

CONTROVERSES ET ACTUALITÉS EN CHIRURGIE VASCULAIRE
CONTROVERSIES & UPDATES IN VASCULAR SURGERY

JANUARY 19-21 2017

MARRIOTT RIVE GAUCHE & CONFERENCE CENTER

PARIS, FRANCE



Digital Pressure Measurements for HAIDI

G.FRANCO

CLINIQUE ARAGO

PARIS





Disclosure

Speaker name: Gilbert FRANCO

.....

- ☐ I have the following potential conflicts of interest to report:
- ☐ Consulting
- ☐ Employment in industry
- ☐ Shareholder in a healthcare company
- ☐ Owner of a healthcare company
- ☐ Other(s)
- ☒ I do not have any potential conflict of interest



HEMODYNAMIC EFFECT OF AVF

Vascular access leads to significant hemodynamic changes

Low-resistance short circuit through the shunt



Absolute blood flow is increased



BUT DRIVE

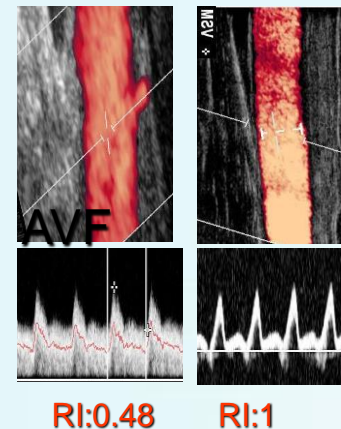
To a net reduction of blood flow to the fingers

WITH

10 to 20% of ISCHEMIC STEAL

AND

4% NEEDS REINTERVENTION



HEMODIALYSIS ACCESS-INDUCED DISTAL ISCHEMIA (HAIDI) DISTAL HYPOPERFUSION ISCHEMIC SYNDROME(DHIS) ARTERIOVENOUS ACCESS ISCHEMIC STEAL(AVAIS)

EBPG on Vascular Access(2007)

Guideline 9.1. Access-induced ischaemia should be detected by clinical investigation and the cause should be identified by both non-invasive imaging methods and angiography (Evidence level III).

Guideline 9.2. Enhancement of arterial inflow, access flow reduction and/or distal revascularization procedures are the therapeutic options. When the above methods fail, access ligation should be considered (Evidence level II).

Diagnosis is sometimes difficult :

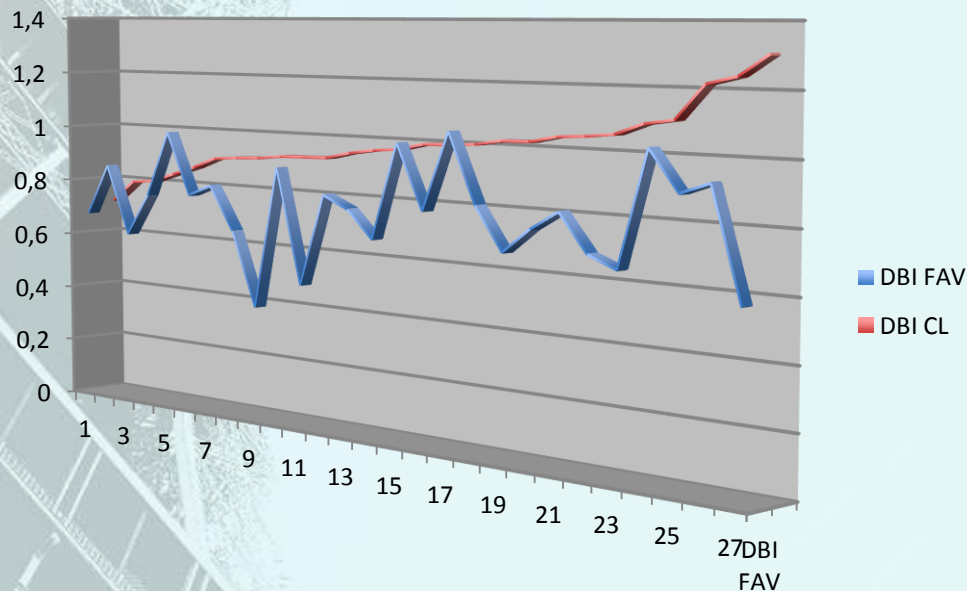
Neurologic disease may closely simulate vascular disease and they could co-exist

