

**Unofficial Ottawa Fellowship Guide to  
Endovascular interventions,**

Anton Sharapov, MD, FRCS©,

Vascular Surgeon

Updated October 26, 2014

What follows is fairly roughly put together hodge-podge to remind me of all the things I should never do and things I should always remember before the endovascular case.

Nothing is foolproof. It is likely that this manuscript will be denounced as blatant heresy in a couple of years:) I did not have any real text to fall back upon when I started: Cook guys did not give me P. Schneider's excellent text until the end of my fellowship. That text is superb for the general content but is outdated for details – e.g. he recommends 7Fr sheath for 7 mm balloon angioplasty. I've gleaned bits and pieces of practical disorganized plagiarized pseudo-wisdom on the subject of endovascular technique typed in between cases and after hours in a hurry before I forgot.

My thanks goes to Dr. Nagpal, Dr. Jetty, Dr. Hill, and Dr. Benko for getting this stuff through my thick skull. They haven't read it, so beware, I may (likely) have gotten it all wrong. Let me know if there is anything you think I should add. What follows is intended for C-ARM interventions in OR setting, even though angiosuite with power injector would be very nice.

I've updated things since completion of my fellowship more or less regularly as I learn new things etc.

## Table of Contents

Tools of the trade:.....	4
Wires: there are so many of them... Get to know 4 or 5 and use them regularly. Get to know what your colleagues and your competition are using and slowly expand your arsenal.....	4
Balloons:.....	6
Stents: .....	7
Catheters:.....	9
Set up: .....	10
Positioning C-arm and the patient:.....	10
Positioning for Right handed approach... ..	11
SFA Angioplasty:.....	11
Principles:.....	11
Antegrade: .....	12
Contralateral groin access: .....	13

Dr. Benko trick: turning Contralateral to Ipsilateral.....	14
Turning Ipsilateral to Contralateral.....	14
Can't get over the bifurcation:.....	15
Going up and over aortobifemoral graft bifurcation:.....	16
Subintimal angioplasty stuff.....	17
Sherbrooke technique of SIA.....	18
Waltman's Loop, or turning C2 into Simmonds catheter.....	19
Can't re-enter the lumen after subintimal.....	19
Dr. Jetty open re-entry cutdown technique:.....	20
How to salvage non-re-enterable situation: re-entering in the middle of the SI plane, not at the tip of the wire.....	21
Should I go SIA or transluminal?.....	21
Short wire problem:.....	22
Polar cath:.....	22
Outback catheter utilization:.....	23
Kissing iliac PTA/stent particulars.....	24
Recanalization of iliacs:.....	26
Targeted controlled subintimal retrograde external iliac recanalization.....	26
Diamondback CSI orbital atherectomy:.....	28
Closure devices:.....	29
Angioseal:.....	29
Prostar:.....	30
Proglide:.....	33
Starclose: by Abbott.....	34
Minx:.....	34
Brachial approach for SMA/renal cannulations:.....	34

Carotid stenting .....	35
Fem Embolectomies: role of angio....	36
Sherbrooke stuff: .....	36
Angiogram and run off:.....	37
IVC filter placement: .....	38
IVC filter Removal: .....	38
Tunneled dialysis catheter. ....	39
Replacing dialysis catheter:.....	40
Venogram:.....	40

## Tools of the trade:

**Wires: there are so many of them... Get to know 4 or 5 and use them regularly. Get to know what your colleagues and your competition are using and slowly expand your arsenal.**

You start with a starting wire (bentson, stor) , then use specialist wire (glide, PT graphics) to get across, switch back to the railroad wire for balloons and stents (SV5, V18, PT graphics).

**Bentson, 0.035**, – soft tip, can’t do any real damage, non-steerable, works fine most of the time... Work horse: won’t dissect, may cross lesions that glide wire won’t take. Was my starter and (most of the time) finisher of most cases in Sherbrooke and Ottawa.

**Stork wire, 0.035**, – stiffer than bentson, angled. Good starting wire. Can dissect if pushed, stiff enough for up and over exchanges. My work horse starting wire at present.

**Glidewire, 0.035 and 0.018**. (or zip wire from BS) are for SIA and they can get you past tight lesions. **Stiff straight glide** is my workhorse for crossing occluded iliacs, thrombosed stents and some occluded SFAs. Really is a very nice wire to cross. It can go subintimal but so can soft wires. I find it hold the lumen better and can actually stay intraluminally longer.

Dissect easily particularly if it has formed J. If it is stiff, you can balloon or stent over them. They are slippery so handling is not ideal - you can EASILY lose your access with this. You need to keep them dripping wet or they gunk up and stall your exchanges. That's why if you can, upgrade for other wires – Bentson or magic torque or V18 or Stork.

**PT Graphix – this one is my favorite, official wire of 2013.** It is glide wire at the tip, 0.014 steel body. I am not sure how it does it, but it can cannulate and go through very tough difficult cannulations, be it a thrombosed graft, tough crural cannulation, etc. AWESOME wire. You can use 4 Fr angiojet over it, it will support small profile viabahn.

**SV5** – 0.018 soft tipped railroad wire, not as stiff as V18.

If you want to deploy stents from 4 or 5 Fr platform, then 0.018 and 0.014 system and low profile balloons the way to go.

0.018 can be used to develop subintimal plane and is indispensable for crural work. Use co-pilot in crural vessels to allow injection over the wire (v18). Do not forget to tighten co-pilot knob before injecting and keep injections pressures low – you'll blow the valve. V18 and straight cath with co-pilot is very useful in checking gradients across iliacs without losing wire access.

**V18** is hydrophilic coated steel wire... Workhorse for crural work. May allow you to work without crossover sheath. It has very soft end **but is able to dissect and perforate if pushed far**. DO NOT push V18 past 2 nd branch in renals – you WILL perforate if it slips forward – perinephric hematoma is a major disaster...For the work other than tibials, you can use Platinum Plus wire, which is non-coated steel 0.018 wire that won't slip out like V18...

Steelcore is Abbott's version of V18.

**ThruWay - 0.018** body and 0.014 tip... it is 180 cm but has an ability to get an extension up to 300 cm. excellent for renal cannulations and delicate work... it is made by BS,

For tricky crural lesions, we have things that can be learned from interventional cardiologists. They routinely use 0.014 wires and they make a huge difference in select number of tight crossings.

Very useful wire in this realm is Spartacore. In Galichia Heart Hospital it is the preferred wire for renal angioplasties. It has soft end, shappable (hence – steerable) that very quickly blends into stiffer body that will allow you to track a PTA balloon over it with minimal purchase length in the renal (without kicking out into aorta). It is useful for crossing near occlusive lesions in tibials as well but it requires 0.018 or 0.014 bases balloon catheter for support.

Grandslam is another 0.014 wire – but it is more stiff compared to Spartacore.

Whisper – can get through toughest lesions. 0.014. Last resort for many cardiologists.

Cardiologists tell me that in selecting 0.014 wires, technique is probably more important than the wire itself. They have a select 3 wires that are used progressively. Most popular starter wire is Balanced Middle Weight (BMW). Other alternative – Asahi Soft. If lesions is tight and chronic –

go to hydrophilic – e.g. pilot 50. Next step up - hi torque Cross it or Whisper – (come in low and high support stiffness wise)  
Last resort - Miraclebros- 3, 4.5, 6 – numbers correspond to increased support – and chances of perforation.

There are cute little wires that are specialized for specific conditions –e.g. Hi-Torque Wiggle - good for instant stenosis - won't go between stent and wall, stays intraluminal.

There are other wires to chose from as well, and it gets bewildering...

hi torque iron ma  
thunder  
asahi prowater (3 cm, 20 cm)  
grand slam (4 cm)  
confianza  
pilot 50 1.5 cm transition, 3 cm end

## Balloons:

Check delivery system French size and Length and make sure you balloon is long enough before you open it: 80cm delivery in CL setting will reach ONLY to medial femoral cortex – i.e. just about middle of Hunter's canal.

You may have to take several shots of CFA bifurcation with extreme RLO if necessary to make sure you know exactly where profunda takes off - you don't want to cover profunda or balloon across it.

**SFA - 5-7 mm,  
pop - 5 mm,  
peroneal 2.5-3 mm.**

Older females SFA dissect VERY easily – so ALWAYS undersize them unless you are prepared to stent.

Balloons come in two categories:

Compliant – majority – i.e. they will change diameter depending on pressure. Nominal pressure will give you rated size, but you can go over rated size by 10-25% for some balloons if you take them to burst pressure. This may come handy as you can use one balloon and treat entire 5 mm SFA starting nominal pressure distally and going to burst proximally – risk of dissection with oversizing is higher in distal SFA.

Non-compliant – maintain their size at the range of pressures.

Most commonly utilized balloons go over 0.35 wire. 0.018 based balloons generally have lower profile – easier to cross very tight stenosis. If you have access to cardiac cath – you have an access to 0.014 balloons – and they may come in handy for renal work and small crural vessels.

Crural Balloons :

- Symmetry balloons – low profile 0.35 system
- Sterlings, Savvy, Fox - 0.018 system.

If you have 0.014 wires, plan on using 0.014 based balloons e.g compliant balloon by Abbott - Voyager Rx... Sizes go up in increments of 0.25 mm 2 to 4 mm, 20 and 30 mm long. You can use balloons for support, or chose quick cross 0.014 cath for that.

Do DSA, mark the beginning of the target lesion, start ballooning from distal to proximal and continue ballooning up - correlate with preop angio. When balloon is up, mark the upper end of it with kelly to know where to place it next and adjust position of the table preparing for the next ballooning. Observe inflation pressures (critical in iliac region) and leave balloon up for anywhere between 30 sec to 3 min. There is no good evidence but some believe longer inflation will allow for better positive remodeling of the wall. In Sherbrooke, they quick inflate first to maximum burst pressure, deflate it then reinflate for 30 sec only. In Pittsburgh and Ottawa – 3 min is the rule, however most places in NA will go for 1 min only. If stenting is contemplated, then minimal (up and down inflation will suffice).

