

INTERVENTISTICA NEFROLOGICA

Color Doppler Ultrasonography (CDU) follow up e CDU PTA degli accessi vascolari: 21 anni di esperienza

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GUIDELINE 4. DETECTION OF ACCESS DYSFUNCTION: MONITORING, SURVEILLANCE, AND DIAGNOSTIC TESTING

Prospective surveillance of fistulae and grafts for hemodynamically significant stenosis, when combined with correction of the anatomic stenosis, may improve patency rates and may decrease the incidence of thrombosis.

4.2 Surveillance of grafts:

Techniques, not mutually exclusive, that may be used in surveillance for stenosis in grafts include:

4.2.1 Preferred: 4.2.1.3 Duplex ultrasound. (A)

K-DOQI guidelines n.6

Trattamento delle complicanze della FAV

Indicazioni per una PTA

FAV con stenosi maggiore del 50% nel tratto venoso o arterioso, associata alle seguenti alterazioni:

- ✓ riduzione del flusso
- ✓ aumento delle pressioni statiche
- ✓ ricircolo
- ✓ alterazioni all'esame fisico

La stenosi, così come i parametri indicativi di stenosi, dopo la manovra dovrebbe tornare nei limiti accettabili

K-DOQI guidelines n.6

Trattamento delle complicanze della protesi

Le stenosi associate ad una protesi dovrebbero essere trattate con angioplastica o revisione chirurgica se la stenosi causa una riduzione del lume del vaso superiore al 50% associata alle seguenti alterazioni:

- ✓ alterazioni all'esame fisico
- ✓ riduzione della portata (< 600 ml/min)
- ✓ aumento della pressione statica all'interno della protesi

Risultati post-trattamento

Angioplastica

- ✓ stenosi residua inferiore al 30% con ritorno dei parametri nei limiti di norma
- ✓ sopravvivenza primaria del 50% a 6 mesi

Revisione chirurgica

- ✓ ritorno dei parametri nei limiti di norma
- ✓ sopravvivenza primaria del 50% a 6 mesi

DOOPS

	Pz prevalenti Europa	Pz prevalenti USA
Cateteri centrali	18	25
Protesi vascolari	8	18
Fav vasi nativi	74	57

VA Procedure Rates Are Much Higher for Grafts versus Fistulae

Type of Procedure	# Procedures/100 pyrs		Adjusted Relative Proc. Rate (G/F)
	Graft	Fistula	
Angiogram	7	6	1.25
Angioplasty alone	8	4	1.86†
Thrombectomy, clot lysis or revision	59	17	3.84‡
Any VA procedure	74	28	2.99‡

†p<0.05; ‡p<0.0001; * per 100 patient years; G=graft, F=fistula; adjusted for age, gender, diabetes, peripheral vascular disease, and facility clustering effects.

Nefrologia interventistica

Per la loro formazione, la loro esperienza, la loro visione unica sulle problematiche inerenti la malattia renale e le varie metodiche sostitutive recenti dati hanno sottolineato come i nefrologi devono assumere un ruolo centrale nei vari aspetti procedurali degli accessi vascolari, essendo in grado di do so with effectiveness, efficiency and safety (Arif Asif J Nephrology 2007)

Effettuare il monitoraggio in realtà significa che accettiamo l'ipotesi che: “ la stenosi causa disfunzione emodinamica nella protesi e che questa disfunzione in realtà precede e accuratamente predice la trombosi “

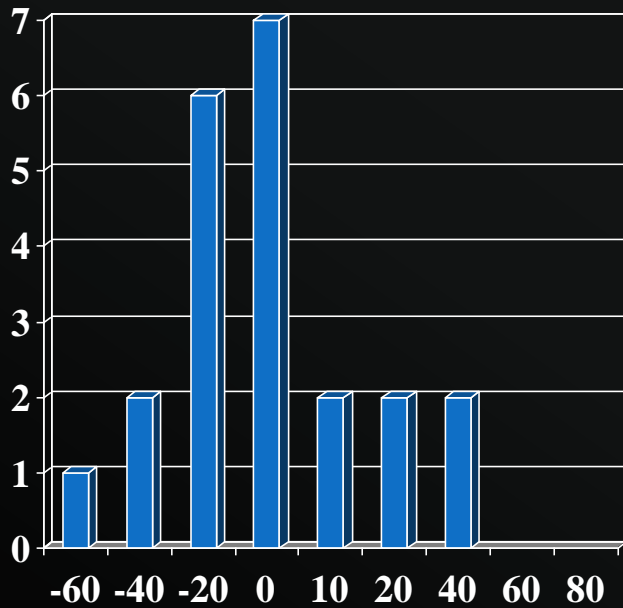
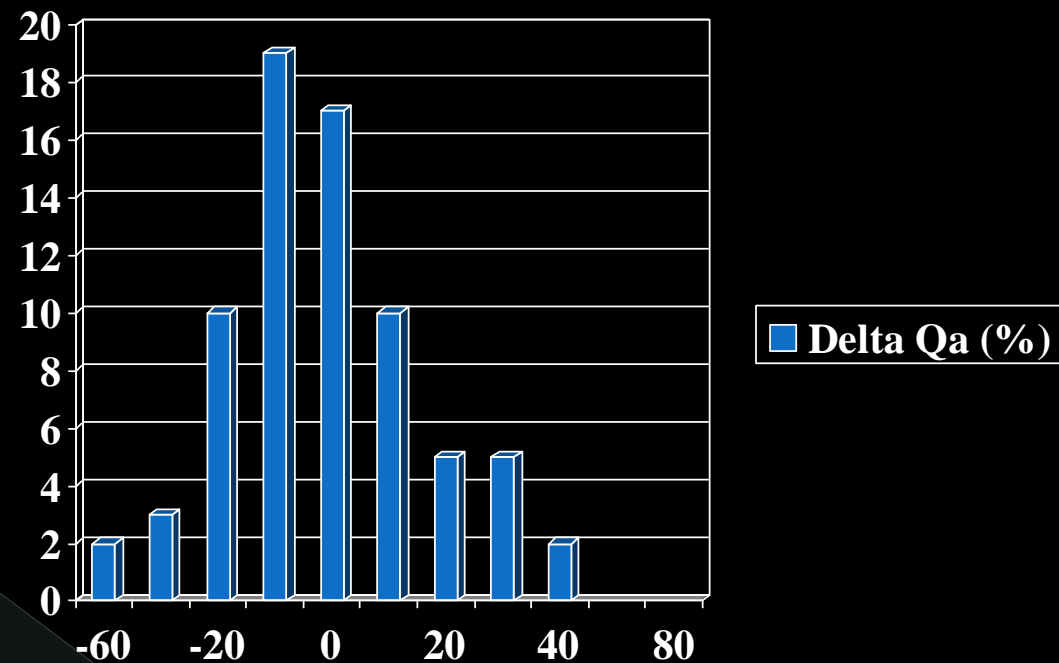
- ❖ la misura del Qa è riproducibile dialisi dopo dialisi, così la stenosi può essere accuratamente scoperta
- ❖ la stenosi progredisce lentamente così si riesce a evidenziare una discesa del Qa e intervenire prima che la trombosi subentri
- ❖ nessun altro fattore se non la stenosi influenza la comparsa di trombosi
- ❖ le protesi che trombizzano evidenziano un Qa in discesa (alta sensibilità), quelle che non trombizzano non evidenziano Qa in discesa (bassa incidenza di falsi positivi)

- ❖ la misura del Qa è riproducibile dialisi dopo dialisi, così la stenosi può essere accuratamente scoperta

Rehman et al **Ultrasound dilution**

Am J Kidney Disease 1999 34:471-477

60 min intervallo



180 min intervallo

Schneditz et al **Thermal dilution**

NDT 1998 13:739-744

Ha la misurazione del Qa una elevata sensibilità e un basso indice di falsi positivi ?

Il Qa non predice accuratamente la trombosi [Paulson WD Am J Kidney Dis 2000;35:1089-1095](#)

La misurazione mensile del Qa ha una sensibilità del 59 % con una incidenza di falsi positivi del 23 % [Paulson WD Blood Purif 2005; 23: 50-56](#)

MAP - CVP

$$Q_a = \frac{\text{MAP} - \text{CVP}}{R_{art} + R_{aa} + R_{graft} + R_{va} + R_{sten} + R_{vena}}$$

Smooth muscle tone of inflow and outflow, transition between laminar and turbulent flow (change Q_a by 16-19%)

- ❖ la stenosi progredisce lentamente così si riesce a evidenziare una discesa del Qa e intervenire prima che la trombosi subentri

Atray NK et al: A longitudinal study of hemodialysis graft stenosis: Role of progressive stenosis in thrombosis (Abstract) J Am Soc Nephrol 2001;12:281A

Si evidenziava come le protesi che rimanevano pervie per i primi 90 giorni avevano una lenta progressione (1% mese), mentre quelle che trombizzavano avevano una elevata progressione (26% mese)

La stenosi gioca un ruolo importante nella genesi della trombosi ma altri fattori sono altrettanto importanti

♣ elevati volumi di UF o la stessa dialisi inducono e ipotensione e quindi trombosi Paulson WD et al Am J kidney Dis 2002;40:769-776

♣ stati di ipercoagulabilità O'Shea SI et al J Vasc Surg 2003; 38:541548

♣ l'ipertrofia intimale ha una superficie trombogenica che può promuovere la trombosi

Ram SJ, Work J, Eason JM, Caldito GC, Pervez A, Paulson WD: A prospective randomized controlled trial of blood flow and stenosis surveillance of hemodialysis grafts *Kidney Int* 2003;64:272-280

I pazienti furono randomizzati in tre gruppi:

- Flow monitoring group** (PTA based to $Q_a < 600/\text{min}$)
- Stenosis monitoring group** (PTA based to stenosis $> 50\%$ by duplex ultrasound)
- Control group** (PTA based to clinical suspicion suggested significant stenosis)

The graft survival was similar in all 3 group

The percentage of grafts that thrombosed was lowest in stenosis monitoring group

Per tutti questi motivi l'ipotesi di disfunzione della protesi causata dalle stenosi non è sempre valida

Recenti studi evidenziano come la diagnosi precoce e l'intervento successivo con l'angioplastica non sono in grado di modificare la “**life expectancy**” dell'accesso

DISCUSSION

◎ William Paulson :

“.....measurement of function is really just a surrogate for measurement of stenosis. If stenosis is important in thrombosis, then it is better to directly measure stenosis. Future studies should further evaluate the benefits of stenosis monitoring.

◎ Anatole Besarab :

“...stenotic lesions should not be repaired merely because they are present” and “... if such correction is performed , it is important to demonstrate a functional improvement with a successful PTA”

Paulson WD. Access monitoring does not really improve outcomes. Blood Purif (2005) 23:50-56

Besarab A. Access Monitoring is worthwhile and valuable. Blood Purif (2006) 24:77-89.