**Positive diagnosis
Choice of treatment**

Should be based on functional and anatomic evaluation



HEMODYNAMIC PERTURBATIONS AFTER AVF PLACEMENT



**AVF RESULTS IN A MEAN :
PRESSURE DROP of 30 mm Hg
DBI DROP of 15%**

	AVF	OPPOSITE
P DIGIT (mm Hg)	99	128
DBI	0.77	0.89



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HEMODIALYSIS ACCESS-INDUCED DISTAL ISCHEMIA (HAIDI)

Combination of the three mechanisms can lead to peripheral ischemia

Retrograde flow +/-High flow
Inflow stenotic lesions
Distal arteriopathy



DIGITAL PRESSURE DROP

*Konner K. Kidney Int 2002
Wixon CLJ Am Coll Surg (2000)
Sivanesan S.Nephrol Dial Transplant (1998)
Berman SS.J Vasc Surg 1997
Haimov M. Blood Purif (1996)
Schanzer HJ. Vasc Surg 1992*



DIGITAL PRESSURE MEASUREMENT

COMPLETE AND FOLLOWS DUPLEX_SCAN

- ISCHEMIC RISK MANAGEMENT PRIOR TO AVF CREATION
- POSITIVE and DIFFERENTIAL DIAGNOSIS of HAIDI
- TEST THERAPEUTIC OPTIONS
- CONTROL OF EFFICIENCY

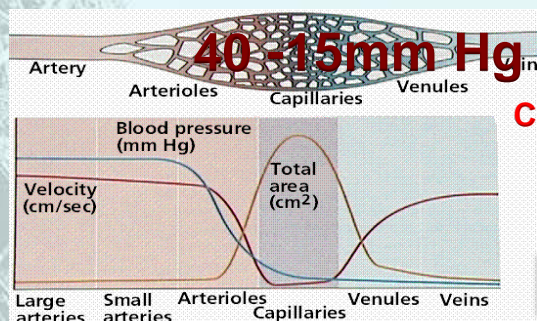
EBPG on Vascular Access
Guideline 9.1.

Access-induced ischaemia should be detected by clinical investigation and the cause should be identified by both non-invasive imaging methods and angiography .*Nephrol. Dial. Transplant.* (2007)



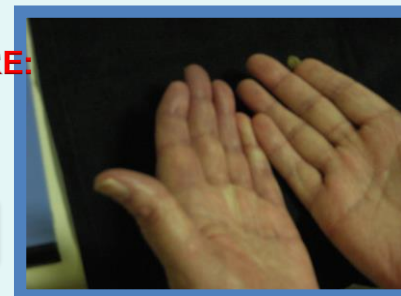
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THRESHOLDS

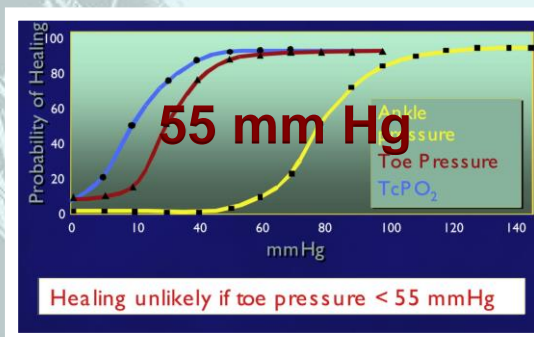
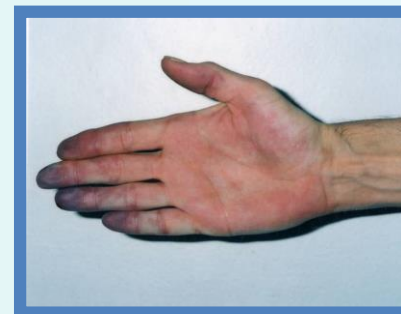


**CRITICAL CLOSING PRESSURE:
VARIABLE WITH TONUS
40-15 mmHg**

HYPOXIA UNDER THIS THRESHOLD



CRITICAL ISCHEMIA



CONDITION OF HEALING

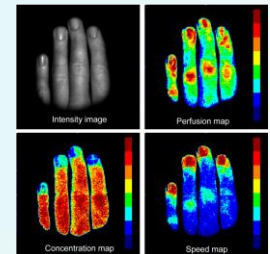
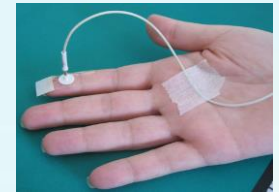




