Regions of interest

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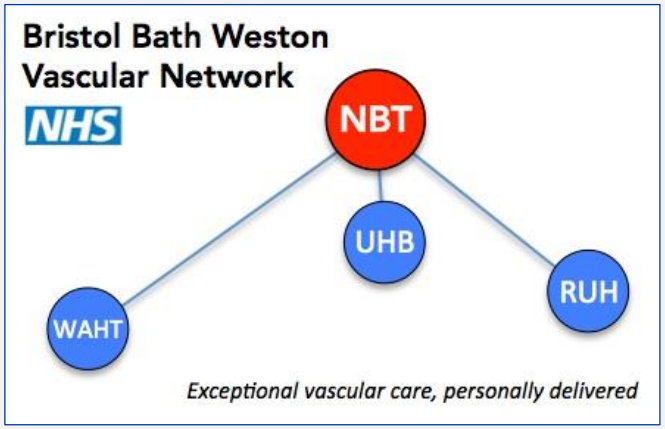
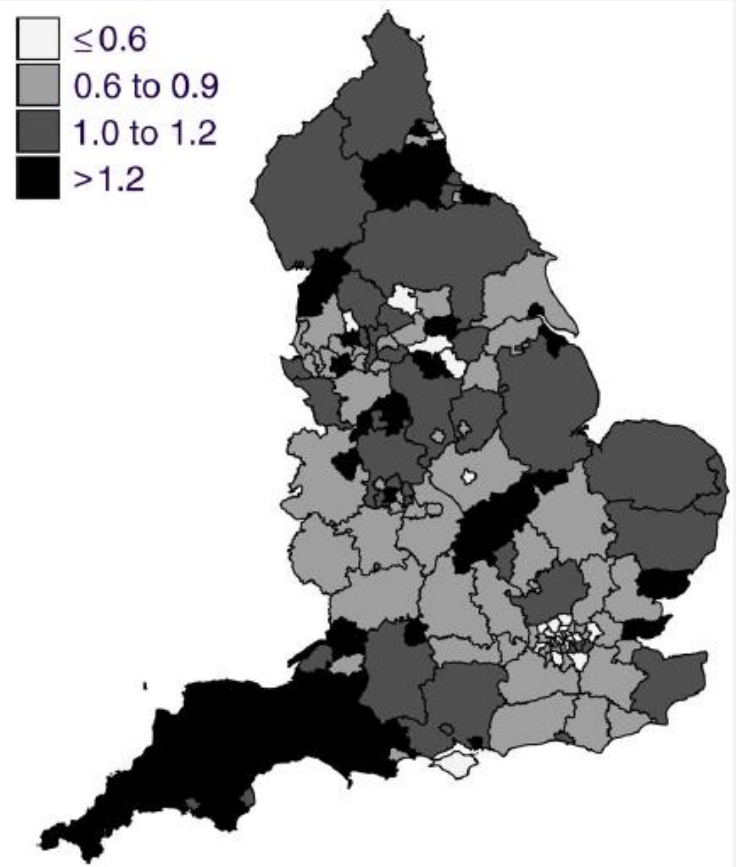


Overview

- Diabetic foot perfusion
- Popliteal entrapment
- Iliac endofibrosis

Diabetes and Amputations

- 8x variation
- Reasons unknown
- Variations in clinical practice
- Organisation / access care
- Standardisation of (vascular) care



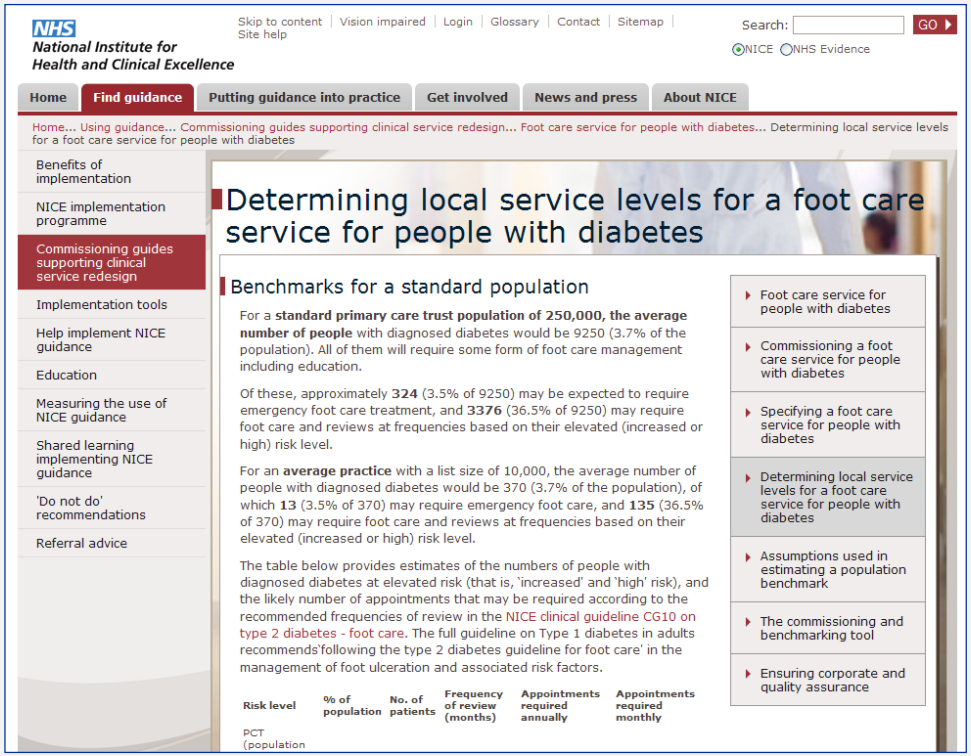
Holman, Diabetologia. 2012;55:1919-25

PAD in Diabetes

- 5% adults with type 2 diabetes
- Common in DFU (70% in >70 years)
- Difficult to diagnose (but common)

Estimated community burden of the diabetic foot by CCG

- 282,000 population
- 11,300 diabetes
- 7,910 (70%) low risk
- 2,825 (25%) moderate-high risk
- 565 (5%) active ulceration
- Annual cost £2,791,784



Classification - 'Critical limb ischaemia'

Definition and problems in the foot in diabetes

TASC II

"should be used for all patients with chronic ischaemic rest pain, ulcers or gangrene attributable to objectively proven arterial occlusive disease"

In any patient with diabetes and ulceration of the foot PAD is likely to be only one aetiological factor

"What do various PAD tests do?"

- Non-invasive tests
- ABPI / toe pressure / tcpO2
- Diagnosis of PAD (first line)
- Physiological not anatomic (perfusion)
- Information on prognosis (healing / amputation)

Imaging

- Duplex / CT angiography / MRA
- Confirm diagnosis of PAD (not first line)
- Road map of disease distribution (anatomic)
- Reveal nothing about severity of perfusion deficit
- No information on prognosis / healing
- When revascularisation planned focus / guide intervention

Digital subtraction angiography

- Usually reserved for intervention
- Gold standard to detect open distal vessels
- Ever improving technology
- Reduced profile

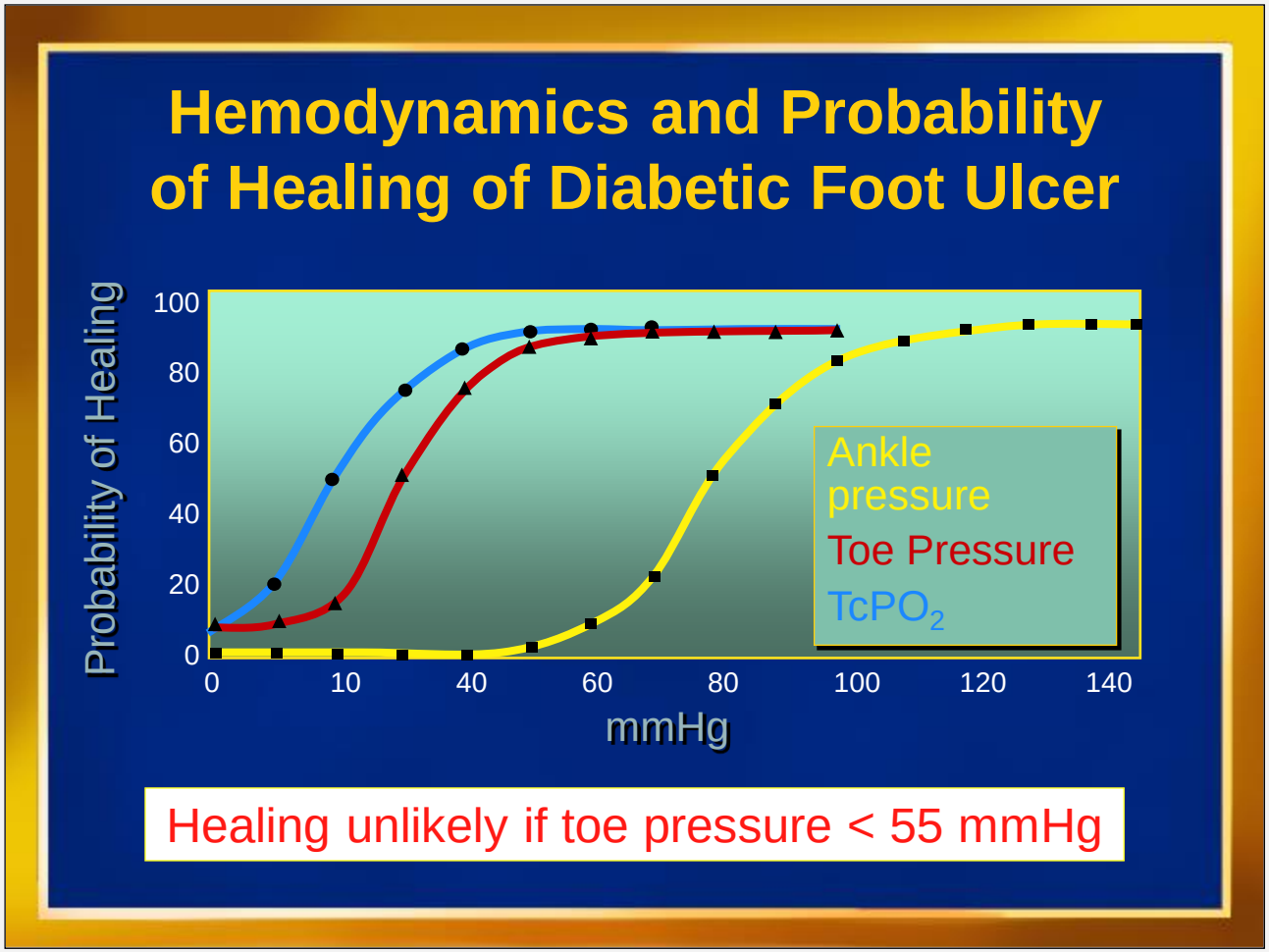
Diagnosis of PAD in patients with DFU

Overall test of performance

Index test	PLR	NLR
ABI <0.9	2-25 (8)	0.1-0.7 (0.3)
TBI <0.75	3	<0.1
Pulse oximetry 2% drop	30	0.2
Mono OR biphasic waveform	3-13	0.1

Brownrigg J et al. Diabetes Metab Res Rev. 2016;32:119-27

Prognosis (healing)



Prognosis (healing)

Annualised healing rates 18-61%

Index test	PLR
Ankle pressure >50mmHg	1.1-1.5
Ankle pressure >70mmHg	2.5-3.2
ABI 0.9-1.3	2.6
TcPO2 ≥25 mmHg	10
Toe pressure ≥ 30mmHg	1.1-5.0
Toe pressure ≥ 45mmHg	2.9-4.3
SPP ≥ 40mmHg	4.9-6.4

Prognosis (major amputation)

Annualised major amputation rates 3-19%

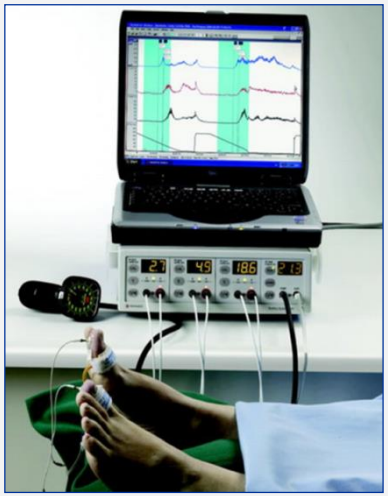
Index test	PLR
Ankle pressure <50mmHg	1.3
Ankle pressure <70mmHg	4.3
Ankle pressure <50mmHg or ABI <0.5	8.2
Toe pressure < 30mmHg	2.6
Toe pressure < 45mmHg	2.1
Fluorescein toe slope (<18 units)	4.0
Monophasic / absent doppler	2.2

When to revascularise?

Trust the ABPI when low

not when high

- ABPI >0.6 (toe pressure >55mm Hg, TcpO2 >50mm Hg) trial of 6 weeks of best wound care and assess response



- ABPI <0.6 (toe pressure and/or TcpO2 <30mm Hg) or wound healing response poor consider early revascularisation

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Diabetes Metab Res Rev. 2012;28 Suppl 1:236-7

When to revascularise?

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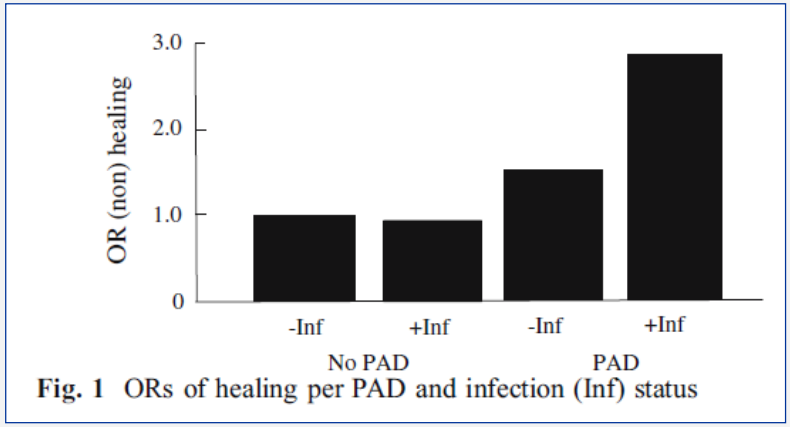

Fig. 1 ORs of healing per PAD and infection (Inf) status

Diabetologia (2008) 51:747–755

- Drain the compartment

Decision to revascularise

- Complex assessment and decision

- Multi-factorial

- ***Ulcer*** – infection, size, depth
- ***Limb*** – perfusion deficit, distribution of PAD, conduit
- ***Patient*** – co-morbidity, long-term survival, preference

- Lack of evidence

- Single professional decision making is sub-optimal

What proportion of patients with PAD and ulceration revascularised?

- 2003
- 14 experienced European centres
- 1,088 diabetes patients (PAD n=505)
- ABI <0.5 (n=94)
- Revascularisation 43%
- Endovascular 22% and/or bypass 27%

DIABETICMedicine

DOI: 10.1111/j.1464-5491.2008.02445.x

Original Article: Complications

Delivery of care to diabetic patients with foot ulcers in daily practice: results of the Eurodiale Study, a prospective cohort study

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Abstract

Aims To determine current management and to identify patient-related factors and barriers that influence management strategies in diabetic foot disease.

Methods The Eurodiale Study is a prospective cohort study of 1232 consecutive individuals presenting with a new diabetic foot ulcer in 14 centres across Europe. We determined the use of management strategies: referral, use of offloading, vascular imaging and revascularization.

Results Twenty-seven percent of the patients had been treated for > 3 months before referral to a foot clinic. This varied considerably between countries (6–55%). At study entry, 77% of the patients had no or inadequate offloading. During follow-up, casting was used in 35% (0–68%) of the plantar fore- or midfoot ulcers. Predictors of use of casting were male gender, large ulcer size and being employed. Vascular imaging was performed in 56% (14–86%) of patients with severe limb ischaemia; revascularization was performed in 43%. Predictors of use of vascular imaging were the presence of infection and ischaemic rest pain.

Conclusion Treatment of many patients is not in line with current guidelines and there are large differences between countries and centres. Our data suggest that current guidelines are too general and that healthcare organizational barriers and personal beliefs result in underuse of recommended therapies. Action should be undertaken to overcome these barriers and to guarantee the delivery of optimal care for the many individuals with diabetic foot disease.

Diabet. Med. 25, 700–707 (2008)

Keywords diabetic foot, PAD, infection, deliver of care

Abbreviations ABPI, ankle brachial pressure index; CRF, case record form; MRA, magnetic resonance angiography; PAD, peripheral artery disease; TCC, total contact casting

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Natural history of severe PAD in DFU

Outcome	No angiography *n* = 319 (53%)	Angiography without intervention *n* = 283 (47%)	Total *n* 602 (100%)
Ongoing ulcer	2 (—)	2 (—)	4 (—)
Primary healing	119 (37)	108 (38)	227 (38)
Healed after minor amputation	34 (11)	38 (13)	72 (12)
Healed after major amputation	40 (13)	61 (22)	101 (17)
Deceased unhealed with/without amputation	123 (38)	74 (26)	197 (33)
Drop out	1 (—)	0 (—)	1 (—)

Elgzyri T, Eur J Vasc Endovasc Surg. 2013;46:110-7

Which patients with diabetes and PAD require revascularisation?

	All patients OR (95% CI)
Pain at rest	0.59 (0.38–0.91)
Ankle pressure >50 mmHg	2.44 (1.27–4.66)
Serum creatinine >130 µmol/L	0.55 (0.34–0.88)
Ischemic heart disease	0.52 (0.34–0.81)
Cerebrovascular disease	0.41 (0.27–0.64)
Max. Wagner grades ≥3 reached	0.51 (0.33–0.77)

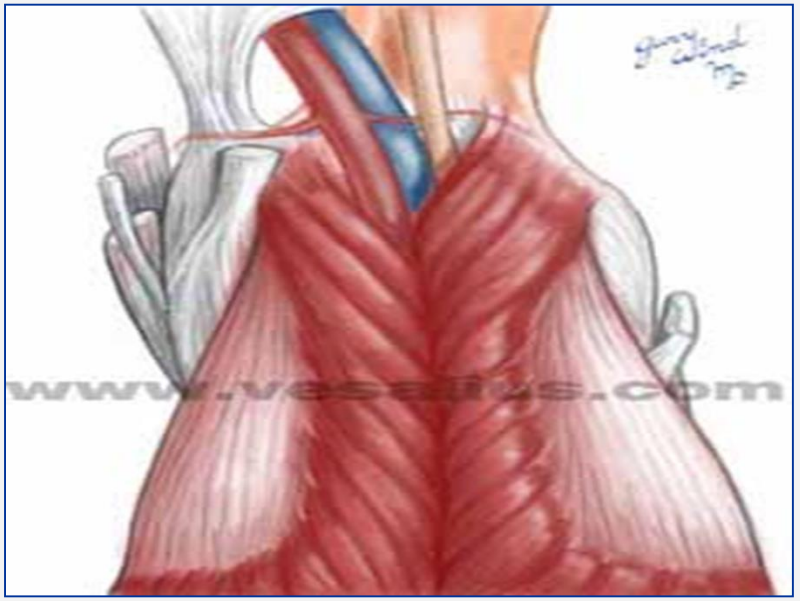
Elgzyri T, Eur J Vasc Endovasc Surg. 2013;46:110-7

Conclusions

- The majority of patients with DFU have PAD
- PAD associated with premature deaths and amputations
- Revascularisation decision not straight forward
- Not all require revascularisation (many do)
- Improved assessment of perfusion

Popliteal entrapment

- Anatomical variant 1879
- First operation 1959
- Entrapment syndrome 1965



Epidemiology

- 0.17-3.5% anatomic predisposition
- Males 9:1 Females
- Mean age 32 (20.7-41) years
- 38% bilateral
- Symptom duration 24 months

Popliteal entrapment syndrome

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Introduction: Popliteal entrapment syndrome (PES) is a rare but important cause of intermittent claudication in young people. Controversy exists about optimal strategies for diagnosis and management, particularly for variants such as functional popliteal entrapment. The aim of this review was to systematically catalog the published English-language literature on PES and to determine if evidence-based guidelines for management could be formulated.
Methods: An electronic search using the MEDLINE, EMBASE, Cochrane Library, AMED, and CINAHL databases was performed to identify articles about PES published from 1947 to December 2010. The systematic review conformed to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement standards. Prospective studies and retrospective case series with more than five patients with arterial, venous, nerve, and combined neurovascular entrapment were analyzed on a study-by-study narrative basis.
Results: The search identified 291 articles, and 44 were included. Of these, 30 studies were on popliteal artery entrapment syndrome (PAES). No relationship was found between duration of symptoms and the presence of irreversible arterial injury. Each study used a median of three diagnostic tests (range, 1-6). Arteriography was used in 28 of 30 studies to diagnose PAES, with an estimated mean sensitivity of 97% (range, 85%-100%). Twenty-three studies described arterial reconstructive procedures, with a median failure rate of 27.5% (range, 0%-83%). The proportion of patients asymptomatic after surgery was reported in only 12 of 30 studies, with a median value of 77% (range, 70%-100%).
Conclusions: A large volume of predominantly retrospective clinical data exists on PES. A subset of studies describe a significant failure rate after surgery, but study quality is insufficient to derive robust conclusions allowing recommendation of any one particular diagnostic modality or operative procedure over another. Improvements in management of this condition are unlikely to result from publication of further retrospective case series, and clinicians should concentrate on prospectively collected data with predefined inclusion criteria, outcome measures, follow-up protocols, and transparent standardized reporting criteria. (J Vasc Surg 2012;55:252-62.)