Accessi vascolari “ tallone d'achille” del trattamento emodialitico

Il punto è il protocollo di sorveglianza in grado di monitorare lo sviluppo di stenosi e quindi determinare la necessità di intervenire con l'angioplastica. Studi randomizzati e controllati dimostrano che la sorveglianza aiuta a scoprire le stenosi ma non riduce l'incidenza di trombosi e la perdita dell'accesso.

study	Predict stenosis	Reduce thrombosis	Prolong access surv.
Lumsden	yes	no	nr
Sands	yes	yes	nr
Ram	yes	no	no
Moist	yes	no	no
Dember	yes	no	no
Malik	yes	nr	yes
Robbin	yes	no	no

Accessi vascolari “ tallone d’achille” del trattamento emodialitico

Al contrario studi osservazionali mostrano come la preventiva angioplastica della stenosi si accompagni a prolungamento della sopravvivenza degli accessi vascolari. (*Lilly RZ et al Am J Kidney Dis 2000, Maya ID et al Am J Kidney Dis 2004, Shwab SJ et al Kidney Int 1989*).

Results

Reference	Type of protocol	patients		PTA/year/pts		Thrombosis/year/pts	
		control	surveillance	control	surveillance	control	surveillance
Lumsden	Doppler us	32	32	0	1,5	0,47	0,51
Ram	Qa	34	32	0,22	0,34	0,68	0,91
	Doppler us		35		0,65		0,51
Moist	Qa	53	59	0,61	0,93	0,41	0,51
Dember	PVS	32	32	0,04	2,1	1,03	0,89
Malik	Doppler us	92	97	na	na	na	na
Robbin	Doppler us	61	65	0,64	1,06	0,78	0,67
Bacchini	Qa		25		1,25		0,58
Bacchini	CDU-PTA		96		0,13		0,35

Lumsden AB et Al. Prophylatic balloon angioplasty fails to prolong the patency of expanded polytetrafluoroethylene arteriovenous grafts: results of a prospective randomized study. *J Vasc Surg* (1997) 26:382–92. Ram JS et Al. A randomized controlled trial of blood flow and stenosis surveillance of hemodialysis grafts. *Kidney Int* (2003) 64:272–280. Moist LM et Al. Regular monitoring of access flow compared with monitoring of venous pressure fails to improve graft survival. *J Am Soc Nephrol* (14: 2645 – 2653, 2003 Dember LM et Al. Randomized controlled trial of prophylatic repair of hemodialysis arteriovenous graft stenosis. *Kidney Int* (2004) 66:390–398. Robbin ML et Al. Randomized comparison of ultrasound surveillance and clinical monitoring on arteriovenous grft outcomes. *Kidney Int* (2006) 69:730–735 Malik J et Al. Regular ultrasonographic screening significantly prolongs patency of PTFE grafts. *Kidney Int* (2005) 67:1554–1558.

MONITORING/SURVEILLANCE: WHY DO YOU USE CDU?

- High Degree of sensitivity and specificity of Doppler ultrasonography to detect stenosis Tordoir JHM, et al. *J Vasc Surg* 10:122-128,1989
- CDU is a simple, non invasive, inexpensive, and accurate method for the evaluation of the vascular access function.
- With CDU you can perform a morphologic and hemodynamic study. During the color doppler ultrasonography evaluation, we detected the peak of systolic velocity (PSV) at artery anastomosis, medium graft and venous anastomosis, and in case of **stenosis** before and in correspondence of it, we also measured the **blood flow** always in the same point for each graft

Cost of PTA with Doppler Ultrasonography and Angiography approaches

	Doppler ult.	Angiography
Equipment	1300	1300
Contrast agent	0	105
Medical doctor	75	75
Technician	0	20
Nurse	20	20
Maintenance	0.35	33
Amortization	0.94	44.5
Total	1396.3 EURO	1597.5 EURO

Methods

from 01/01/02 to 31/12/09 we evaluated 96 patients:

- **115 grafts** (PTFE® grafts, mesenteric bovine vein grafts, polycarbonate)
- **1720 CDU control, 408 CDU-PTA**, 147 thrombectomy (74 CDU mechanical thrombolysis).

