CLINIX Webinar
03 March 2022

ACUTE LIMB ISCHAEMIA

OVERVIEW

- Definition
- Epidemiology
- Causes
- Pathophysiology
- Clinical
- Grading
- Guidelines
- Management
- Cases
- Summary
- Questions

DEFINITION

SUDDEN REDUCTION OR CESSATION OF ARTERIAL PERFUSION

- LIMB (LIFE) THREATENING

TWO WEEKS SYMPTOM ONSET

EPIDEMIOLOGY

- **suggested incidence UK and Sweden**:
  3 – 14 per 100 000 person years
  > 80 years

- **US MediCare data**:

1998-2009 :	ALI admissions ↓	45 to 26 per 100 000 person years
	open revascularisation ↓	57 to 52%
	endovascular techniques ↑	15 to 33%
	amputation rates ↓	8 to 6.4% (N/S)
	in-hospital mortality ↓	12 to 9%

→ **1)** ***increased use of thrombolysis and endovascular techniques***
2) ***better detection and treatment of conditions like AF & atherosclerosis***

TRIALS

- Rochester, TOPAS and STILE trials

- STILE (Surgery vs Thrombolysis for Ischaemia of the Lower Extremity) trial
  - 393 patients
  - compared open surgery to thrombolysis (r-tPa or urokinase)
  - < 14 days results favoured thrombolysis
    * amputation at 6 months (11% vs 30%)
  - > 14 days results were in favour of surgery

EPIDEMIOLOGY

- **shift in aetiology**
  - young : previously embolisation from RH and valvular disease
  - elderly : embolism from arrhythmias
    thrombosis
- **main causes**
  - embolisation due to AF or atrial/ventricular thrombus
    (acute MI or DCMO)
  - acute thrombosis of highly atherosclerotic arteries
- **time to presentation** after symptom-onset
  - 70% within two weeks
  - 30% after two weeks

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CAUSES

- **Embolism**
  - cardiac (80%)
  - arterial (arterial plaque, aneurysm thrombus eg AAA)
- **Thrombosis**
  - native artery
  - peripheral aneurysm (eg popliteal aneurysms)
  - vascular graft
  - vascular stent
- **Acute arterial dissection** (malperfusion)
- **Trauma**
  - blunt (eg knee dislocation)
  - penetrating (stab/GSW)
- **Iatrogenic**
  - venous/arterial catheterisation
  - surgery in proximity to arteries

- **Swedish vascular registry , 2018**
  - 16 229 ALI patients
  - 44% embolic
  - 53% thrombotic
  - 3% popliteal aneurysm

- **Embolic**
  - mainly cardiac dysrhythmias
  - 67% AF
  - 20% ventricular thrombus
  - valvular heart disease in LMIC

LESS COMMON CAUSES

- **Vasculitis**
  - Buerger's disease (TAO); HIV; RA; SLE; Takayasu arteritis; COVID
- **Thrombophilia**
  - Prot C, Prot S deficiencies; antiphospholipid syndrome; COVID
- **Popliteal adventitial cystic disease**
- **Popliteal artery entrapment syndrome**

} Embryological aberrations

- **Paradoxical embolisation**
  - venous embolism traversing a patent ASD or foramen ovale
- **Tumour embolisation**
  - atrial myxoma
- **Acute compartment syndrome**
  - athletes with well-developed leg muscle
- **Low cardiac output states**
  - decompensated heart failure, septic shock

