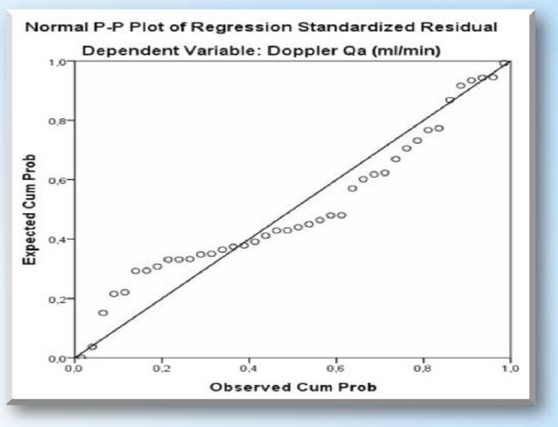
- DU-Qa varied significantly:
  - motive for request,
  - ↓ distal VA,
  - ↓ artery stenosis,
  - stenosis presence, number and location.

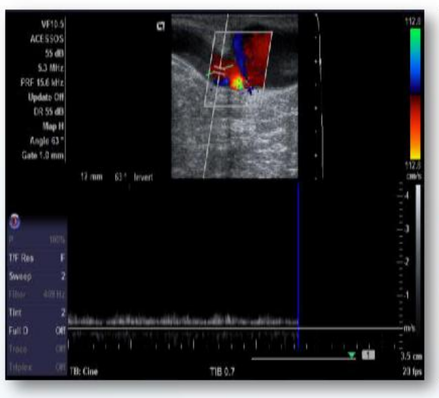
DU-Qa (NOT significant):
- ↓ venous stenosis with hemodynamic significance.

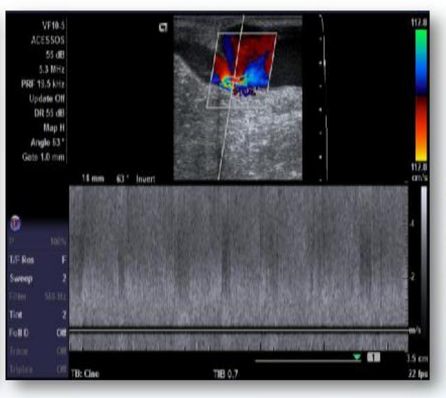
- TD-Qa varied significantly.
  - ↑ first VA,
  - ↓ stenosis presence and number

Both methods varied significantly:
- ↓ with IA arterial pressure <-185 mmHg.

- **Both** methods (NOT significant):
  - ↓ stenosis (any) with hemodynamic significance.







CONCLUSION

- ✓ The goal of this program is early detection of VA dysfunction and pre-emptive correction by angioradiologic or vascular surgical techniques without placement of a central venous catheter.
- ✓ TD represented a good indirect method of DU-Qa measurement but their relative accuracy vary differently with several factors.
- ✓ Regular VA monitoring by DU provides a sensitive, non invasive tool, because it provides evaluation of both morphologic and hemodynamic characteristics, anticipating thrombosis. Is also useful in the evaluation of other anatomical VA abnormalities.
- ✓ Ultrasound evaluation allows a better and easy approach by the interventional nephrologist. It also minimizes unnecessary exams because not all dysfunctional VA have stenosis and need an angioplasty, as well as, it allows early intervention in VA with silent abnormalities that may suddenly cause failure.

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Maria Guedes Marques
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