CDU FOLLOW UP

Duplex ultrasonography

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graph TD; A[Duplex ultrasonography] --> B[Evidence of stenosis (morphological and haemodynamical point of view PSV ratio)]; A --> C[No stenosis]; B --> D[Duplex ultrasonography PTA or/and stenting]; C --> E[Monitoring Grafts (CDU every one or two months)];
```

Evidence of stenosis
(morphological and
haemodynamical point of view
PSV ratio

Duplex ultrasonography PTA
or/and stenting

No stenosis

Monitoring Grafts
(CDU every one
or two months)

Methods

We calculated:

- **Thrombosis rate (per graft year)**
- **CDU-PTA rate (per graft year)**
- **Primary patency (PP):** PP was defined as the time between the construction of a vascular access and its first failure.
- **Secondary patency (SP):** SP was defined as the time between the construction of a vascular access and its ultimate failure, including all interventions

Secondary patency

Cox analysis

% survival

100

80

60

40

20

0

0

6

12

18

24

30

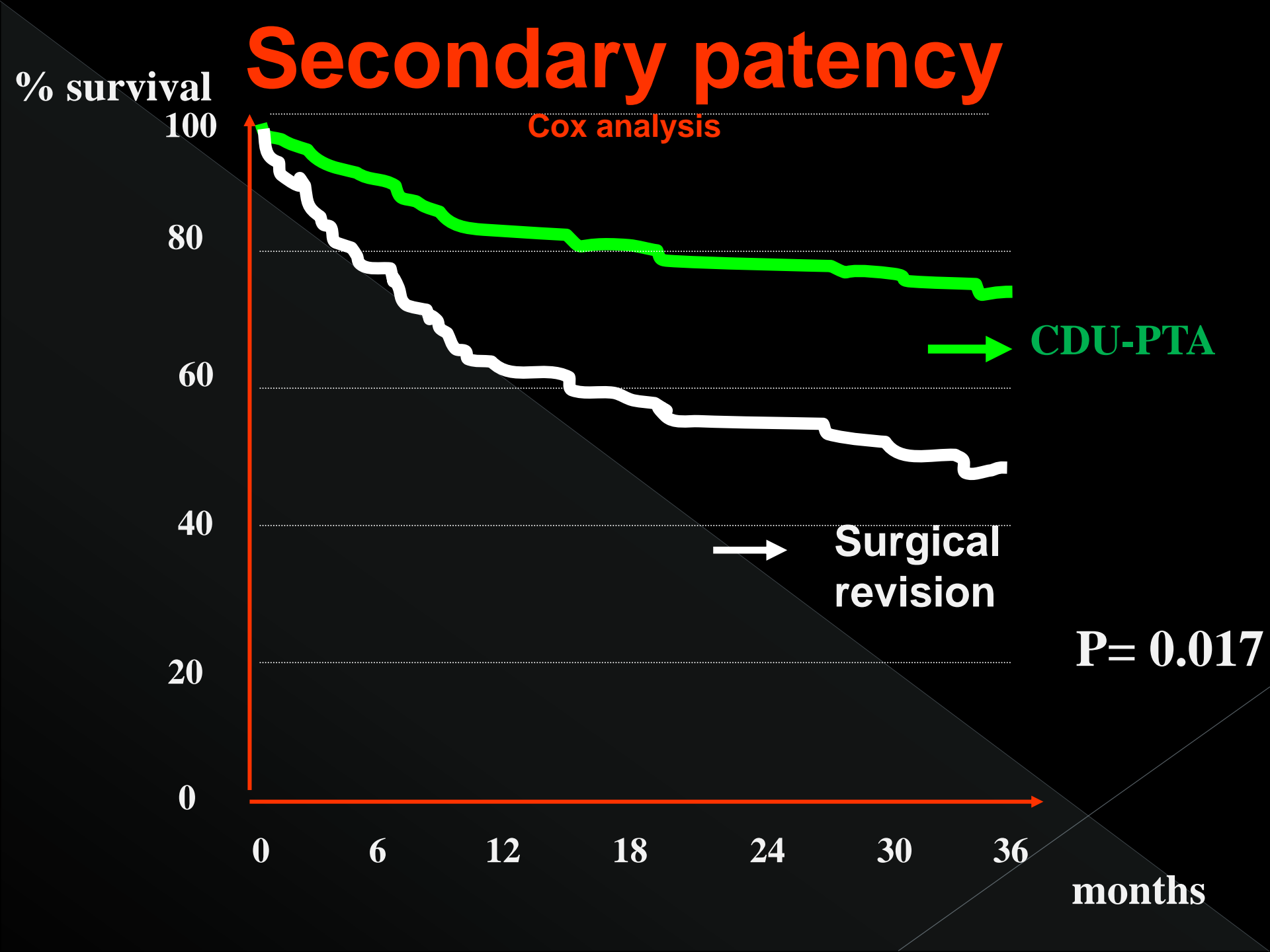
36

months

→ CDU-PTA

→ Surgical revision

P= 0.017

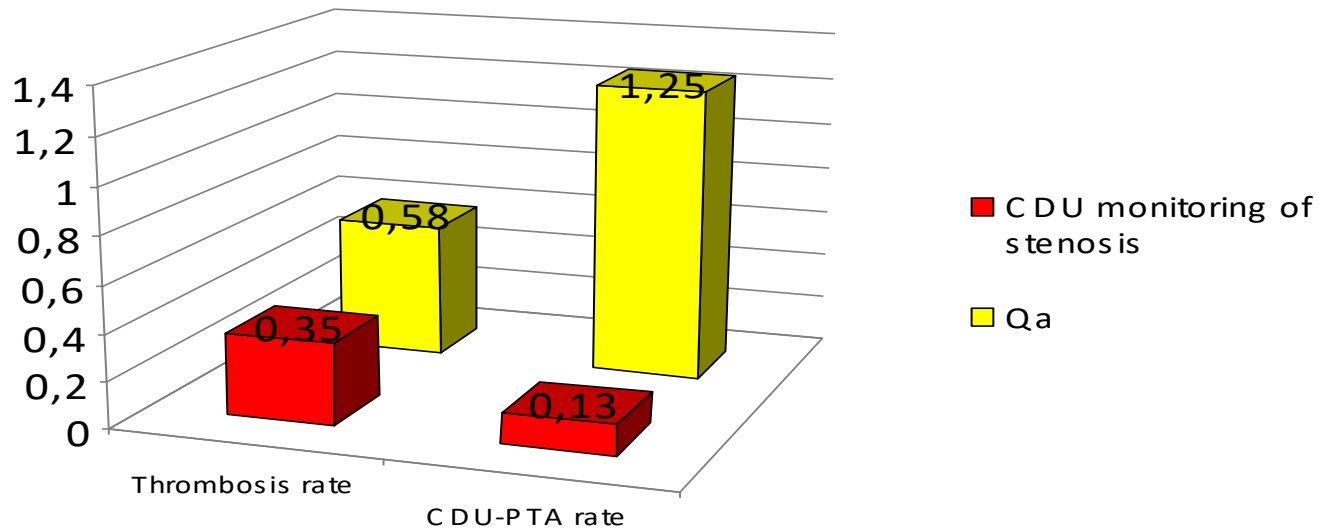


