Dear BB, Raj,Marian and all,

The pressure Gradient DP calculation is: For an iliac venous stent = 10 cm long and 16 mm wide stent caliber an flow =240ml/mn at rest, DP = 0,05 mmHg. For 14 mm width , DP = 0,08 mmHg. The difference is negligible = 0,03 mmHg. In contrast, for a 8 mm width stent, the difference 1,6 - 0,05 = 1,55mmHg and begin to be non negligible because may increase ( x 5) when walking. The intravenous measurement of the venous pressure is not reported in the Raj’s article as support of the statement.

We cannot ignore physics as well as clinics and static imaging. But in vascular, as you know very well, an anatomic lesion/anomaly, can be non hemodynamically significant in terms of flow rate, regimen and pressure and clinically symptomatic or asymptomatic hemodynamically significant when hemodynamically significant.

So a vascular lesion is treated when symptomatic, or asymptomatic but “threatening” as risks of venous and arterial embolism, wall rupture. May be leaving behind a no more hemodynamically significant lesion but still present though smaller could be more risky than its total disappearance in terms of recurrence and aggravation. Nevertheless, the benefit/risk assessment should be lighted by reasoning on reliable data. In vessels, the image of segmental narrowing along a vessel cannot bring any reliable hemodynamic information. I suggest you to read on the attached file, my Bernouilli calculations and demonstrations. the DP should taken in account in arterial stenosis by flow, caliber and length measurement of the stenosis, in order to assess the very hemodynamic significance. I addition, DP should be measured with the IV catheter before and after venous stenting procedures

I suggest you to read on the attached file, my Bernouilli calculations and demonstrations.

According to Poiseuille, the pressure gradient P1-P2 = Q.8Lμ/πr4

P1-P2= gradient de pression= Pa (Pascal) 1Pa = 1/98,0638 cmH²O = 0,74/ 98,0638 mmHg

Q=flow: m3/s L=Length in meters r=radius =meters μ=Viscosity blood = 6.10-3

Values in laminar regimen (Newtonian) in a cylindrical vessel , in absence of turbulences ( Reynolds < 2500) . Shear stress and Reynolds number as well as the shape of the area interfere but only for very high flows.

DP=Q.8Lμ/πr4

Mesure automatique:

À partir du calibre, débit et longueur :

 8μ ( 8 x 6. 10-3= 0,042)

DP= 0,042 x Q m3/s….x L m …..x 0,75 = 0,0315x Q m3/s….x L m …..

 3,14 x r4 x 98 308 x r4

0,0315x Q m3/s….x L m …..= 3,14 r² x Vm/s……x Lm….

 308 x r4 308 x r4

DP varies proportionally with Q and L but with the r4 wich means that the % of a stenosis cannot per se give the value of the DP .

So, the caliber must be known as well as the flow and the length of the stenosis. Interestingly

The NASCET stenosis % (A-B/A) x100, (A post-bulbar internal carotid diameter, B stenosis lumen diameter) is supposed to begin hemodynamically significant around 70% .

Yet, this % varies with A and B, and NASCET should be reconsidered:

Examples: B = 1,8 , A= 3 St = 40 % , if B = 1,8 , A= 4 St =55 %, if B = 1,8 , A= 5 St = 64 %

If cerebral flow is 750 ml/min and IC = 300, then , if the lumen of the stenosis is 1,8 mm diameter and 10 mm long , the DP ( pressure loss) due to the stenosis is 56 mmHg, so if max Arterial pressure is 120 mmHg , the pressure downstream the stenosis is 64mmHg, if L= 5 mm, DP is 28mmHg , if L=2mm DP is 11mmHg….So the stenosis lumen should be principally taken in account for the Carotids.

Because in the venous system the Pressure is much lower than in the arterial (residual pressure around 20mmHg vs 120), DP is more influent than in arteries. A venous stenosis DP = 20 mmHg blocks the flow…then the residual increase to cross the stenosis . Nevertheless, the DP = 1,30 mmHg begins to be significant when a stenosis = 4mm caliber and L=10mm for a Flow = 120 ml/mn.