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NON INVASIVES TOOLS

- **Plethysmography/Photoplethysmography**
- **Nailfold Capillaroscopy**
- **Laser Doppler blood perfusion imagers**
- **Laser Doppler measurements**
- **Oxymetry:tcpo2 /sao2**
- **Thermography**



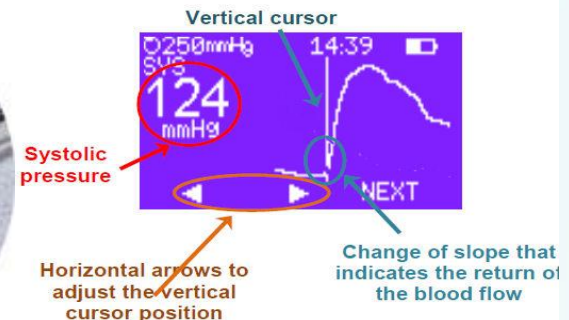
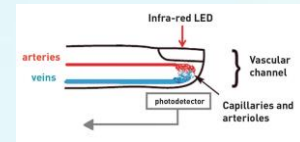
Perfusion
/concentration/ speed
signals





PHOTOPLETHYSMOGRAPHY (PPG) OPERATING METHOD

- Light from LED is directed towards the skin where it is absorbed and scattered in tissues
- Detect blood volume changes in the microvascular bed
- Photosensor is placed on the distal pad of the finger detects the backscattered light
- Occlusion cuff inflated automatically is wrapped on the proximal part of the finger
- Deflated slowly at a controlled rate.
- During deflation, resumption of blood flow downstream from the cuff is detected by the PPG sensor





PRESSURE MEASUREMENTS PRIOR VASCULAR ACCESS CONSTRUCTION

- (BDP) :BASAL DIGITAL PRESSURE: SEVERITY OF PERFUSION DEFICIT
- (DBI) :DIGITAL BRACHIAL INDEX: $< 0,7$

SENSITIVITY 90/100% TO POSTIVE DIAGNOSIS OF PAOD



- ALLEN'S TEST WITH US AND DIGITAL PRESSURE MESUREMENT
IN CASE OF AVF AT WRIST

COMPRESSION TEST

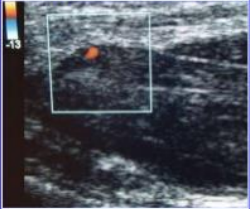

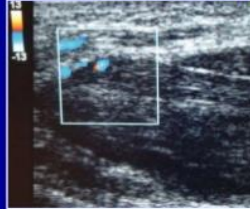
PRIOR AVF CREATION or DRAL

ALLEN'S TEST WITH US AND DIGITAL PRESSURE MEASUREMENT



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Color Doppler of palmar artery	Occlusion of radial artery while imaging arch	Reversed flow Flow via ulnar artery
		

US may improve accuracy of Allen's test
First reported in 1973

Mozersky DJ et al. Am J Surg. 1973 ; 126 : 810 – 812.
Levitov A et. Critical care ultrasonography. McGraw-Hill Medical, NY, USA, 2009.

RA Compression



PATENCY of UA and PALMAR ARCH

ULNAR ARTERY IS THE KEY STONE OF HAI



PREDICTION OF HAIDI

MUST BE FOCUSED ON PREDICTION OF STAGE 3 AND 4



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Do preoperative finger pressures predict early arterial steal in hemodialysis access patients? A prospective analysis

R. James Valentine, MD, Charles W. Bouch, MD, Daniel J. Scott, MD, Shujun Li, MD, Mark R. Jackson, MD, J. Gregory Modrall, MD, and G. Patrick Clagett, MD, Dallas, Tex

Background: Hand ischemia resulting from arterial steal is a serious complication in patients undergoing hemodialysis access, but specific risk factors for steal remain in dispute. The purpose of this study was to determine whether plethysmographically derived finger pressures (FPs) or digital-brachial indices (DBIs) are predictive of symptomatic arterial steal.

Methods: We prospectively studied 72 patients (37 men, 35 women; mean age, 57 ± 10 years) who were undergoing brachial artery-based hemodialysis access. All patients had complete pre- and postoperative hand examinations and FP determinations. Surgeons were blinded to preoperative FP results.