## Stents:

**If you are going to use stents, make sure you select stent delivery length according to the wire length. There are two basic stent delivery lengths, 65-80 range and 110-120 range depending on the manufacturer - for 180 cm and 250 cm wires respectively.**

Stent- try doing it over stiff wire... but bentson may do just fine...

**Balloon expandable (stiff, for common iliacs) – palmaz, express, genesis, ev3, abbotts:**

- Offer very precise placement – you know exactly where proximal and distal end is going to deploy – unlike for self-expanding – due to shortening/lengthening of the stent, the proximal end may shift... Big deal in treating CL iliac lesion in up and over fashion.
- These are deliverable thorough 6 Fr sheath *except* large aortic palmaz AND anything above 8 mm Express that's is 57 mm long. Express comes in 17,27, 37 or 57 mm length.
- On the package for express, it states it needs 7 Fr but in reality you can get away with SHORT 6 FR sheath - but you have to push VERY hard...
- If going up and over, long 6 Fr (balkan, Raabe, ansel) won't work, need to either use several short 37 stents or switch to 7 Fr.
- Express SD - these are 0.014 and monorail, Express LD - these are for 0.035 system.

If going bareback, there is high risk of dislodging the stent off the balloon. It usually happens if tech inadvertently partially inflates balloon during priming loosening the stent, so always crimp stents in yourself before you get them in. Also, always deliver them through a sheath or at least under direct vision over straight arterial segment.

If you dislodge the stent so now it is sitting on a wire, try using low profile balloon and sneak back inside the stent, go past the proximal end and inflate the balloon dragging it to the place in the iliac where you can deploy it. If the stent is off the wire, you can either try grabbing it with snare or try caging/crushing it with another balloon expandable stent against iliac wall... NOT ideal but may let you get out of trouble and certainly is better than free-floating stent.

Balloon expandable stents are used in common iliacs. Some use it external iliacs, but I am not sure it is reasonable. Some believe that very short stents can be used for focal dissection in SFA and even popliteal... While balloon stents allow very precise delivery and come in shorter versions than self-expanding cousins, I have concerns about balloon expandable stents as they are crushable and non-recoverable...

Very useful stent is ATRIUM. Some 6 mm need 6Fr sheath, most others 7 Fr. Black box (older version) can be post dilated up to 12 mm. IT IS A COVERED stent. Good to seal off perforation or to treat in-stent stenosis.

### **Self-expanding:**

- Non-crushable – hence may be ideal for large iliacs and small distal aortas –
  - If sum total of proximal iliacs is more than distal aorta diameter, then you need to deploy stents JUST at the bifurcation AND kissing balloons are not a good idea – they will either need to be downsized (and this won't expand stents) or they can stress distal aorta if sized to iliacs' size.
- Precision of application applies to distal end only – deployed from distal to proximal end. Proximal end of stent may shift:
  - Stent can get elongated or compressed if there is slight movement deployment body. This is crucial when going up&over in iliac stenting, where proximal end needs to be just AT the bifurcation – you may deploy it too far in common or too much into aorta.
- Ideal for external iliacs
  - or X-over application of proximal common iliac stent in sharply angulated bifurcated aorta - balloon expandable may not clear the bifurcation
- EV3, smart, epic, medtronic
  - When you deploy the stent, it will open up distally first, **DO NOT pull on the stent after you deployed first cm of it** - it will stretch it and reduce its' integrity. Also, if you are trying to end the stent proximally at SFA origin, if stretched, you'll creep over and occlude the origin of profunda.
  - Epic stent - fix your right hand with deployment device to the table, don't move it, don't obstruct free travel of the triangular piece as graft is deployed...



- EV3 - fix hold distal flat knob, release the knob on proximal sliding part and then slide proximal part toward the distal while watching the stent
- Smart - just rotate the dial. It slips of the delivery devise easily after 50% deployment so don't try pulling on it.
- Smart stents tend to jump forward, Epic (BS) and EV3 creep forward particularly if going contra lateral.
  - So you'll need to
    - advance stent further than you need and pull back (this will take the slack out of stent)
    - steady pull on the stent initially for the first cm making sure it does not jump, then totally relax and let the stent deploy naturally.
- For SFA:
  - They say there are no ideal stents for SFA and pop
  - **The only FDA approved self-expanding stent for SFA and proximal popliteal is Bard Life Stent**, the rest (EV3, epic, smart) – are OFF label application.
  - **I looked at all stents side by side and when you place them in 180 degree flexion position, Lifestent gets LEAST luminal compression compared to EV3 and Smart.**

Abbott makes 3 and 4 mm self-expanding billiary stents: Expert. 0.018 system. Off label for crurals. Cardiologists love to use them below knee but their utility there is questionable. Possible bail out solution to a dissected single vessel ... Some say drug eluting stents have better promise for crural disease but I can guarantee - a hospital will freak if you use cardiac stents below knee as they are not likely to get reimbursed for these.

I have Promus stent (0.014) on the shelf, drug eluting stent, sometimes used in below knee setting for bailout.

VIABHAN – very nice stent. Covered. Now comes in lower profile. Can deploy up to 8 mm via 7 French, all 6 mm via 6 Fr. These low profile stents will need 0.018 system. Larger diameter (9 mm) may go over 0.035 wire. Largest (13 mm) needs 12 Fr sheath... This can be EASILY closed with 8 Fr Angioseal so you can still use this sheaths in cath lab without need for cutdown (or preclose with 2 6 Fr Perclose devises).

The last thing I always forget... Give plavix post SFA stent interventions. Limited use code for plavix in Ontario is 376. Make sure to give 300 mg po in recovery post sheath removal and then 75 mg od for 3-6/12. Also set up f/u in 1/12 for duplex for fu

## Catheters:

There is a bunch of them out there. Select your 3 or 4 favorite and stick with these.

Single curved/angled ones: - KMP, MPA, glide

Straight ones: glide/slip, quickcross

Crossover catheters (into CL iliac): ominflash, rim, C2, internal mammary, simmonds.

Complex curved – simmonds, internal mammary etc.

5 or 4 Fr angled catheters – used to support wire to cross lesions.

If you can get your hands on MicroTracker – DO SO: 3 Fr (i.e. 1 mm) low profile... I've seen it support a flimsy 0.018 Platinum plus and complete a successful SIA in peroneal occlusion in matter of 1 min when all the previous tricks (4 Fr slip, savvy balloon support) failed.

Quickcross – long catheter – comes in 0.35 and 0.014 configurations. Great for up and over exchanges with your wires deep in the tibials...

Smallest catheter there is... Marathon - 0.008 for neurorads

Cannulation of anterior tibial artery - use KMP (100 cm) or Vert (vertebral, hockey stick), and try using v18 with an angle - dent it over the handle of the blade, that would make this wire steerable. Once cannulated, you may exchange KMP for Quickcross - the long (150cm) catheter..

## Set up:

Most of these notes were originally written for C-arm in OR. Needless to say, with access to angio-suite this renders some of the stuff redundant.

**Rate of contrast infusion - equals normal non-aneurismal diameter of the vessel, i.e. for aorta it would be 15 cc/sec, for iliac 8 cc/sec, for SFA – 6 cc/sec over 2 sec**

## Positioning C-arm and the patient:

If the table is long enough (most new models), the base should go at feet. The table should allow unimpeded imaging of the chest, abdomen and legs without C-arm catching/pushing at the base...

For older shorter tables, the base should be up for infrainguinal cases, but it should be positioned down for iliac&aortic cases.

OR tables and control should be on the same side with you. So you need to think where you are going to stand and where you are going have the imager.

## Positioning for Right handed approach...

For ipsilateral R sided cases, stand on patient's Left side, have machine across from you, instruments behind you, and T-table at you right hand so that you can work with your R hand down stream.

For up and over, you can stay on the R side for the R and L sided lesions (but for L side you'll have to work around the image intensifier, hugging it).

Alternatively, if you are ok with left hand use, any approach is ok, as long as you let the nurses know where the equipment should be prior to the start of the case.

## SFA Angioplasty:

**Remember to Flush all sheaths frequently. If you do a lot of work with small diameter guidewires through 6 Fr sheath, don't forget to ASPIRATE first - as clots will form in the space between the wires and inner lining of sheath - with resultant embolism...**

**Cordis sheath has a peculiar advantage – if it gets thrombosed, you can pop off the cap and hopefully backbleed the clot. Cap goes back without much difficulty. Safest alternative is to back off the sheath, pull back some wire, press on the groin, remove sheath, wipe wire and replace it with the new one.**

## Principles:

**puncture – femoral (antegrade, retrograde or x-over CL) vs brachial vs pop**

**choose your needle – micro (stiff or floppy) or regular 18 gauge.**

**starter wire - always short bentson (glide will get torn by needle tip).**

**X-over wire access and catheter (rim, omniflash, internal mammary, C2, simmonds)**

**X-over stiff wire exchange - stiff glide (cheap) vs magic torque (expensive) vs V18**

**X-over sheath placement (unless decide to go bareback with low profile balloons)**

**Angios**

**Assess lesion**

**Cross lesion - transluminal vs subintimal**

**Consider need for stent**

**Exit strategy (wait for ACT <180, pull up to 8 Fr vs closure device)**

**Unless you work with ipsilateral access for iliac and very proximal SFA lesions, all wires should be exchange length 260 cm...**

## Antegrade:

Dr. Hill's favorite. Tricky - may get into profunda, hence puncture high at the ilioinguinal lig and aim for the mid CFA. If fails, be prepared to cut down.