 For a iliac venous flow =240ml/mn at rest a 10 cm long and 16 mm wide stent caliber DP = 0,05 mmHg. For 14 mm width , DP = 0,08 mmHg . The difference is negligible = 0,03 mmHg. In contrast, for a 8 mm width stent, the difference 1,6 - 0,05 = 1,55mmHg and beging to be non negligible because may increase ( x 5) when walking.

Conclusion: the DP shoulb taken in account in arterial stenosis by flow, caliber and length measurement of the stenosis, in order to assess the very hemodynamic significance. I addition, DP should be measured with the IV catheter before and after venous stenting procedures. ,

1-**Diameter = 16 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x L= 0,01 m = 0,0000000084

r= 0,008 m r4= 0,000000004 m4

X π= **0,00000001256**

DP= 0,0000000084/ **0,00000001256 = 0,67 Pa = 0,005mmHg**

DP=Q.8Lμ/πr4

Diameter = 16 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP=0,05 mmHg

**2-Diameter = 14 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,007 m r4 = 0,000000002401 m4

X π= **0,0000000075429816**

DP= 0,0000000084/ **0,0000000075429816 = 1,11Pa = 0,008 mmHg**

Diameter = 14 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 0,08mmHg

**3-Diameter = 12 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,006 m r4= 0,000000001296 m4

X π= **0,0000000040715136**

DP= 0,0000000084/ **0,0000000040715136= 2,06 Pa = 0,015 mmHg**

Diameter = 12 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 0,1 mmHg

**4-Diameter = 10 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,005 m r4= 0,000000000625 m4

X π= **0,0000000019635**

DP= 0,0000000084/**0,0000000019635 = 4,27 Pa = 0,033 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 0,33 mmHg

**5-Diameter = 8 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,004 m r4= 0,000000000256 m4

X π= **0,0000000008042496**

DP= 0,0000000084/**0,0000000008042496= 10,44 Pa = 0,080 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 0,8 mmHg

**6-Diameter = 6 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,003 m r4= 0,000000000081m4

X π= **0,0000000002544696**

DP= 0,0000000084/**0,0000000002544696= 33,00 Pa = 0,26 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 2,6 mmHg

**7-Diameter = 4 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,002 m r4= 0,000000000016 m4

X π= **0,00000000005024**

DP= 0,0000000084/**0,00000000005024= 167,20 Pa = 1,30 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP= 13 mmHg

**8-Diameter = 2 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,001 m r4= 0,000000000001 m4

X π= **0,0000000000031416**

DP= 0,0000000084/**0,0000000000031416= 2673,8 Pa = 20,7 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP = **207 mmHg**

**9-Diameter = 1,8 mm** , L=10mm, Flow = 120 ml/minute, v=25,6 cm/s

Q= 0,000002 m3

x 8μ ( 8 x 6. 10-3= **42.** 10-3)= 0,000002 x 0,042 = 0,000000084

x = 0,01 m = 0,0000000084

r= 0,001 m r4= 0,0000000000009 m4

X π= **0,00000000000282744**

DP= 0,0000000084/**0,00000000000282744= 2970 Pa = 22,7 mmHg**

Diameter = 10 mm , L=100mm, Flow = 120 ml/minute, v=25,6 cm/s

DP = **227 mmHg**

Nombre de Reynolds : Re=VitesseXcalibre/viscosité cinématique (viscosité dynamique par volume) nb= 2000 à 4000

Viscosité sang = 6x10-3 (Pa.s)

Nb reynolds = Re= VL/v = Ro.VL/nu ; =( V(m/s) x D (diameter en metre) )/ v ( visco ciné) = Ro.VD/nu

V=vitesse fluide m/s L=dimension caracteristique ( rayon en m) v= viscosité cinematique = nu/Ro ( Ro=masse volumique (kg/m3)

Renolds sang : pour V= 1m/s D=0,001m Ro=1056 / nu=0,006 = 176

 pour V= 1m/s D=0,01m Ro=1056 / nu=0,006 = 17600

Re= V x r x nu/Ro nu/Ro = masse specifique =stokes

Masse volumique sang = 1 056 kg/m3

Dear Claude,

I just responded in detail on same if not similar issue involved to 25% residual lesion to Raj and also Marian with my opinion based on my own experiences so that I will not repeat it.