Results: Prosthetic graft was used in 60 patients (6-mm polytetrafluoroethylene [PTFE] in 50, tapered PTFE in 10), and brachial-based arteriovenous fistulas were created in 12. Fourteen (19%) patients developed arterial steal symptoms. The mean preoperative FP was significantly lower in steal patients than in those without steal (131 ± 27 vs 151 ± 31 mm Hg, $P < .03$). Nine (64%) of the patients with steal had DBIs < 1.0 , compared to 18 (31%) of the patients without steal ($P = .02$). However, there was no absolute FP or DBI threshold below which steal was inevitable. The occurrence of steal was attributed to proximal arterial stenoses in seven, to distal arterial disease in five, and was unknown in two. When comparing the 14 patients who developed steal to the 58 who did not, we noted that a higher proportion of steal patients had coronary artery disease (57% vs 17%, $P = .005$). Steal was more likely to develop in patients with arteriovenous fistulas than in patients with prosthetic grafts (43% vs 14%, $P = .009$). There were no significant differences in demographic factors, atherosclerotic risks (diabetes, smoking, hypertension, dyslipidemia), prevalence of peripheral vascular disease, cerebrovascular disease, shunt location, tapered vs straight graft, or number of prior grafts placed.

Conclusions: These data indicate that preoperative DBI is lower in patients who develop steal syndrome after hemodialysis access. Patients with preoperative DBI < 1 are likely to develop steal, but there is no DBI threshold below which steal is inevitable. Steal is more likely to develop in patients undergoing brachial-based arteriovenous fistulas than in those receiving prosthetic grafts. (J Vasc Surg 2002;36:351-6.)

DBI < 1



[Vasc Endovascular Surg.](#) 2003 May-Jun;37(3):179-84.

Prediction of arteriovenous access steal syndrome utilizing digital pressure measurements

[Papasavas PK¹](#), [Reifsnnyder T](#), [Birdas TJ](#), [Caushaj PF](#), [Leers S](#).

Abstract

Steal syndrome is a well-known complication of arteriovenous (AV) access placement. To assess the derangement in hemodynamics of the upper extremity after AV access creation, brachial and digital pressures were performed before and after operation. Thirty-five patients (ages 20-88 years) with end-stage renal disease requiring new upper extremity hemodialysis AV access were prospectively evaluated. Values were obtained preoperatively, on the day of surgery, and 1 month postoperatively. Follow-up at 1 year was obtained on all patients. Of the 35 patients, 19 (54%) were diabetic and 9 (26%) had had a prior AV access. The AV accesses created included the following: autogenous brachial-cephalic (n = 14, 40%), autogenous radial-cephalic (n = 10, 29%), brachial-basilic transposition (n = 5, 14%), prosthetic brachial-antecubital forearm loop (n = 3, 9%), autogenous brachial-axillary saphenous vein translocation (n = 2, 6%), and 1 (3%) prosthetic brachial-axillary. After AV access creation the digital brachial index (DBI) dropped in 28 (80%) of the 35 patients. Six patients (17%) developed a symptomatic steal, 3 of which (9%) eventually required revision. In those patients without ischemic steal symptoms (n = 29) the mean DBI decreased from 0.9 to 0.7 (p < 0.01) immediately and decreased no further at 1 month. For those with a symptomatic steal the DBI decreased from 0.8 to 0.4 (p < 0.01) immediately and decreased no further at 1 month. Utilizing a DBI less than 0.6, the sensitivity was 100%, the specificity 76%, the positive predictive value 46%, and the negative predictive value 100%. Hemodynamic steal after AV access creation is very common, with symptomatic steal occurring nearly a fifth of the time. Utilizing digital pressure measurements, a DBI < 0.6 obtained on the day of surgery can reasonably predict which patients are at risk for the development of a symptomatic steal.

DBI < 0.6



[Ann Vasc Surg. 2000](#)

Steal syndrome complicating hemodialysis access procedures: can it be predicted?

[Goff CD¹](#), [Sato DT](#), [Bloch PH](#), [DeMasi RJ](#), [Gregory RT](#), [Gayle RG](#), [Parent FN](#), [Meier GH](#), [Wheeler JR](#).

Abstract

The development of steal syndrome distal to an arteriovenous fistula (AVF) created for hemodialysis access remains a significant clinical problem. This study was undertaken to determine the role of intraoperative noninvasive testing in the prediction and management of steal syndrome following arteriovenous fistula creation. First, in order to determine a threshold digital/brachial index (DBI) for patients at risk for steal syndrome, we performed a retrospective review of patients who had DBI measured and who developed symptoms (steal syndrome) following AVF creation. This was followed by a prospective evaluation of the ability of the DBI to predict which patients undergoing AVF surgery would develop steal syndrome. A DBI of <0.6 identifies a patient at risk for steal syndrome. Intraoperative DBI cannot be used to predict which patient will develop steal syndrome; however, if revision is indicated, the DBI should be increased to >0.6 . Failure to accomplish this puts the patient at risk for continued steal syndrome.