- Place hemostat over groin below projected course of the ilioinguinal ligament
- Fluoro shot to ID medial 1/3 of the femoral head
- Incise skin
- *Micropuncture* needle access artery - **ALWAYS use stiffened type.**
  - *It has 4Fr catheter and stiffened dilator, comes with platinum 0.018 guide*
  - *Some micropuncture have ready 5Fr sheath to go over 0.018 guide – wont' track easily if scarred/diseased vessel, do use 4Fr cath instead, get stiff wire, then try sheath*
- Twist Micropuncture Guidewire to advance past the tip
- Confirm with fluoro
- Remove dilator (metal tip), cover opening of micropuncture catheter
- Advance Benson guidewire under fluoro, remove micropuncture catheter.
- 5 french sheath placement (or 4 Fr if just planning on angiogram).
- Also, for angiogram alone, some use omniflush or pigtail catheter bareback without the sheath.
- If using regular needle from the start, use J wire/or Bentson

**Note - if you use long 25 cm sheath, you can turn it 180 degrees, U shape it, and then you will have wires along side body directed to the foot of the table instead of flimsy side table. Make sure sheath does not get pulled out with you push through hard stenosis - the guidewire will buckle as you try to traverse it.**

Upgraded to 6-10 Fr sheath if you are planning to stent, otherwise, you can switch to 0.018 system, use monorail low profile balloons, and perform angioplasty through 5 or 4 Fr Sheath. You can get better angios through 5 Fr, but 4 Fr is sexy and cardiologist pride themselves on being able to do quite a bit through 4Fr design.

See note below about stents and sheath sizes... nothing is written in stone...new technology comes out all the time. Note, that advantages of 6 Fr for up and over is greater stiffness (easier to push) and ease of flushing when you have a 5 Fr Catheter in the sheath.

- ADMINISTER HEPARIN when 6 french sheath goes in goes in

Interventional radiologists and cardiologists do not use heparin until they are going to stent below inguinal ligament, or access renals/carotids. They don't use protamin freely so they need to consider angioseal vs 60 min pressure on the groin vs closure device post procedure if heparin is given.

- DSA to ID profunda and SFA.
  - Tilt fluoro head out ipsilateral 30 degrees to visualize femoral bifurcation.
- Advance wire under CF to target lesion.

Interestingly enough, Bentson wire will go through lesions (staying transluminally) when glidewire will dissect and go subintimally. It is not steerable, but very safe. So no harm trying to send Bentson all the way down to the lesion and past it... If that fails, then other –stiffer or more slippery wires (see below) - basically stiff bentson cousin can cross lesion transluminally where glide will go SI. That may be an advantage. Glidewires dissect, which may be a bane or a boon (if going subintimally intentionally).

- Place glidewire catheter to improve torque/direction as close to the wire tip as possible to give wire backing. You may want to exchange for soft glidewire +/- torque devise. Once close to the lesion, remove glidewire to do DSA to orient yourself.
- Get across (see below for details on SIA)
- remove cath
- place balloon or stent
  - undersize for females – SFA dissects very easily
  - keep balloon pressure low distally (nominal), go higher proximally
- completion DSA via glidewire cath or introducer sheath
- remove wires
- Do ACT.
  - IF > 180, consider waiting or reversing with protamine
  - when ACT < 180, remove sheath, place pressure above and below puncture for 15 min minimum

### Contralateral groin access:

- Always prep ipsilateral groin - in case if you need to switch if can't get over the bifurcation.

VERY IMPORTANT: make sure your glide wires are all 260 cm, NOT 180 cm... you will save yourself a lot of trouble.. e.g. you get you SHORT stiff wire across and all the way down in the SFA for good purchase, and then you can't exchange RIM or omniflash for a slip-cath because the wire is too short - so you lose your SFA purchase, the all wires flips out at the bifurcation - you are back to ground 0...

Stiff glide wire is in Brown box, soft glide wire is in Blue box. You need Glidecath 100 cm, not 50. Crossover sheath (Raabe, Destination, Arrow, Balcan) should be at least 40 cm long as you need to park it in CFA and have the injection port flush with skin to allow the use of the entire length of catheters. With the sheath, try not to go past the profunda at least initially to allow

profunda-geniculate collaterals to fill the distal end. When planning is over, you can advance sheath further for improved wire support.

To cannulate contra lateral iliac, may use Bentson wire or glide wire over catheter. Rim or omniflash catheter are used to get over the bifurcation.

### **Dr. Benko trick: turning Contralateral to Ipsilateral.**

**If you are doing bilateral SFA interventions, you can start contra lateral X-over then change over for ipsilateral. This may increase the size of the hole and, you punctured artery almost vertically and change direction without enlarging the arteriotomy, invariably you are looking at increasing the size of the sheath.**

Say you start with 6 Fr sheath. At first, you should get sauce or Soft Vue to reform in the aorta or CIA and pull it down in the common iliac. Waltman's Loop is fine too, see below. Get soft glidewire to redirect back into CFA and, hopefully, cannulate SFA. Go deep. Upgrade for stiff glide wire. Get Raabe 6 Fr SHEATH INTRODUCER (i.e. not SHEATH at first) or long 6 Fr sheath INTRODUCER, curve it, and dilate the tract watching the wire redirecting the wire downward. Then put 7 french (i.e. go one size up ) sheath over the wire: you want to use 7, since you want to have a tight closure around your arteriotomy.

Matter is simple if you start out with 4 or 5 Fr sheath to go retrograde, image CL side, and then you decided not to do the intervention on the CL side but want to go ipsilateral. For ipsilateral turn, you don't necessarily need to upgrade your sheath to 6... To facilitate your tracking, remove sheath's dilator, load sheath onto KMP or glide catheter, then advance the glide catheter into the artery. Then you slide sheath over in place.

### **Turning Ipsilateral to Contralateral.**

You can start with 5 Fr and do IPSILATERAL recanalization/SIA. Use 4 Fr based glide catheter. 0.018 system low profile PTA balloons may be required. You can even stent over 0.018 but 0.018 based stents are short - there are no 10 cm stents. If you do have to put a 0.035 based stent, and it is ipsilateral approach, you can simply remove the sheath, and put the stent bareback onto the wire... This is not as solid as with sheath, and there will be slight size discrepancy between 5 Fr hole and stent requiring 6 Fr sheath, but this will work. At least it works in Sherbrooke. Note you'll need to carefully mark your lesion and don't move pts as once the sheath is gone, you are deploying stent blindly. Do road map – helps. When puncturing grafts and ipsilateral vessel, where you don't want big hole in the artery – consider going 5 or 4 French based.

Use 5 Fr sheath, leave security blanket wire in SFA, pull the sheath until it's tip is barely into the CFA. Introduce glide wire or micro-puncture wire with tip turned for steerability through the same sheath. If you have 6 Fr sheath - it's even better, it will accommodate slip catheter for steerability. Then it is a matter of luck and skill to get up into external iliac and into aorta.

Once there, exchange wires for bentson, remove your security wire from SFA (you don't want to burn bridges before that), then load your sheath onto KMP and reintroduce in a retrograde direction. You can use angioseal to close artery...

However, be careful as I have CFA dissection with this monkeying around. So weigh your risk and options.

### Can't get over the bifurcation:

**Remember:** *if using 4Fr omniflash you can do angio/x-over bifurcation. BUT: you'll need to have a power injector. Also, the tip of the ominflash (shaped like a tennis racket) is very flimsy... When you try to reform it in the aorta (i.e. to get it into the pre-determined shape once the wire is out of it - you do this by pulling the wire down and pushing omniflash up) - you can actually TWIST the tip or the entire head of the catheter - you won't be able to advance the wire afterwards... The only way to go about it is to either untwist it, or perforate the catheter (which I've done inadvertently) ... then slide the catheter out, and replace it, being more careful next time...*

- Visualize bifurcation and iliacs clearly on preop angio - i.e. AP straight shot to see the anatomy. Also, get oblique views as you won't see posterior wall and that's where calcifications are most commonly found. Check out the bifurcation angle, if is acute and there is iliac tortuosity, then anticipate trouble... Get old angio for that if necessary.
- Place tip of Rim into the orifice of iliac, CONFIRM with quick dye injection.
- Can't get glide past the proximal iliac..
  - Do roadmap. IF you have purchase in proximal CIA, try exchanging Rim for glide cath: this will allow you to advance the glide cath slightly further into proximal iliac. Place torque device on wire and see if you can get wire into the internal iliac - this will give you purchase to advance catheter further. Once catheter is at the iliac bifurcation, steer wire further.
  - Occasionally switching to stiffer catheter (KMP) may improve steerability but that is not always possible: soft wire will kick back if you try advancing KMP over it...
- Advance guidewire deep: to SFA or profunda (occasionally, circumflex iliac a). then exchange rim for straighter catheter - usually angled glidecatheter
- Get catheter deep into SFA, then try getting a magic torque wire through it
- IF stiff wire (Amplatz, Magic Torque) kicks out the glide catheter, then try to place **stiffer catheter** - KMP and get magic torque wire across that way.



- If KMP is too stiff for the glide - i.e. glide wire gets kicked out, try using 4 French glide cath and use **stiff glide wire (not as stiff as the A & M)** over which you can get KMP.

Say, you got your magic wire across but you can't get the sheath to go past the bifurcation...

- You need to *splay open the bifurcation*, so you use amplatz wire over KMP, and then you get your sheath over.
- Amplatz superstiff wire can be stiffened further by having assistant hold the wire and pull it apart - this will slide the outer wire covering over the mandrel and may give an extra bit of strength to allow sheath to go over the bifurcation...
- Preloading sheath on KMP catheter is useful as well – it will make sheath less stiff but will hide sharp edges of the sheath to prevent endothelial snow plough.

To get sheath out, always put dilator in, then watch the bifurcation on fluoro...

Finally, if you still can't get the sheath over, get 0.018 wire stiff across, use Tue Boersts (copilot) on 0.35 balloon and do your procedure without the sheath – less optimal but what can you do? Interventional cardiologist often go bareback with a stiff wire up and over with no crossover sheath. They do this to keep the smaller sheath size and keep volume of injection low – you are forced to use small diameter hand injected catheters with co-pilot over 0.018 system. This means that all PTA and balloons are done blindly and require exchange for a catheter to inject dye to check results (unless you try injecting through the balloon – however, it offers only very low flows).