	PSV artery	PSV medium Graft	PSV _{vein}	I.R.	Access flow (ml/min)
Flow study	238.35±90	93 ± 51	215.4 ± 121	0.3 ± 0.3	1008 ± 340*
CDU study					942.38±187*

* P= 0.2

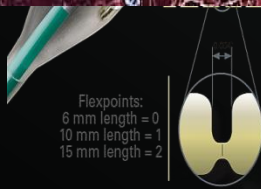
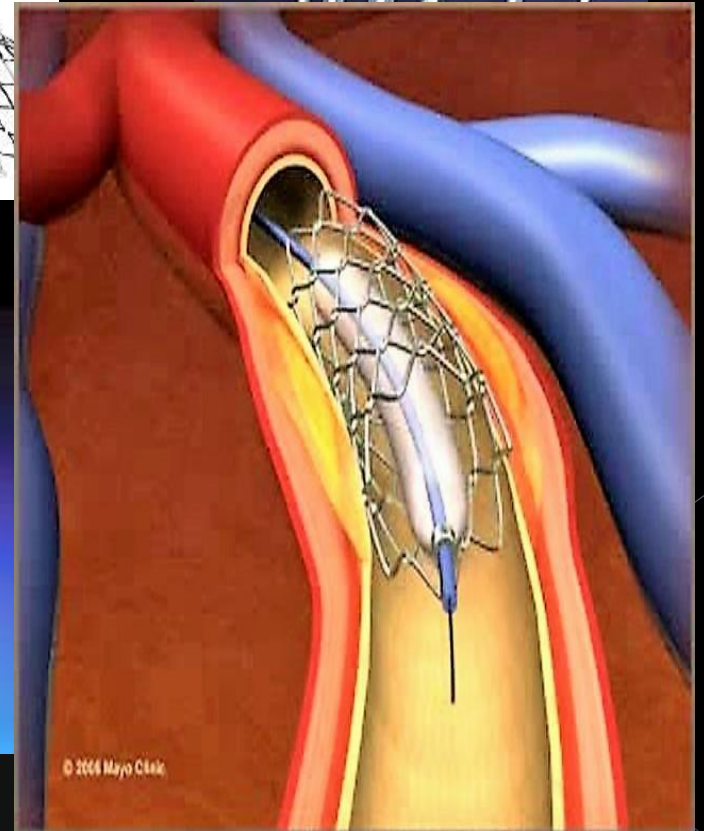
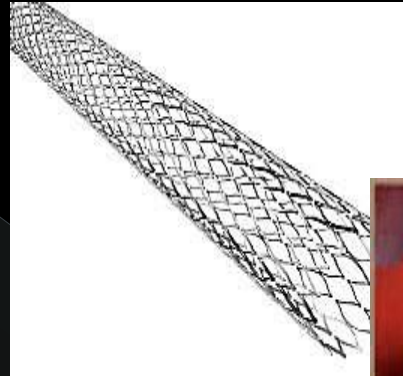
RESULTS

THROMBOSIS RATE AND CDU-PTA RATE (PER GRAFT /YEAR)



	Qa	CDU-PTA monitoring of stenosis
Thrombosis rate	0,58	0,35
CDU-PTA rate	1,25	0,13

MATERIALI E DEVICE



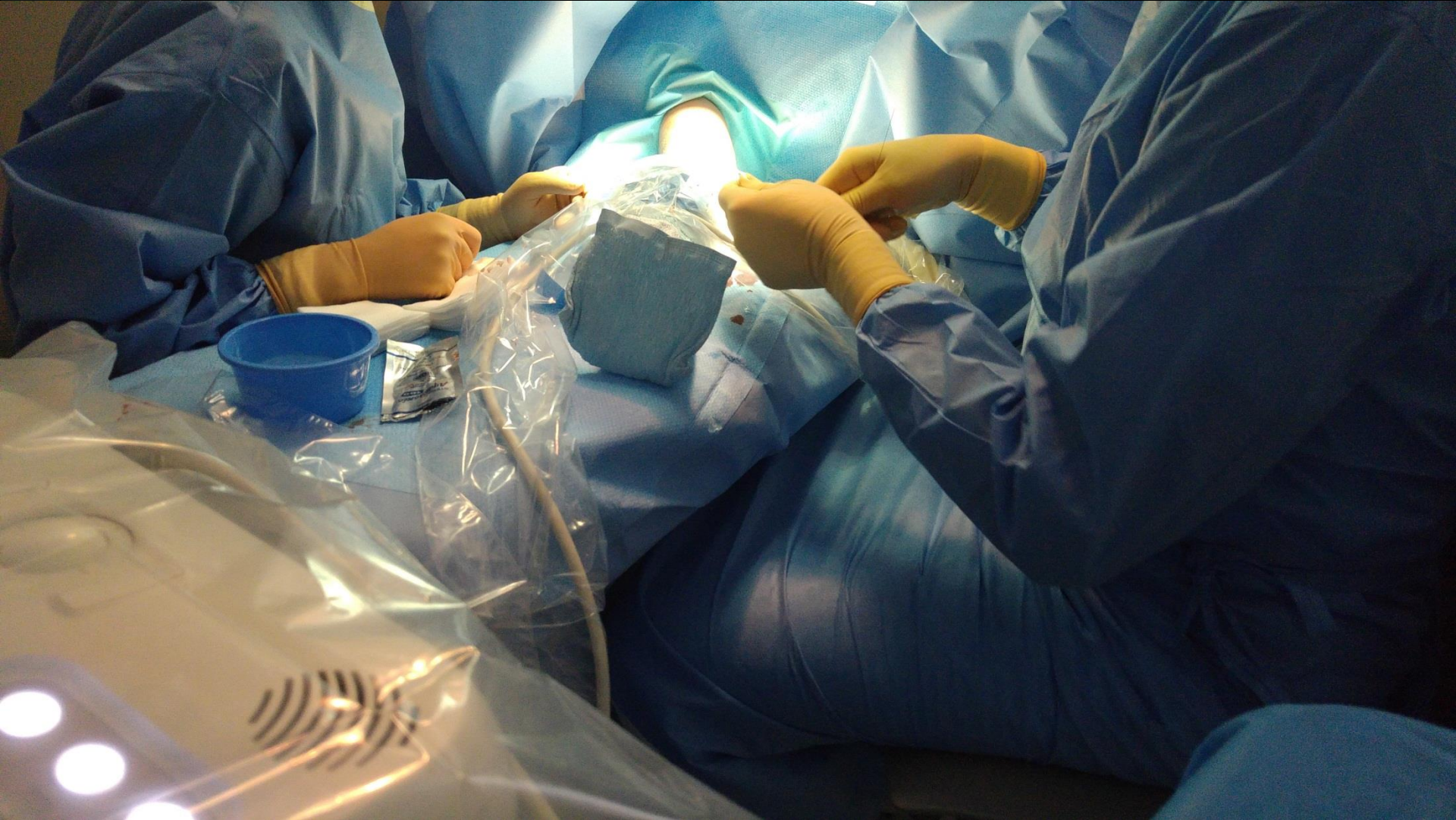
Flexpoints:
6 mm length = 0
10 mm length = 1
15 mm length = 2

Atherotomes with flexpoints assist in tracking to lesions that may have been previously out of reach.

Stainless steel micro-surgical blades:
- Flexpoints every 5 mm on the 10 mm and 15 mm lengths
- Working height of blades 0.005"

Our experience

- Only CDU procedure (no angiography)
- Stenosis monitoring. So it is possible to find a difference between an evolution stenosis and another one that it isn't
- CDU-PTA only on evolution stenosis





PST C#2 MV

MI 0.9
TIS ---

ADDOME LA523



38Hz