PATHOPHYSIOLOGY

acute tissue hypoxia
*** no collateral circulation ***

anaerobic metabolism

generation of reactive oxygen species

cell lysis

liberation of intracellular components

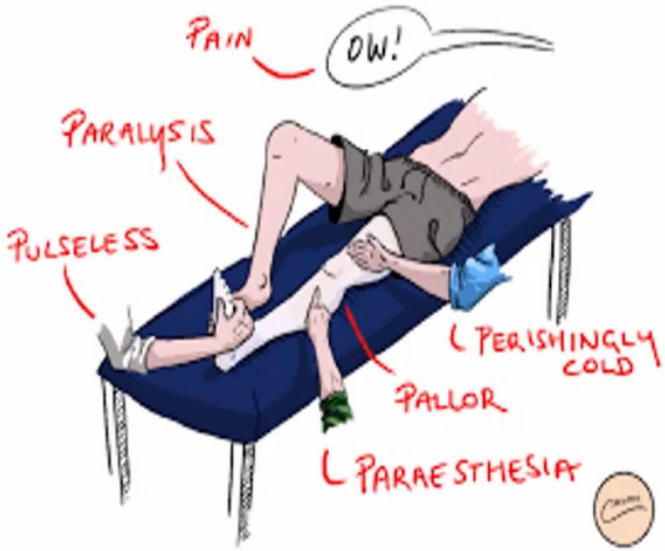
tissue oedema

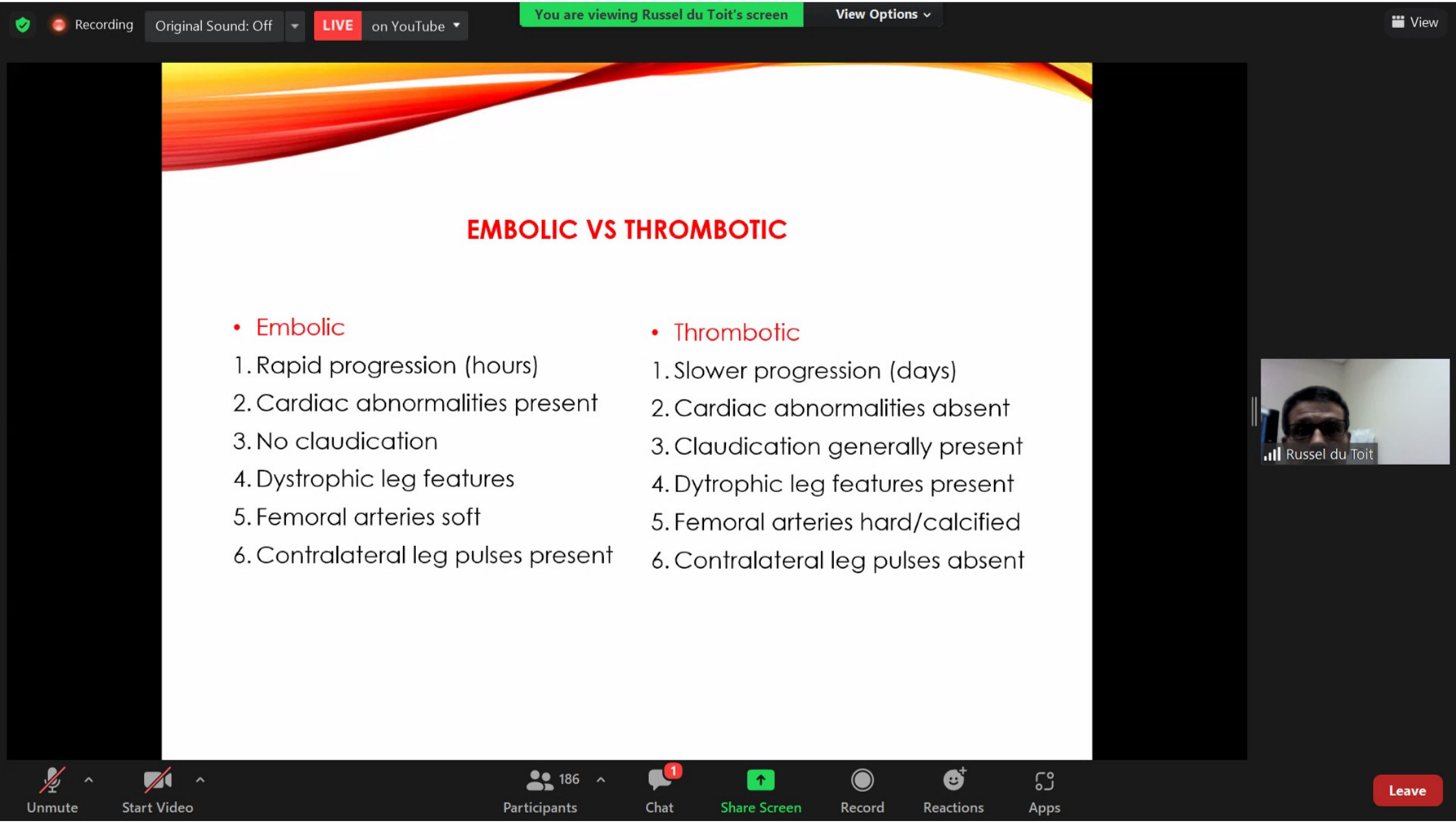
compartment syndrome

CLINICALLY

The 6 P's

- - pain
- - pallor
- - poikilothermia
- - pulselessness
- - paraesthesia
- - paresis/paralysis