### **Going up and over aortobifemoral graft bifurcation:**

It is said you can't cross bifurcation of the ABF graft or kissing stents... It all depends, according to Dr. Benko, to whom nothing is impossible, it seems. If kissing stents are deployed flush at the origin of the iliacs, then you can try... “Endovascular Skills” book by PS tells me that 0.025 wire (now, try finding one!) is nimble yet strong enough to bend over and maintain good shape to go over the ABF.. But I've never see this done. Besides, after you crossed over, you may not be able to get sheath across or run the risk of mangling iliac stents in trying to do so...

If you can't get through the bifurcation with the sheath, then you still can do a couple of things. First, if your wire does not go past bifurcation (as in very acute angle or in ABF graft), you can get ipsi puncture, size 4 sheath, get snare and grab wire to bring it down to the ipsi groin. Then you can either pull it out from the ipsi groin and do a tooth floss with stiff wire, or, if you can bring the wire into ipsi CFA, you can compress the CFA completely, pinching the wire between the A and P wall of the CFA and then you can try and push the sheath across. I'd recommend actually taking the wire end out through the sheath, though.



If you can get a tip of the sheath introducer across, you can try shimming the sheath forward slowly as the introducer is about 3.5 cm longer than the sheath thus getting slowly ahead. If the system does not back out, you can then advance the introducer forward and keep on slowly creeping along.

Try getting 4 french sheath (long) inside the 6 Fr sheath. Park tip of the 6 french at bifurcation and slowly shimmy forward 4 french sheath on the the introducer. Then advance 6 french over stiffened highway. There will be small gap so mind the plaque.

You can try getting stiff wire (lunderquist) once you have 4 Fr. Sheath up and over.

Finally, if 4 French sheath went over, get a balloon, say 6 mm, to get to CL CFA, inflate it, compress it from the outside and then shimmy 6 Fr sheath up and over 4 french sheath and balloon.

If all else fails, just go ipsilateral - you can either turn your ipsi 4 Fr sheath or repuncture, but that may be difficult...

Once get wire access, push angled catheter to the other groin, replace for stiff wire (Magic torque for Nagpal), place crossover sheath, and over it place glide cath and glide wire to target lesion. If your target lesion is in the internal iliac, then you just keep the floss wire in place, park you sheath opening at the Internal iliac, and enter the internal iliac with a catheter in the sheath that is advanced as a buddy-system next to the floss security wire. You need to keep the security wire in place since the tip of the sheath may get kicked out if you have to work in short Common iliac artery...

## **Subintimal angioplasty stuff.**

This refers to total occlusions... If you have a lumen, staying in the lumen with angled guide catheter/straight wire (or straight catheter/angled wire) is the way to go. Bentson will cross most of the lesions. Hydrophilic wires – be careful as these dissect easily. For very small residual diameter arteries, may even chose 0.018 or 0.014 delicate wire with cath support to stay in the lumen.

However, when approaching total occlusions, there are 2 choices – transluminal vs subintimal.

In general, SIA gets you a cleaner plane and final appearance than transluminal. They like this technique in Europe, in NA some use it intentionally, some avoid it. In Sherbrooke, they believe it is preferred in claudicants as you can get away without stenting it. The worst that can happen after the procedure, the Subintimal space may simply collapse with no negative outcome of downstream thrombosis and distal clot propagation. This space, in their opinion, can be re-opened again and again if necessary. However, once stented, the collapse of the SI plane won't happen and the repair will fail through thrombosis with the risk of distal propagation & embolism. From what I've seen, however, stents fail not through thrombosis (unless it is in

acute postop period) but through intimal hyperplasia – gradual stenosis that can be detected and treated in time....

In Sherbrooke, they prefer to get in to SI plane right away. In Ottawa, transluminal approach is preferred.

To get SIA, get the glide wire to make J. It is preferable to use a SOFT glide to start with – stiffer one, while allowing for better pushability, tends to create larger diameter loop and, if media is calcified – it may rupture adventitia and cause extravasation.

Forming a J happens through jerky movement of the soft glide wire tip. Occasionally, you may guide the tip in the collateral, and then gently advance the catheter forward thus forming the loop. Also, you may see wire go in a spiral pattern.

Advance 3 cm then advance the supporting catheter. When getting subintimal stard, you may want to use angled glide catheter (gives you direction) and soft glide wire. Don't let wire coil excessively in the subintimal space - you are about to perforate the vessel. Using straight glide catheter may improve your chances of going intraluminally. If can't get into SI plane, you may start subintimal with the tip of the catheter and that will get things rolling...

**What if you can't get into SI plane? Use stiffer catheter - say vertebral Davies - ONLY to start with, and stiff wire - that will allow you to dig in and develop you J (while risking a perforation)... Important: once in SI, switch to glide cath (may use low profile 4Fr - but it is less stiff - less support) and soft glide; continue with that - DO NOT use stiff vertebral catheter as you will surely perforate...**

Getting along the very narrow and diseased vessel can be facilitated by 4Fr glide sheath instead of 5 Fr... But gaining on lesser profile you'll lose on lesser pushability. In this case, consider advancing longer sheath into proximal SFA for more support... Occasionally you may have to switch back to 5 Fr. To decrease friction, you may pre-dilate tight passages along your track with small balloon. This will allow you to continue to follow your glide with supporting catheter. This particularly applies in crural vessels, where tight stenosis may prevent you from advancing your catheter to the tip of your wire....

### **Sherbrooke technique of SIA...**

**Starter wire always bentson, 180 cm. start with 4 fr and upgrade to 6 fr balkan only if stenting or can't get across the lesion without sheath support.**

they start with crossover, 4fr short sheath and try to get into SIA plane early with soft angled glide wire (they call it Kayack here) supported by 4Fr glidecath, angled (slip cath). If it goes easy, they just carry on with it. If not, then they get 6 Fr Balkan sheath (into CFA level only) over armplatz superstiff and they try again. They believe in starting SIA plane early to get clean

start and finish. They always have Outback ready so that they have virtually no problem with re-entry. they use it 1 or 2 a month, or so tech told me.

There is a nice trick with angio suite set up... Because they can convert their stepping angiograms into roadmaps (Roadmap -> Sub-mask->save mask then fluoro regular - R screen will have roadmap), they simply go from one saved angio imaged to another adjusting the up/down position of the bed (they make sure they don't move the image intensifier, or bed to and away from the operator) - thus easily reproducing same body position. Saves on dye big time. Also, they do manual runs – Cine (cardiologists love this, they don't use DSA as often) - i.e. they set Fluor to rec-Fluoro and then inject dye through sheath while sliding the table manually down, thus manually chasing bolus down into the calf... Saves on dye.

For small vessel visualization, obtaining image in roadmap setting gives you very stark clear picture of bright vessels vs black background. Downside – can't get bony landmarks...

### **Waltman's Loop, or turning C2 into Simmonds catheter...**

This was demonstrated to me doing uterine artery embolization bilateral with C2 and bentsons. This will allow you to reshape Kumpe (KMP) catheter, glide or C2 into double curve catheter (simond's equivalent to allow ipsilateral cannulation of internal iliac artery. Use C2 GLIDE cath version (but I am told any old regular C2 would do), via 5 Fr. Cannulate CL side first, then form a Simmond`s equivalent catheter about 6 cm into the CL iliac: put stiff end of bentson up to the level of aortic bifurcation and push up into the aorta. This will bend the catheter in two at that point and will drag the tip into the aortic lumen but this time it will be pointing downstream. Then pull back the catheter into ipsilateral iliac and try to get the tip to fall into the ipsilateral internal. Same can be done with Kumpe or other angulated catheter.

Incidentally, for ovarian ablation, cannulate anterior division of internal iliac artery, go to uterine a (transverse), then use high flow Renegade 0.018 catheter and Tracker 0.018 wire (less stiff than V18) to go past the cervical branches. Inject microspheres suspended in NS/visipaque until you see refluxing of the dye into uterine artery. Spare cervical branches (otherwise dyspareunia). Pt is either given epidural post op or PCA - she will be in pain for the next 24 hours...

### **Can't re-enter the lumen after subintimal.**

Re-entry is most difficult. Most of the time you just fall back into the lumen. Sometimes, it is a royal pain.... When you approach the point of reentry, shoot angio via Raabe sheath parked over profunda - collaterals will fill in the distal stump. DO NOT inject more than 1-2 cc of dye in subintimal space.

Outback (Medtronic)? Expensive, ideally need to see distal circulation, so if your sheath is in the SFA, and profunda is not perfused, geniculate branches will be closed... Very expensive. Pioneer – IVUS version of outback.

Develop SI plane all the way down to the distal SFA/prox pop. Try using straight glide, stiff glide, V18 wire, magic torque. If still can't re-enter, you either do Outback (see iliac recanalization for technique), Pioneer (if you have IVUS and cash) or consider opening up a little... If you had a tough go so far, crossed TASC C lesion and can't re-enter, some may not like going for open re-entry and prefer to go with bypass. However, if you choose to preserve, here is how it is done.

### **Dr. Jetty open re-entry cutdown technique:**

Make sure your subintimal dissection wire is in the distal SFA...

1. inform anesthetist what you are doing, tell it's going to be 45 min, patiently endure unbridled scorn. Get back at them asking to check ACT and top up heparin. Keep access to the wires in the groin, re-prep the knee if necessary. You will need access to the wires.
2. place catheter over the wire as far as it will go. Leave wire in the subintimal plane. Make sure catheter is at least 100 cm for ipsilateral and 150 cm (that means, quick cross cath, the longest cath on the market) for contra lateral approach. You need to have catheter long enough to go into peroneal, or at least tib-per trunk.
3. expose distal SFA and prox pop, control prox and distal with loops.
4. locate the wire and the catheter travelling under the very thin adventitia. Transverse arteriotomy, extricate the tip of the catheter and wire.
5. locate true lumen distally. Place tip of the INTRODUCER for the 6 Fr sheath in it, shoot an angio through it to see distal pop etc.
6. feed the wire that you extricated from subintimal space into the introducer, confirm placement into distal circulation/true lumen with angio.
7. pull out proximal portion of that wire out of the catheter. This will allow you to slip out the INTRODUCER, then rethread the end of the wire back into the catheter.
8. remove the loop from the wire by gradually backing the wire into the proximal catheter. Then, when the wire and cath are totally within the vessel, advance catheter distally under vision.
9. Close arteriotomy taking care not to include the wire/catheter in your stitches.
10. loosen vessel loops, then stent the distal re-entry point true lumen. May stent as far as the top of patella. use flexible stent (EV3 or Viabahn).