<input type="button" value="TEI"/>	<input type="button" value="ORIENT"/>	FREQUENZA 12	B-STEER ← B-STEER →	RANGE DIN 10	FUOCHI 1	SUCC PREC	<input type="button" value="INVERTI"/>	<input type="button" value="TPVIEW"/>
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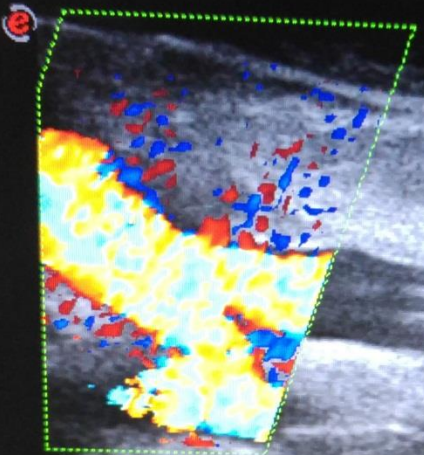
MyLabFive





Y
P 12 MHz G 70% CFM F 6.6 MHz G 74%
PRC 5 CM XV C PRF 1.4kHz
PST C#2 PRS 4 PRC 3-B-A PRS 4
FP M

ADDOME LA523

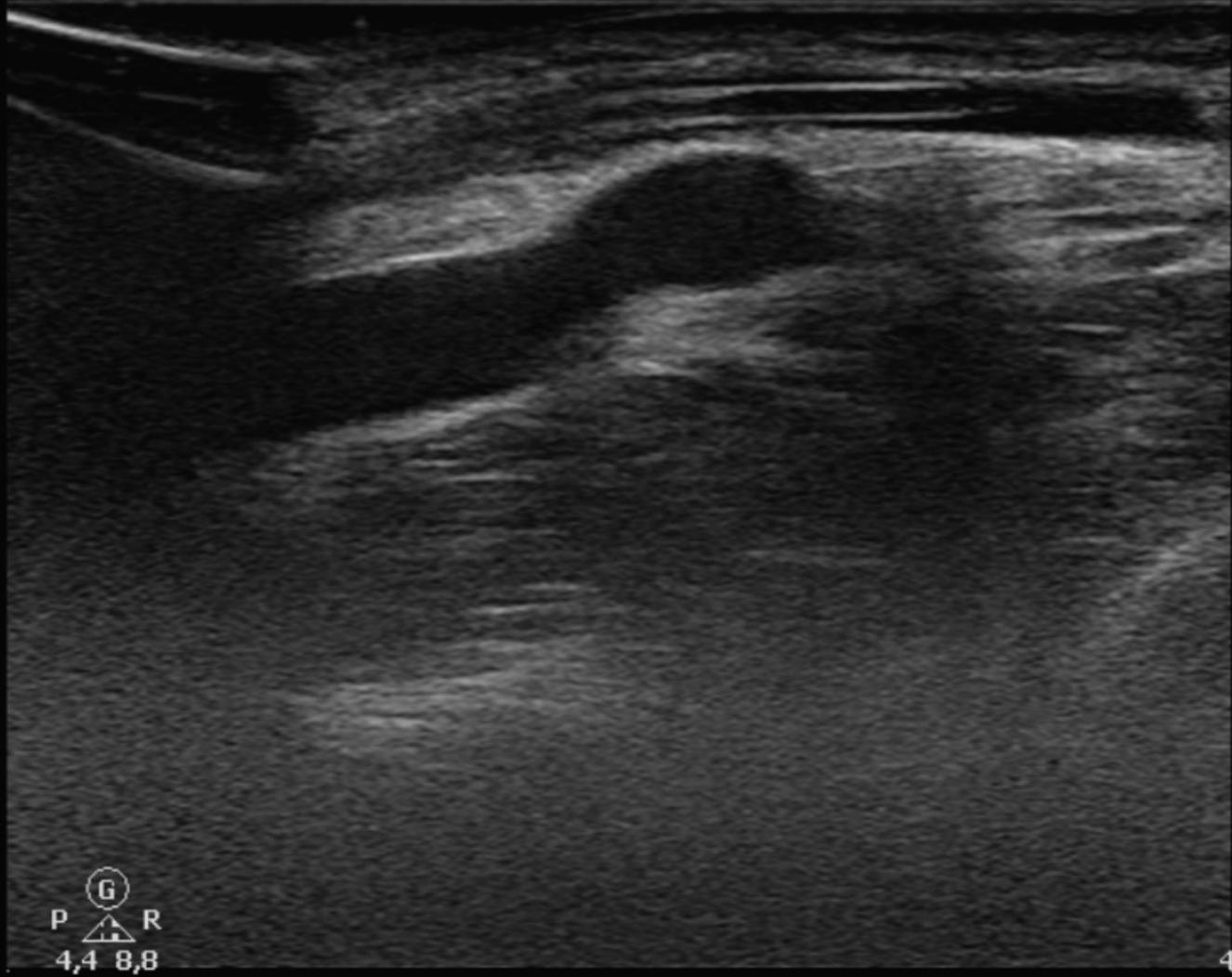


398/398

FAV
L12-5
40Hz
4,0cm

2D
AGen.
Quad. 40
55
3/3/2

P



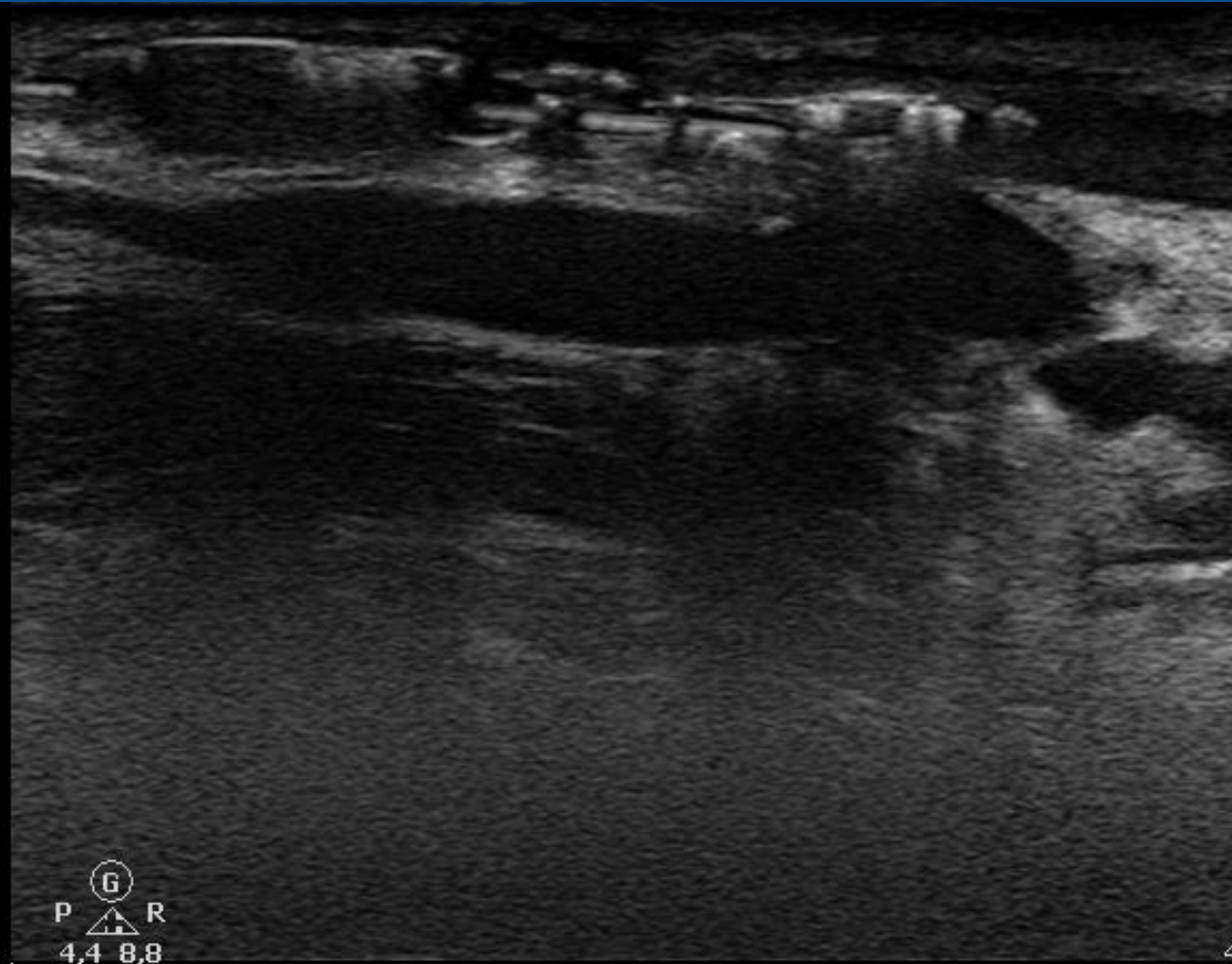
2

G
P R
4,4 8,8

4,0cm

FAV
L12-5
40Hz
4,0cm

2D
AGen.
Guad. 40
55
3 / 3 / 2



2

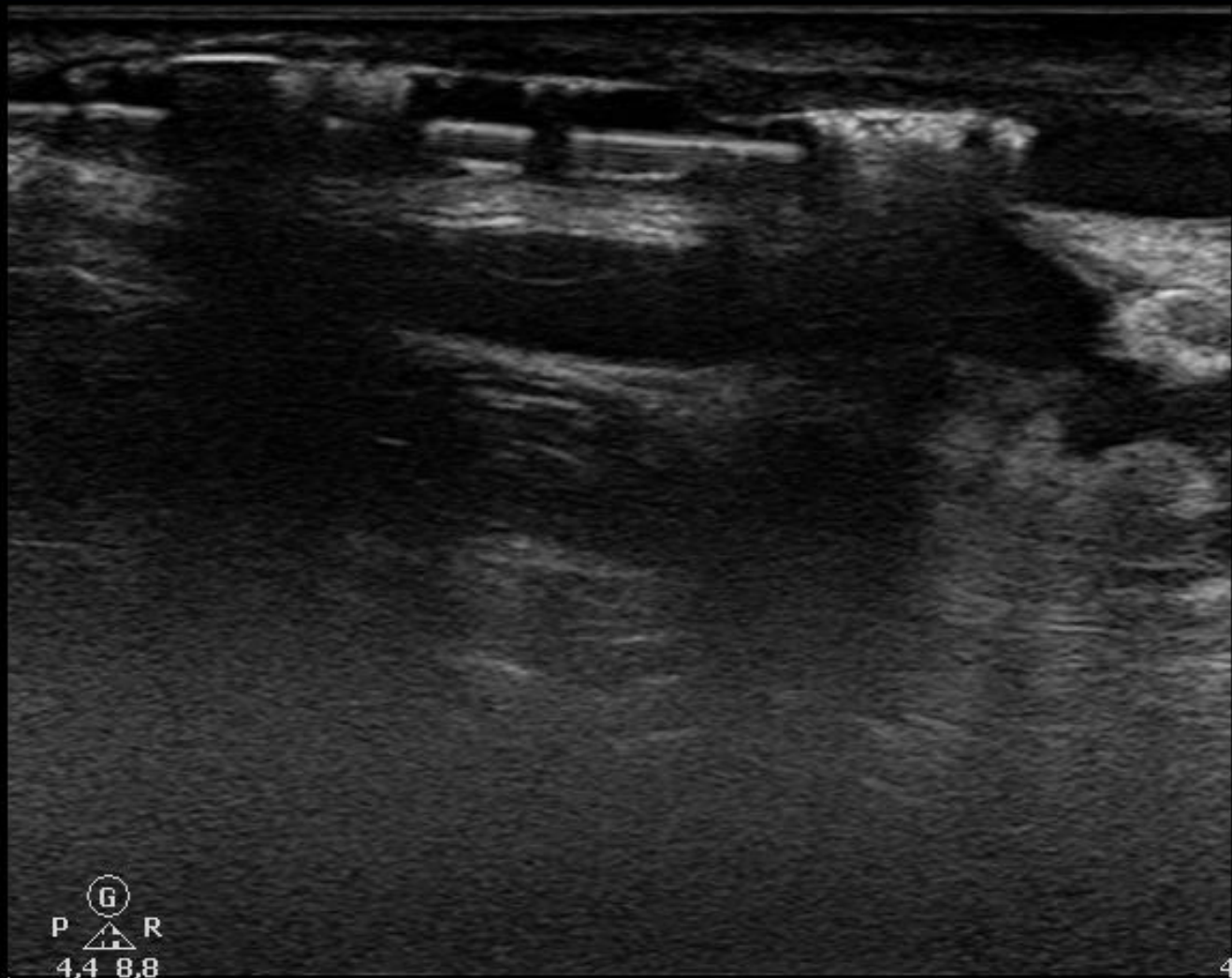
4,0cm



FAV
L12-5
40Hz
4,0cm

P

2D
AGen.
Guad. 40
55
3/3/2



2

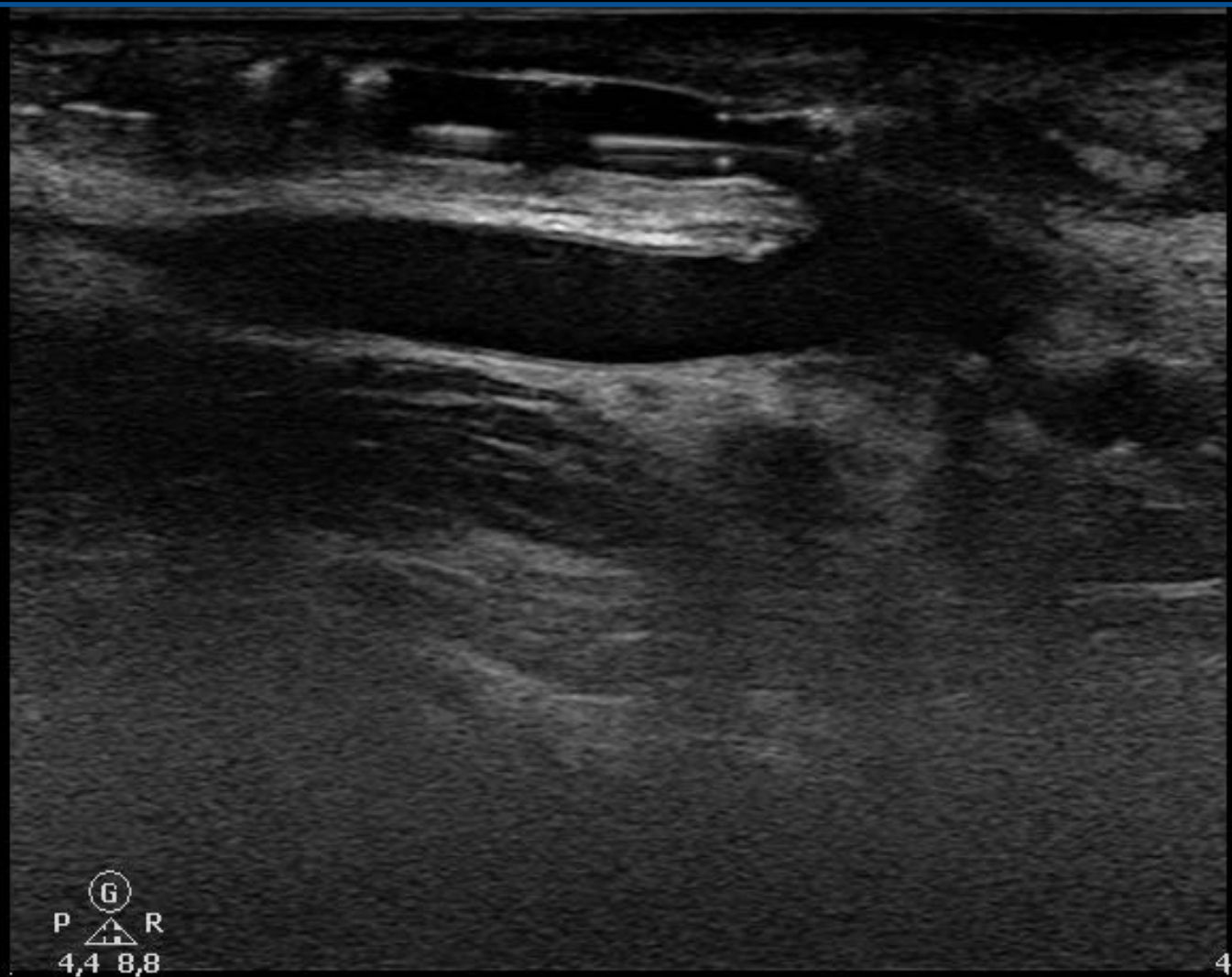
G
P R
4,4 8,8

4,0cm

FAV
L12-5
40Hz
4,0cm

2D
AGen.
Guad. 40
55
3 / 3 / 2

P



G
P R
4,4 8,8

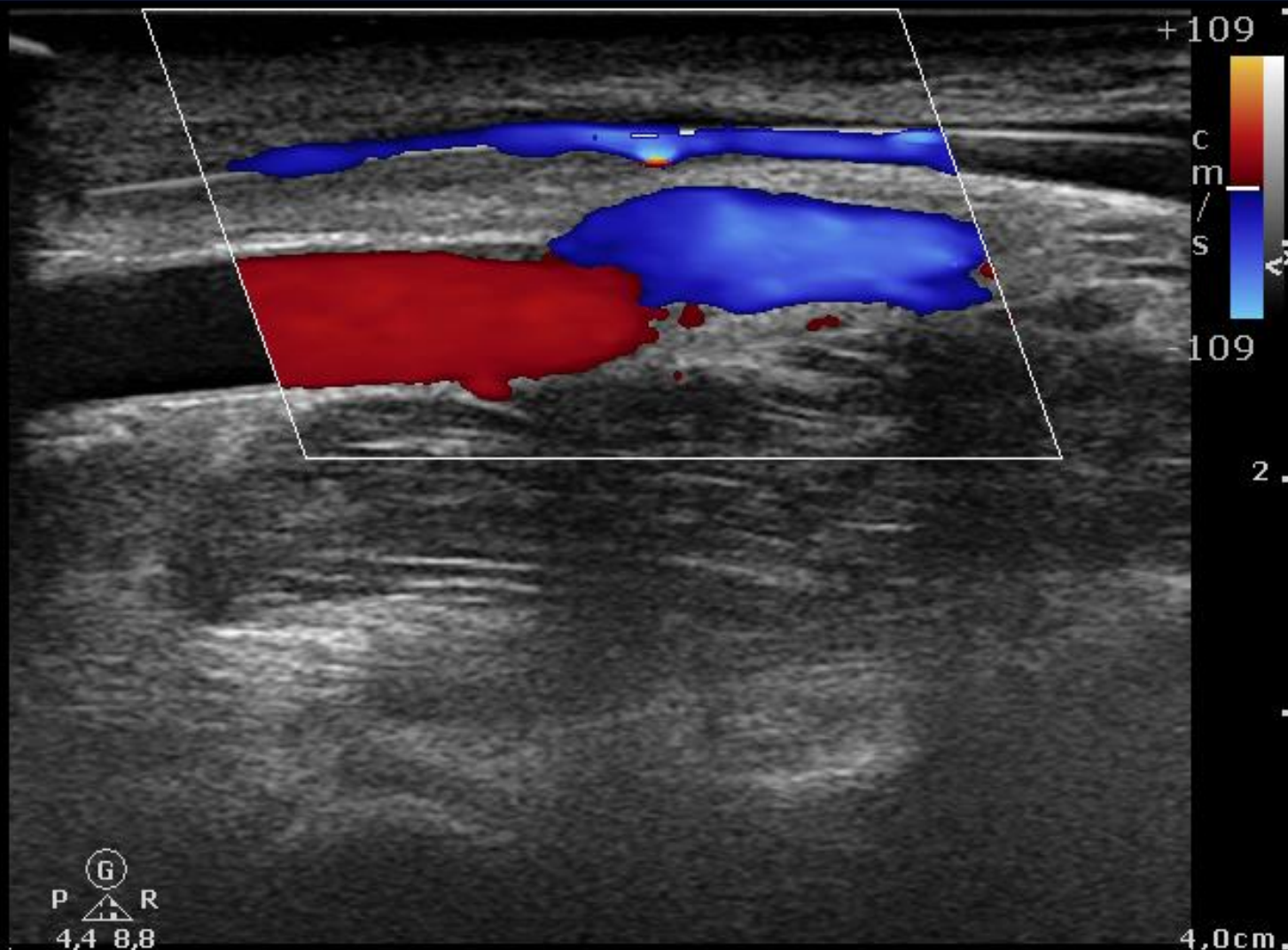
4,0cm

FAV
L12-5
29Hz
4,0cm

2D
AGen.
Guad. 40
55
3/3/2

Colore
5,7 MHz
Guad. 60
3/8/4
Filt. Med.

P



+109

cm/s

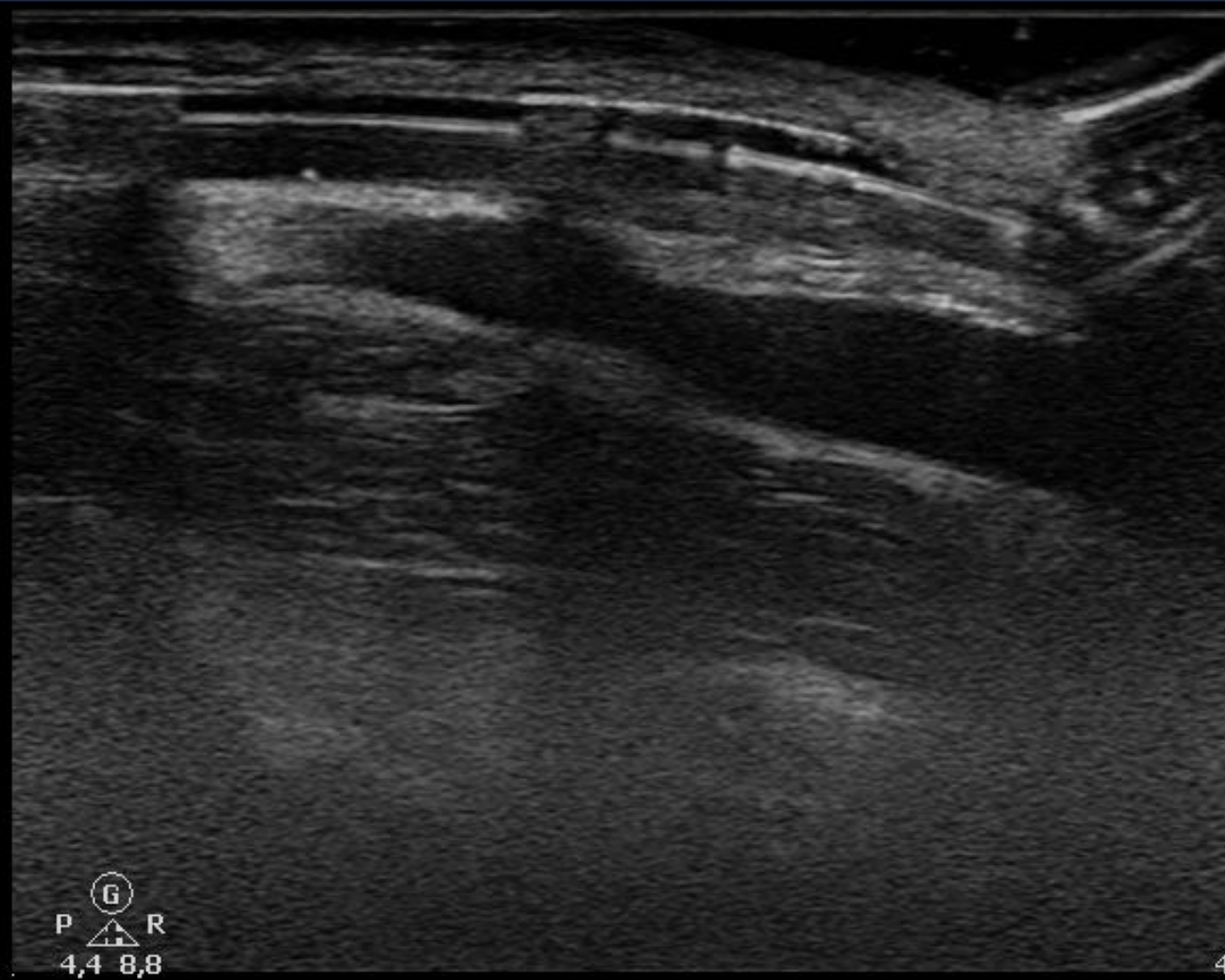
-109

2

4,0cm

FAV
L12-5
40Hz
4,0cm

P



2D
AGen.
Guad. 40
55