DBI $<0,6$



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European Journal of Vascular and Endovascular Surgery

Volume 32, Issue 3, September 2006, Pages 309–315



Educational Article

Strategies for Predicting and Treating Access Induced Ischemic Steal Syndrome

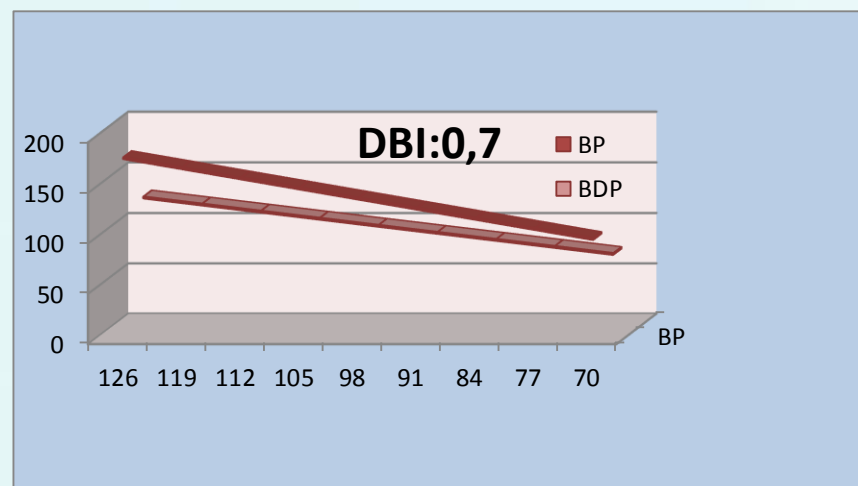
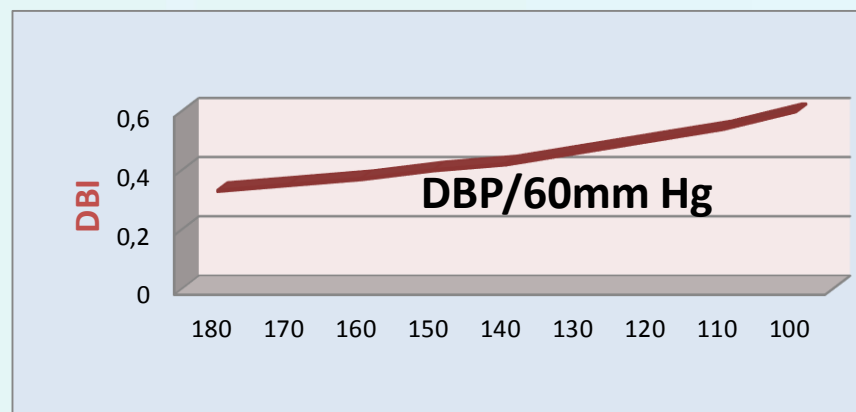
G.S. Tynan-Cuisinier², S.S. Berman^{1, 2},  . 

Access induced ischemia is an uncommon but devastating complication for patients maintained on hemodialysis. A number of clinical risk factors have been identified to select patients at risk. Intraoperative measurement of the digital–brachial index may further distinguish at-risk patients when the **DBI<0,45**. Once clinically significant steal has developed, surgical strategies to treat this problem should ideally reverse the ischemia while maintaining uninterrupted access for hemodialysis. To date, the distal revascularization–interval ligation or DRIL procedure has been the most consistently successful tactic in achieving these dual objectives. A number of alternative strategies have recently been proposed and will be discussed.