11. Recheck your arteriotomy after stent.

### **How to salvage non-re-enterable situation: re-entering in the middle of the SI plane, not at the tip of the wire.**

**Don't get me wrong, you DO need to re-enter before you finish your SIA, just the re-entry does not take place where you prefer it at the tip of the wire... Here you are hoping that you've gotten into transient re-entry along the course of dissection, did not create perforations, and assuming that SI plane distal to the re-entry (where your wire tip is hopelessly parked) will eventually seal off and close... One important condition: you have to have flow into the distal circulation signifying that you do indeed have the re-entry.**

Here is what I mean... Suppose you developed SI plane around an occlusion in mid SFA. But can't re-enter no matter what. So you got the wire up to the top of the patella but no re-entry. you shoot DSA, and it shows that the distal circulation is open and somehow you've re-entered or created a hole in the intima somewhere along the course of the SI dissection but got back in the SI space. That means that the wire is in SI, then goes briefly into true lumen, then back into SI space.

Consider doing angioplasty of the area where you think brief re-entry took place - that may actually create a stable non-flow limiting dissection with re-entered blood flow that will reperfuse distal circulation.

Beware, though, that if you have a perforation and no-re-entry anywhere along the course of the SI plane, you'll reperfuse this perforation and may make matters worse....

Dr. Nagpal sometimes blows up a balloon in the SI plane and that gets blood in and creates re-entry but I haven't tried it yet... It may help, but also make matters worse - will create very wide SI space that will occlude the true lumen and won't let you use the outback to get in (see outback notes.)

### **Should I go SIA or transluminal?**

SIA will give you prettier picture, smooth nice DSA the only areas of irregularity on entry and re-entry. According to Dr. Benko, if subintimal plane occludes, it would be due to the mechanical causes, it just shuts down with little or no downside... Problems begin when you have flow limiting > 30% dissections at entry/exit... Then you consider stenting... While stenting will improve the appearance AND likely durability of your repair, the downside is - if the stent goes down, it does so through thrombosis, it can't simply collapse... it will also keep the SI plane open to thrombose as well and that can lead to problems - i.e. embolism and trash and conversion to critical limb ischemia....

Transluminal AP usually give your uglier messy DSA and you are more likely to consider stenting just to improve the appearance and sort those borderline 30-40% out... Beware of perfectionism, though, as stent, while improving things in the short term, can convert a claudicant (which, hopefully, you were forced to take to OR with much reluctance and admonishing that he should instead quit his evil atherogenous ways) into a dismal critical limb ischemia patient...

### **Short wire problem:**

In the heat of excitement and against better judgment you started doing SIA on X-over approach in the crural vessels with 180 cm glidewire... Say you got carried away, made good progress but your catheter is too short/or you can't track it so it is stuck 10 cm from the tip. So that means, if you got to the mid tibial vessel, you have only 10 cm of wire sticking out of the groin and you can't safely exchange a catheter (for a less/more stiff/trackable one... or a balloon)... So after you wiped the floor with your dignity you may still try something borderline on cowboy stuff...

#### **Option 1:**

You can still exchange the catheter PROVIDED that the wire can't really move forward and dissect stuff - i.e. as in SIA situation where you haven't re-entered yet... I.e. you can't use this for free floating wire that can continue going and going and going... Start sliding the catheter out, then push the stiff end of the bentson vs the end of your short wire and continue sliding the catheter - now over bentson - without moving the bentson and always watching where the tip of your wire is on fluoro... Then you select the lower profile catheter or balloon to increase the traction space, load bentson over your new catheter stiff end first, and, pushing with this wrong end vs the old wire in the pt you then slide in your new catheter...

This is not ideal and will only work provided your old short wire can't move forward...

#### **Option 2:**

Other final alternative is to try slide V18 wire alongside 5 Fr catheter to the level of the tip of your glide wire and then do the exchange for the longer catheter.

#### **Option 3:**

I've also done some experimenting with getting a 4 or 5 Fr catheter into an exchange monorail catheter. Make a hole with micropuncture needle in the distal end of it. Insert the short end of the wire in a retrograde fashion through the distal orifice of the exchange catheter and let it emerge through the hole you created. Then slide down the catheter up to the level of the distal end of the wire - you can push it down in a monorail fashion. It actually works well.

### **Polar cath:**

Does not work well, many think it's on the way out...

**position balloon**

**protect balloons plug from moisture - remove plug cover and connect to the unit.**

**screw in cooling gas container**

**red light will come on - CHK VAC - that means you need to aspirate all air from balloon with syringe until message goes away and indicator turns from standby to ready**

**Press button ON**

**wait - the machine will cycle through testing, to treatment, to warning light. Do NOT disconnect balloon during WARNING light - do that only when DEFLATE comes on.**

## **Outback catheter utilization:**

Get an outback catheter: can be rotated and made to protrude *radiolucent* needle to the side into the true lumen. Needle is hollow, so once the needle gets into true lumen, one then can thread a wire into the true lumen.... It uses **0.014 wire i.e. mailman... (300\$)**.

Position wire in subintimal, may use glidecath to inject A LITTLE bit of dye to confirm. Inject some die via rim/omniflash and see where the lumen is and what is the position of the subintimal space.

Outback:

Do lat and AP projection:

L point to the side where the sharp re-entry hollow needle will point, T is how it is seen in AP projection.

If OB is located *posteriorly or anteriorly*, then orient outback to be T in AP and L in lateral. If outback is lateral, then in AP, you should see L and in Lateral - T.

Once the OB is oriented, advance the needle... you may check the position of the needle again in AP/lat projection but you need to advance a tip of platinum end of the mailman to opacify fluoro-translucent needle.

*Important caveat: if the subintimal space is too wide, the catheter will bow backward and the needle won't be able to penetrate the media/intima. Calcification will make the penetration harder as well.*

Then, hopefully, you'll be able to advance the mailman in the true lumen. Occasionally you'll need to use a back end of wire to poke through the tough intima. You'll know if it is in true lumen if the tip of the wire flicks around with heartbeat, plus AP/LAT projection. Also, if the lumen of the vessel you want to re-enter is small, you may have to partially withdraw the needle into the outback first before advancing your 0.014 wire. The other challenging part is trying not to bend the 0.014 wire when exchanging Outback for Sterling or Savvy low profile balloon. The wire is very fragile....



**OK, you've reentered with the wire...** Now try to advance glidecath over and confirm placement with and injection. Problem: glidecath won't advance - too much of a protruding profile...

Options:

- use quick-cross catheter (remember to switch to 260 cm glide wire first);
- use glidewire with the very tip cut at a slant (sharp PJ-Sharapov modification);
- savvy balloon (say 2-4 mm) and that always gets across.
- Have seen introducer of the long 6 Fr sheath used to poke through - but it's not radiolucent, so beware about snowploughing etc....

Savvy are monorail - i.e. NO second injectable lumen. Once in place you won't be able to use them as injection catheters with copilot. Once tight lesion is crossed, inflate the balloon, open up the space then advance glidecath and exchange for glidewire or something stiff.

Once balloon is in place, switch 0.014 for the main ballooning wire system - which for these balloons is is 0.018

Do kissing balloon on both iliacs and inflate simultaneously. Have fluency on standby. max 7-9 mm. Then put 7-8 mm express bili stent - deploy them simultaneously.

### **OB has a couple of quirks...**

First, once the needle is deployed into the side lumen of the catheter, if you then decide to withdraw the needle back, you may not be able to advance the floppy tip of 0.014 through the end hole of the outback... it will tend to come out on the outside...

Secondly, if you decide to withdraw the mailman with the needle of the outback engaged in the side lumen, the edge of the OB needle can scratch the plastic cover off the flexible tip of the mailman and ruin it... This may also dull the needle and make it jagged (hence precluding repeat use of OB). HENCE: WITHDRAW NEEDLE FIRST, then remove the wire...

### **Kissing iliac PTA/stent particulars...**

Best way to assess HD significance of stenosis is to measure a pressure. There are two ways of going about it.

- Simultaneous 6 (5) Fr sheath in EIA and 5(4) Fr catheter in distal aorta
- Pull back 5 Fr Cath over wire from distal aorta to external iliac slowly



Measure the size of distal aorta and common iliac arteries first... Decide if you need to;

- use balloon expandable (most common choice) vs self-expanding stent
- up and over vs b/l retrograde (preferred)
- b/l kissing PTA expansion vs unilateral balloon

If sum total of proximal iliacs is more than distal aorta diameter, then you need to deploy stents JUST at the bifurcation AND kissing balloons are not a good idea – they will either need to be downsized (and this won't expand stents) or they can stress distal aorta if sized to iliacs' size.

Raising the bifurcation will make it near IMPOSSIBLE to access CL iliac in up & over fashion down the road.

For self-expanding, precision of application applies to distal end only – deployed from distal to proximal end. Proximal end of stent may shift:

- Stent can get elongated or compressed if there is slight movement deployment body.
- This is crucial when going up&over in iliac stenting, where proximal end needs to be just AT the bifurcation – you may deploy it too far in common or too much into aorta.

Kissing balloons/stents are not essential – as long as you have wire across both iliacs, it is SAFER to dilate/expand iliacs one side at a time. If there is significant size discrepancy between distal aorta and sum total of iliacs – DO NOT USE simultaneous KISSING technique, go one side at a time with wire across.

You can deploy stents over glide wire or bentsons or stiff - depending on how tortuous the arteries are... With glide wires – watch out – stents (particularly self-expanding) tend to move at the very last moment. Unlike SFA, don't oversize iliac stents beyond normal arterial caliber of the receiving vessel. Both self- expanding and rigid stents can be used in common iliacs.