3 / 3 / 2



2

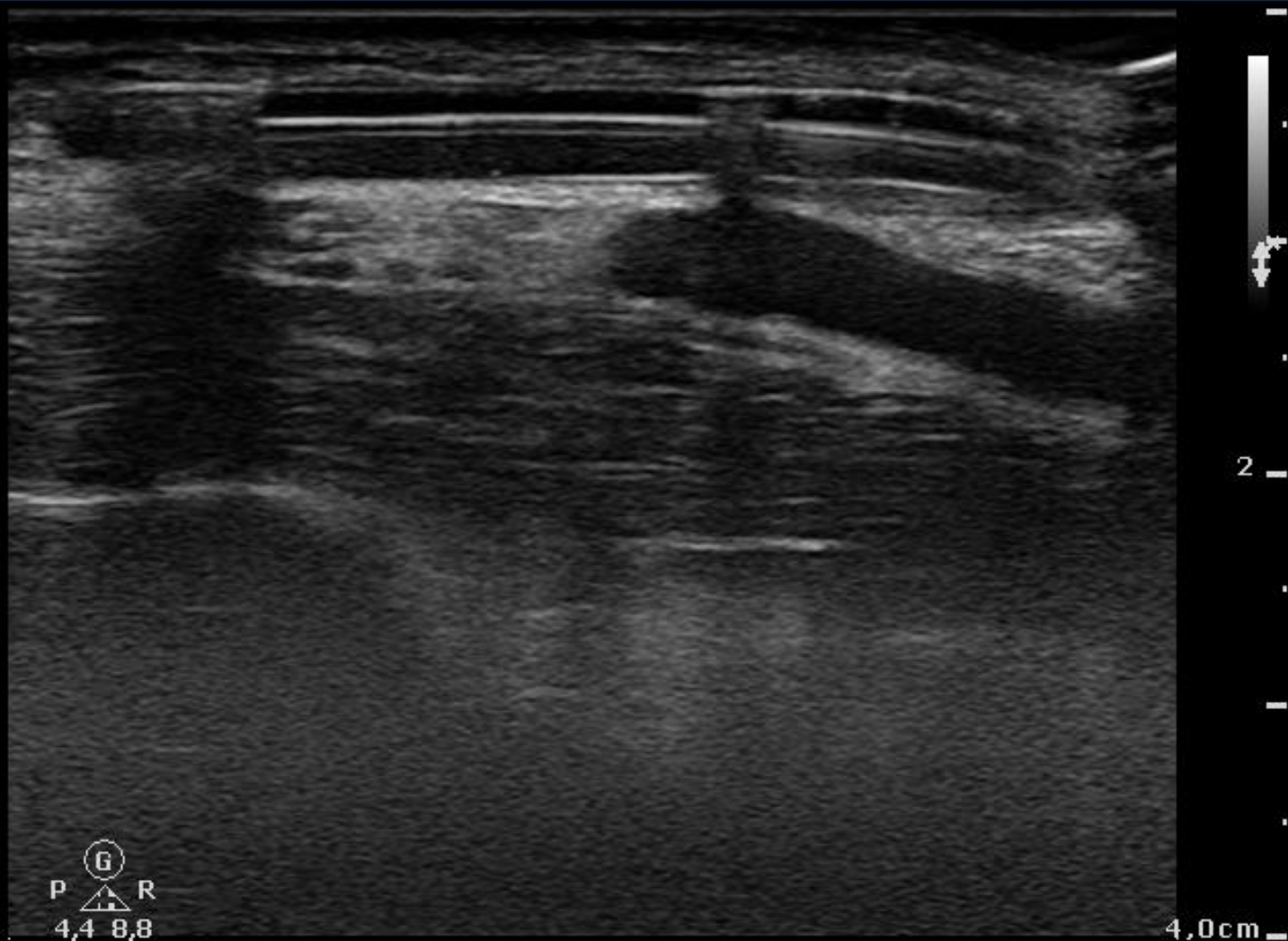
G
P R
4,4 8,8

4,0cm

FAV
L12-5
40Hz
4,0cm

P

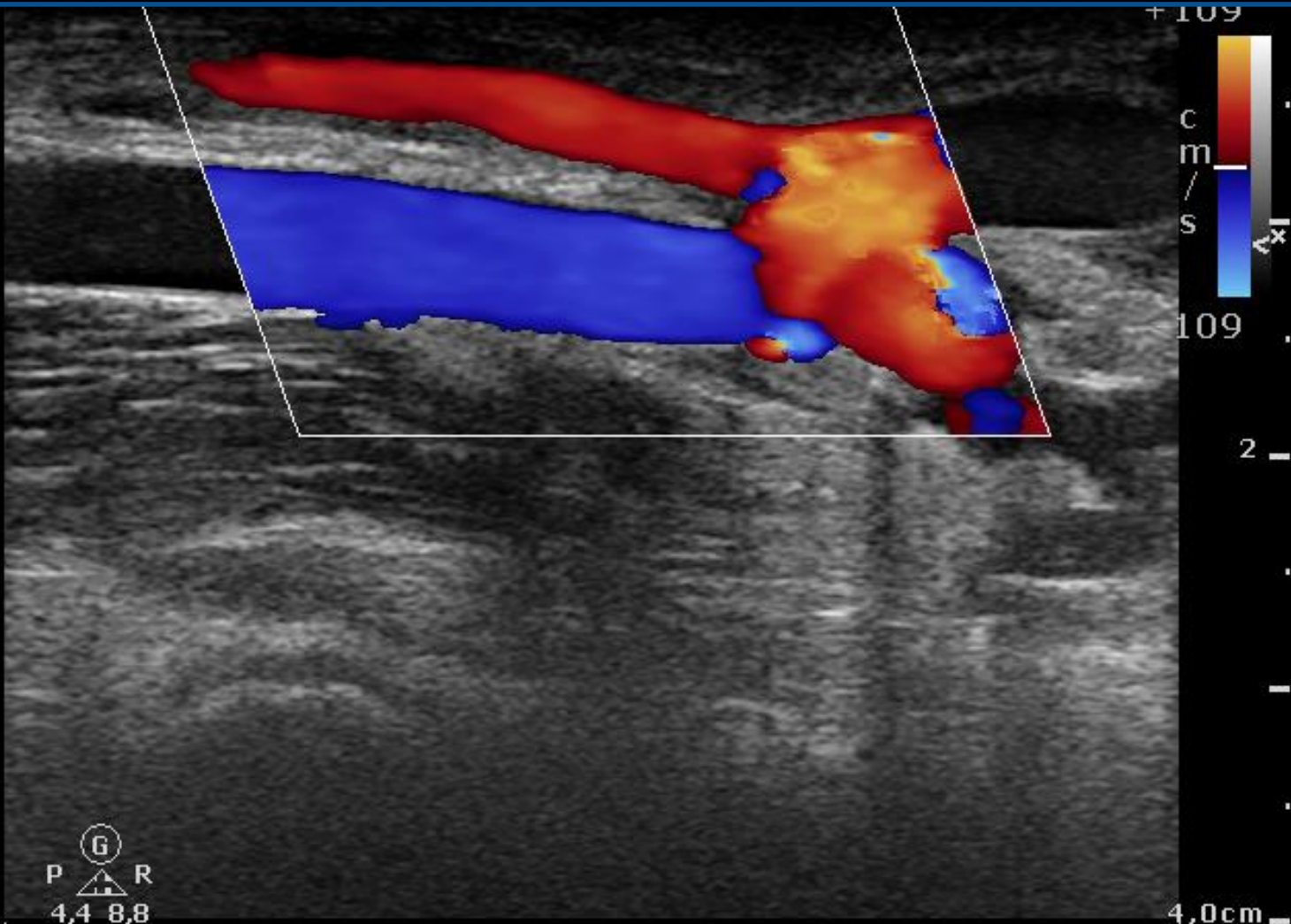
2D
AGen.
Guad. 40
55
3 / 3 / 2



PAV
L12-5
29Hz
4,0cm

2D
AGen.
Guad. 40
55
3/3/2

Colore
5,7 MHz
Guad. 60
3/8/4
Filt. Med.

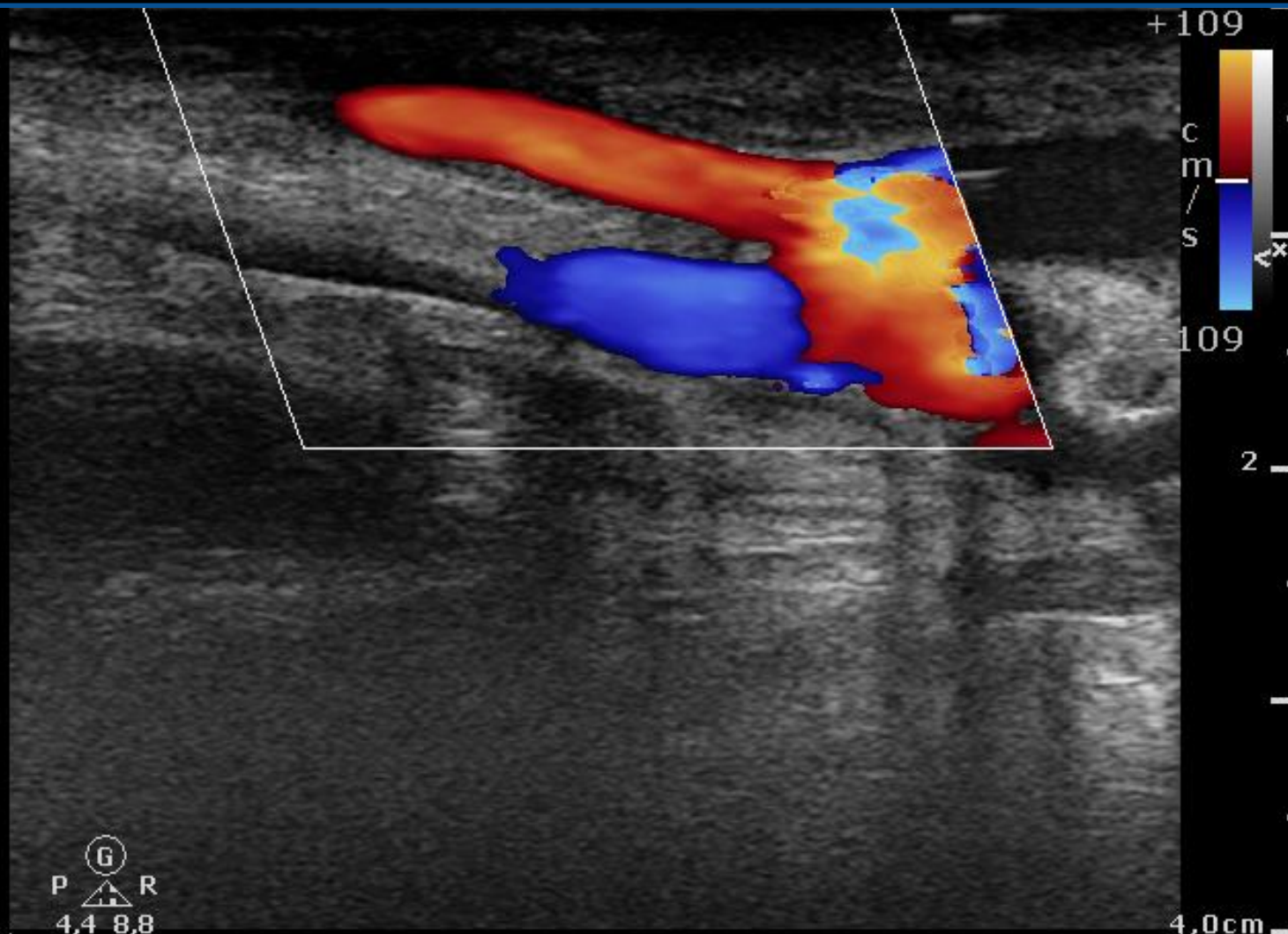


FAV
L12-5
29Hz
4,0cm

2D
AGen.
Guad. 40
55
3/3/2

Colore
5,7 MHz
Guad. 60
3/8/4
Filt. Med.

P



G
P R
4,4 8,8

4,0cm

FAV

L12-5

25Hz

4,0cm

2D

AGen.

Guad. 40

55

3/3/2

+ Cicli

PSV

EDV

MDV

TAPV

RI

HR

2

-254 cm/s

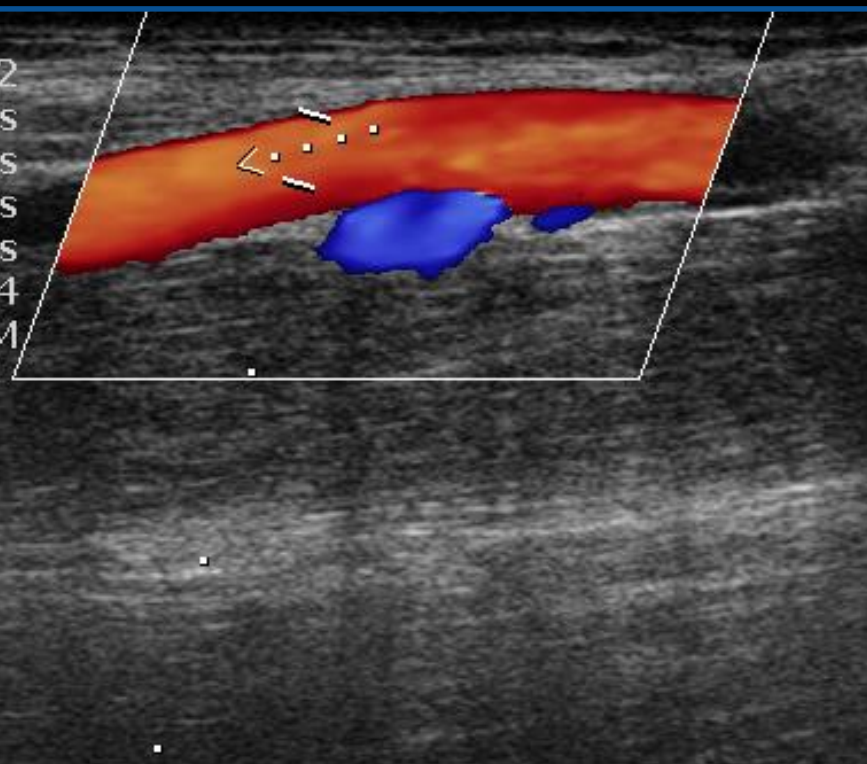
-119 cm/s

-110 cm/s

-171 cm/s

0,534

67 BPM



Colore

5,7 MHz

Guad. 60

3/8/4

Filt. Med.

PW

4,4 MHz

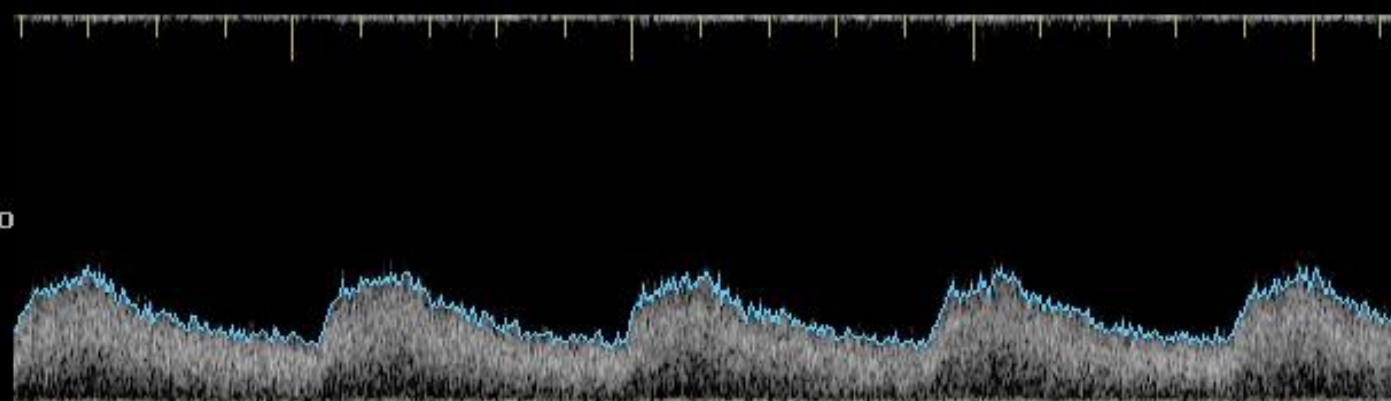
Guad. 44

0,8 cm

Angolo 60°

Filt. 75Hz

50 mm/s



FAV
L12-5
25Hz
4,0cm

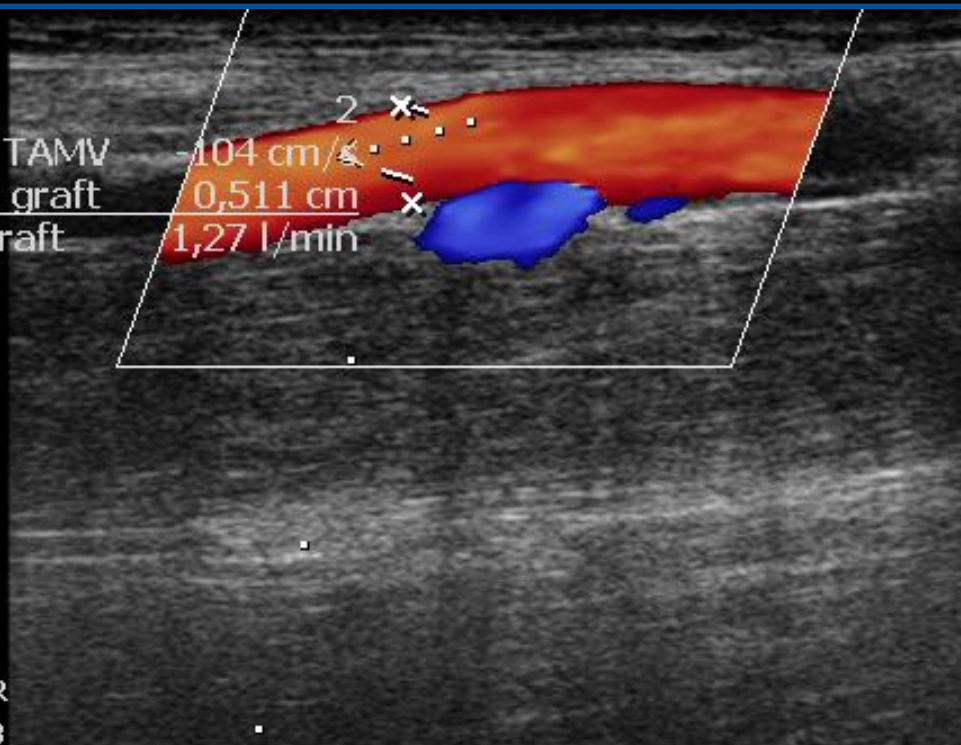
Dx
+ Cicli
Flusso graft TAMV
× Diam. flusso graft
Vol. flusso graft

2D
AGen.
Guad. 40
55
3 / 3 / 2

Colore
5,7 MHz
Guad. 60
3 / 8 / 4
Filt. Med.

PW
4,4 MHz
Guad. 44
0,8 cm
Angolo 60°
Filt. 75Hz
50 mm/s

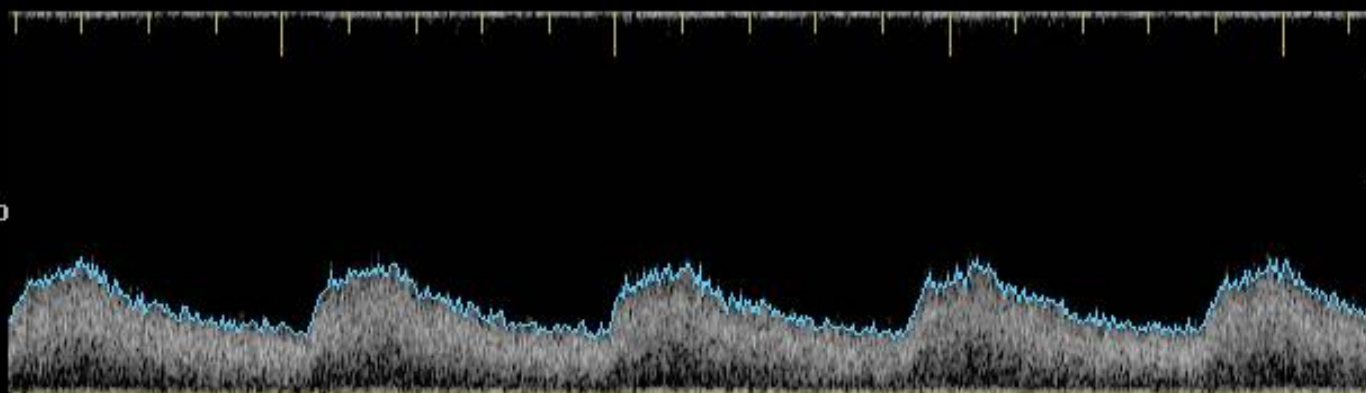
⊙
P  R
4,4 8,8



+80
c
m
/
s
-80

4.0cm