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EMBOLIC VS THROMBOTIC
• Embolic
1. Rapid progression (hours)
2. Cardiac abnormalities present
3. No claudication
4. Dystrophic leg features
5. Femoral arteries soft
6. Contralateral leg pulses present
• Thrombotic
1. Slower progression (days)
2. Cardiac abnormalities absent
3. Claudication generally present
4. Dytrophic leg features present
5. Femoral arteries hard/calcified
6. Contralateral leg pulses absent
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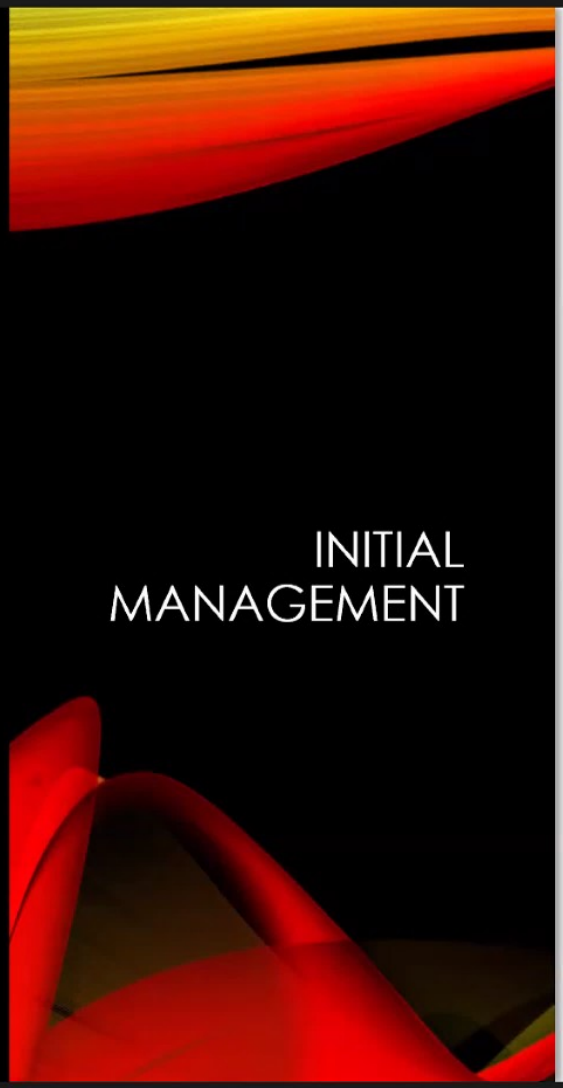
GRADING

Rutherford classification

Grade	Category	Sensory loss	Motor deficit	Doppler signals		Prognosis
				Arterial	Venous	
1	Viable	Nil	Nil	+	+	Good
2a	Marginally threatened	Nil or minimal (toes)	Nil	+	-	Good
2b	Immediately threatened	More than toes	Mild/moderate	+	-	Guarded
3	Irreversible	Profound/insensate	Profound/paralysis	-	-	Poor