Don't cheap out on the wire length - you'll need all of it so choose 260 cm wires, not 180, or else you'll keep slipping out the aorta and, hence, lose your access.

You can use pig tail parked over the bifurcation or simultaneous injection of 6 Fr sheaths with contrast (use two person injection).

Place express stents (their length always ends with number 7...) at the same level.. May chose to pre-dilate with balloon first.

When exchanging catheters, ALWAYS hold your sheaths - they will pull out and you'll need to control the bleeding and reinsert them with introducers. Does not look good plus unneeded blood loss.

Do back injection through 6 Fr sheaths. Done.

Say, patient develops back pain and drops her pressure post stent deployment.... First thing, DO NOT LOSE your wire access, move your balloons from stent deployment further into aorta and inflate these, notify anesthesia. Then back inject - WITH POWER injector - 6 French sheaths and see which iliac is bleeding. If you see which one, get a 14 Fr sheath into opposite groin, then advance Coda into aorta (you'll need to deflate stent balloon first). If this works and pt stabilizes, you'll need to send for covered stents (fluency, viabahn) to cover ruptured iliacs. Will need large sheaths. Otherwise, you are looking at laparotomy aortoiliac/fem bypass...

### **Recanalization of iliacs:**

Try going antegrade from up and over from contra lateral approach. Brachial is also appropriate. Position Rim or omniflush over bifurcation above and glidecath from below, inject dye simultaneously, ID occlusion and its' extent, mark out on screen.

Try to go intraluminal – in this case angled cath and straight glide wire may do the trick – but outline starting, ending and projected course of the lumen with bilateral DSA first. Some people use Fronrunner to start dissection and stay intraluminally. However, I find that most of the time you don't have a choice – the wire takes path of least resistance and it may be intraluminal or subintimal. If you take subintimal plane, it is likely to end up on the posterior of distal aorta. Then you face the problem of re-entry. Stop wire at distal aorta – subintimal plane can dissect all the way to the renals – so be careful. Outback may be an option but if this is TASC D lesion, may want to consider open reconstruction.

Have Fluency covered stents (or Viabahn) in the room, as well as 12 Fr sheath and Coda balloon (for aortic occlusion, coda needs 10 Fr sheath at least), plus 7 mm balloon (for iliac rupture) in case of rupture...

### **Targeted controlled subintimal retrograde external iliac recanalization**

Over the past 2 years I have utilized this technique for recanalization of occluded external iliac arteries in patients that are not good candidates for open iliofemoral reconstruction with 100% success.

It relies on creation of subintimal re-entry spot via open iliofemoral endarterectomy and patch in distal external iliac artery and selecting entry point into subintimal plane on the proximal enteral iliac artery.

1. endarterectomize occluded CFA and distal EIA for a distance of 1-2 cm by eversion technique. Patch and reconstitute flow from profunda and SFA. Ensure to remove ALL intima and plaque from distal EIA on the side of occlusion. This creates controlled re-entry site.

2. retrograde puncture patch with 7fr sheath, attempt to traverse transluminally with straight stiff glide wire or wire of your choice - 25% chance you will re-enter in distal CIA. If can't re-enter, before you break out Pioneer or Outback go to next step.

3. contralateral puncture CFA, retrograde. Go up to bifurcation, cannulate CIA on occluded side, navigate to distal CIA and then hopefully into Internal iliac. Upgrade to stiff glide wire over 4Fr catheter, advance 6 FR up and over into internal iliac then pull back into distal Common iliac. If can't get enough purchase into iliac to advance up and over, then select 8 Fr RIM catheter - it will be stiff enough to hang into your common iliac for the next step. If you can't get good purchase into CIA on the affected side, go from brachial or axillary puncture with 5 FR catheter.

4. navigate 4 Fr angle catheter into distal CIA on the side of occlusion. I usually use straight stiff glide wire to cross all of my occlusions. It will undoubtedly enter subintimal space, or may traverse transluminally. I have not had it perforate but sure, this can happen. Use soft glide if you would like. Here is where you chose where to start your dissection.

5. push your wire until it reaches your patch, it will pop into CFA - subintimal re-entry site that you chose. Then I usually cannulate my 7Fr sheath with wire, pop out the cap on the sheath, deliver the wire (use long wire), replace the cap and feed catheter of my toothflossed aorta from occluded side up to the level of aortic bifurcation as I back out contralateral catheter and sheath. I then redirect ipsilateral wire into aorta. Can use snare (more expensive).

6. predilate occluded tract, figure out take of internal iliac and end of you patch, use covered stent to open up external iliac.

I used this technique over past 2 years on variety of complicated elderly patients with no real open option due to comorbidities, to get inline flow through their occluded external iliac arteries. you control where you start dissection and where you finish. Femfem bypass? well, this technique will allow you stay away from the contralateral groin and will allow more physiologic reconstruction with better flow.

This can be used for occluded common iliac arteries as well with brachial/axillary approach to select re-entry spot.

## Diamondback CSI orbital atherectomy:

CSI makes orbital atherectomy device. 6 Fr compatible wire with eccentrically mounted burr that spins at either 60, 80 or 120,000 rpm. As it spins, burr shaves off the calcified plaque. Debris is uniformly under 2 microns, or 1/4 the size of the RBC, and so far no detrimental effect of distal embolization have been noted if one follows the protocol. Theoretically it is possible to inundate distal outflow if work times are long, and complete occlusions are opened. It is different from Silverhawk atherectomy device as Diamond back does not shave off the plaque – it pulverizes it and works better on calcified plaque.

Another interesting aspect of the burr is that it shaves off calcium, but would not harm soft tissue significantly, i.e. media/intima - according to the company. Also, company has changed the protocol for the device as the goal of treatment is not to eliminate plaque completely, but to modify it, shave off the hard component, make it more compliant and then balloon angioplasty at low (half nominal) pressures with results that would not require stenting. This is big deal for the below knee angioplasty.

Generally device is contraindicated for clot, in-stent stenosis (don't want to catch a strut at 120,000 rpm) and subintimal space at high settings (avoid perforation). It is ideal for transluminal crossing of total occlusions in tibial and even SFA.

There are two types of burrs. Original is called "classic" - which is a short diamond coated band that is flexible and allows passage into tortuous vessel (prox AT). Predator - is a longer burr that is ideal for straight vessels (e.g. peroneal, PT, distal AT).

There are several sizes for burrs - 1.25, 1.5, 2, 2.5 mm. But the faster burr spins, because of its eccentricity, the wider is the diameter of the path it carves. So a 2 mm burr will carve out a 4 mm path.

So basic use is to visualize the stenosis, place 6 Fr sheath above it, cross the stenosis. Dr. Makam (very experienced cardiologist at Munster hospital, Indiana, who was very kind to demonstrate this device for me on 4 very challenging BK cases) uses

1. up and over 90 cm Ansel 6Fr Sheath parked in pop artery
2. Choice PT (0.014 wire by BS) +/- 0.018 quick cross for support, try to stay intraluminal. Choice PT is then exchanged for viper wire (supplied by company) which is a stainless steel stiff wire over which device will be employed. If subintimal space was used to cross total occlusion, generally don't recommend use of device but if space is short and it is below knee, probably safe.
3. locks wire

3. runs the device according to protocol (selects appropriate bur (classic for AT origin, predator for straight vessel, usually 1.25 for below knee, 1.5 or 2 for pop and SFA, keeps lubrication mix going with nitro mixed, starts low, keeps each run under 25 sec, 1 cm/sec smooth advancement, a total of 9 cm can be covered without moving the wire, don't do high speed in below knee). Lubrication mix is for the device only and contains, well, lubricants. Vasodilators are crucial and can be injected separately (nitro boluses from 50 to 200 mcg into the artery). Important to keep the device straight and not bent at the tip between the catheter and the housing of the device.

4. then use low profile balloon, use 1/2 nominal atm for 3 min inflation. Keeping inflation at low atm is key. DO NOT need to have picture perfect result as the goal is to modify calcified plaque without shaving off the media thus causing hyperplasia and restenosis.

5. final thing, if working with total occlusion, run device from distal cap to proximal. That way you will have the chance to microembolize total occlusion contents (if any) slowly and gradually without overwhelming the outflow.

For BK Total occlusions company posts 86% patency at 2 years, and Dr. Makam has close to 90% at 1 year... Incredible but time will tell if this can be replicated.

## Closure devices:

### Angioseal:

No needles or sutures involved. In an angiosuite setting it is an essential essential - if you used heparin, then it is not likely you'll have the nerve to give protamine without anesthesia... hence, you either wait a hour or so or use the device. Comes for 6 and 7 Fr.

### Basic construction: from inside out:

It is a string with the following components on it: starting distally and going proximally

- a flat rod piece on the end
  - will end up on the inside of the artery
  - made of CHO polymers, dissolves with time
- collagen plug
  - is snuggled up against the outside of the artery plugging the hole
- pre-tied knot that is loose
- green sleeve to push the knot down and tighten it,
  - sandwiching the hole in the artery between the T (inside) and the collagen plug

This string is sitting inside the proper angioseal delivery tube sheath with T piece loaded longitudinally along the length of the distal end of the sheath.

Second component - delivery tube: it has two parts:

- the sheath goes into artery
- the cap is removed once the tip of the sheath is exactly 1 cm inside the artery. To make sure it is one cm immersion, there is following mechanism in place:

### **Technique for Angioseal application:**

Douse everything with chlorxidine and remove the working sheath compressing the groin. The angio sheath is loaded onto the wire and advanced within the lumen of the vessel. This stops the bleeding around the wire in the arteriotomy. There is a small indicator hole close to the distal part of the sheath. It starts bleeding the moment the beveled end of the sheath enters the vessel lumen. At that moment you stop advancing, and pull the sheath back until bleeding from the indicator hole stops. At this moment, the sheath is sitting outside the artery.

Advance the sheath 1 cm - look at the markers on the outside of the sheath wrt skin surface. then you remove the cap AND the wire. Now the sheath is positioned close to the wall of the vessel with the tip inside.