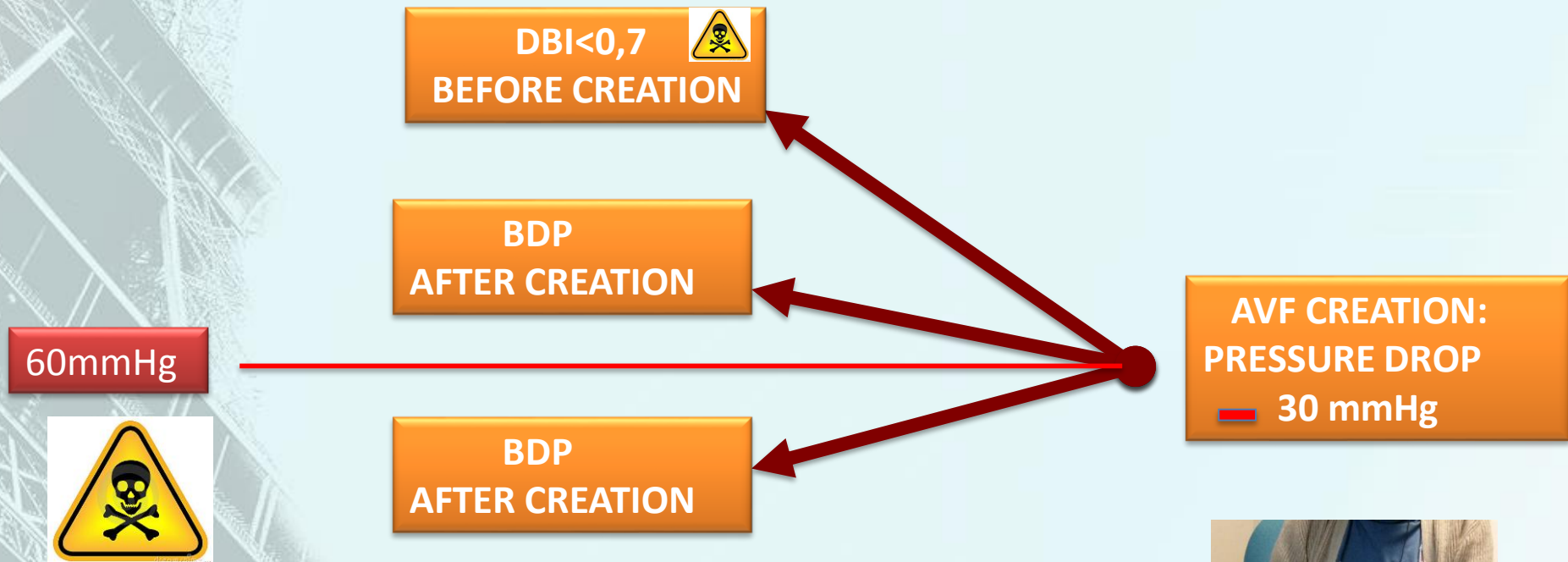
CORRELATION BDP/DBI/BP

BLOOD PRESSURE mm Hg	BDP mm Hg	DBI	BDP mm Hg	DBI
180	60	0,33	126	0.7
170	60	0,35	119	0.7
160	60	0,37	112	0.7
150	60	0,4	105	0.7
140	60	0,42	98	0.7
130	60	0,46	91	0.7
120	60	0,5	84	0.7
110	60	0,54	77	0.7
100	60	0,6	70	0.7