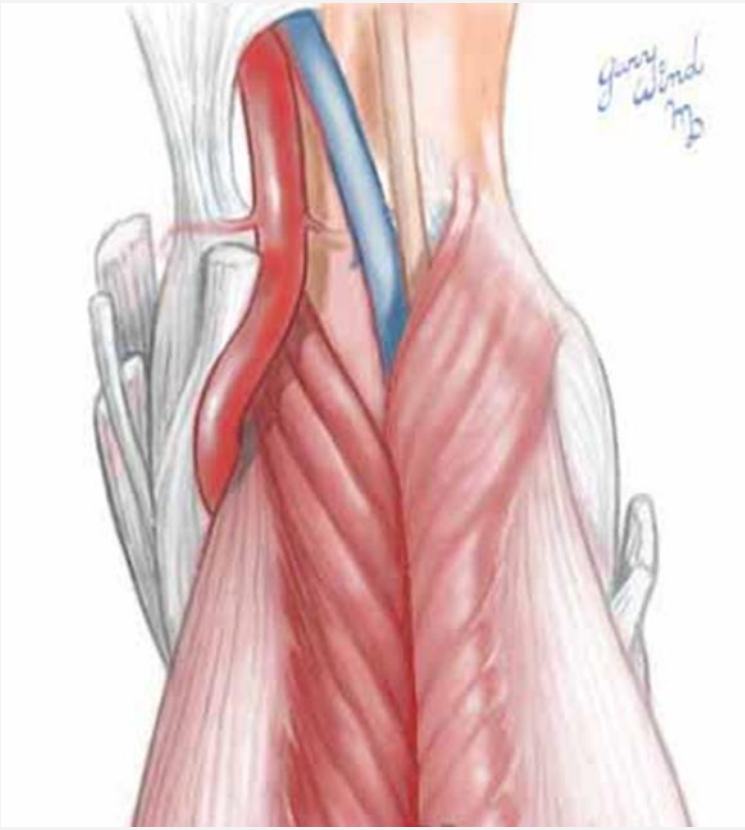
Presentation

- Symptom duration 24 months
- Intermittent claudication (calf)
- 11% acute limb ischaemia
- 17.5% (6-31%) asymptomatic
- Foot symptoms (neurological)

Classification – Type I

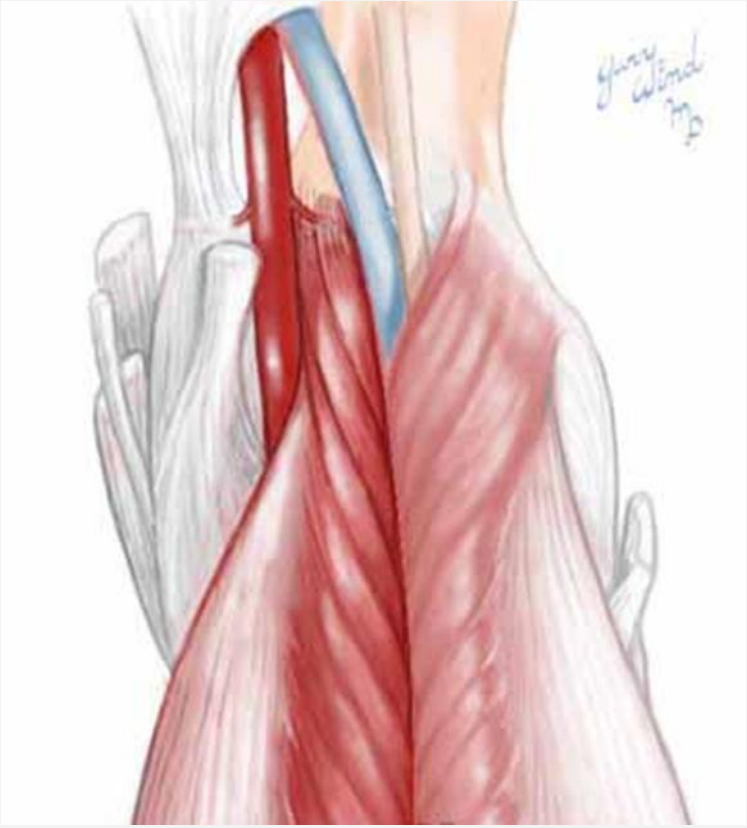
- Popliteal artery passes medial to and under a normal medial gastrocnemius head

- The vein remains in its normal position



Classification – Type II

- Medial head of the gastrocnemius inserts more lateral than normal
- Artery descends in a straighter path around the medial margin of the muscle



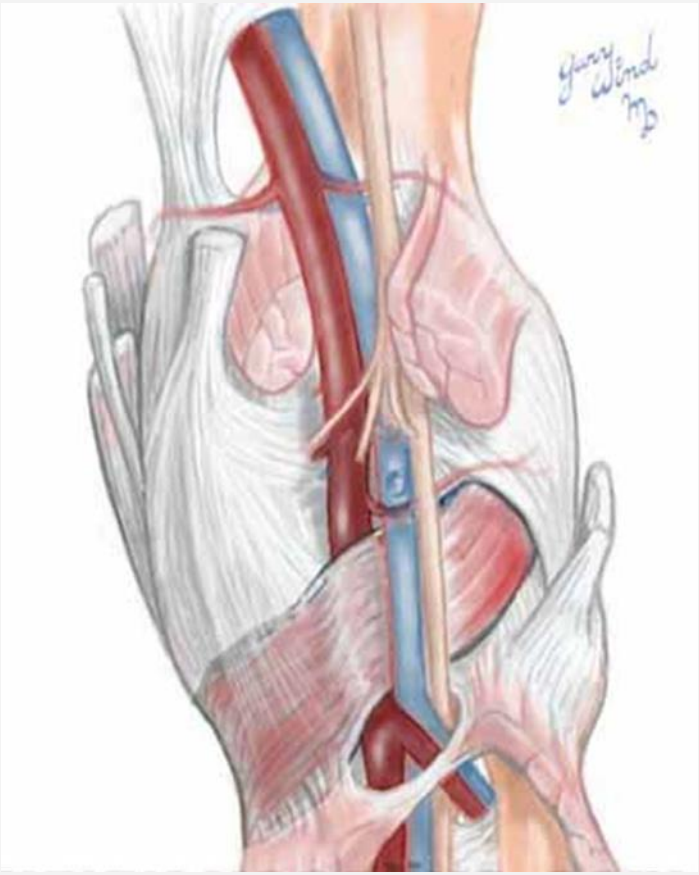
Classification – Type III

- Artery is compressed by a slip of the medial head arising more laterally than normal
- Artery passes through the body of the medial head in a relatively straight path

Classification – Type IV

- Popliteal artery passes deep to the popliteus muscle or a band, with or without associated gastrocnemius abnormality

- Reflects a persistence of a more primitive embryological vascular pattern of the leg



Classification – Type V

- Any of the preceding types with the addition of popliteal vein entrapment

- Rare

Type VI – 'functional'

- Extrinsic compression of the popliteal artery without identification of anatomical alterations
- Hypertrophy of the gastrocnemius muscle
- 23% (6.3-88%)
- ?Soleal sling involvement
- ? a risk factor for future vascular complications

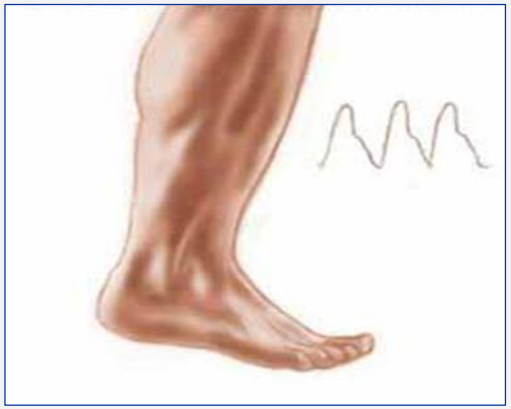
Histological changes with continued entrapment

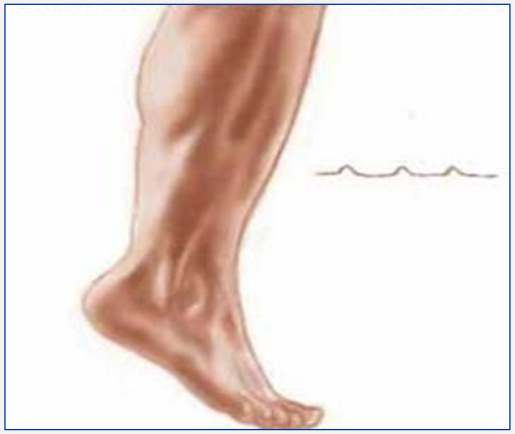
- Stage I Adventitial thickening and fibrosis
- Stage II Medial disease
- Stage III Intima

- ANEURYSM / OCCLUSION

Clinical examination

- Popliteal bruit
- ABPI drop post exercise?
- Active plantar flexion diminish foot pulses





Differential diagnosis

- Arterial
- Musculoskeletal
- Neurological

Musculoskeletal

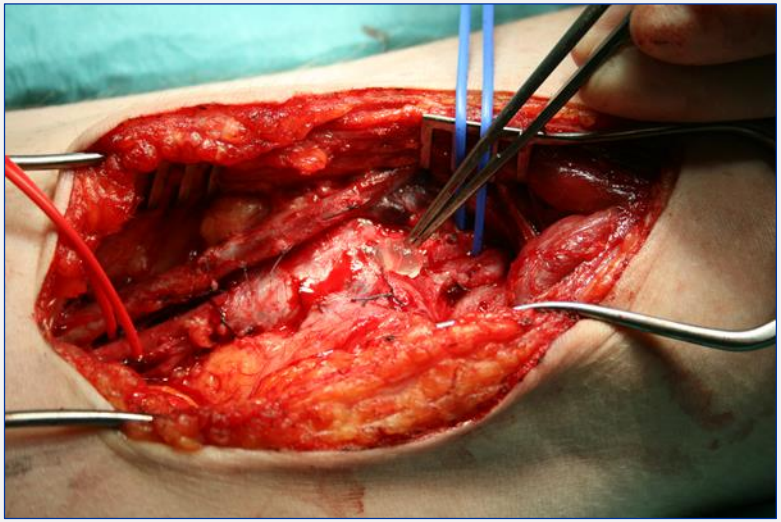
- Gastrocnemius or soleus strain
- Compartment syndrome
  (resting pressure >20mm Hg, normal <15)
- Stress fractures
- Periostitis
- Tibialis posterior tendonitis

Neurological

- Back pain
- Spinal stenosis
- Neuropathy

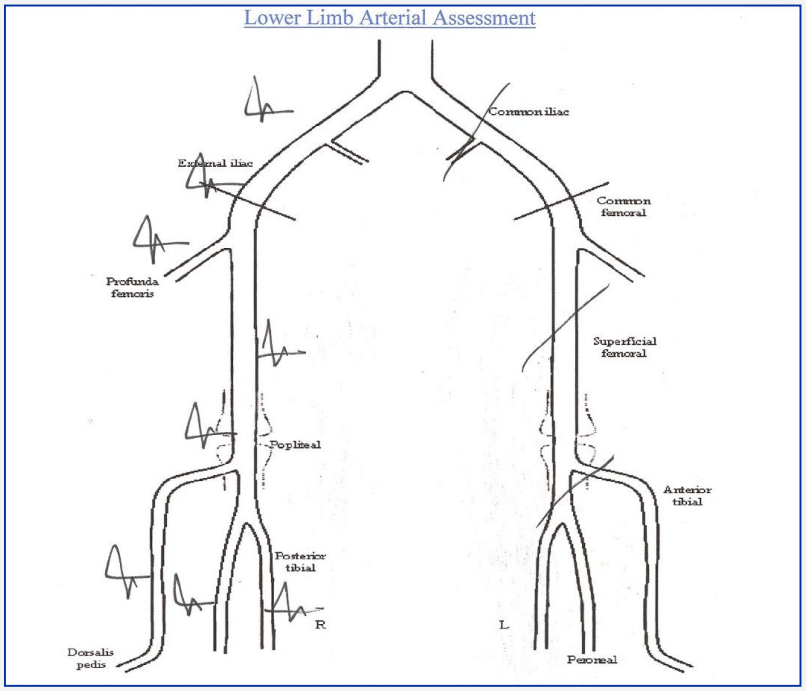
Other causes of claudication in young patients

- Cystic adventitial disease
- Iliac endofibrosis
- Persistent sciatic arteries
- Dissection
- Atherosclerosis



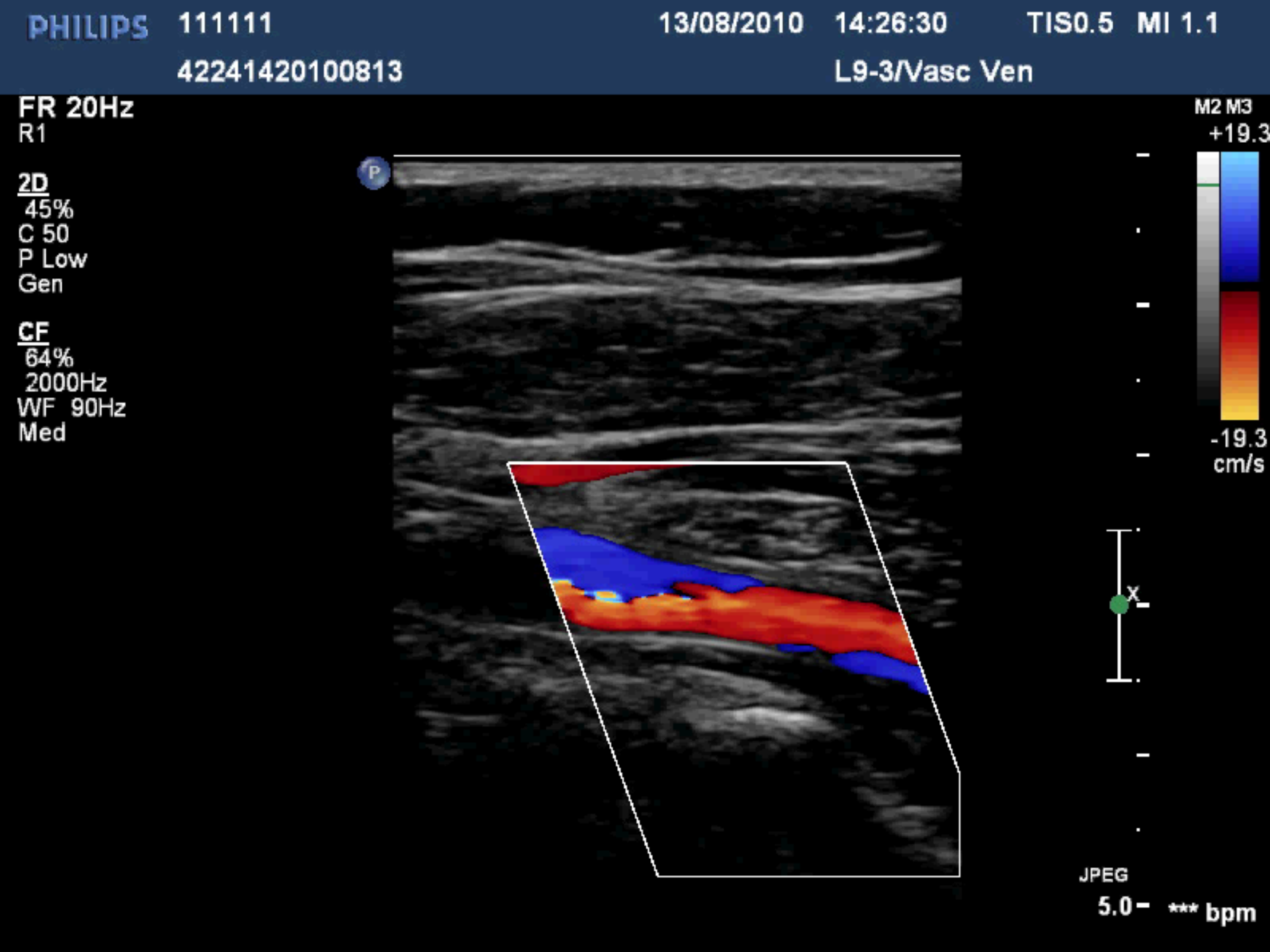
Investigations

- History
- Clinical examination
- ABPI resting / exercise
- Arterial duplex
- MR angiogram
- Digital subtraction angiography