BENEFIT VS HARM



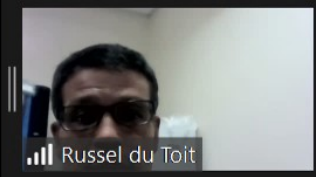
INITIAL MANAGEMENT

Medical management

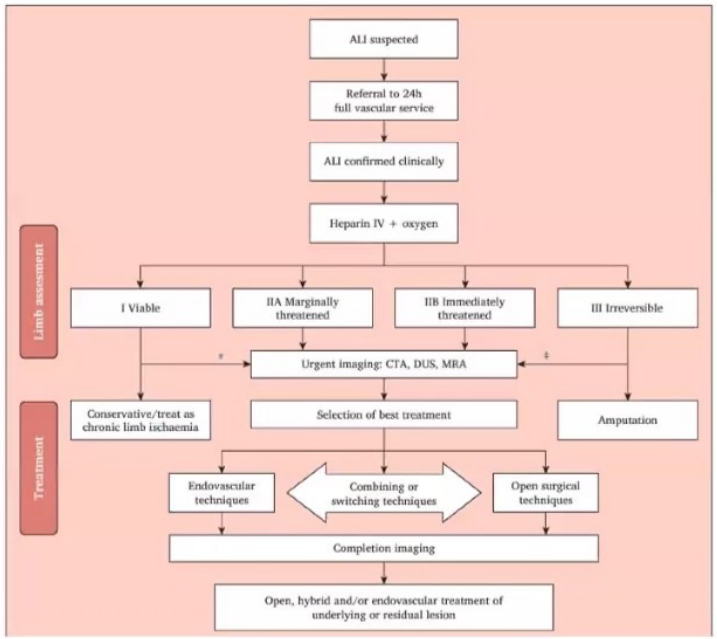
* **supplemental oxygen**
* **good analgesia**
* **anti-Trendellenburg** (feet down)
* **antiplatelet** (- platelet aggregation)
- aspirin 300mg stat po
* **statin** (anti-inflammatory)
- eg simvastatin 40-80mg stat po
* **unfractionated heparin iv**
- 5000 IU stat (70-100 IU/kg)
- infusion to maintain aPtt 1,5x normal (90-120 sec)
* **grade the ischaemia**
- assess response to treatment
* **timeous referral**

WHY UNFRACTIONATED HEPARIN?

- to prevent thrombus extension/propagation
- inactivates more clotting factors than LMWH (AT 3&9 and FXa)
- pleiotrophic effects
- → anti-inflammatory
- rapidly reversible
- * protamine sulphate
- < 30min : 1.0 – 1.5 mg/100 units UFH
- 30-120min : 0.5 – 0.75 mg/100 units UFH
- > 120min : 0.25 mg/100 units UFH
- * not to exceed 50mg protamine
- * check aPtt after 10min then in 2-8 hours



ALGORITHM



IMAGING IS PARAMOUNT

Recommendation 5

For patients presenting with acute limb ischaemia, diagnostic imaging is recommended to guide treatment, provided it does not delay treatment, or if the need for primary amputation is obvious.

Class	Level	References
I	C	Weiss *et al.* (2017)[39]

Recommendation 6

For patients presenting with acute limb ischaemia, computed tomography angiography is recommended as the first line modality for anatomical imaging.

Class	Level	References
I	B	Jens *et al.* (2013),[50,51] Jakubiak *et al.* (2009)[52]

WHERE TO TREAT?

THE IDEAL

Recommendation 13		
It is recommended that patients diagnosed with acute limb ischaemia in a non-vascular centre be transferred to a vascular centre that offers the full range of open and endovascular interventions with an urgency that depends on the severity of the ischaemia.		
Class	**Level**	**References**
I	B	Grip *et al.* (2018),[23] Bath *et al.* (2019)[27]

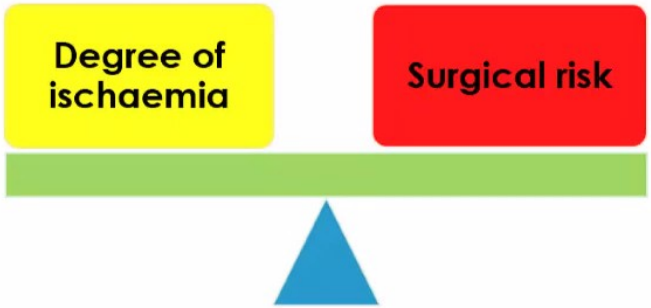
Recommendation 14		
It is recommended that patients with acute limb ischaemia should have access to treatment in a hybrid theatre, or operating theatre with C arm equipment, and by a clinical team able to offer a full range of open or endovascular interventions during a single procedure.		
Class	**Level**	**References**
I	C	Consensus