Load the delivery tube - ideally wear a second pair of gloves, DO NOT touch the tip or let blood soak the transparent end of the tube with T piece in it.

Push the tube into the angiosheath until it is snug and locked onto the sheath. Then you incline the sheath at 45 degrees without withdrawing it, and pull back on the delivery tube until it clicks TWICE - you won't be able to pull **any further**, there is a catch mechanism. Now the tube and the sheath are fused together but your movement has freed up the T piece and it is engaged in horizontal position on the inside of the artery.

Now you pull on the sheath until you feel the resistance (T-piece is snug against the intima). In doing this you'll pull the sheath out completely and will expose the string and the green sleeve. Stop when you feel the snug tension but maintain it sliding down the green sleeve down into the wound. This will compress the collagen plug onto the adventitia (outside) of the vessel and tighten the knot.

Cut the string above the sleeve, discard the device, cut the string at the level of the skin.

Inspect if there is any bleeding. May hold pressure for a couple of minutes. Company does not think it is necessary, but in Sherbrooke they believe that helps to mold the collagen on along the outside of the vessel and secure the bleeding... Done.

### **Prostar:**

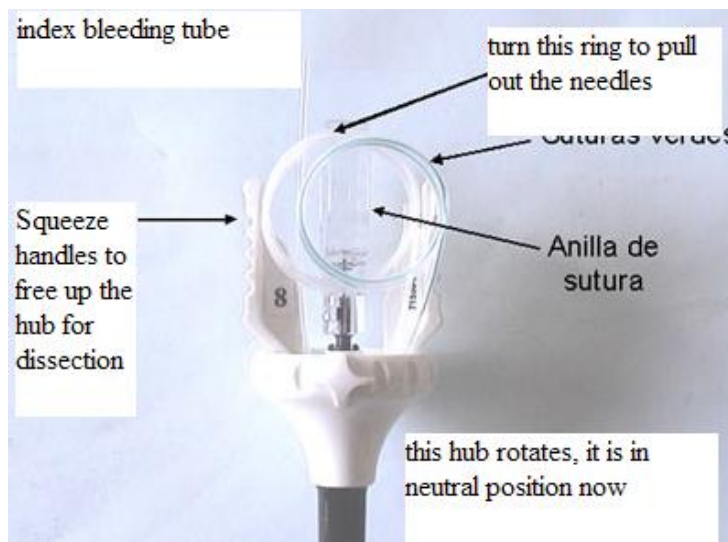
Needles/suture based device. Passes 2 sutures around the opening of the artery. Intended for holes up to 10 Fr diameter, but off label use have been described for up to 24 Fr (with 10%

failure rate). Usually device is placed at the beginning of the case (for totally percutaneous EVAR) and sutures are tied after procedure is completed.

### Construction:

Long black (50 cm) delivery body with flexible tip. It has two basic parts, the long tubing housing 4 needles & monorail port for the wire; and proximal deployment knob and a dissection assembly. Going from tip proximally you'll see:

1. at 28 cm, a monorail port for wire that will protrude through the tip.
2. Space between port and the index bleeding hole (at 38 cm) is occupied by 4 needles 9 cm needles housed within the delivery body. These needles point to proximally and slide out when the index hole is within the lumen of the vessel. They pierce the vessel wall from inside out and then re-enter the guide channels in the top of the deployment device. Thread (two white ends and two green ends), is attached to the distal ends of the needles.
3. Top: white handle, rotates, can be used to dissect tissue as the device is advanced into tissues.

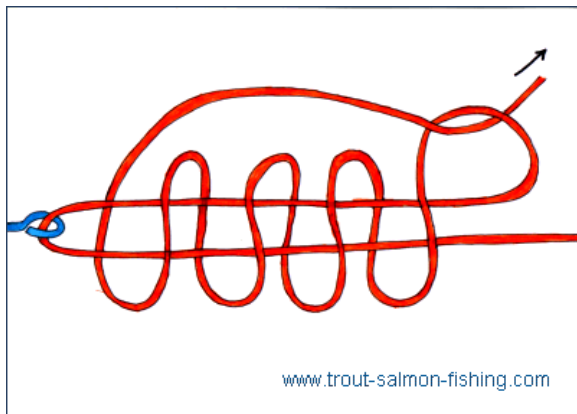


### Principles of deployment:

1. Get wire in the artery, place device in through monorail port.
2. Advance device up to the level of the port – remove wire and continue advancing until index bleeding hole enters the lumen of the vessel – you'll get pulsatile bleeding from the plastic SHORT tube on top. (two other LONG plastic tubes house suture, ignore these). Sometimes the sc fat is abundant, hence rotating the handle of the proximal deployment

device is helpful to get the dissection through dense tissue. To dissect, unlock the handle but squeezing the two levers on top and the base can now be rotated.

3. **IMPORTANT:** when you got to the index bleed, make sure you re-lock the handle in neutral position again – this will realign the needles and the holes in the proximal handle. If you don't do this, at the next stage, needles will not re-enter the handle but will surface elsewhere through the skin and may injure the operator...
4. Turn the ring in between the handles 90 degrees – this unlocks it and now by pulling it slowly out, you will get needles to emerge from the delivery housing, pierce the vessel wall from inside out around the hole and re-enter the proximal handle... Needles then appear on top of the deployment device in 4 corners – harvest these carefully with needle driver, be careful not to pull out entire thread – just enough to cut the needle off... At the end of this step, the threads are surrounding the hole and now you'll need to harvest them.
5. Now start withdrawing the device out until index bleeding hole appears at the skin level.
6. Identify threads and pull them out from PROXIMAL part of the device. You will see two ends of both white and green threads, i.e. a total of 4 threads. Put hemostats on these. Continue withdrawing the device until you see monorail port – slide wire in and then complete removal of the device. Now you have wire in the hole and 2 bites of sutures around the hole. When procedure is done, you can tie fisherman's slipknot on WHITE suture first, then GREEN. Use knot pusher to push knots down.



This is a very reliable device. You can leave the wire in until you tied all your sutures – that way if things don't work, you can always re-access an artery. The only downside is the device's length and the fact that you need to advance part of it without a wire. If setting up for percutaneous EVAR, that means you'll need to advance the tip of the device up to the neck of the aneurysm. This is not a problem as it has a soft curled tip.



Final modification that can be made – to cover a large hole - after you got your strings out, use French eye needle and put a small bovine patch as a pledge, parachute it down and tie your sutures – WHITE first, then GREEN....

### Proglide:



Needle based device. Monorail. Officially for up to 8 Fr.

Unlike Prostar, needles are housed proximal to the bleeding index hole and the suture is passed first from outside in, bounced against the footplate (which is snuggled up against the intima), and then passed back to the proximal end of the device. Deployment is as follows:

1. Wire in, get device up to the level of monorail port (20 cm from tip), remove wire.
2. Push device another 6-7 cm down – until bleeding start in the index channel
3. Pull lever #1 up (deploy foot on the inside of the artery), and pull the device out slightly to snug the foot vs intima
4. Press the top mechanism down (marked as #2 with arrow pointing down) – this gets the needle through the vessel wall
5. Pull top mechanism out (marked as #3 with arrow pointing out) until you see blue thread that changes into white thread – STOP. Cut the needle off.
6. Depress original lever down (marked as #4) – this hides foot step away.
7. Pull device out a little bit UNTIL you see the thread again at the deployment point. Grab the thread and pull it OUT of the PROXIMAL end of the device.
8. Now continue withdrawing the device until monorail port – reintroduce wire – then remove device completely.
9. Knot is prettied – it is a fisherman slipknot – PRETIED. Use knot pusher supplied – and holding BLUE end of the thread as rail slide down WHITE end – do not pull on white end. Remove wire if no significant bleeding. Done.

You can put two devices through the same hole – just orient the face of the device at 180 degrees – that way you have a more expensive version of Prostar equivalent. This device is not as reliable as Prostar – I had 3 failures while trying to figure this thing out when practicing on the bench top...

### **Starclose: by Abbott**

For 5 and 6 Fr only. Applies outside clip on the adventitia.

1. Make about 5 mm skin incision around the entry site and DISSECT out the tract to the vessel with arterial clamp – you need this to reduce chances of bunching up tissue between the skin and the vessel into the clip.
2. Replace sheath with the device's own sheath. Note that actual sheath size is 5 Fr so expect to have some bleeding around the sheath. Remove wires.
3. Slide and CLICK device into place. Press top button (marked as 2) – this engages the step on the inside of the vessel.
4. Slide out the device until feel resistance of the step vs inside of the vessel.
5. Slide thumb slide (marked as 3). This will deliver the clip and slice the sheath in half.
6. Press button 4 – this removes the step and engages with clip.
7. Massage the groin for 5 min.

### **Minx:**

Newest addition. FDA approved. Supposedly painless to the pt.

<http://www.accessclosure.com/the-mynx/mynx-overview/>

### **Brachial approach for SMA/renal cannulations:**

- **Do not use stiff micro puncture - only floppy**
- Get 6Fr sheath
- bentson to aorta
- lateral view
- C2 catheter to turn into descending aorta
  - Other alternatives include RIM catheter
- Then get Benson close to SMA or Renals
- you can preload Ansel 6 Fr Sheath onto KMP catheter
  - Ansel comes in 3 forms, with increasing curvature)

- If you have no Ansel, then get Raabe and twist the end of the catheter.
- Sherbrooke go-to guiding catheter is RDC, they swear by it... But it is 7 Fr
- Place 70 cm sheath close to the orifice of the vessel of interest
- Use KMP and glidewire to cannulate the vessel
- advance Ansell/Raabe sheath into the vessel orifice
- confirm placement with angio
- inject 50-100 mcg of nitro into renal
- exchange glide wire for stiffer wire (Rosen)
- (alternatively, may have used 0.018 wooley wire or 0.014 - Spartacore/ V18 – beware of perforations).
- use balloon expandable stents to stent, will have to back off sheath from the orifice of the renal
- do completion angio

Stents - Express SD - these are 0.014 and monorail, Express LD - these are for 0.035 system.