Duplex ultrasound

- Occlusion on provocation
- Normal individuals – 56% (7-80%)
- No difference
  ‘athletic -v- ‘non-athletic’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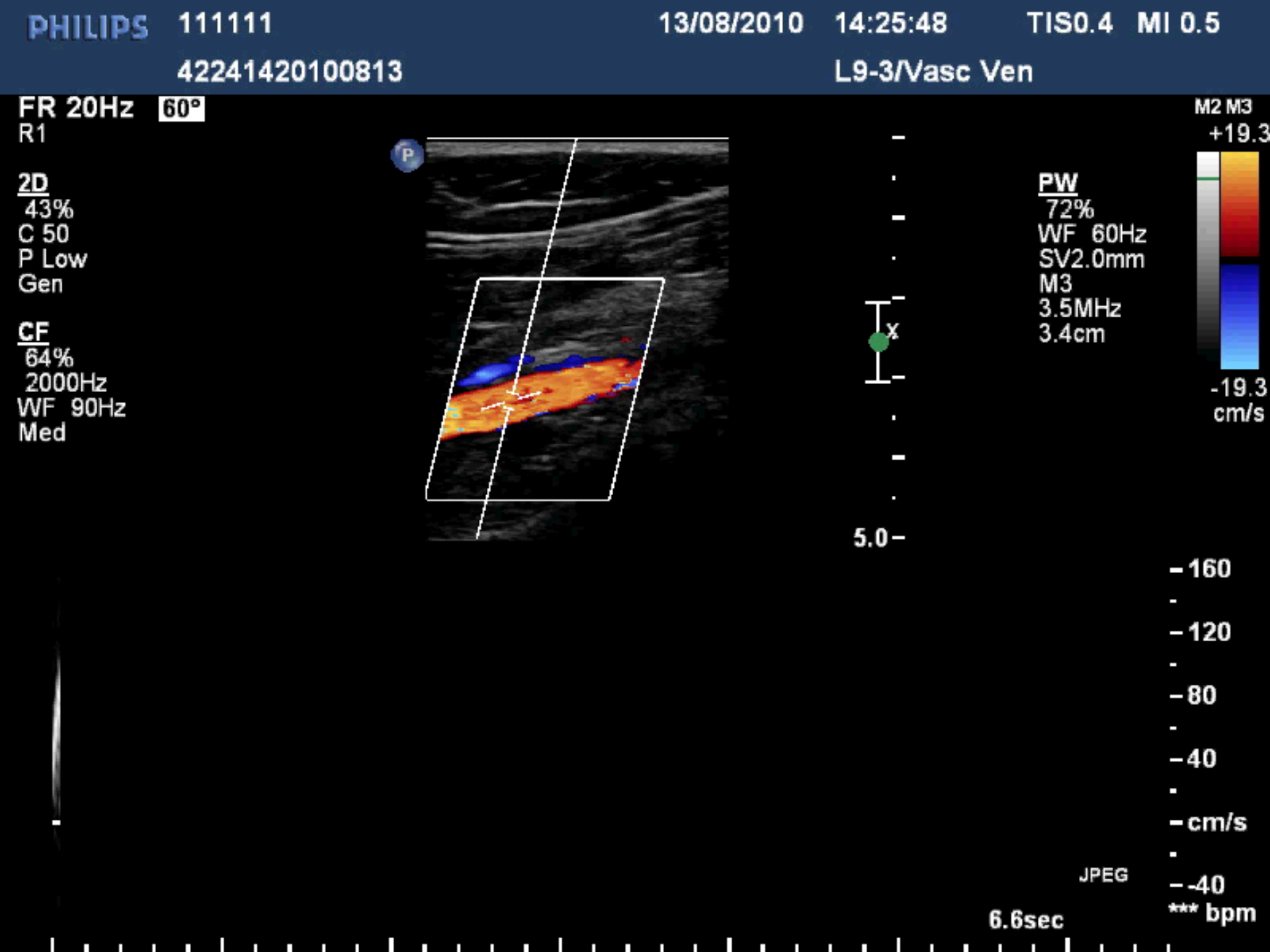
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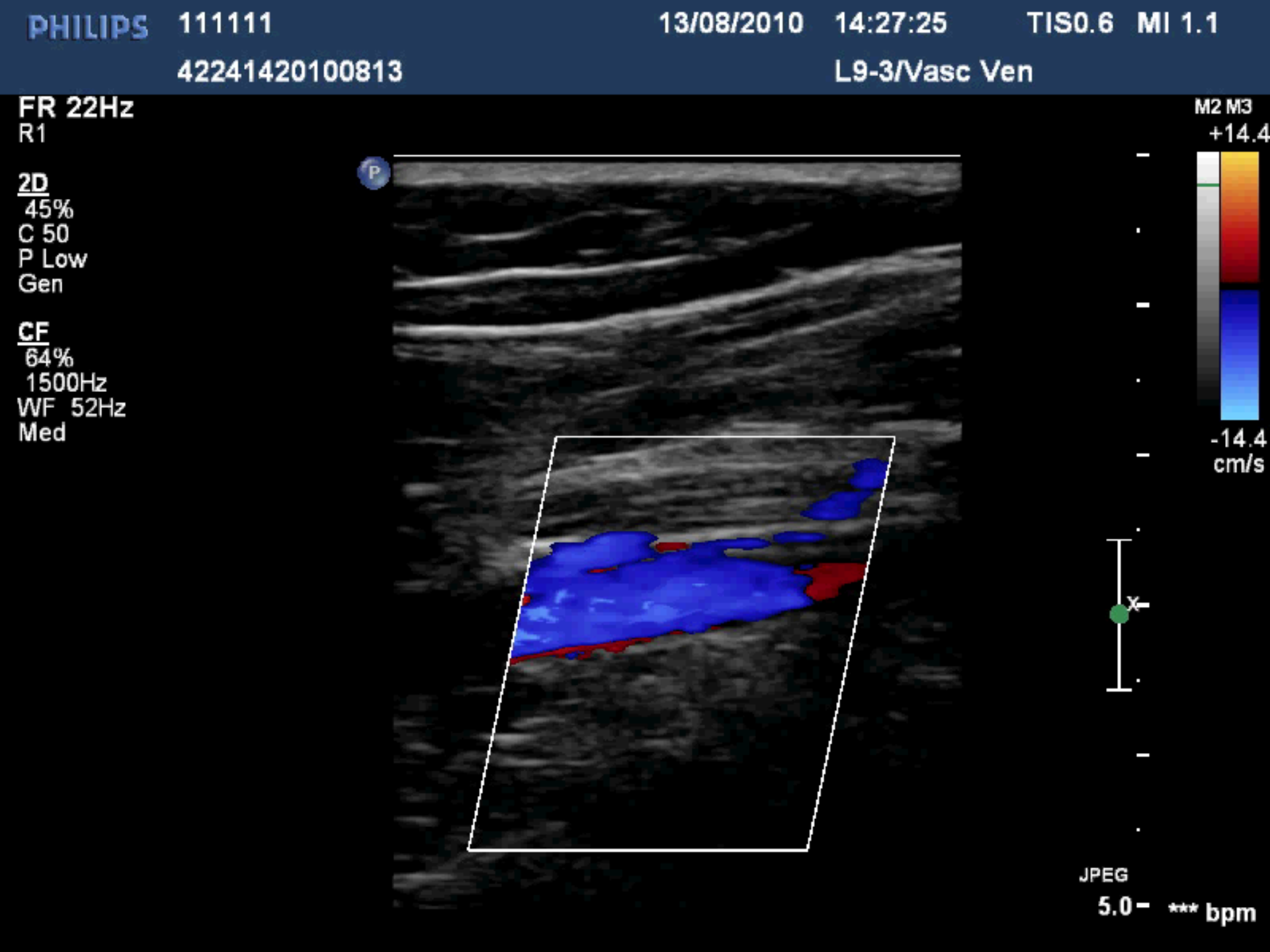
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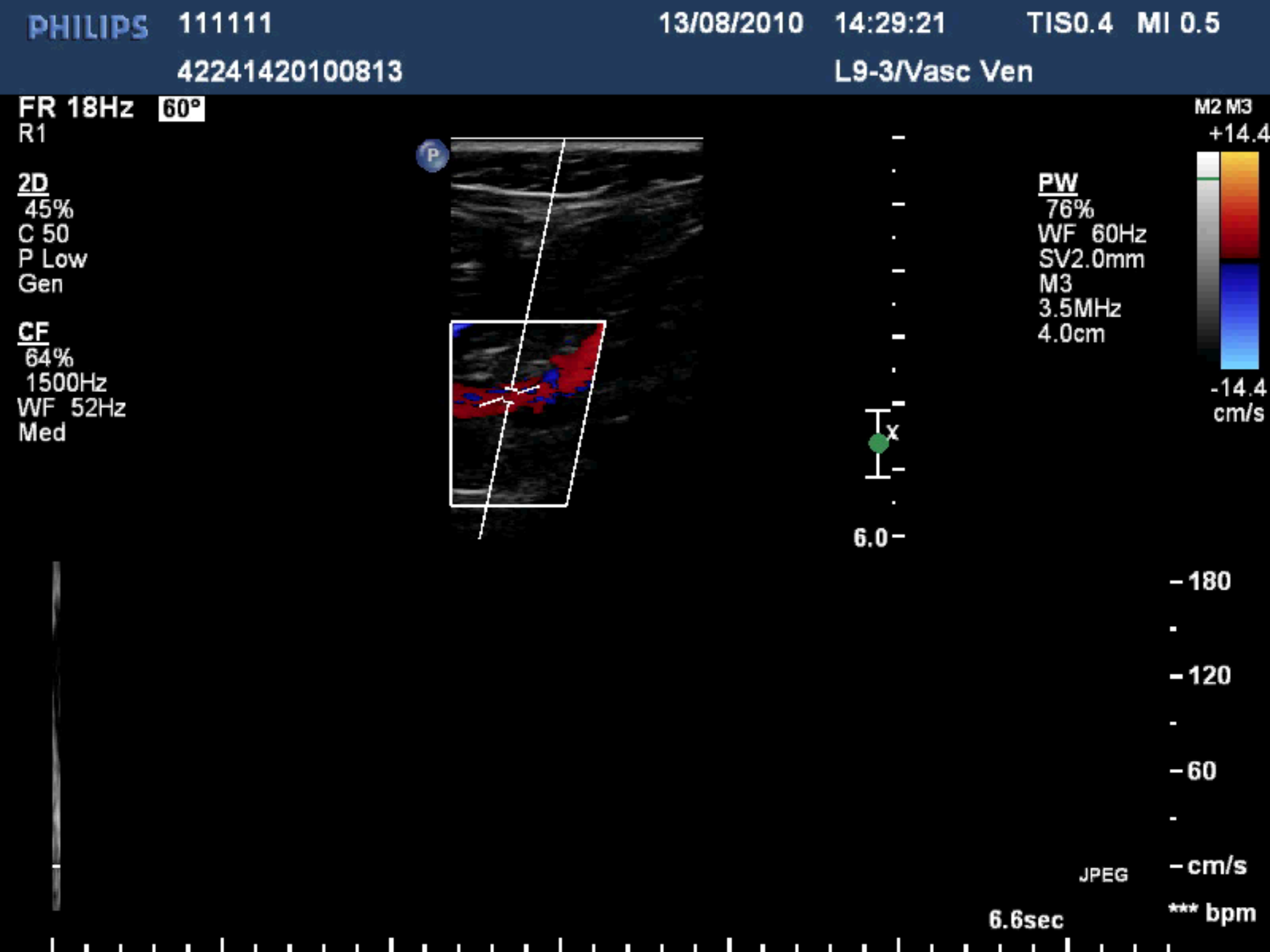
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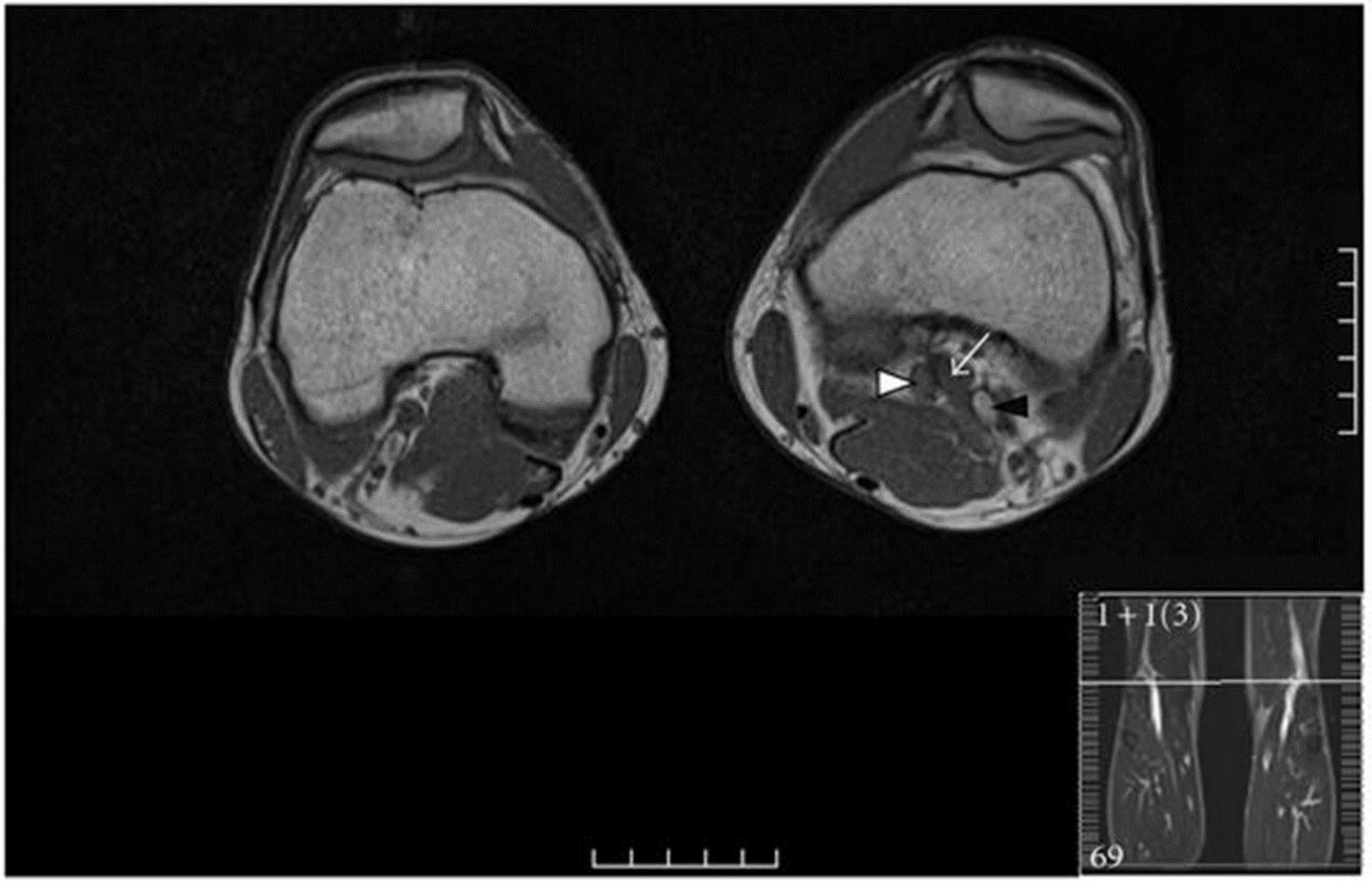
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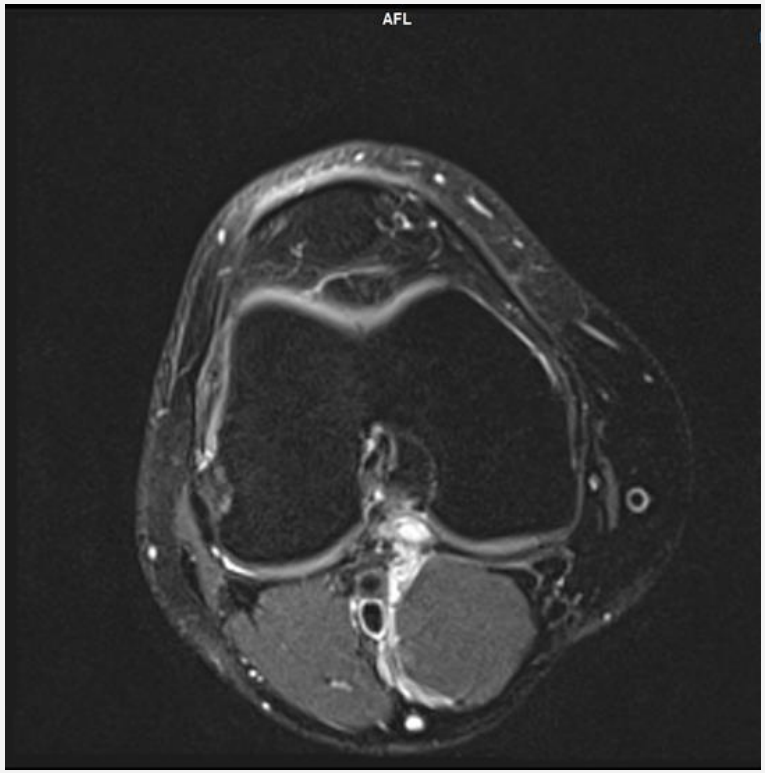
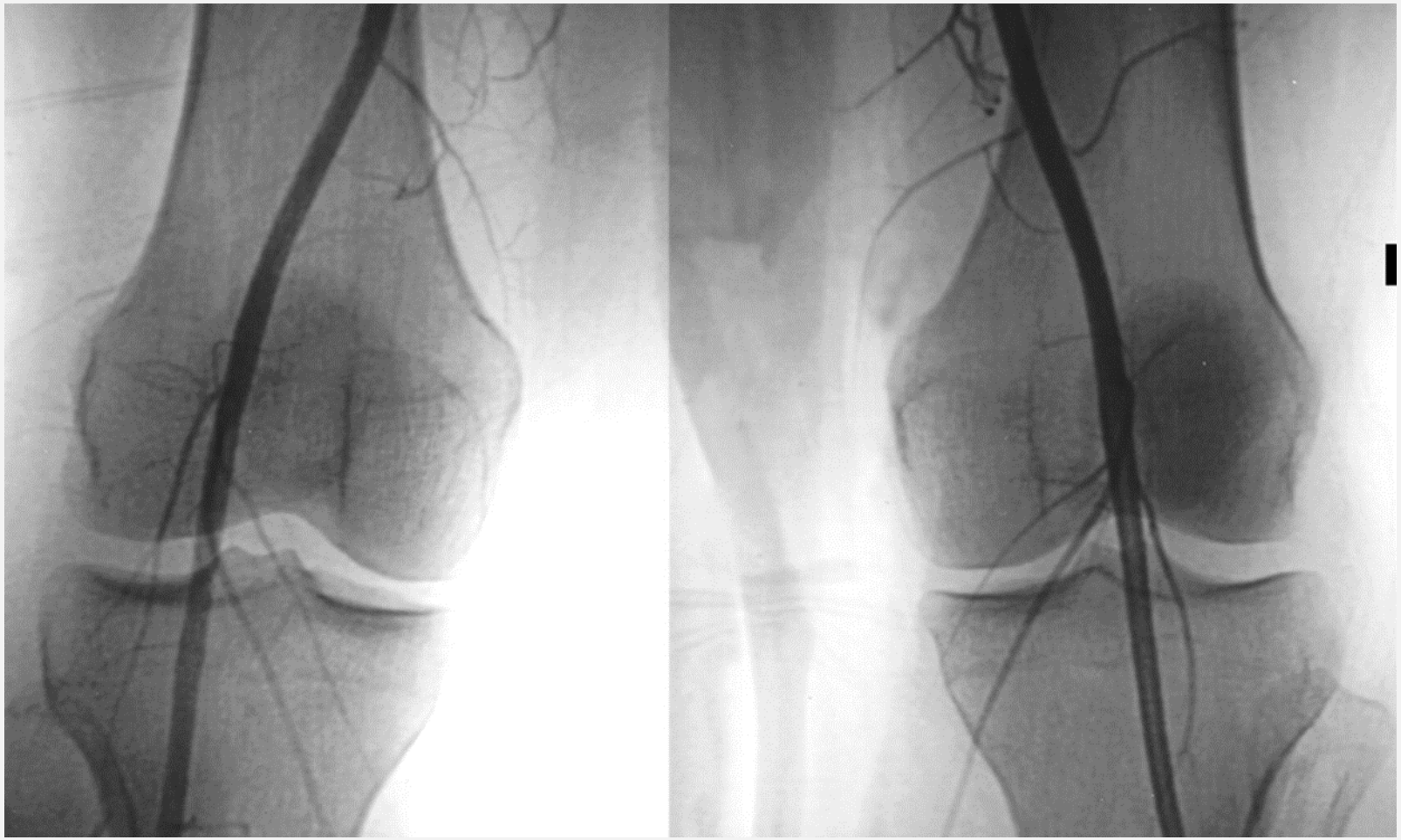
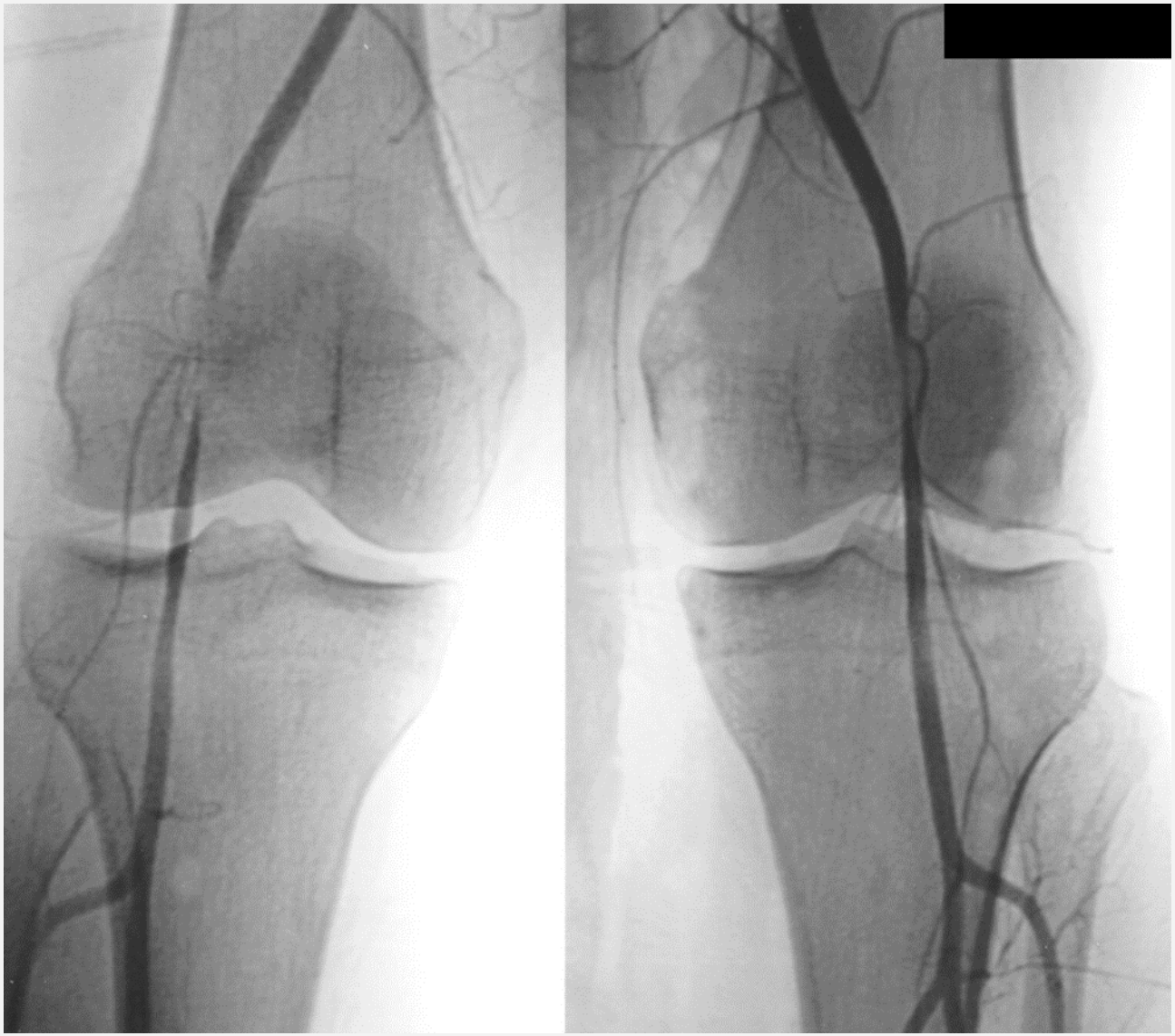
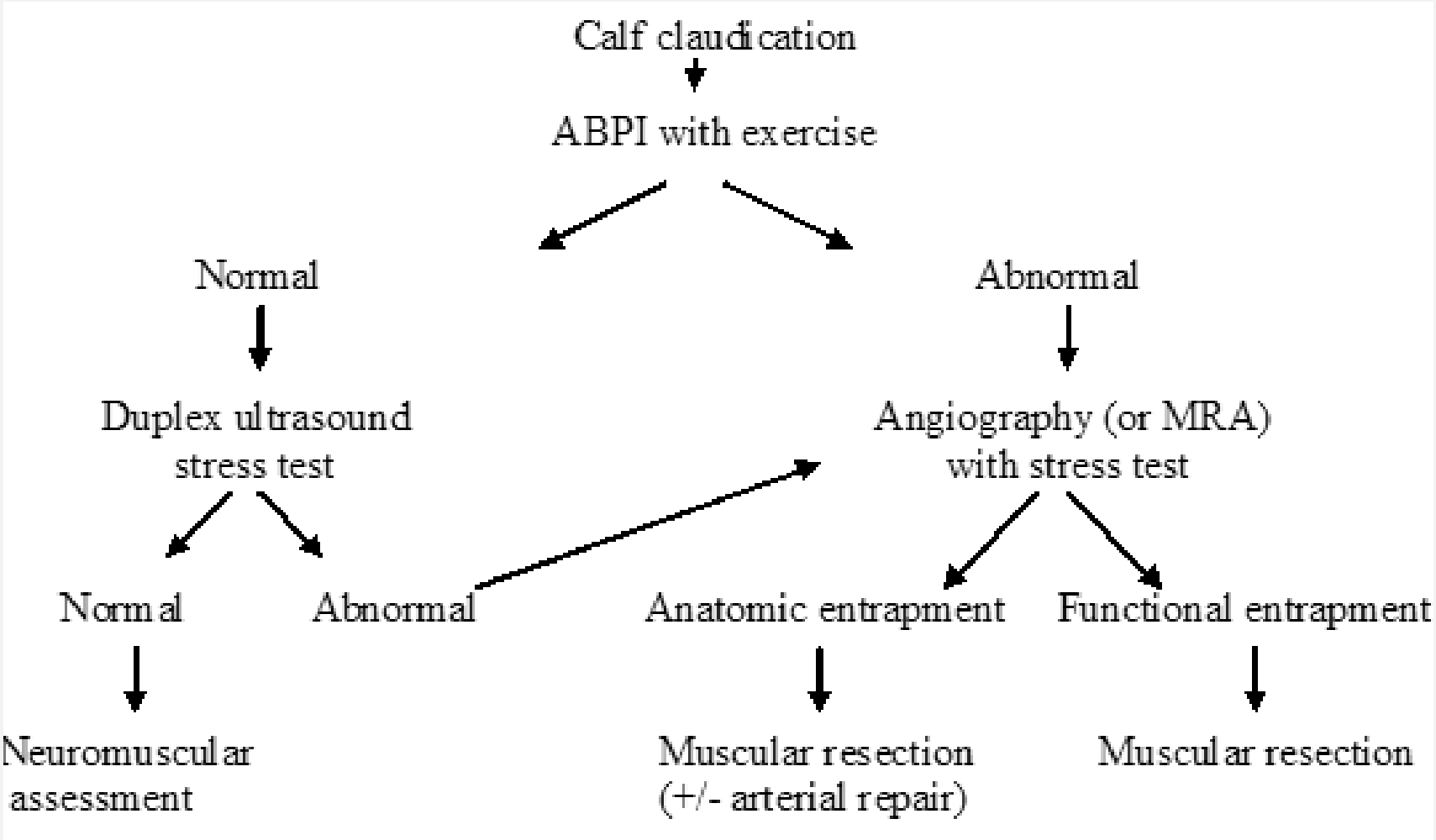
Excluding alternative causes of pain – MR angiography