But, your concern on ‘pelvic veins embolization in curiously expanding pelvic congestion syndromes and in pelvic leaks’ is quite agreeable. Indeed, we do NOT deny that there are substantial evidence for the abuse of the indication if not over-extension of its limit. But no more in any leading institutes here in the U.S. as I know of!

I also would like to clarify that the direct measurement of pressure gradient was indeed THE gold standard for decades at least during my active stage. But, the era of direct pressure measurement is OVER now! Duplex US and further IVUS assessment are more than enough to give enough/sufficient back up on the clinical indication for the treatment as a new gold standard. Indeed there are tons of data/evidences to support this new approach. And such direct measurement of pressure gradient is now one of the options for any angioplasty and stent procedure in many institutes.

Regardless, as a clinician, whether ‘hemodynamically significant or insignificant’ is only ONE of many guideline criteria for decision making on the management of ‘symptomatic’ vascular lesions, and it is NOT a sole criterium, here in the U.S. absolute majority accepted.

Warm regards,

BB

Dezr Raj and BB

Sorry Raj , i apology ,you are right about the conductance that increases 3 times when the stenosis is 25 % ( I had reversed the factors......) but may neverthless be negligible if  the conductance at the normal calibre was low in relation to the viscosity, the lengh and the volume flow velocity. We see every day 25 to 50  %  arterial stenosis without any signicant increase of the pressure gradient i.e severe conductance effect.

In addition stopping a flow converts the driving pressure into lateral pressure (Bernouilli)  that dilates the vein we can state on the superficial veins of our ower upper arms.
Regards



Dear BB, Simka and all,

Indeed, Iliac stenting is an important progress by its efficiency and its unexpected lower rate of thrombosis than I and others feared. Nevertheless, any affirmation needs scientific confirmation. Raj states in his article: A 14 mm  iliac stent instead of 16 mm, i.e 25% area is declared iatrogenic at the outset without any pressure measurement evidence , and the example of symptomatic case is 8mm instead of 16mm is 75% i.e  16 times more resistant and likely hemodynamically significant. Surprisingly, while catheters, aimed to treat or IVUS , are introduced in the veins, no pressure measurement is reported. A caliber reduction is suspected to be significant….but  shoud be convicted with hemodynamic evidence, as pressure , plethysmography, Doppler and venous catheter. By the way, Doppler venous flow features at the femoral vein and Doppler venous pressure measurement at the ankle at rest and stress are non invasive and  easy achieve.

So I am afraid that to many patients are treated for so far innocent  lesions, particularly  not post thrombotic. In one of my past mails, I remembered that decades ago we stopped drastically to treat the May turner syndrome by iliac artery transposition when we saw with DUS that most of them shown by venography,  were due to the supine position and disappeared in semi-sitting posture.  IVUS shows what were the intra-operative findings reported by some surgeons who performed direct operation. Nevertheless, these lesions are not always necessarily hemodynamically significant.

This reminds me when the arterial stenosis were treated only on angiography imaging , fortunately later better defined by  hemodynamic assessment that could finally select the hemodynamically significant lesions and stop useless operations of “permissive” lesions.

I am a strong advocate of miraculous stenting iliac veins when useful and at the same time as well strong against the useless indications that are growing due to inadequate hemodynamic assessment. The same for pelvic veins embolization in curiously expanding pelvic congestion syndromes and in pelvic leaks easy to treat just by the leak points ligation.

Regards