- 600
- 400
- 200
+
0
c
m
/
s

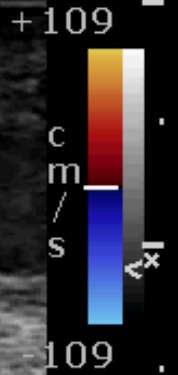
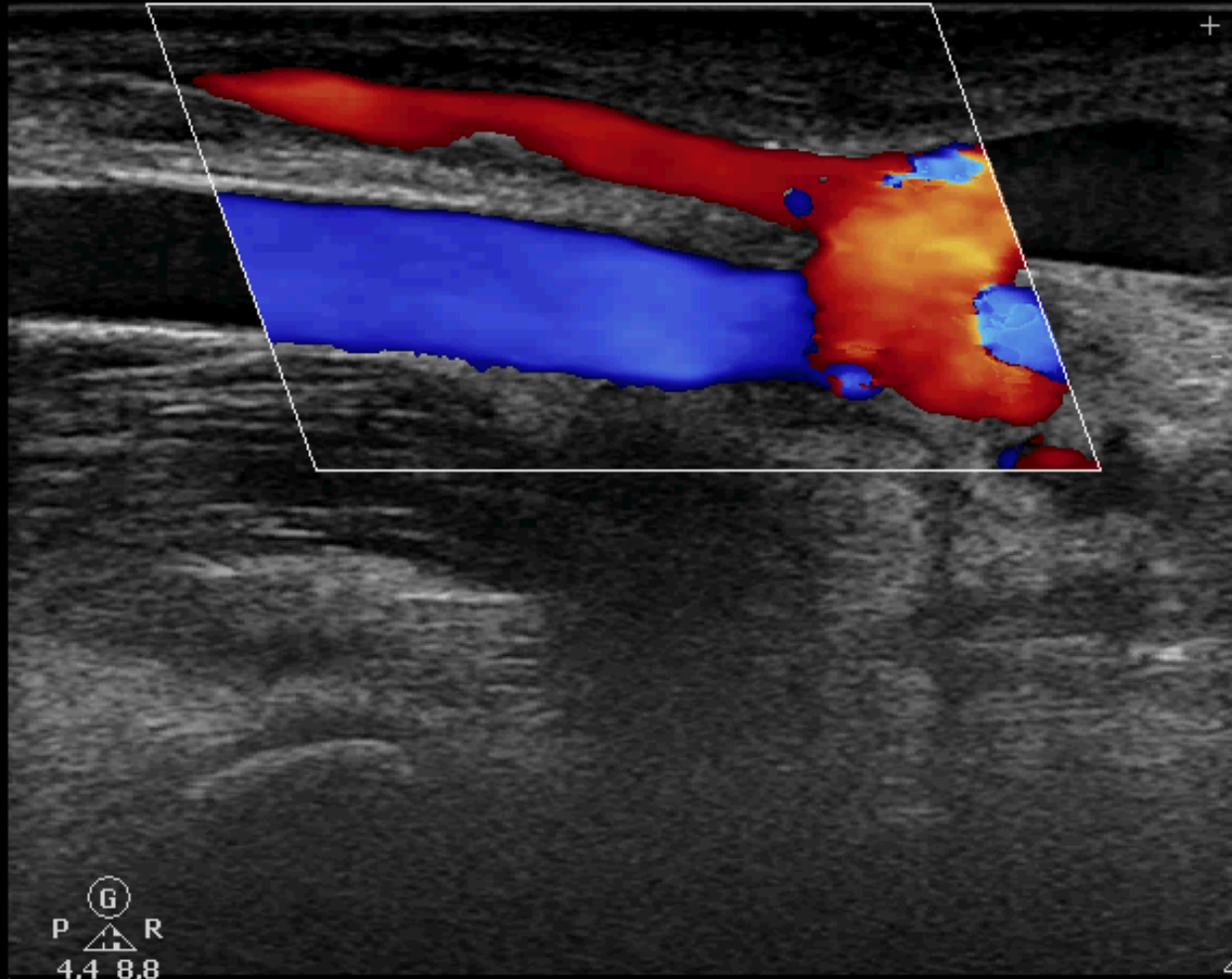


FAV
L12-5
29Hz
4,0cm

P

2D
AGen.
Quad. 40
55
3/3/2

Colore
5,7 MHz
Quad. 60
3/8/4
Filt. Med.



2



4,0cm

CDA PTD

59 patients with graft occlusion underwent mechanical thrombolysis with PTD during 125 months (from October 2002 to April 2013). Patients characteristics are shown in Table I.

Age (years)	64 \pm 13
Male sex	28
Diabetes mellitus	25 (42.4%)
Hypertension	39 (66.1%)
Anticoagulant therapy	40 (67.8%)
Age of AVG (months)	80 \pm 83
Upper-arm AVG	24



RESULTS

The mean follow-up period was 29.2 months.

the technical success rate (defined by restoration of a palpable thrill) was 100%, while the clinical success rate (defined as resumption of at least one successful hemodialysis session) was 91.7%.

There were no major complications. In 47 patients, additional procedures were needed for patency.

The 3-month primary and secondary patency rates were 42.2 % and 73.3 % respectively.

Angiojet

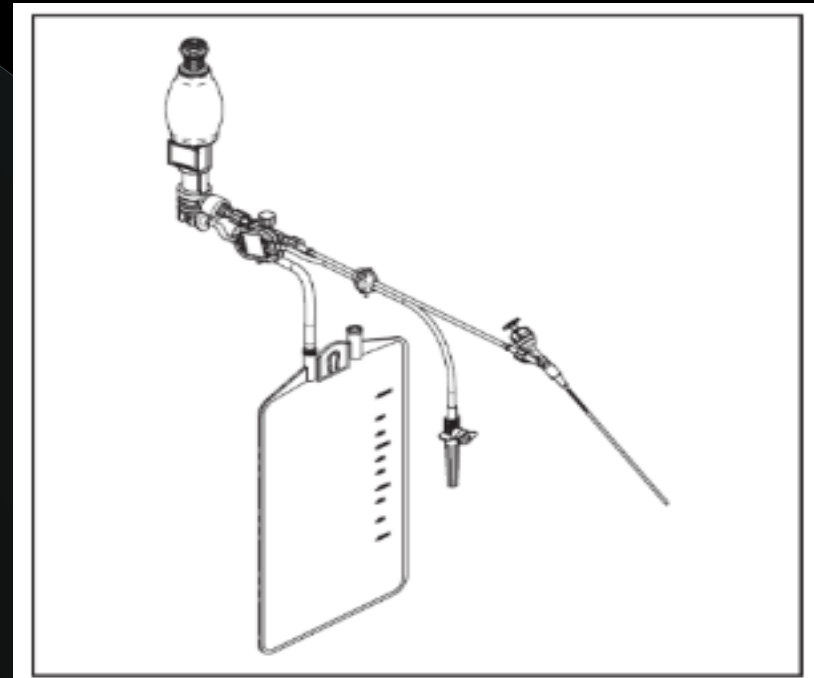
Console angiojet ultra



Set per trombectomia :