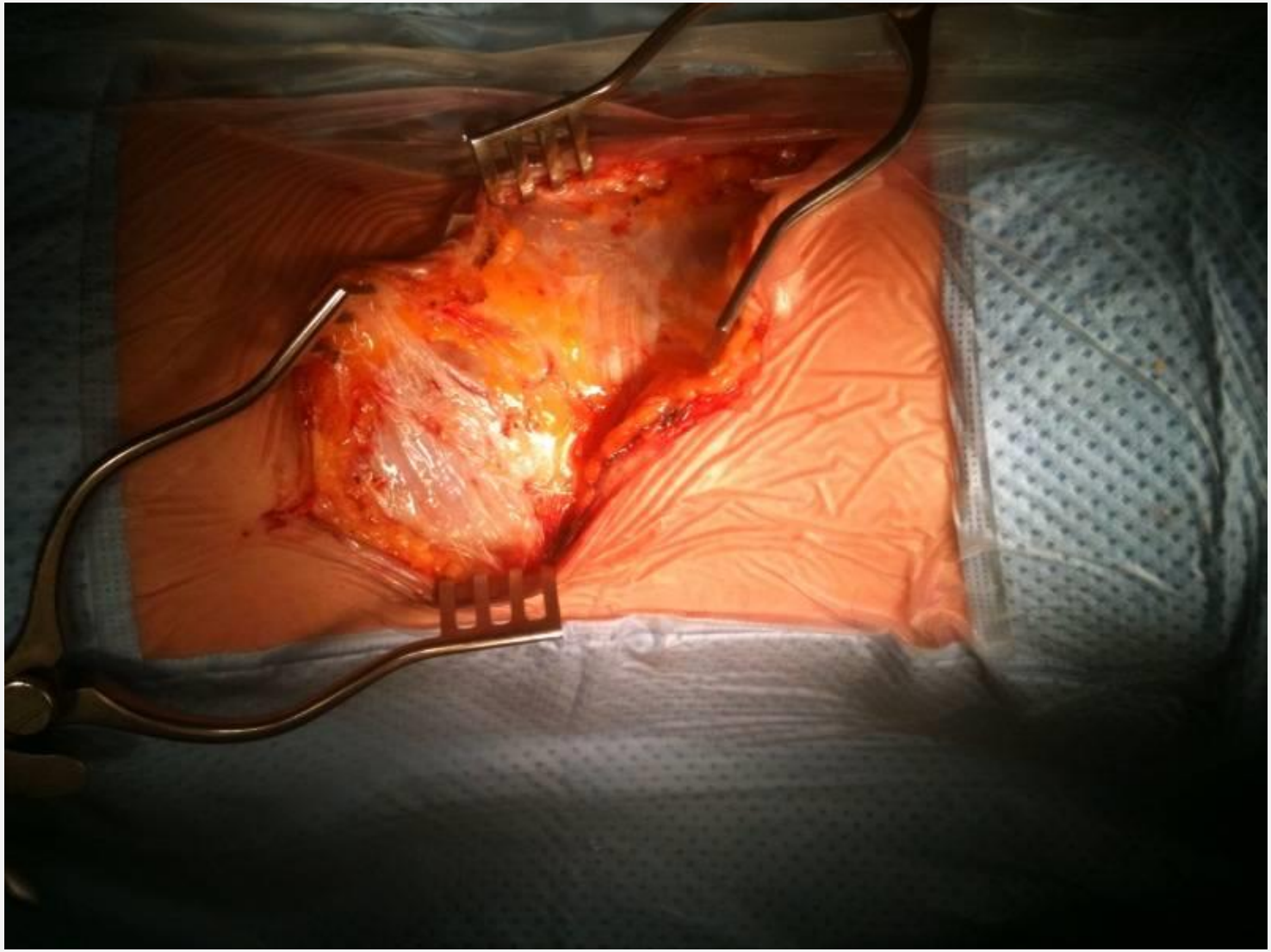


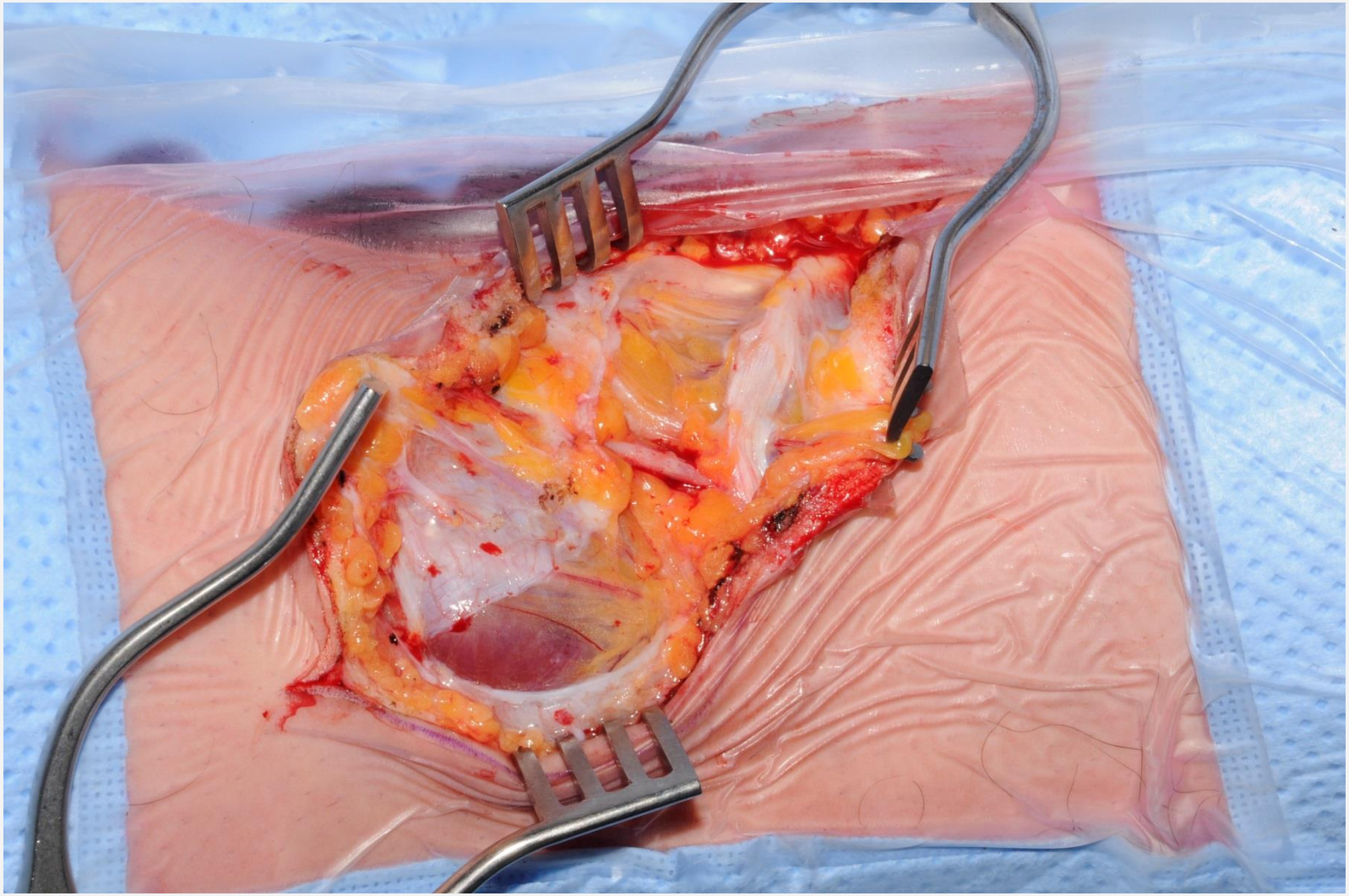


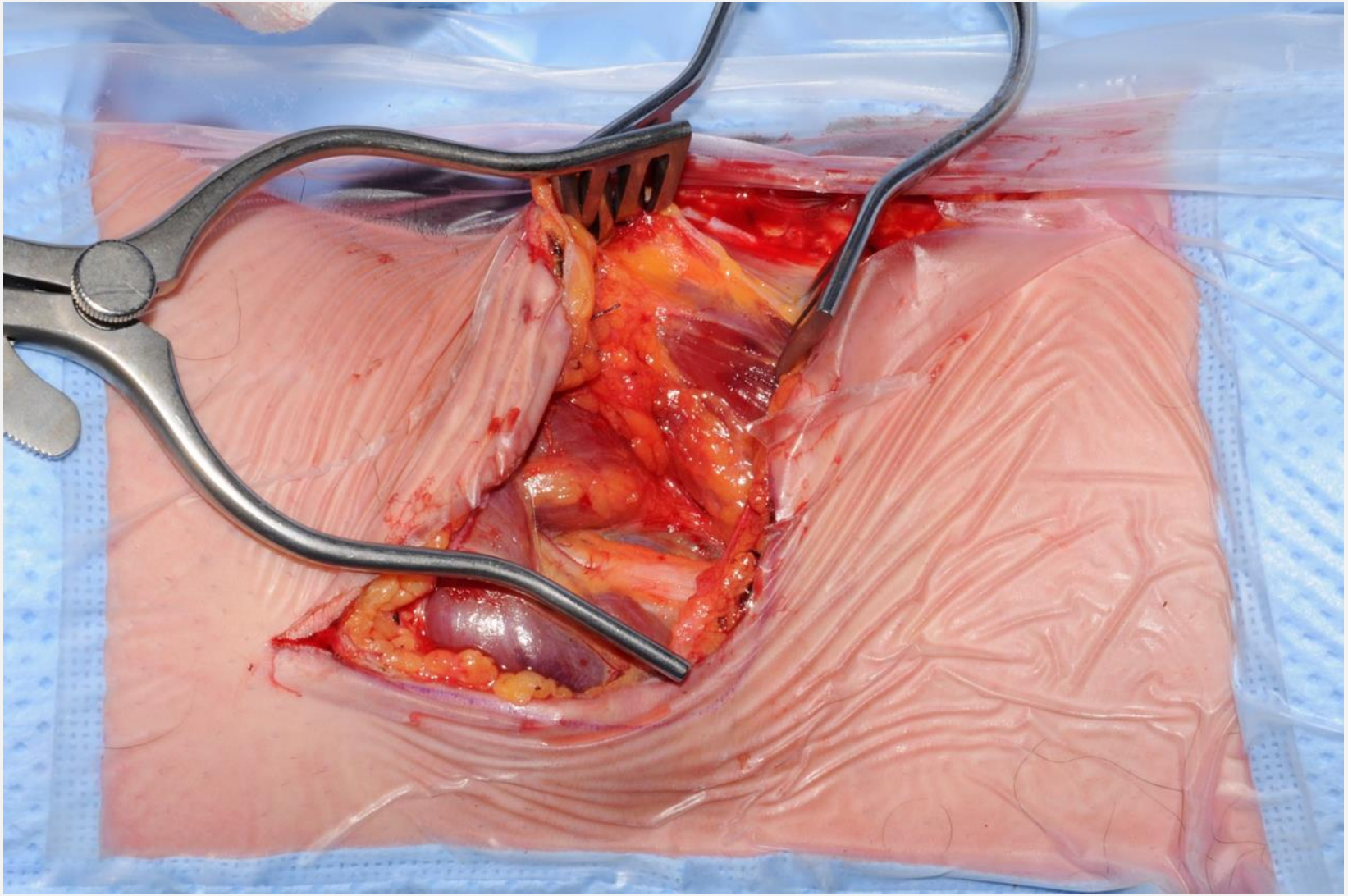


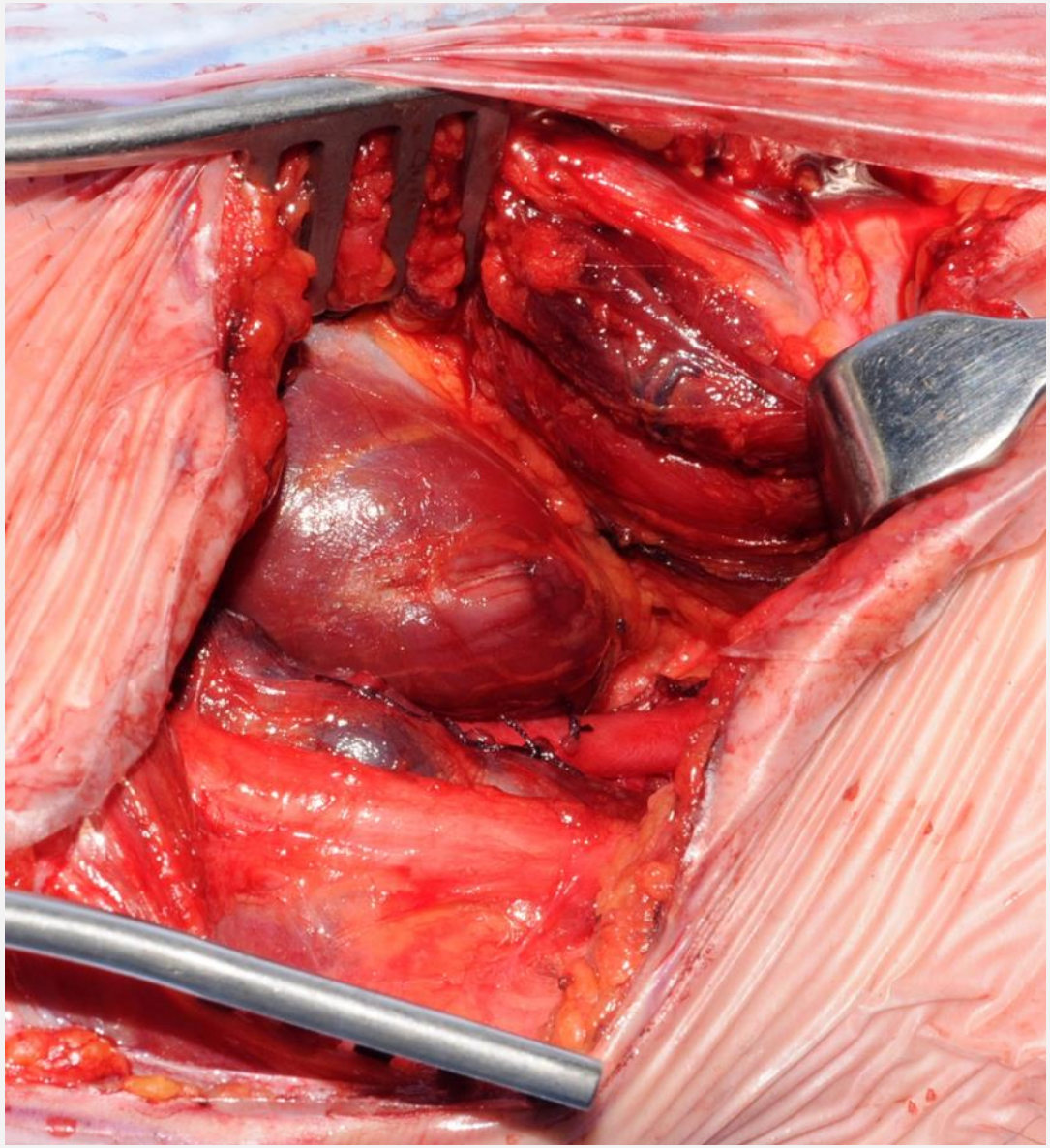
Investigation pathway

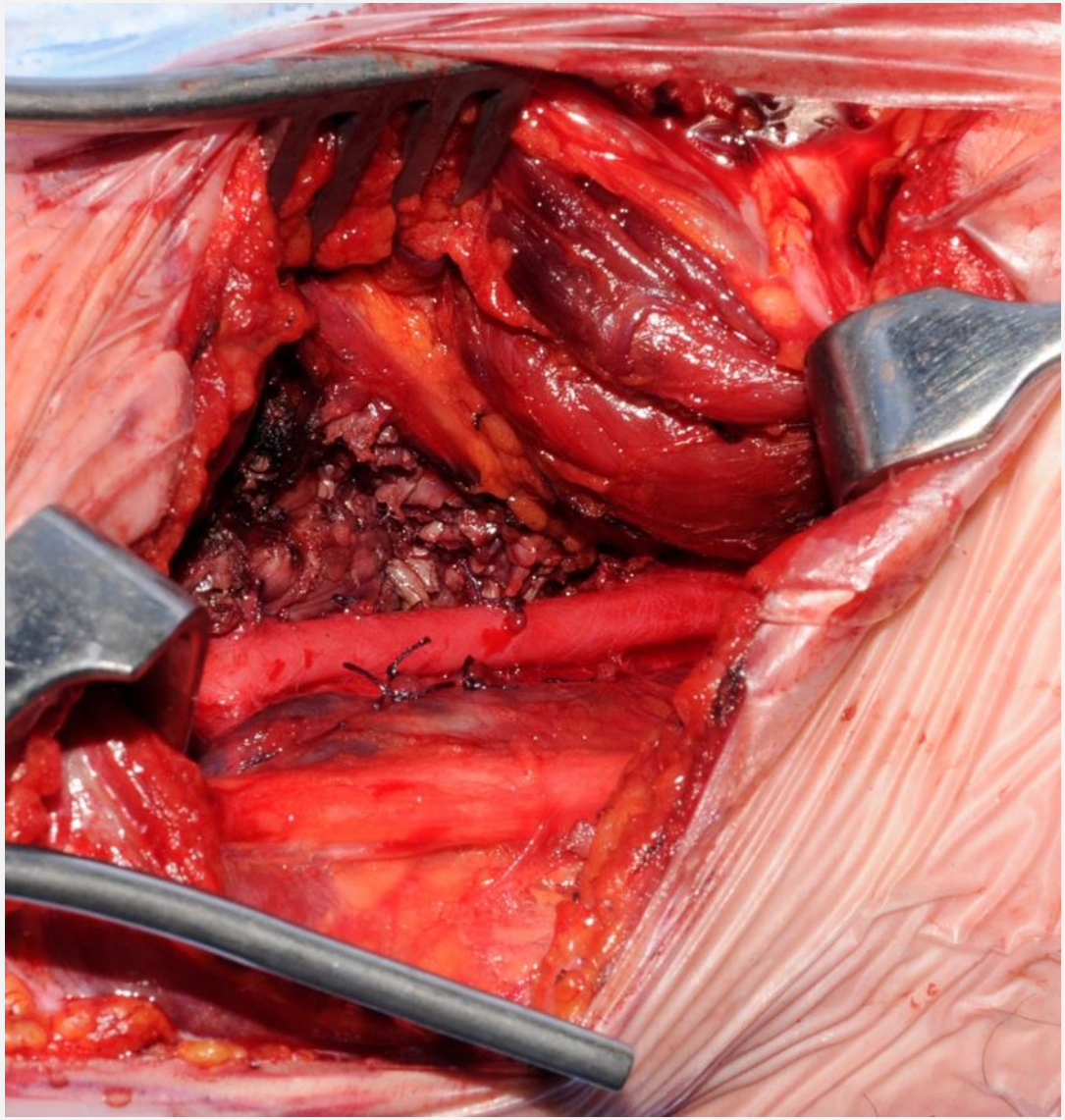










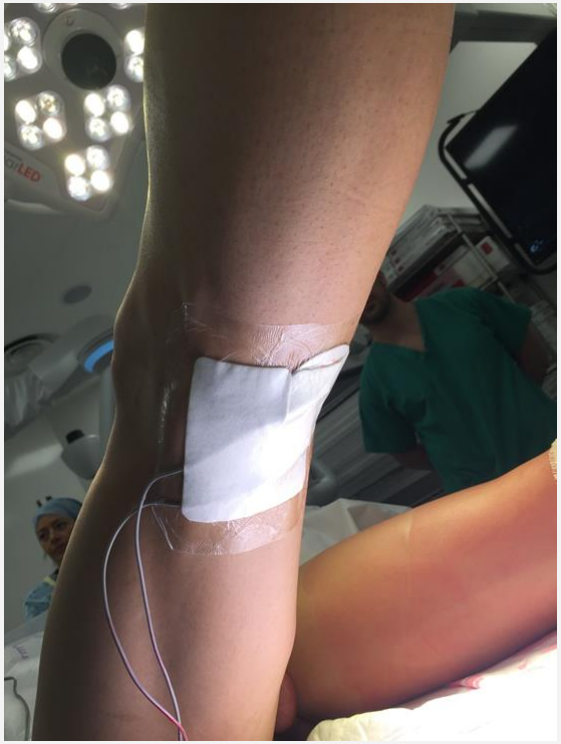


Intra-operative assessment

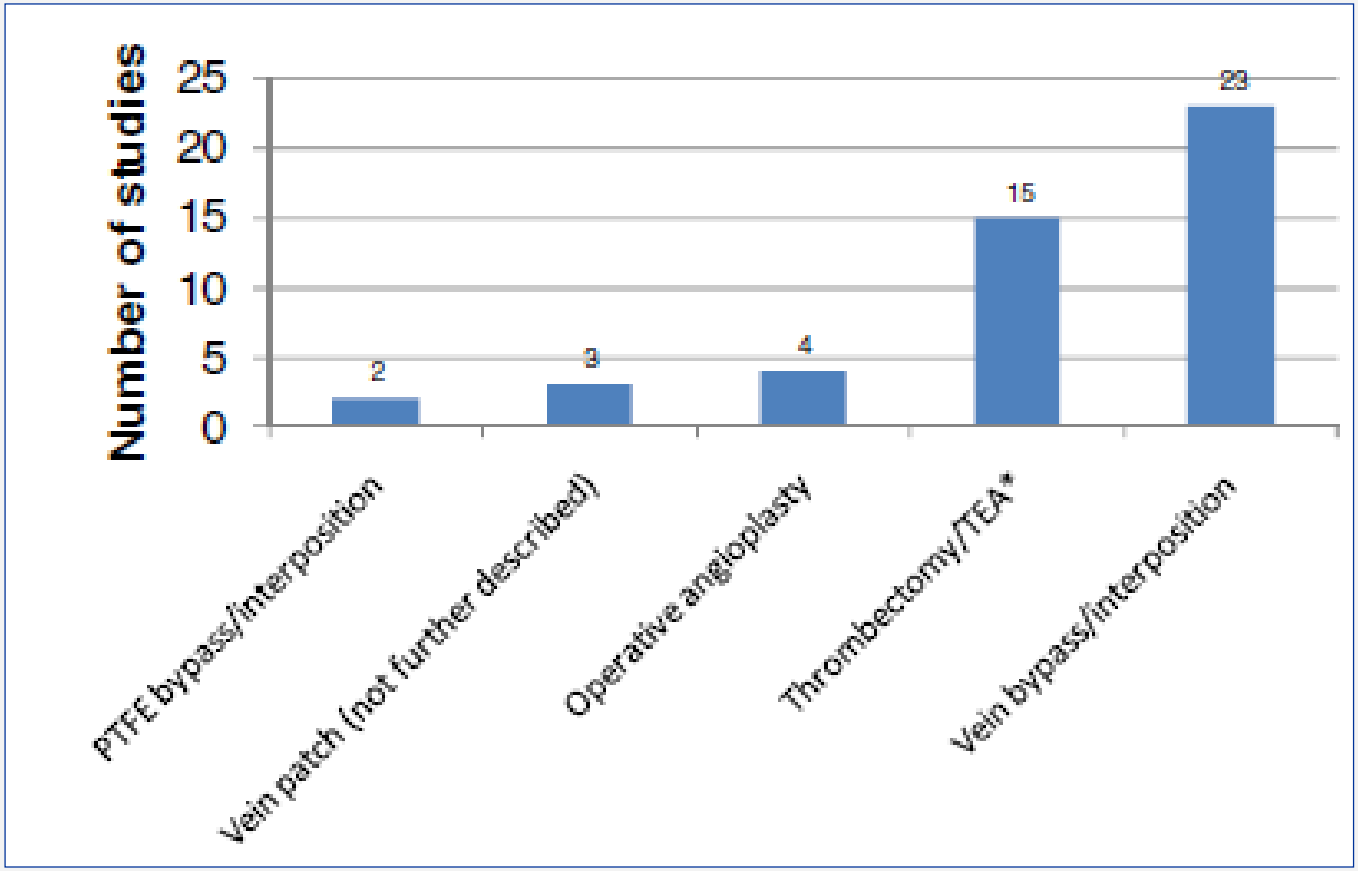
Intra-operative control

Intra-operative control

- Nerve stimulator
- Access to pedal vessels
- Duplex control
- Medial below knee popliteal approach
- Resect medial head gastrocnemius



Arterial reconstruction



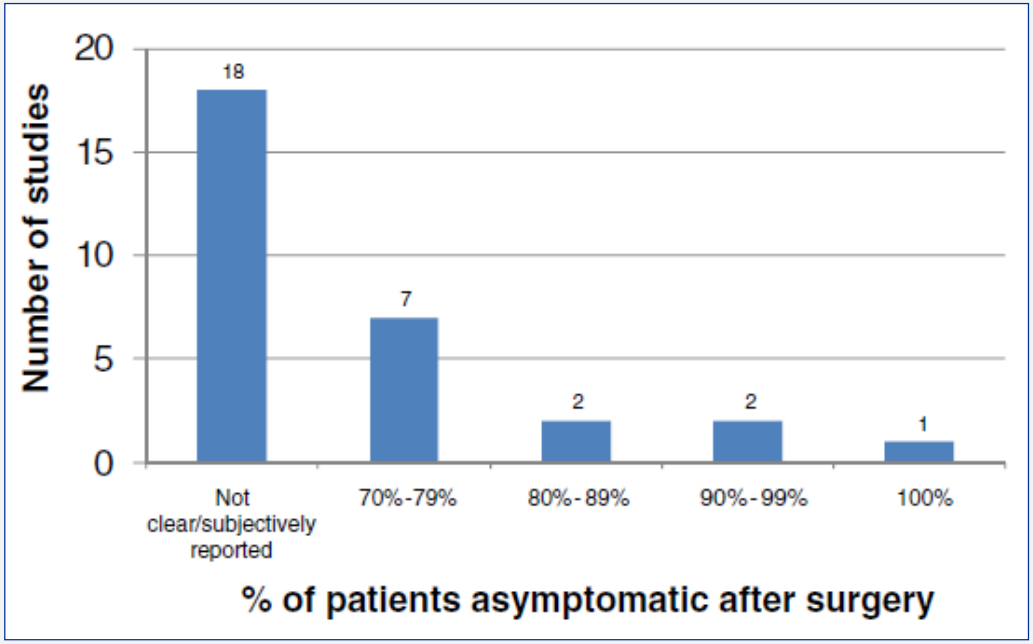
Surgical complications

- Graft related
- Nerve damage (sural/tibial/common peroneal)
- Bleeding
- DVT
- Wound infection
- Skin contracture

- Failure to relieve symptoms

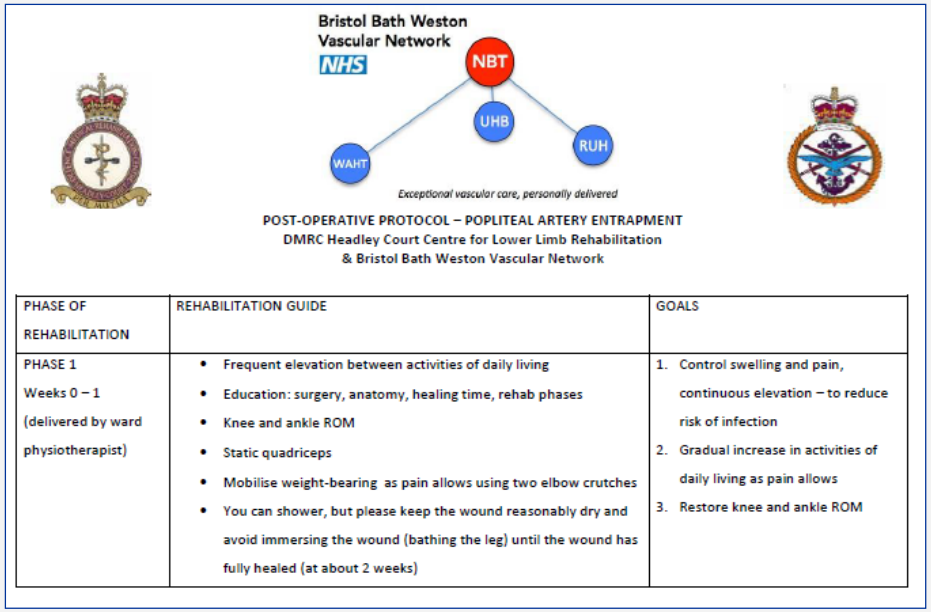
Outcomes of surgery

- Paucity of data
- Successful resolution symptoms 77% (70-100%)
- Nabil Chakfe 5 years data EJVES 2016



Post-operative recovery

- Dedicated rehabilitation schedule
- Bed rest 48 hours
- Crutches 3-4 days
- Non-impact aerobic rehab 1 week
- 4-6 weeks low impact running



Bristol Bath Weston Vascular Network

NHS

NBT UHB RUH WAHT

Exceptional vascular care, personally delivered

POST-OPERATIVE PROTOCOL – POPLITEAL ARTERY ENTRAPMENT
DMRC Headley Court Centre for Lower Limb Rehabilitation & Bristol Bath Weston Vascular Network

PHASE OF REHABILITATION	REHABILITATION GUIDE	GOALS