### **Groin approach for renal stenting:**

When sheath is advanced to the CFA, use C2 catheter to cannulate... VS1 (shorter tip) or Soft-Vu (longer tip) can also be used...



...to push against the opposite wall and cannulate the orifice...

To form the catheter, you need to rapidly push the catheter up then turn it as you pull down. needless to say, do it under direct vision.

### **Carotid stenting**

Based on the simulator experience at VIVA, Medtronic course and Sherbrooke...

Here you ought to be at your utmost anal-retentive and paranoid.... That means, you double check for air bubbles in your syringe, you irrigate the hub of the catheter when you withdraw wire (so that you won't suck in the air), you don't move the wires once they are in place and you are mindful of where the ends of the wires are... You will use 0.018 system.

- pig tail into arch, get arch views and roadmap
- cannulate carotid with either angled Glide (L) or HeadHunter (R)
  - may use different types of Simmonds (double reverse curve) or JB4 or Viteck

- Give heparin.
  
- advance glide wire into External carotid
- advance catheter (simmonds) into external carotid
- exchange for armplatz wire into external carotid
- exchange for sheath, pull into common
  
- get angio of internal carotid, measure stenosis, CCA and ICA
- get filter wire across ICA lesion, do not move it
- deploy filter
- predilate with 3 mm balloon
- may need to give atropin and get them to squeeze the duck
  - in Sherbrooke, they have pacer on standby
  
- choose stent to fit into ICA -
- deploy stent
- do angio
- remove filter
- remove wire
- completion angio
  - add nitro if spasm

## **Fem Embolectomies: role of angio....**

When you want to do an angio and perfuse profunda thus filling in profunda-crural collaterals, close CFA arteriotomy, puncture above it (may use angiocath 16 gauge), then direct it UP. So that when you inject, dye will go to both profunda and SFA.

**IMPORTANT:** do not jam the 6 Fr sheath up the arteriotomy... it is too stiff and the wound is too deep - the tip will dig into posterior wall and will dissect... So use 16 gauge angiocath instead.. but be careful still, with the smallest amount of resistance, recheck you position and don't pump in dye at full force: this will exacerbate the dissection.

If dissection is created, you'll need to extend your arteriotomy distally at most the length of your angiocath/or sheath you used to create a dissection (hence, don't use wires off the bat). Find the entry point, tack it down and close arteriotomy with patch

## **Sherbrooke stuff:**

In angio suite, you can get a multi-step angio run off, and then convert it to road-map. You can have 16 inch view of field. You have power injector that will allow you to do run-off with 4 and 5 Fr catheter... you can have the world...

### Angiogram and run off:

- Use 12 inch view for initial aorta and pelvic.
- Use 4 fr sheath
- Omni-flash to L1-L2 interface- once wire has been through it, it is not as screwed up as it looks and actually is quite useful - it turns into a RIM... Hence, OMNI... neat thing.

**Remember:** *if using 4Fr omniflash you can do angio/x-over bifurcation. BUT: you'll need to have a power injector. Also, the tip of the omniflash (shaped like a tennis racket) is very flimsy... When you try to reform it in the aorta (i.e. to get it into the pre-determined shape once the wire is out of it) - you do this by pulling the wire down and pushing omniflash up - you can actually TWIST the tip or the entire head of the catheter - you won't be able to advance the wire then... The only way to go about it is to either untwist it, or perforate the catheter (which I've done inadvertently) ... Slide the catheter out, and replace it, being more careful next time...*

- shoot at renals 15 for 25
- shoot at bifurcation 10 for 20
  - may do LEFT (in Sherbrooke, that's the custom) AO at 30 degrees
    - you'll get both iliac bifurcations at an angle.
- then do a stepping bolus chase -
  - Use meg up 1 (i.e. 9 inch screen)
  - line up the leg so that when the bed travels linearly leg and lined up.
  - set the stepping in motion

you can either do both legs or each one individually.

Table will go through 4 stations, figure out kVa and penetration, then will go through same stations again getting mask image, then will run the bolus and DSA.

You control when the station are changed for DSA part.

For 4 French catheter, you need power injector to get a good aortogram.

*Poor fellow version of bolus chase in OR:*

You have to make sure the bed is locked to travel only head-heels, not sideways.

Start DSA, inject dye, see it fill up the initial segment, then without stopping the DSA slide the table down visually following the dye. If you do this evenly, with 20 cc of dye you can cover 2/3 of the leg....

### **IVC filter placement:**

Deploy below renal veins. Make sure you rule out accessory or circum-aortic renal vein or duplicate IVC. IVC has got to be less than 30 mm - then need to use large filter or put filters in BL iliac veins.

0. R groin CFV puncture with 5 Fr
1. put IVC pig tail (with graduations at 28 mm) into L iliac vein
2. shoot DSV (15 for 25)
3. ID renal veins, confirm size less than 28 mm (check graduations on pig)
4. pull out 5Fr and place introducer sheath (9Fr)
5. place sheath tip above where you want to deploy
6. track collapsed Gunther tulip ceclect to the deployment level
7. withdraw sheath, deploy filter but MAKE SURE hook is facing AWAY from the wall. This will make retrieval easier...
8. unscrew attachment piece on the wire
9. withdraw sheaths.

### **IVC filter Removal:**

1. jugular puncture, 11 Fr sheath, Pig or KMP PAST the filter to shoot venogram 15.30 to confirm absence of clot.

2. then use snare - guidewire with loop on the end threaded through straight catheter. Hook the filter, pull into sheath.

### **Troubleshooting:**

hook is sitting on the wall, can't get snare around it ... so

Solution:

Option 1:

you need to make catheter- snare steerable - use preshaped Raabe sheath, Ansel sheath.. Alternatively, may take an inside introducer for 11 Fr sheath (it come with middle pink introducer, black inner lining - tough, shapeable, and blue outside sheath itself - cut the blue sheath so that black lining sticks through. Preshape black lining and re-insert. then you can steer your snare...

Option 2:

alternatively, put wire against the side of IVC against which the filter tip is sitting, and slide snare over the wire to get it in proximity of the hook. may use balloon to push the filter away from the wall. May use pigtail to tangle the filter and strengthen it. Don't snare the main struts as it will skew the filter and you won't be able to pull it out... Gotta catch to hook...

Option 3:

finally - go up and push the filter so that it centered in the middle... Failing that, consider leaving filter in place..

### **Tunneled dialysis catheter.**

Make incision above clavicle and DISSECT OUT A SPACE toward the vein with snaps. VERY important as you want to create a tunnel.

Keep US parallel to the clavicle over the attachment of Sternocleidomastoid muscle. Guide the needle parallel to the US head and enter the jugular vein. ID Jug vein on US (superficial and lateral to CCA), ID at the proximal neck, close to the Sternoclavicular junction.

Go with needle parallel to the clavicle along the longitudinal line of the transducer nestled above the clavicle and enter vein laterally. You may need to push through the elastic wall as it will buckle before it yields.

Measure out the wire length from the R atrium to the supraclavicular skin incision, then add extra 3 cm and make an incision below clavicle at that length, small. you can use micropuncture guide wire to bend it at the exit from the sheath so that you can measure the length correctly. To improve advancement of the micro guide wire, you may need to make lift the hub of the needle to make it inline with the longitudinal orientation of the jugular vein... Ask pt to take deep breath also helps...

get bentson wire into IVC.

Catheter has an aluminum blunt trocar - bent it and track into supraclavicular incision from the infraclavicular one. Remove trocar and needle just leaving the tip of the dialysis catheter.

Put dilator over the guidewire under the fluoroscopy STRAIGHTENING the dilator and the wire course so that it is in semi-straight line. You don't want to be pushing at the innominate junction or pushing into the wall with the dilator.

put in introducer peel away sheath. It has valve that will let the tip of the dilator but not let the air in. It is not 100% safe for air embolism so you need to pinch the sheath at the skin level. Introduce the tip of the dialysis catheter into the introducer peel away sheath and guide it to the level of the R atrium.

Break the upper portion of the peel away sheath and pull it out in two pieces.

Accommodate dialysis catheter under skin through two incisions. Then do a test run:

you should be able to aspirate 5 cc of blood through Arterial port under 1 sec, i.e. 10 cc in 2 sec... If you can't do that, and the plunger catches, you need to put a wire back into the dialysis catheter and turn it around or advance it further into the atrium. Use short amlatz wire if necessary. close incision. Dialysis cuffed end should be under skin.

For Bard access port, it is similar except - sheaths is smaller and it does not have the valve. You will need to inject with lidocain with epi over the chest to dissect out sc pocket for the port. Ideally, you should make incision below the pocket so that you can simply pull the catheter into the pocket snug... The snag is, if you overestimated the length of the catheter and it is sitting in the IVC, you will need to carefully dismantle the attachment to the injection port - retract skin pocket up, clamp catheter, slide off the sleeve, disconnect, shorten, reattach, replace sleeve pushing it up with teased out dry gauze - without pulling the catheter too far out... then you'll need to try and milk it back through a small supraclavicular incision...

Two layered closure with absorbable suture follows.

### **Replacing dialysis catheter:**

Any manipulation can be done with a glide stiff wire placed in Venous and arterial limb. ASPIRATE limbs first before you unlock these- the NS/heparin mix in the limbs is 10,000 u/heparin per ml I was told...

Then you can re-tunnel a new catheter in place.

Occasionally there forms a fibrin sheath around the distal end of the catheter and the only thing that can break it is a balloon (say 12 mm) placed through 8 Fr sheath....

Re-lock the limbs with heparin after you are done and checked the ease of flow (5 cc / sec of blood in 20 cc syringe with no plunger hesitation)

### **Venogram:**

upper extremity - puncture anticubital vein, otherwise you will need to use more dye.

If using dorsal wrist vein, and doing study to r/o subclavian vein occlusion, you may inject 20 cc of dye in the vein first (load it up) then image with second bolus of 20 cc going. Do this in arm abducted position above the head and 90 degrees.