PREDICTION and PREVENTION OF HAIDI PRIOR CREATION



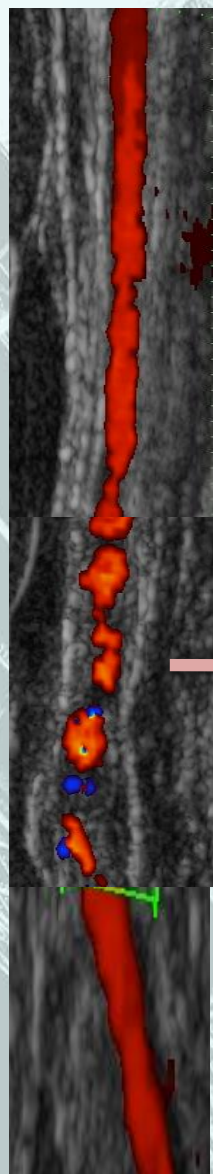
PATIENT SAFETY SHOULD BE A MAJOR CONCERN TO AVOID THIS DISASTER



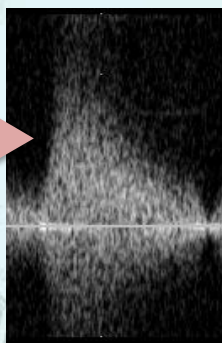


ISCHEMIC RISK and STRATEGY PRIOR TO CREATION

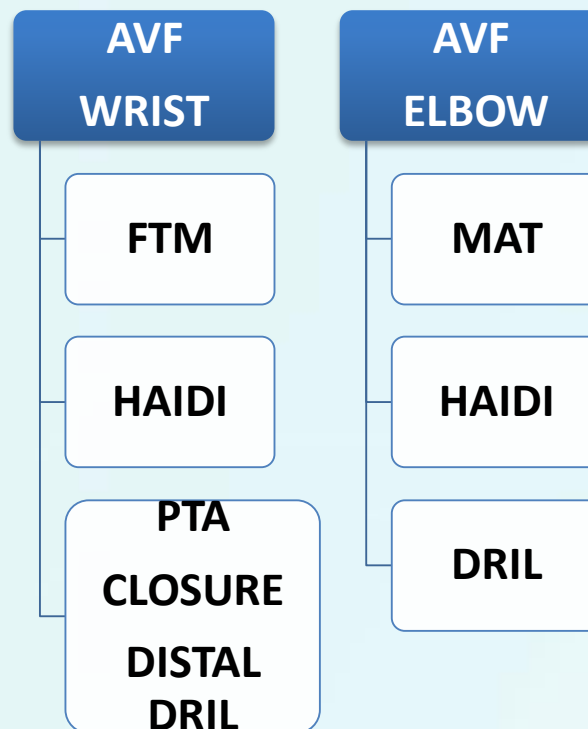
FOREARM ARTERY STENOSIS and /or OCCLUSION



DISTAL RA STENOSIS
UA :OCCLUSION



LOW DIGITAL PRESSURE





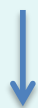
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DIGITAL PRESSURE AFTER VASCULAR ACCESS CREATION

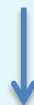


PRESSURE MEASUREMENTS

- (BDP) :BASAL DIGITAL PRESSURE
- (DBI) :DIGITAL BRACHIAL INDEX
- (CDP) :CHANGE IN DIGITAL PRESSURE UNDER COMPRESSION:WITNESS OF IMPORTANCE OF STEAL



WITH ACCESS COMPRESSION



**WITH DISTAL RADIAL COMPRESSION (fav at wrist)
STOREY?**



DIGITAL PRESSURE AFTER CREATION

AUTHORS	BDP mm Hg				DBI				CDP mmHg			
	<i>S</i>	<i>p</i>	<i>AS</i>	<i>p</i>	<i>S</i>	<i>p</i>	<i>AS</i>	<i>p</i>	<i>S</i>	<i>p</i>	<i>AS</i>	<i>p</i>
Papasavas PK 2003					0,4	0,01	0,7	0,01				
Schanzer A 2006	30	0,01	102	0,01	0,3	0,001	0,8	0,001	85	0,001	40	0,001
Vaes RH 2013	22 +/-10	0,1	102 +/-10	0,1	0,18 +/-0,8	0,1	0,7 +/-0,08	0,1	46	0,3	26	0,3
Modaghegh MH 2014	61 +/-26	0,01	114 +/-38	0,01	0,44 +/-0,16	0,01	0,82 +/-0,19	0,01	57 +/-24	0,01	19 +/-17	0,01
Journet J 2012			99 +/-32				0,72 +/-23					



POSITIVE DIAGNOSIS OF HAIDI

	ACCUR	SENS	SPEC
BDP <60mm Hg	92%	100%	76%
DBI<0,6	92%	100%	87%
DBI<0,4	94%	92%	94%

BP	DBI:0,6 BDP	DBI:0,4 BDP
180	106	72
170	102	68
160	96	64
150	90	60
140	84	56
130	78	52
120	72	48
110	66	44
100	60	40
90	54	36