PHASE 1 Weeks 0 – 1 (delivered by ward physiotherapist)	• Frequent elevation between activities of daily living • Education: surgery, anatomy, healing time, rehab phases • Knee and ankle ROM • Static quadriceps • Mobilise weight-bearing as pain allows using two elbow crutches • You can shower, but please keep the wound reasonably dry and avoid immersing the wound (bathing the leg) until the wound has fully healed (at about 2 weeks)	1. Control swelling and pain, continuous elevation – to reduce risk of infection 2. Gradual increase in activities of daily living as pain allows 3. Restore knee and ankle ROM

Conclusions

- Dedicated referral pathway (musculoskeletal specialist)
- Diagnostic algorithm (exercise ABPI, Duplex, MRA)
- Majority functional
- Medial approach favourable (medial head gastrocnemius)
- Intra-operative Duplex control
- Dedicated rehabilitation schedule
- Long-term / functional data sparse

Diagnostic algorithm in normal population – functional entrapment syndrome

Iliac endofibrosis

- First described in 1985
- High performance athletes
- Unexplained leg symptoms

Epidemiology

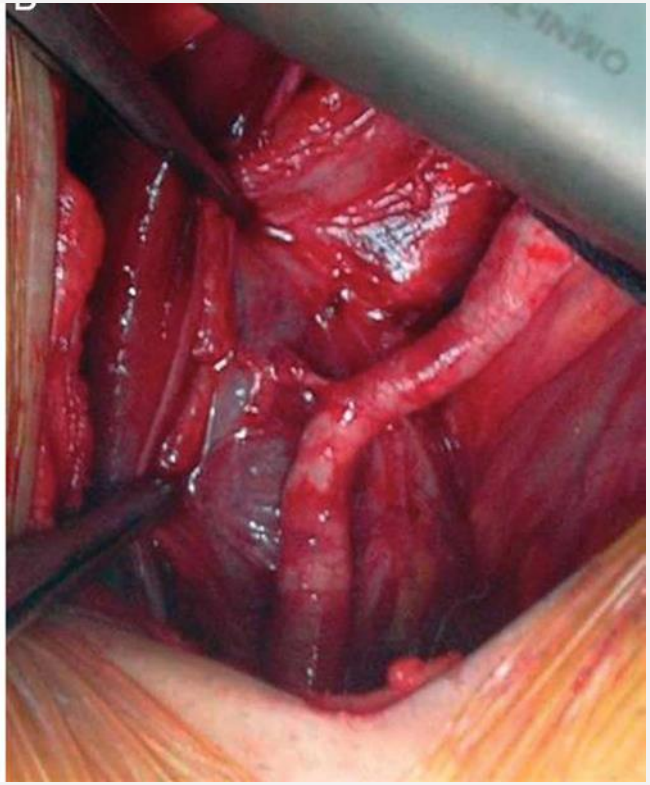
- Mainly cyclists
- Distance cycled (>15,000km per year)
- Intensity of training
- <40 years
- 78% male
- Incidence unknown
- External iliac artery (CIA / CFA / profunda)

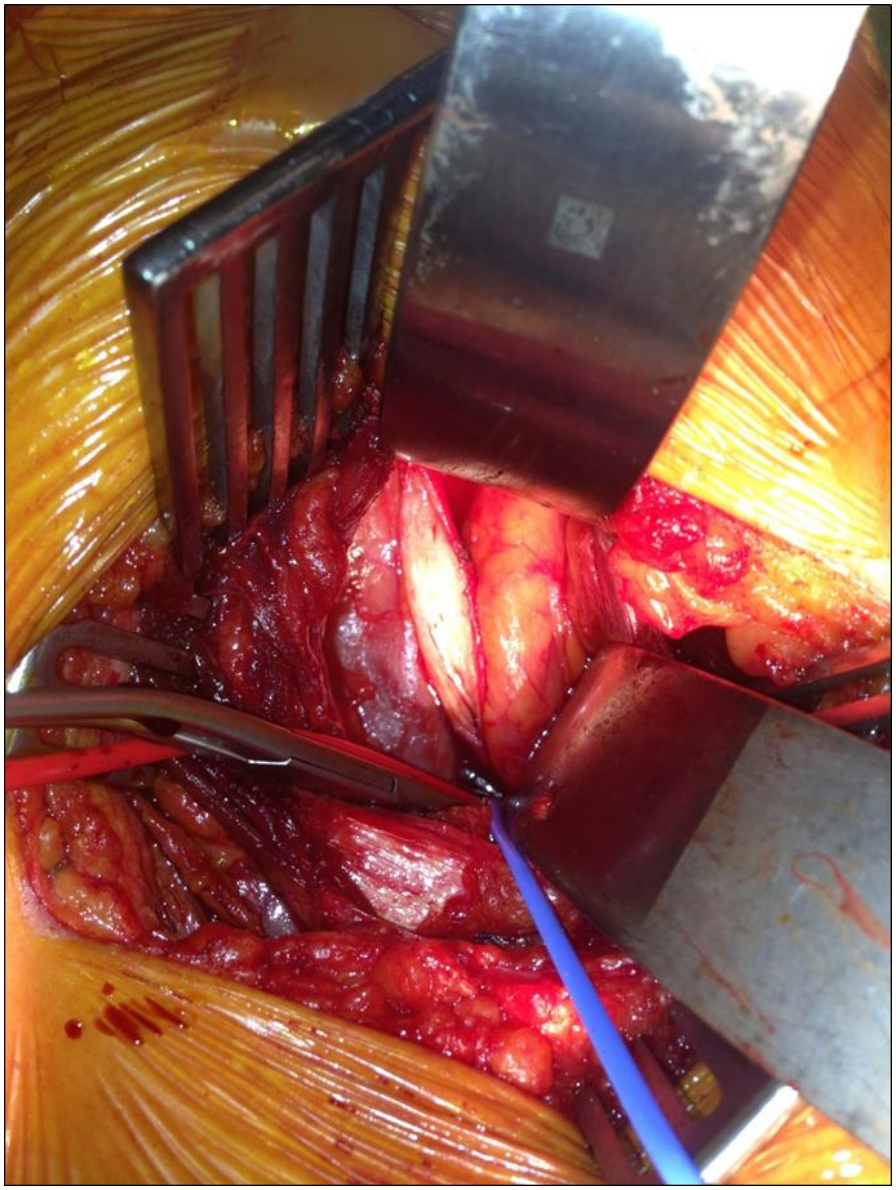
Aetiology

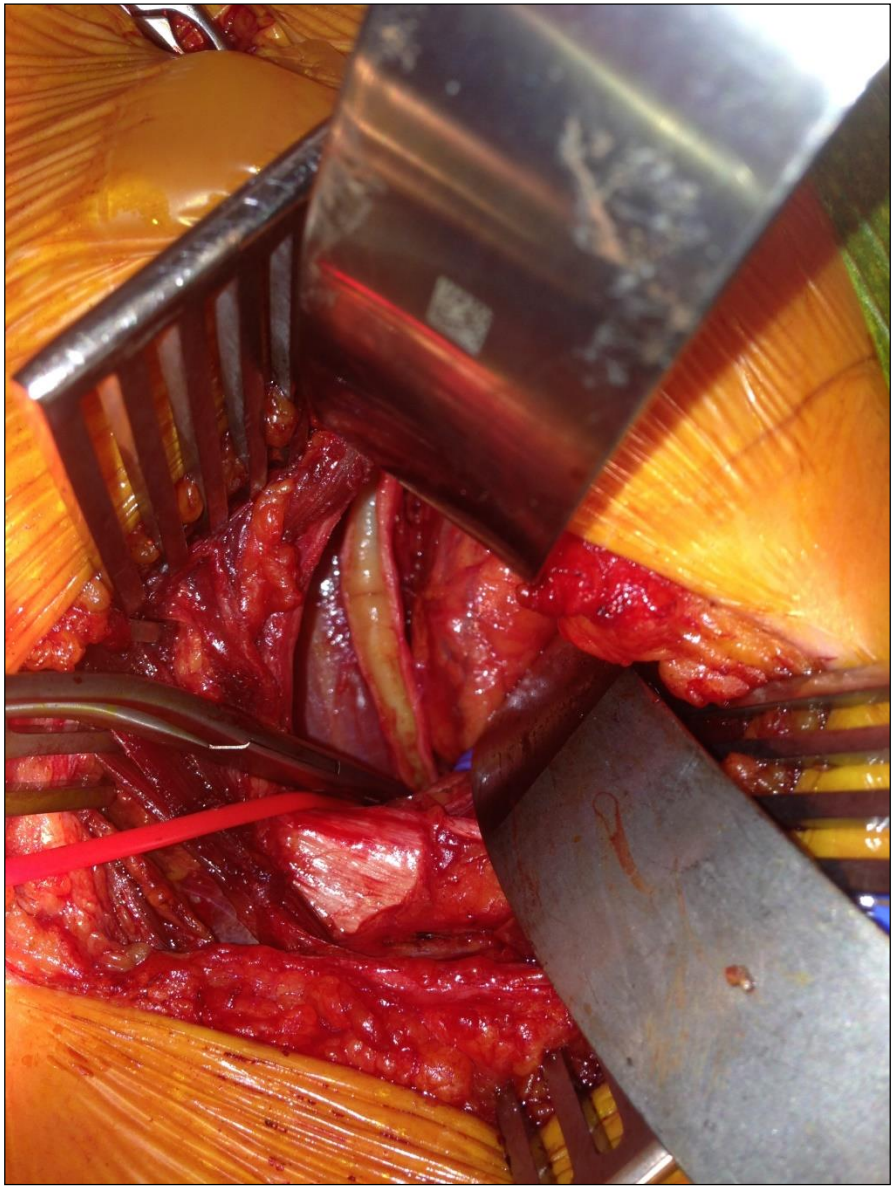
- Inter-play of two major factors
- Haemodynamic injury (shear stress / high blood flow)
- Mechanical stress (repetitive stretching / position)

Mechanical factors

- Repeated stretching
- Psoas hypertrophy
- Arterial fixation
- Excessive vessel length
- Kinking
- External compression
- Systemic factors (homocysteine)?