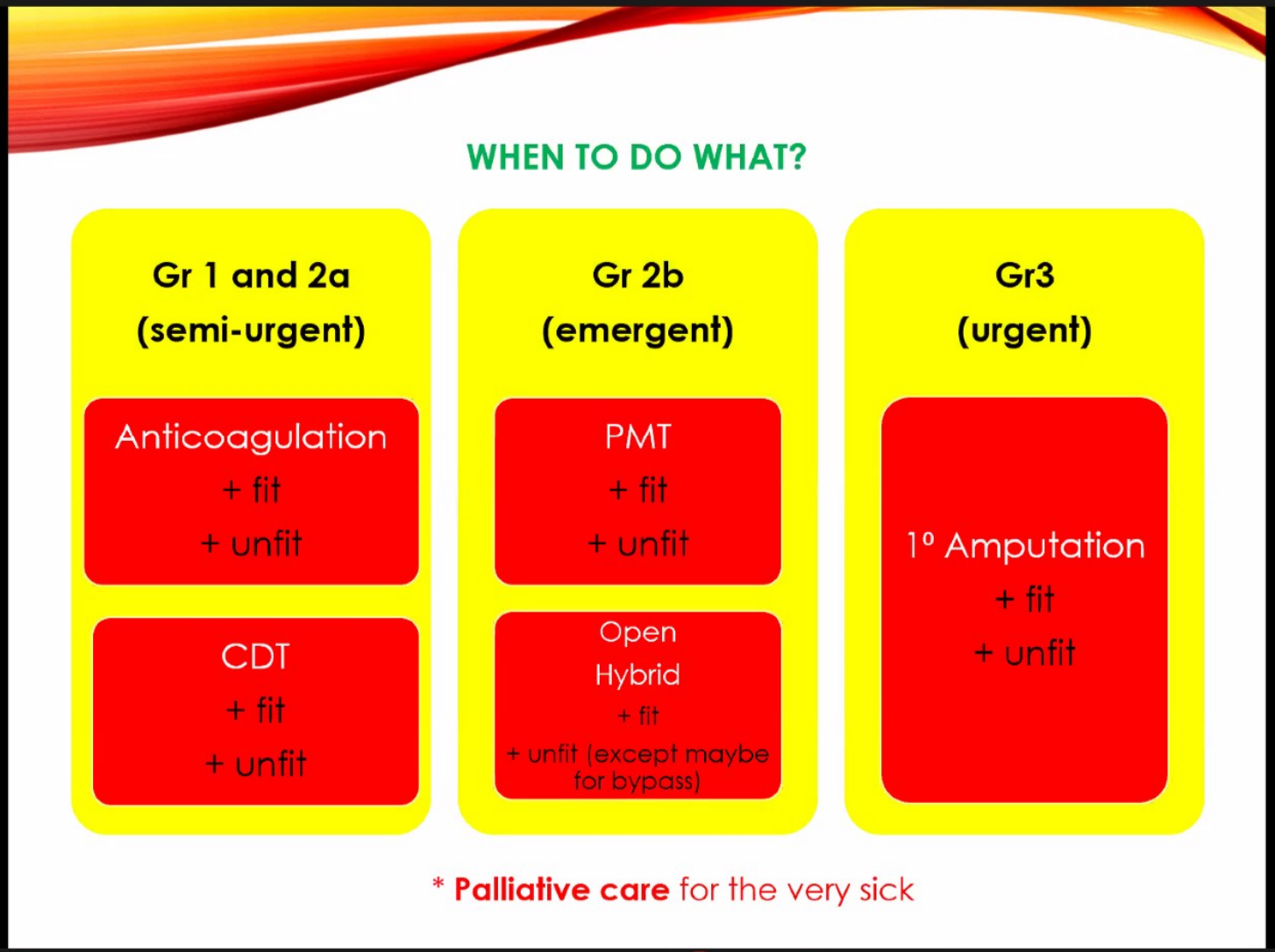
INTERVENTIONS

- **Medical management**
  - anticoagulation

- **Surgical**
  - **Percutaneous endovascular**
    * catheter-directed thrombolysis (CDT)
    * mechanical thrombectomy (PMT)
    * angioplasty +- stenting
  - **Open techniques**
    * Fogarty thromboembolectomy
    * endarterectomy and patch-plasty
    * surgical bypass
  - **Hybrid techniques**
    * open + percutaneous technique

WHEN TO DO WHAT?