Odland MD .Surgery 1991

Lazarides MK .J Am Coll Surg 1998

Papasavas PK Vasc Endo Surg 2003

Schanzer A. Vasc Med 2006

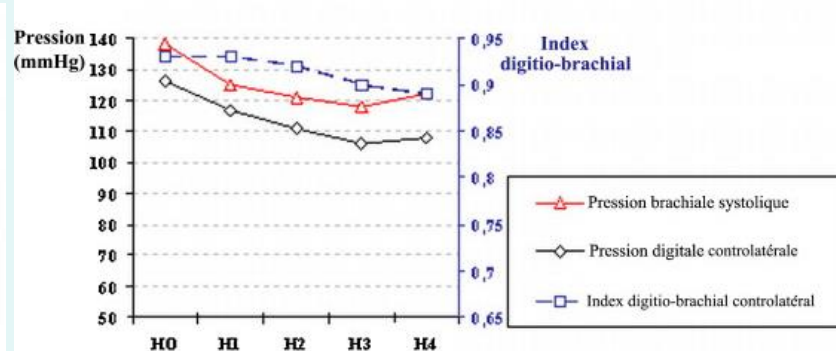
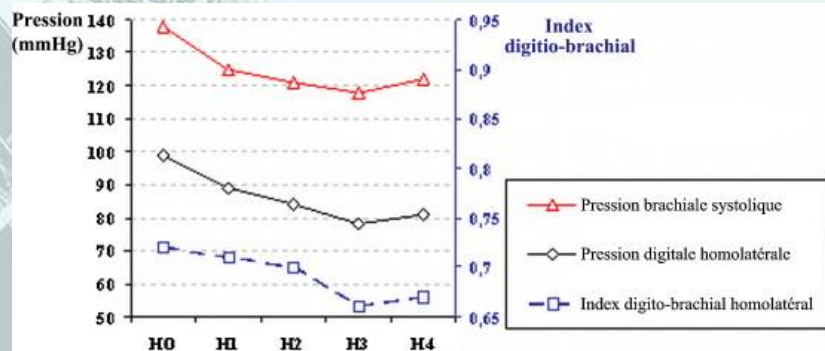
Goff CD .Ann Vasc Surg 2000

Vaes RH JVS 2013

Modaghegh MH. JVS 2014



DIGITAL PRESSURE DURING DIALYSIS SESSION



Digital pressures, systemic blood pressure and digital brachial index recorded before and during the dialysis (mean ± standard deviation) (n = 49).

		H0	H1	H2	H3	H4
Pression digitale (mmHg)	HomoDP	99 ± 32	89 ± 36	84 ± 32	78 ± 31	81 ± 30
	ControDP	126 ± 28	117 ± 27	111 ± 27	106 ± 26	108 ± 25
	HomoDP vs ControDP	p < 0,001	p < 0,001	p < 0,001	p < 0,001	p < 0,001
Pression systolique brachiale (mmHg)		138 ± 25	125 ± 23	121 ± 21	118 ± 21	122 ± 18
Index de pression digito-brachial	HomoDBI	0,72 ± 0,23	0,71 ± 0,26	0,70 ± 0,25	0,66 ± 0,23	0,67 ± 0,23
	ControDBI	0,93 ± 0,19	0,93 ± 0,15	0,92 ± 0,16	0,90 ± 0,17	0,89 ± 0,17
	HomoDBI vs ControDBI	p < 0,001	p < 0,001	p < 0,001	p < 0,001	p < 0,001

BDP significantly decreased on both sides during dialysis

Brachial pressure decrease was correlated with the decrease of digital pressure **IN BOTH HANDS**

BDP was less than 30 mm Hg in six patients (12%) without ischemia (silent ischemia related to neuropathy?)

VanHoek F, Nephrology (Carlton) 2010
Journet J, J Mal Vasc 2012



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DIFFERENTIAL DIAGNOSIS OF ISCHEMIC PAIN

REST PAIN



BDP:83 mm Hg
BDI:0,7



NON ISCHEMIC PAIN





PRESSURE MEASUREMENTS with COMPRESSION and CHOICE of TREATMENT

CHANGE IN DIGITAL PRESSURE (CDP): WITH ACCESS COMPRESSION

- WITNESS OF THE RELATIVE IMPORTANCE OF STEAL COMPARED WITH ARTERIAL LESIONS
- IF BDP INCREASES ABOVE ISCHEMIC THRESHOLD UNDER ACCES COMPRESSION

INTERVENTION TARGETTING STEAL IS INDICATED :FLOW REDUCTION (If High Flow)
DRIL /PAVA/PAI

➤ CHANGE IN DIGITAL PRESSURE (CDP): WITH DISTAL RADIAL COMPRESSION

- IF BDP INCREASES ABOVE ISCHEMIC THRESHOLD UNDER DISTAL RADIAL COMPRESSION

INTERVENTION TARGETTING STEAL IS INDICATED:DRAL

- FOR THOSE PATIENTS WHO DO NOT MEET THESE THRESHOLDS
SURGICAL INTERVENTION AIMED AT REVERSING THE STEAL IS NOT THE APPROPRIATE TREATMENT



CONCLUSION

- Digital pressure measurement despite some limitation and scepticism is helpful
- Complete physical examination
- Complete Duplex-scan
- Providing objective data
- Help management of HAIDI
- Why is it underused?
- What hematologist will be satisfied with the white of the eye and give up blood tests ?



However
Randomized trials on HAIDI are still lacking and should be designed



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