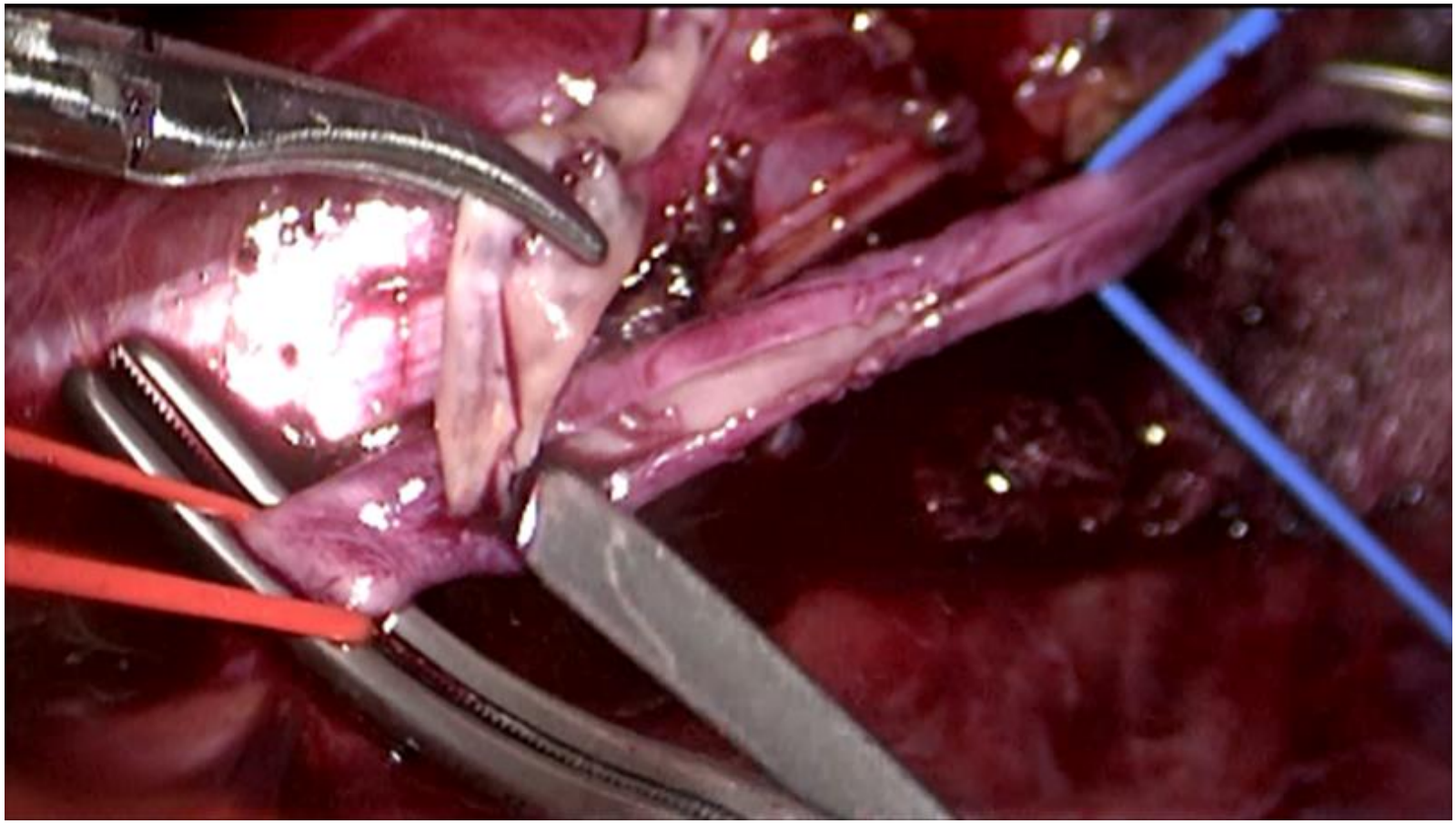






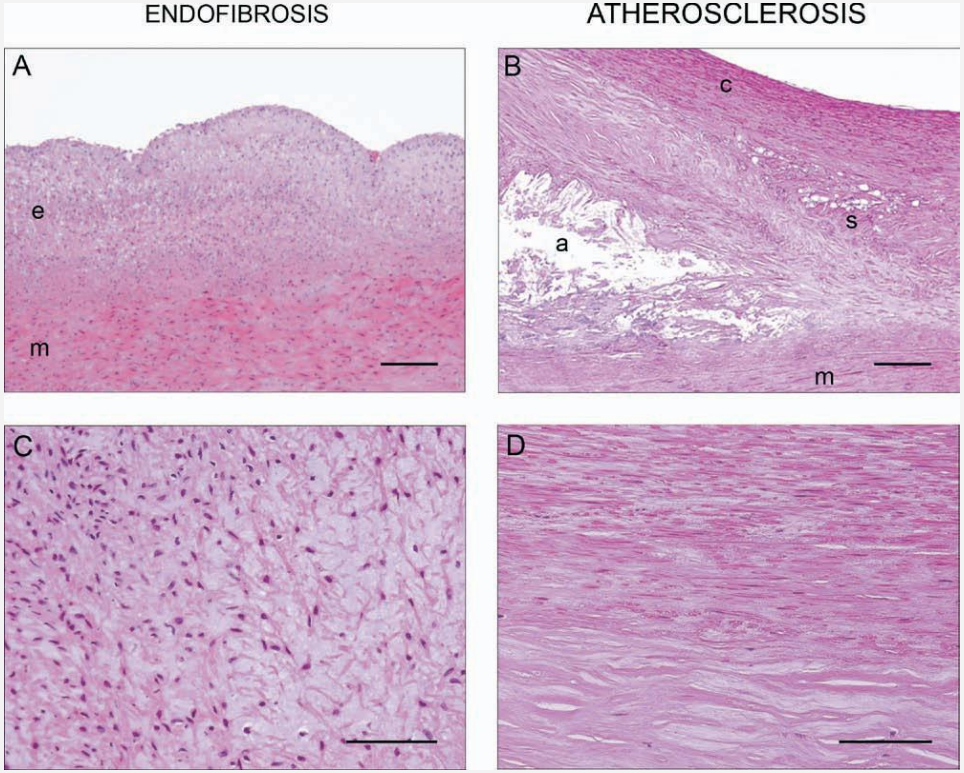
Pathology

- 90% EIA
- 15% bilateral
- Eccentric plaque
- 2 - 6cm length
- Extension to CFA



Pathology

- Distinct from atherosclerosis
- Subintimal thickening
- Accumulation of loose connective tissue
- Natural history poorly understood



Reduction in arterial flow

- Luminal narrowing
- Kinking
- Combination

Symptoms

- Delayed presentation

- Unilateral
- Weakness / lack of power
- Numbness / paraesthesia
- Swelling
- Cramp

- Acute presentation unusual

Clinical signs

- Clinical examination

  invariably normal

- Bruit on hip flexion

+ve LR 2.17

- Bruit on hip extension

+ve LR 6

Diagnostic value of specific history

Test Variable	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Disappearance of complaint in less than 5mins of rest	0.97	0.29	0.70	0.83
Progression of the complaint	0.79	0.53	0.74	0.60
Symptoms in >3 muscles (out of 6)	0.48	0.94	0.93	0.52
Symptoms in >3 muscles + calf pain + iliofemoral bruit	0.90	0.50	-	-

Investigations

- ABPI

Exercise tests

Provocative tests

- Duplex ultrasound

During exercise

Dynamic (hip flexion)

- MR angiography

Angiography

Dynamic (hip flexion)

GTN

Natural history

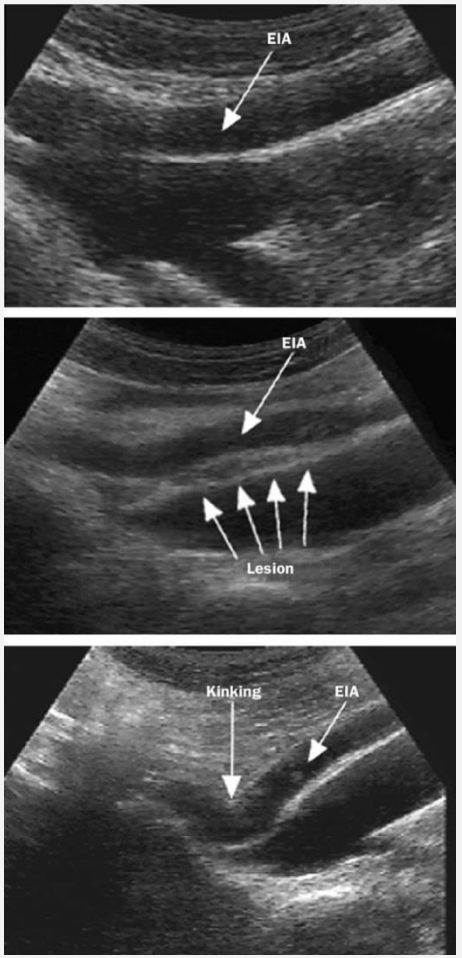
- Symptoms often appear at specific times
- Time trialling / interval training
- Stable / progressive
- No improvement
- Increasing numbers of dissections / occlusions

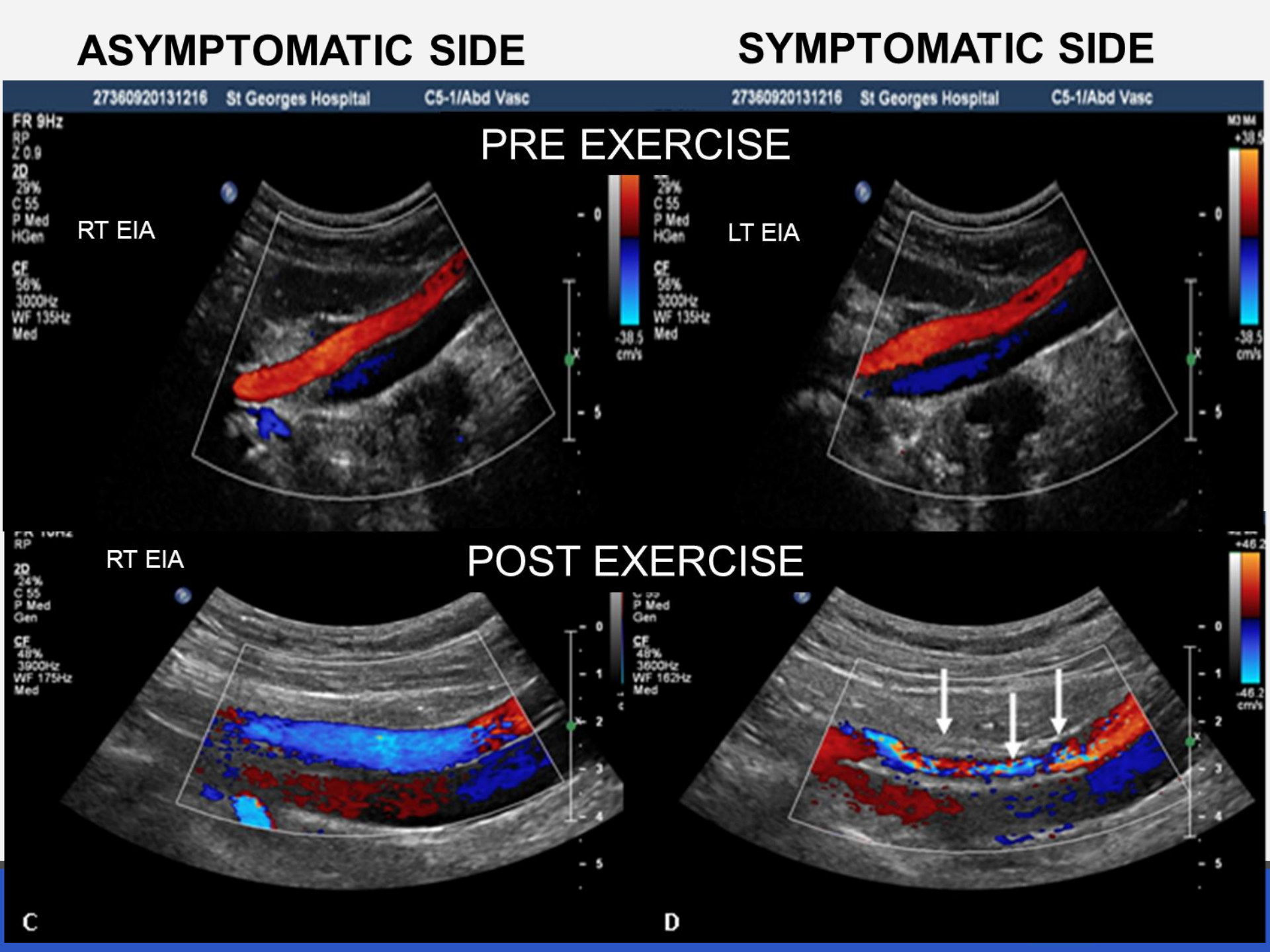
Diagnostic utility of post-exercise testing using Doppler ultrasound

Test Variable	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Inter-ankle pressure difference >23mmHg (1min post exercise)	0.73	0.95	0.97	0.61
Reduced ABPI during first 5 minutes post-exercise	1.0	1.0	-	-
ABPI <0.66 at 1min after max exercise	0.90	0.87	-	-
ABPI <0.48 1 minute after max exercise	0.80	1.0	-	-
Inter-ankle pressure difference >22mmHg During first 4 mins after exercise	0.93	0.93	0.93	0.93
Inter-ankle ABPI difference >0.1 during first 4 mins after exercise	0.90	0.95	0.95	0.90

Duplex ultrasound

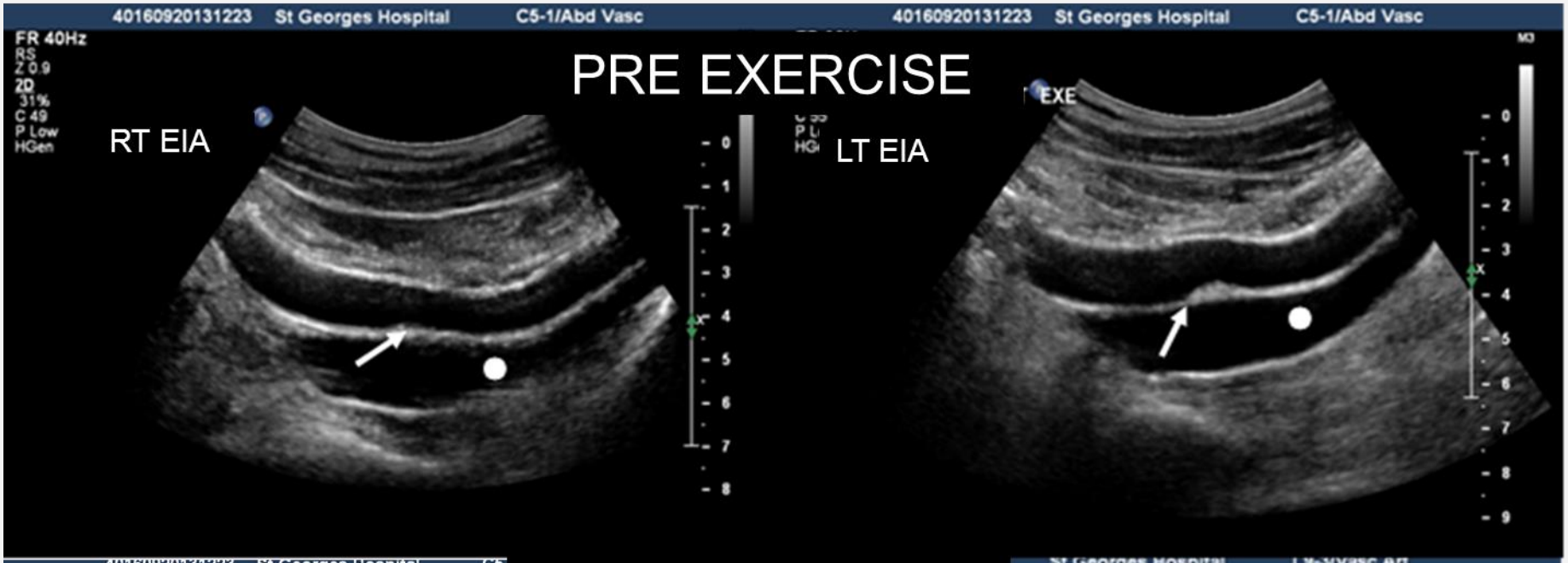
- Normal EIA (increased IMT common)
- Smooth non calcified endofibrotic plaque located on the dorsal side of the external iliac artery
- Bending common but kinking (haemodynamic changes) of external iliac artery with hip flexed unusual

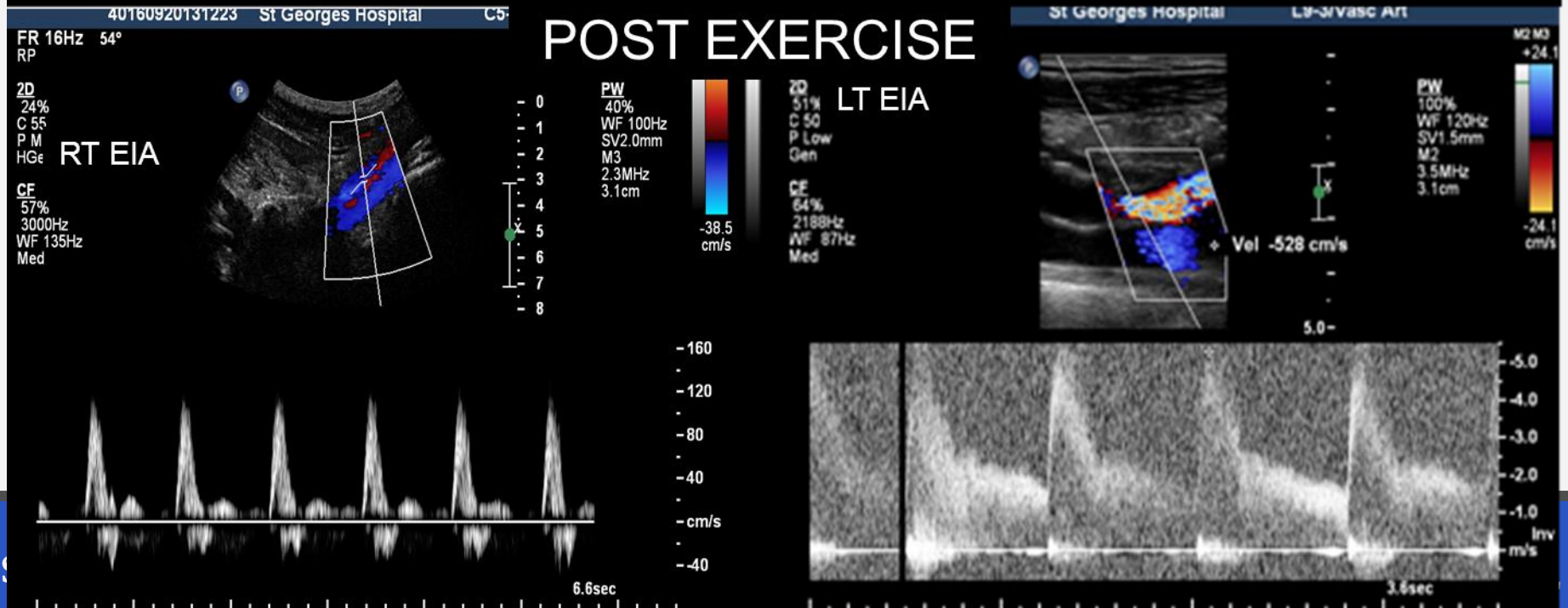



ASYMPTOMATIC SIDE
SYMPTOMATIC SIDE
27360920131216 St Georges Hospital C5-1/Abd Vasc
27360920131216 St Georges Hospital C5-1/Abd Vasc
PRE EXERCISE
RT EIA
LT EIA
POST EXERCISE
RT EIA
C
D