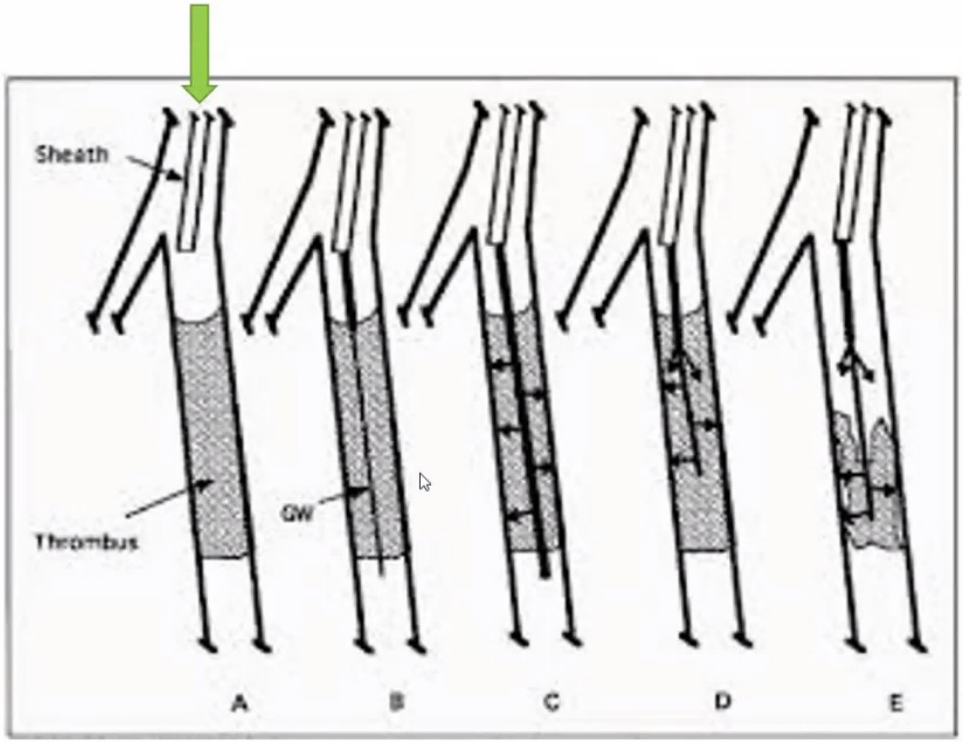


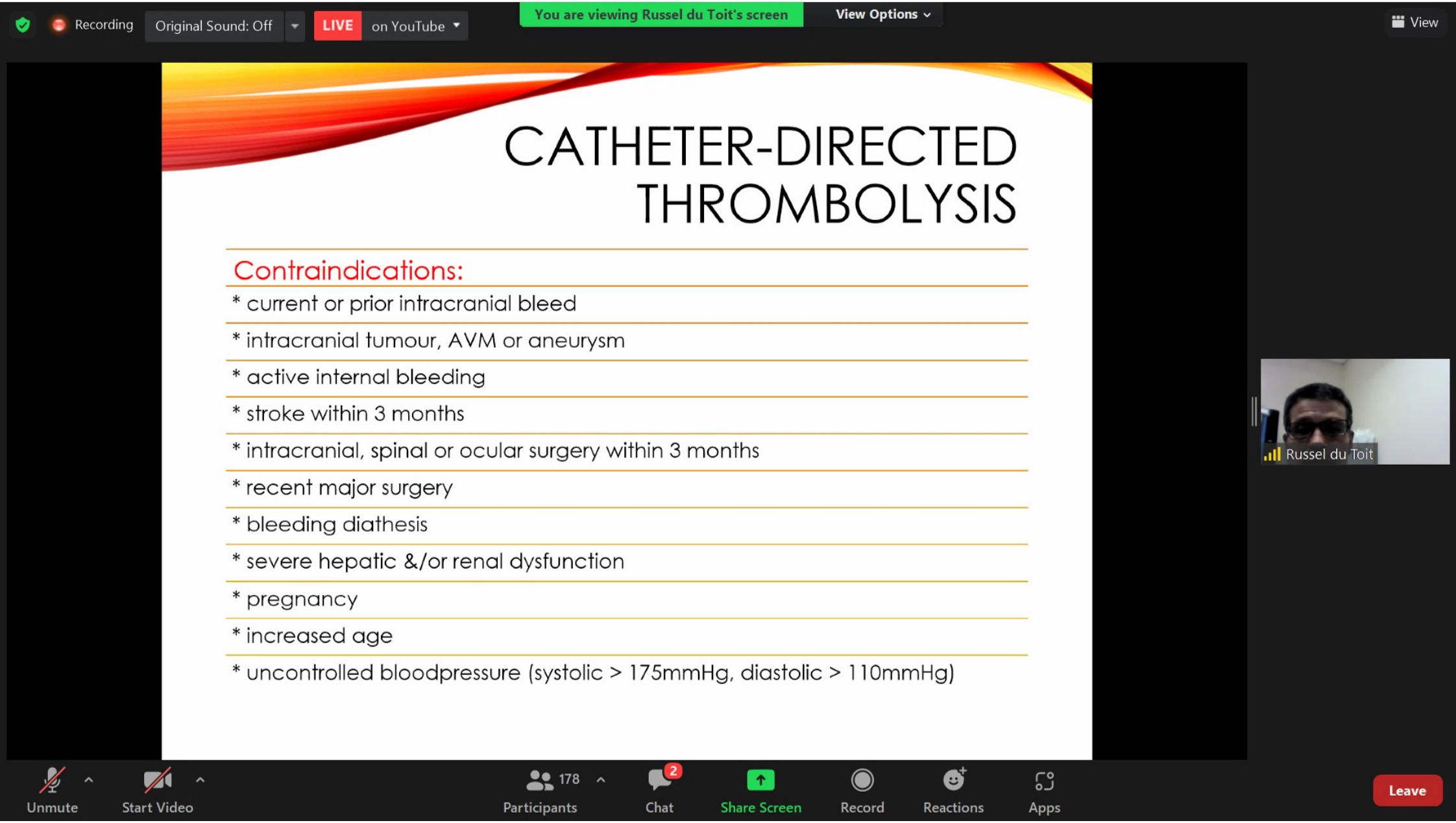


CATHETER-DIRECTED THROMBOLYSIS

- Actilyse (rh-tPA)
  - t½ 5-10 minutes
- Direct activation of plasmin within the thrombus
  - allows reduced doses
- 5-10mg bolus intraarterial
- then infusion at 0.05-0.1mg/kg/hr
- repeat angiography in 12 hours
- *continuous limb perfusion monitoring
- *monitor for bleeding

ULTRASOUND-GUIDED ARTERIAL PUNCTURE AND SHEATH INSERTION

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CATHETER-DIRECTED THROMBOLYSIS