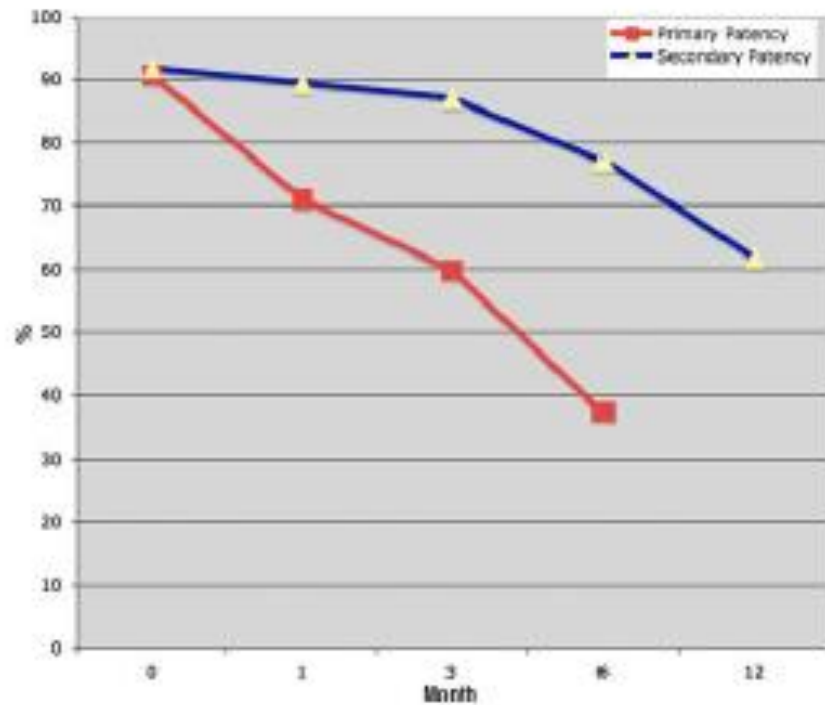
Catetere

- Pompa
- Linea per l'erogazione di soluzione fisiologica e tubo di scarico
- Sacca di raccolta



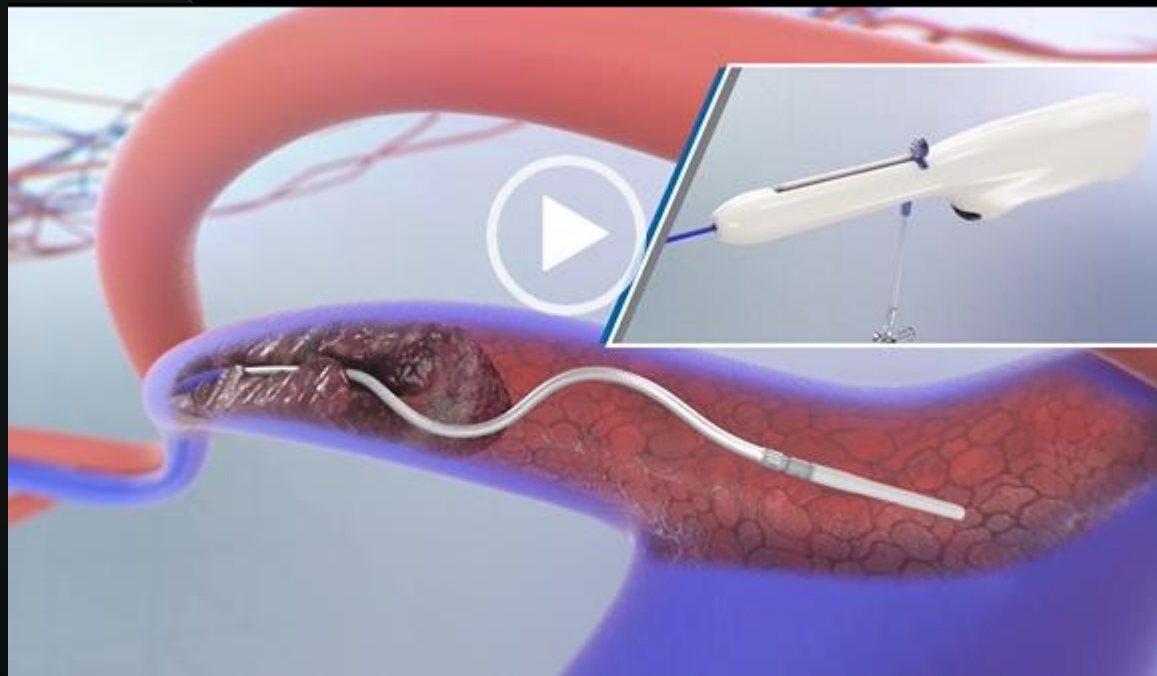
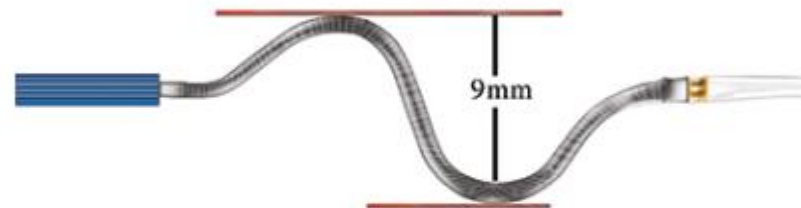
Ognuno dei cateteri per trombectomia può essere utilizzato esclusivamente in combinazione con la console pluriuso AngioJet Ultra.

All'interno di ogni catetere vengono iniettati dei getti di soluzione salina ad alta velocità: questi, in base al principio di Bernoulli, generano una zona di bassa pressione in corrispondenza delle finestre di aspirazione (distali rispetto a quelle di infusione).



AngioJet Thrombectomy for occluded dialysis fistulae: outcome data
Peter Littler, Nicola Cullen et al. Cardiovasc Intervent radiol (2009) 32:265-270

CLEANER XT™ Rotational Thrombectomy System



CONCLUSION

- **CDU Stenosis monitoring enabled us to reach and keep the international guide lines quality standard about thrombosis rate and PTA rate**
- **This kind of surveillance protocol reduced need of hospitalization, reduced the costs (CDU vs angiography, no contrast agent, maintenance and staff costs)**