ASYMPTOMATIC SIDE

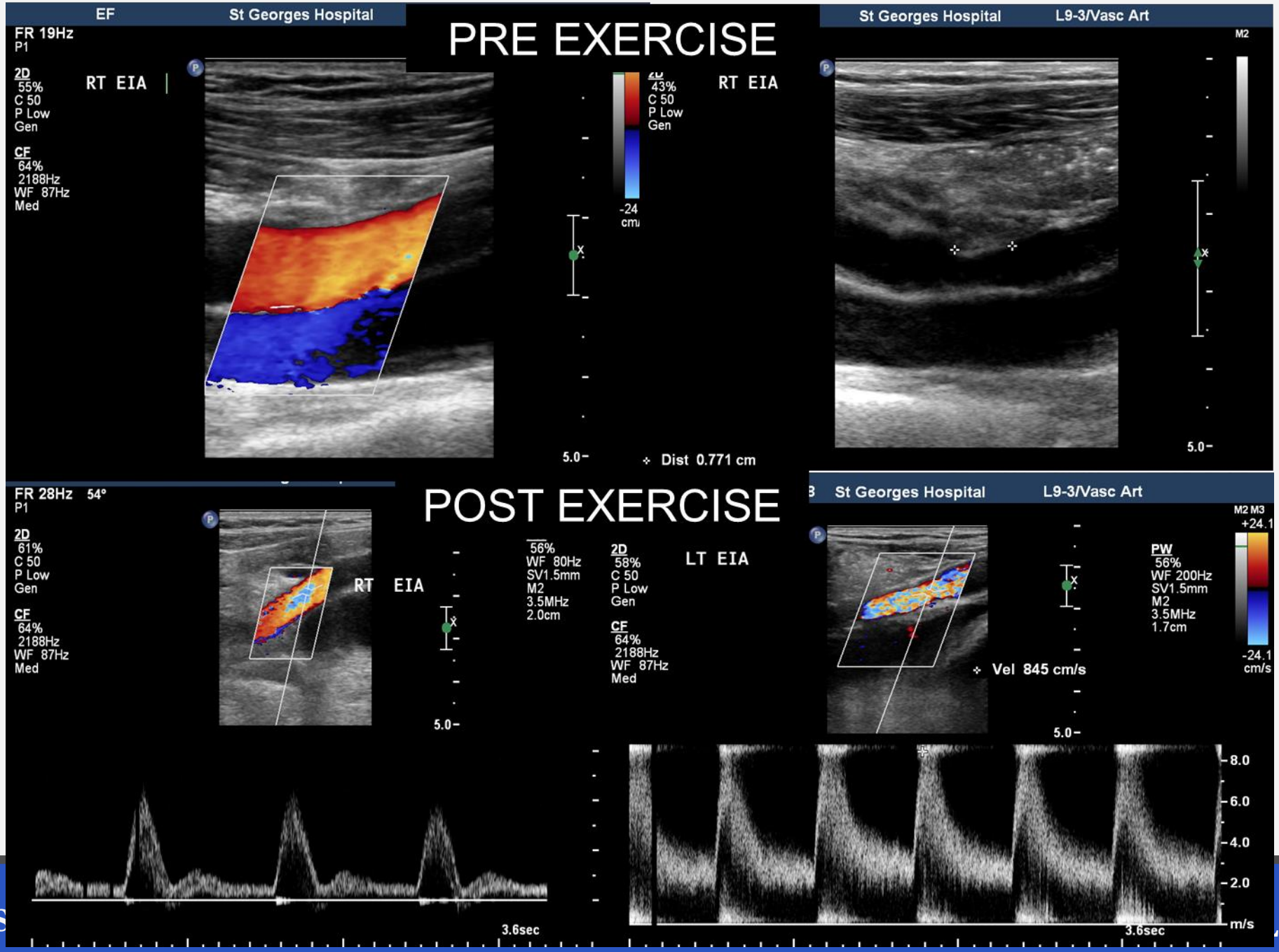
SYMPTOMATIC SIDE





ASYMPTOMATIC SIDE

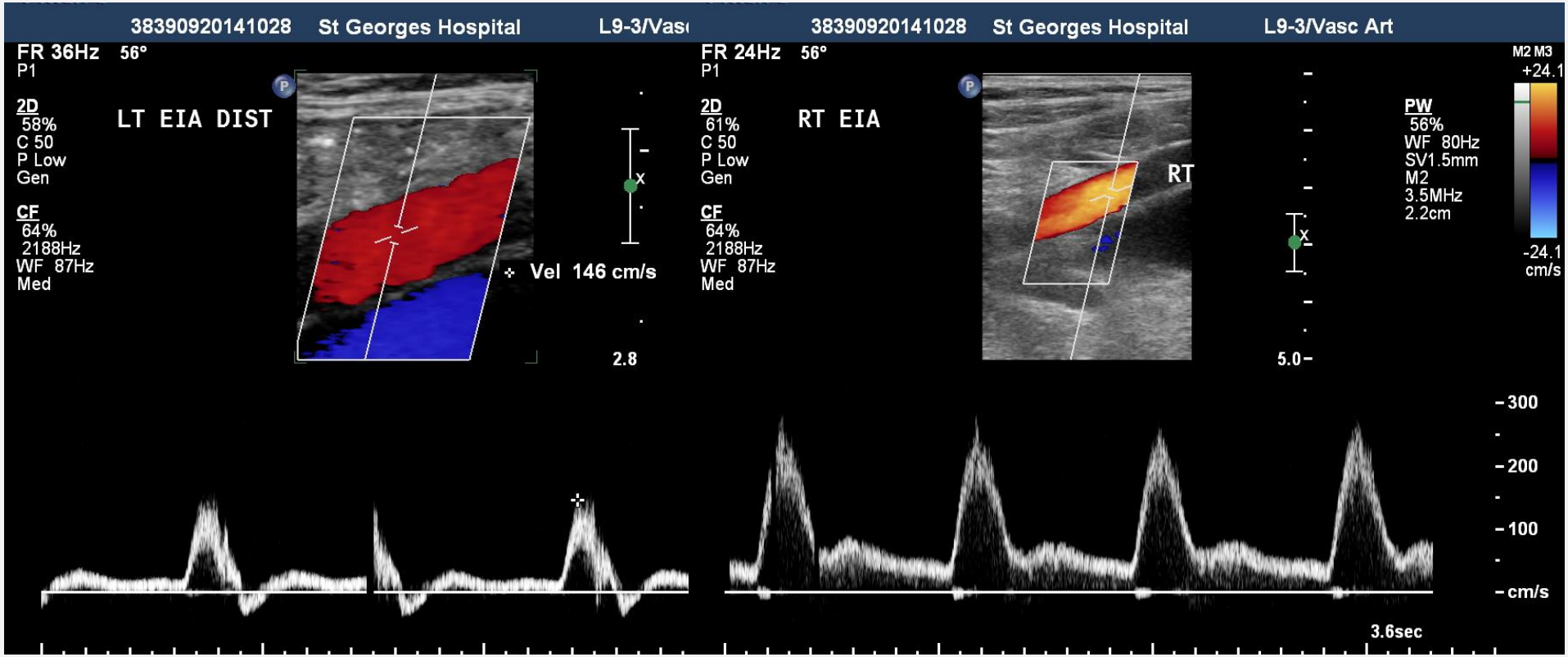
SYMPTOMATIC SIDE



AT REST WAVEFORMS

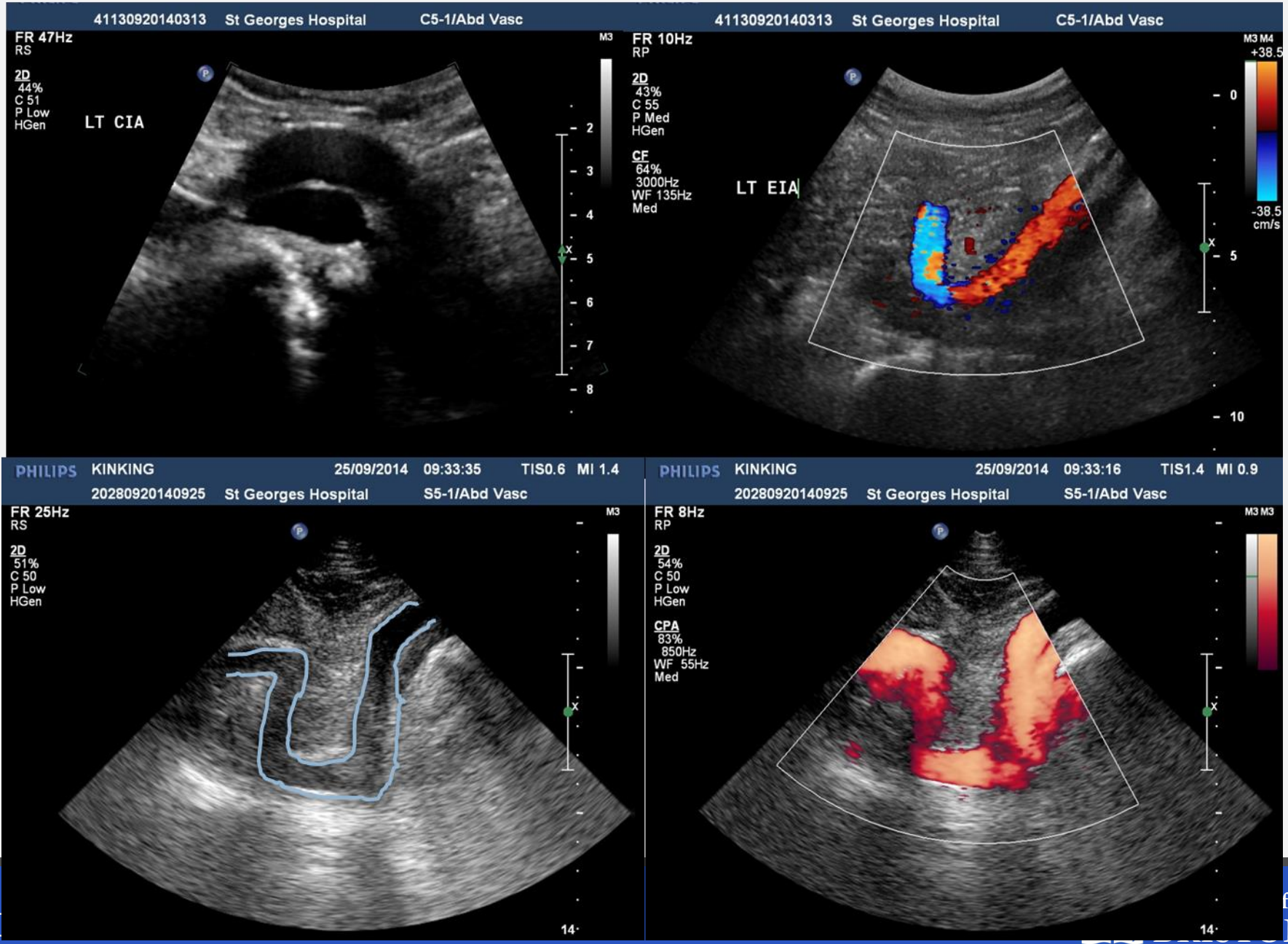
ASYMPTOMATIC SIDE

SYMPTOMATIC SIDE

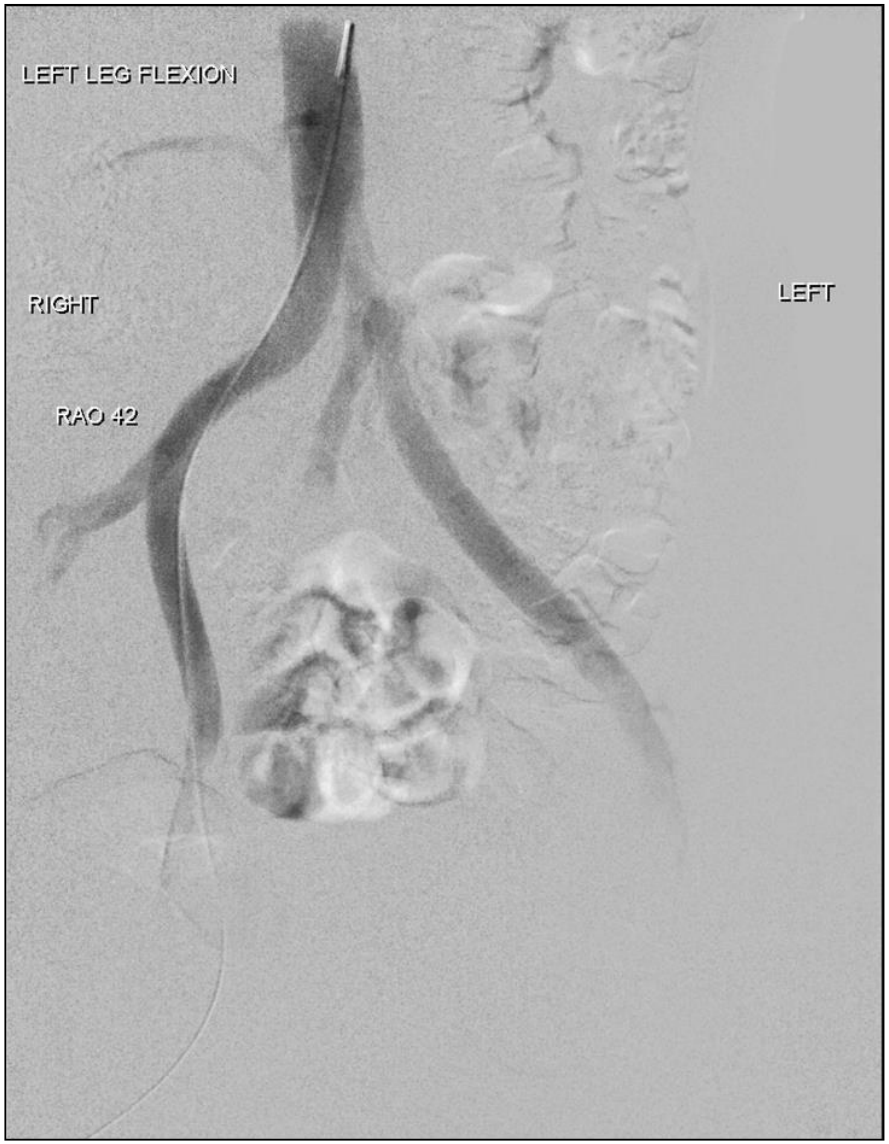


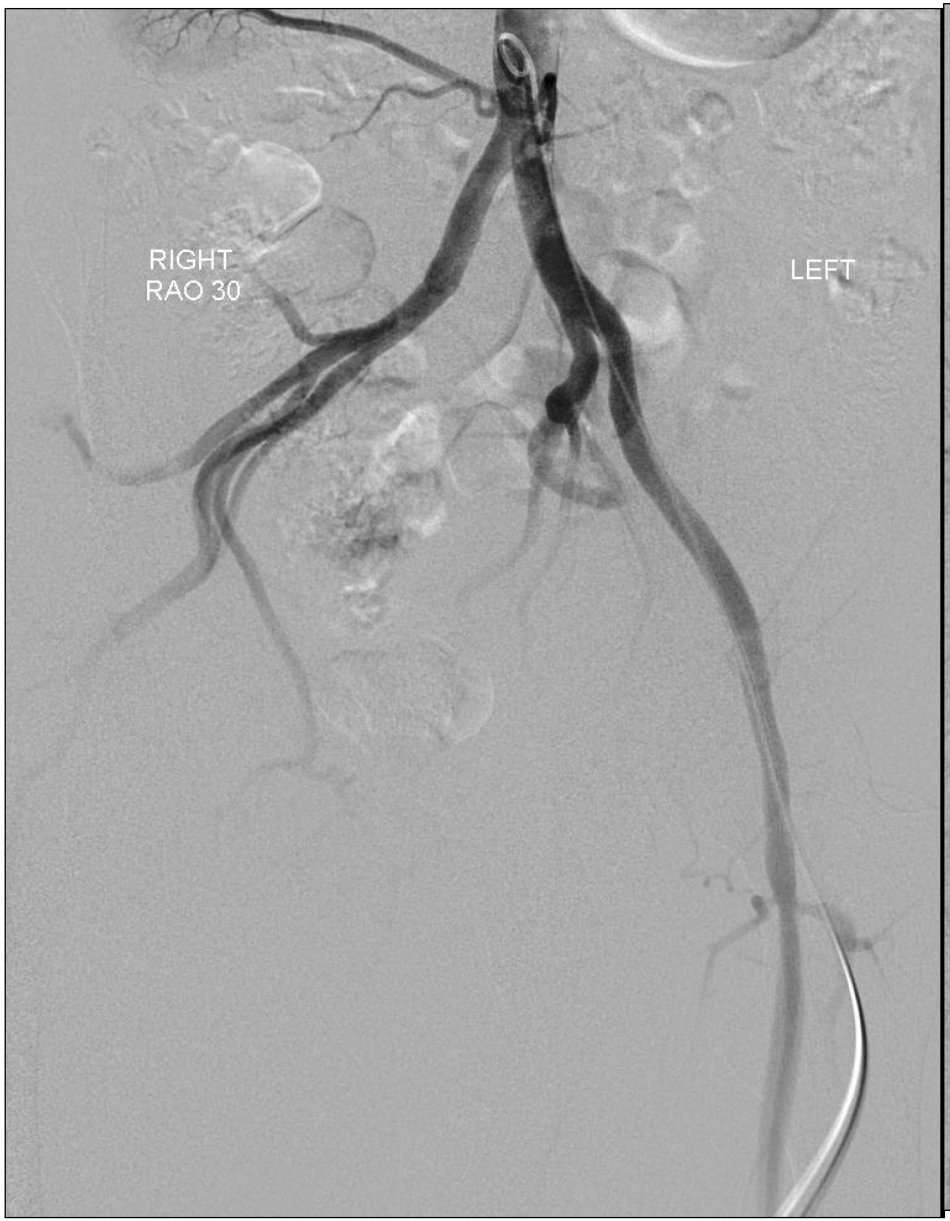
Reduced arterial compliance

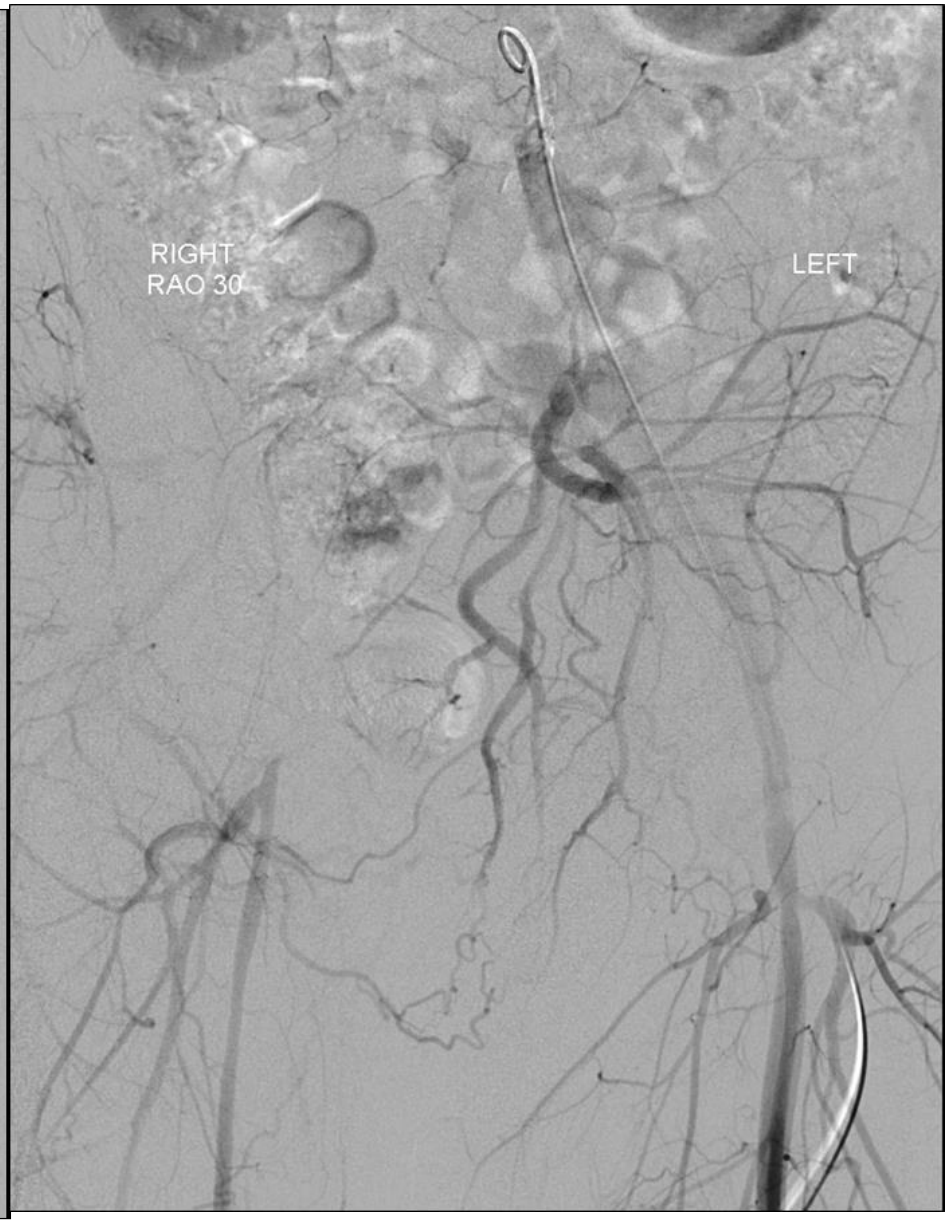
COMMON TORTUOUSITIES OBSERVED IN THE EF




RIGHT
RAO35


LEFT LEG FLEXION
RIGHT
LEFT
RAO 42


RIGHT
RAO 30
LEFT


RIGHT
RAO 30
LEFT

Management

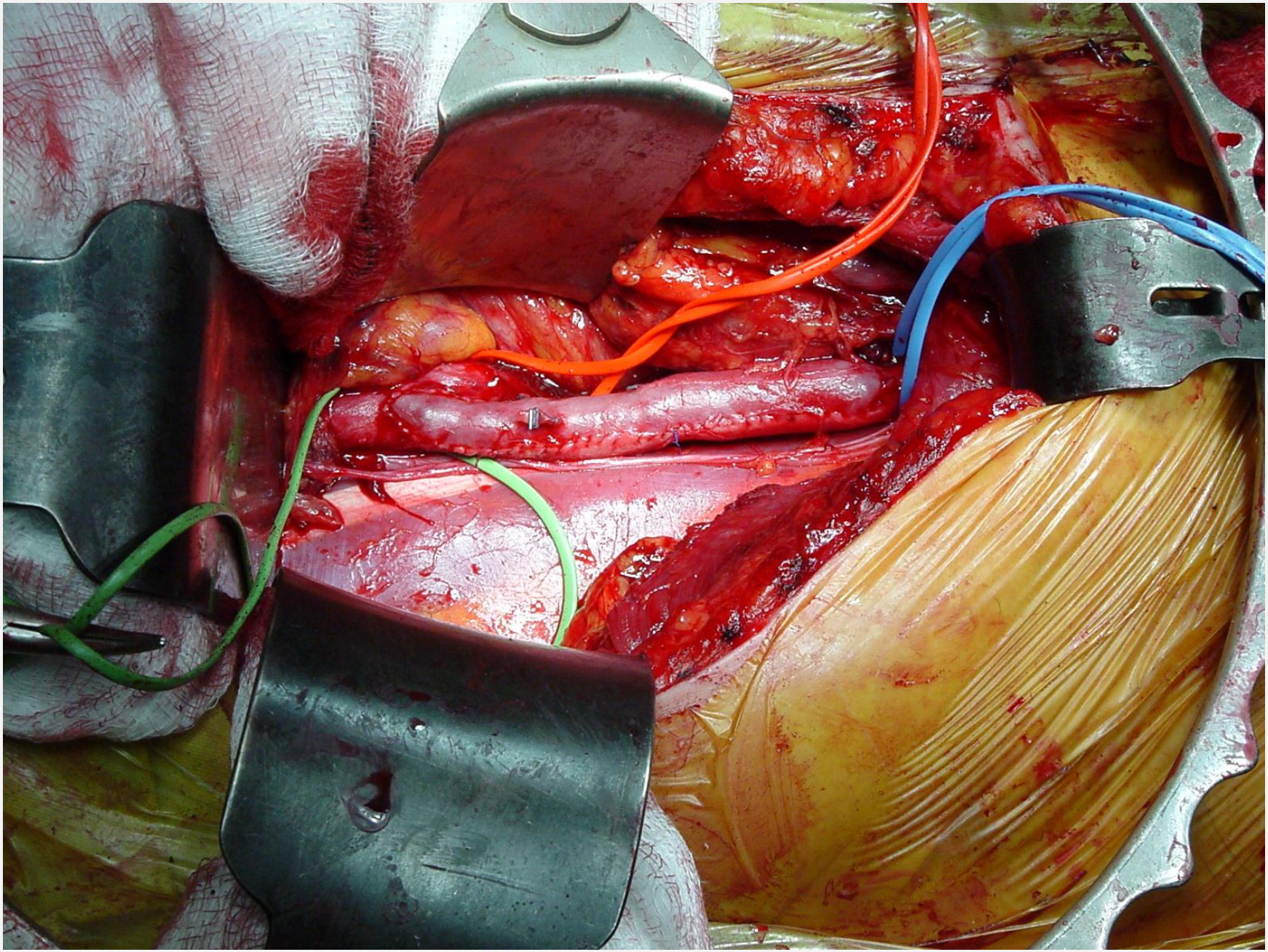
- Change cycling position
- Different sport
- Conservative
  - *Angioplasty / stent*
- Surgery

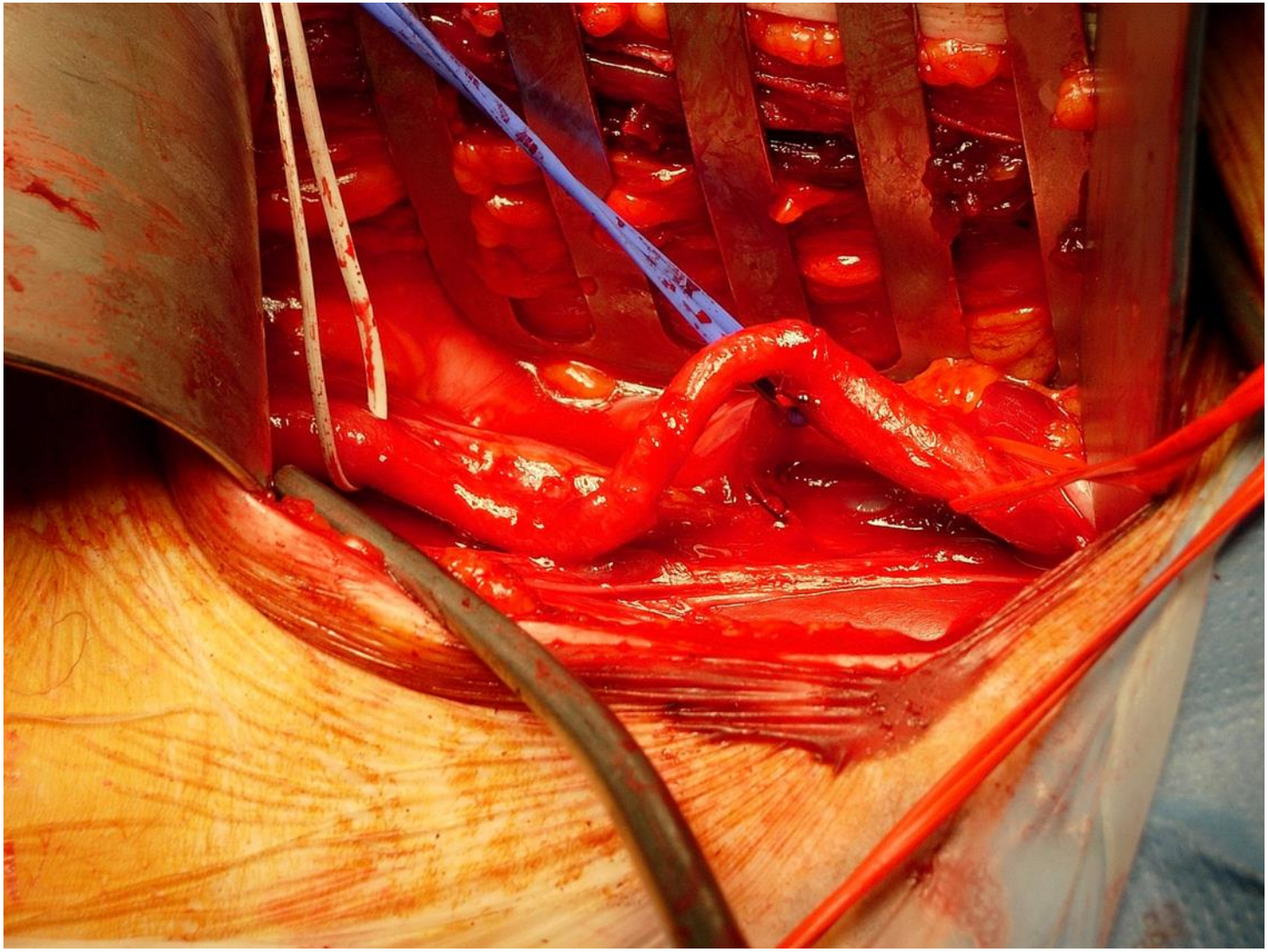
Management

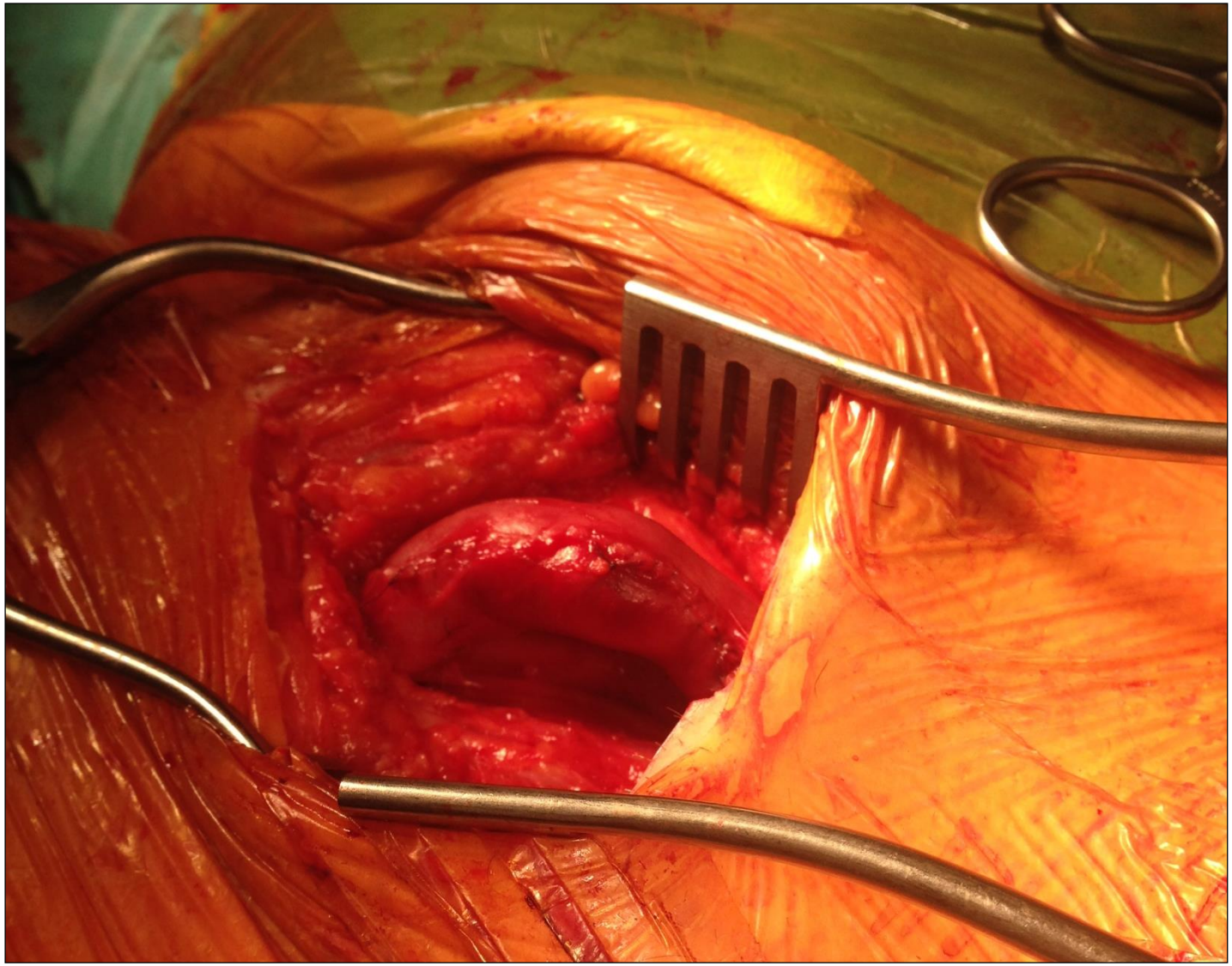
- Change cycling position
- Different sport
- Conservative
- *Angioplasty / stent*
- Surgery

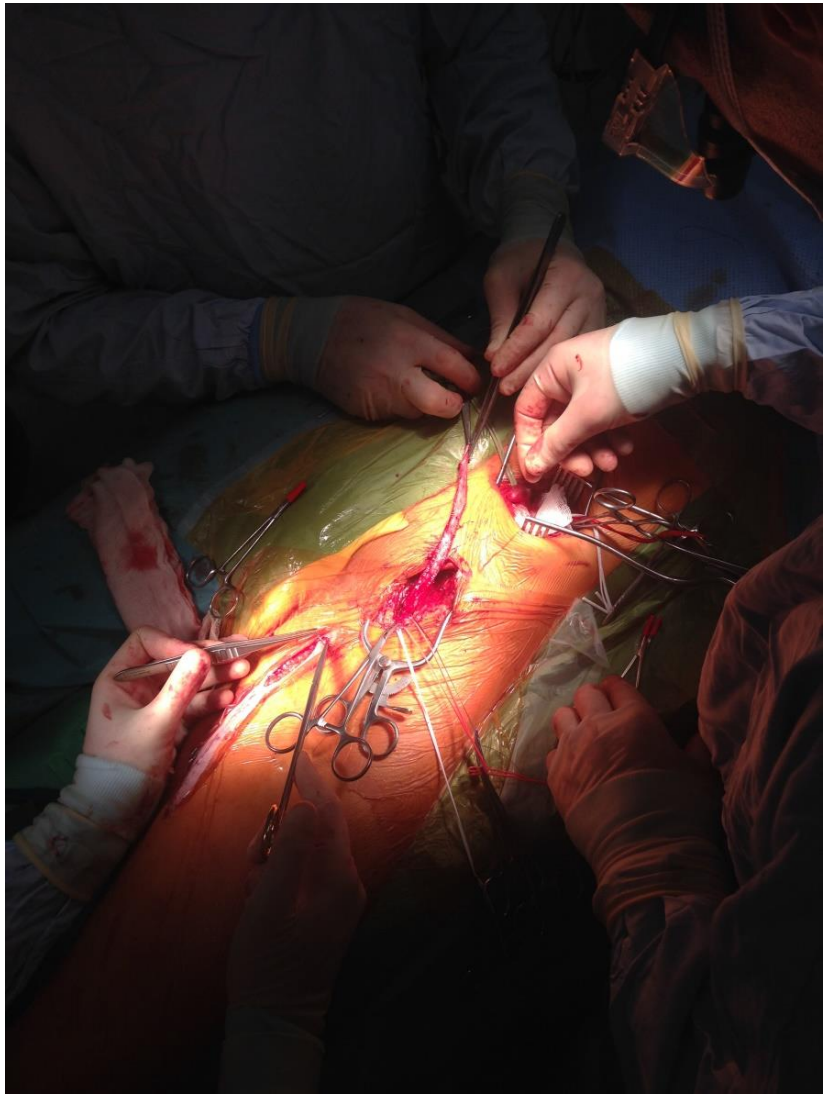
Surgical options

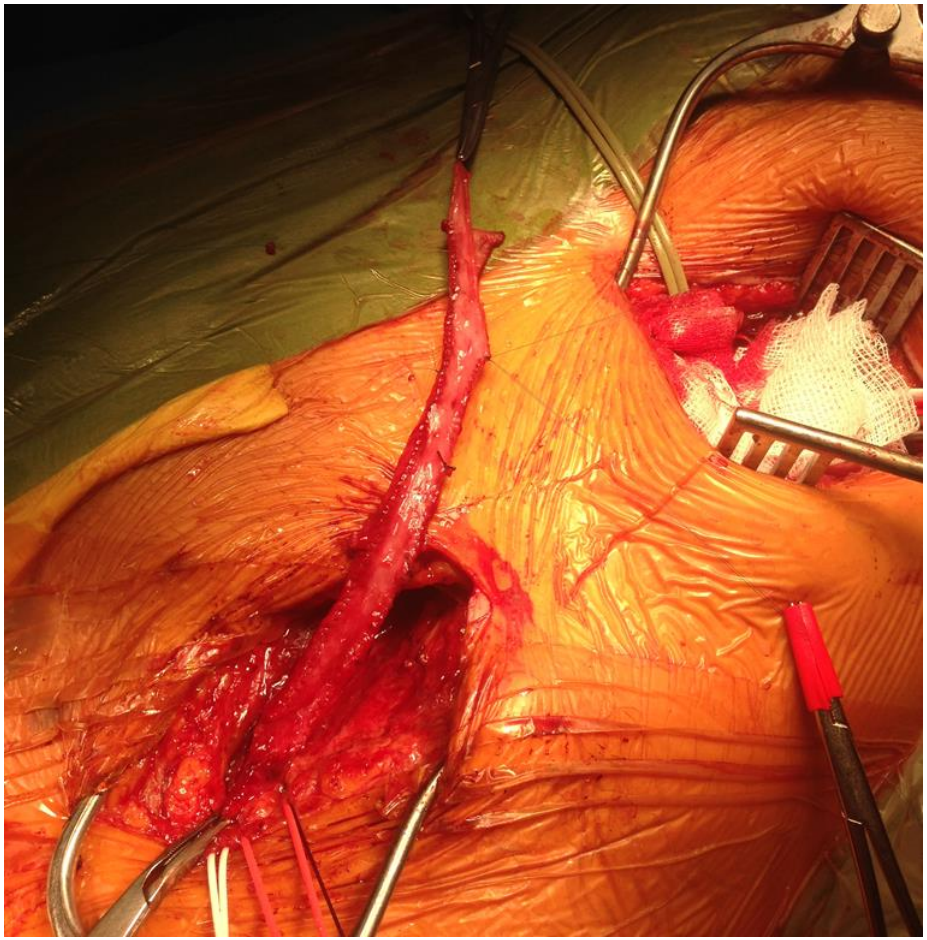
- Arterial release
  (for kinking only and must exclude luminal narrowing)
- Arterial shortening
  (kinking and arterial redundancy)
- Endarterectomy and vein (prosthetic) patch angioplasty
- Resection of fibrotic segment and saphenous vein interposition (diameter may require panel graft)
- *Prosthetic graft*
- *Inguinal ligament release in combination*











Results

- Arterial release

Schep (2002)

n=23 - 53% symptom free

- Endofibrosectomy + arterial shortening / saphenous bypass

Feugier (2004)

n=350 - 5 persistent symptoms

332 returned to sport

Alimi (2004)

n=14 - 12 symptom free


TOPEAK
ERGON

Conclusions

- Increasing prevalence
- Often dismissed / inappropriately managed
- Exercise test key in diagnosis
- Angiograms often normal
- Natural history uncertain (increasing number dissections)
- Outcomes from surgery encouraging (avoid angioplasty / stents / shortening alone)