Contraindications:
* current or prior intracranial bleed
* intracranial tumour, AVM or aneurysm
* active internal bleeding
* stroke within 3 months
* intracranial, spinal or ocular surgery within 3 months
* recent major surgery
* bleeding diathesis
* severe hepatic &/or renal dysfunction
* pregnancy
* increased age
* uncontrolled bloodpressure (systolic > 175mmHg, diastolic > 110mmHg)
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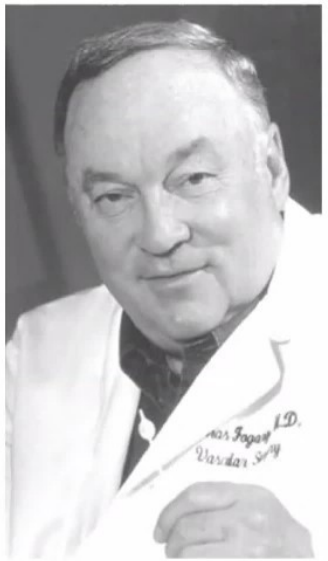
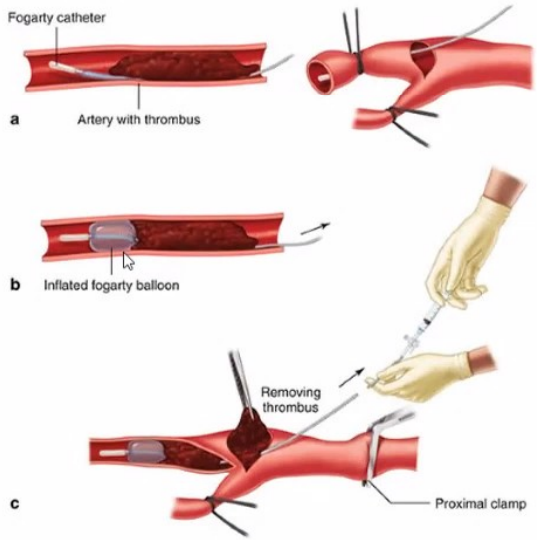
FOGARTY THROMBOEMBOLECTOMY

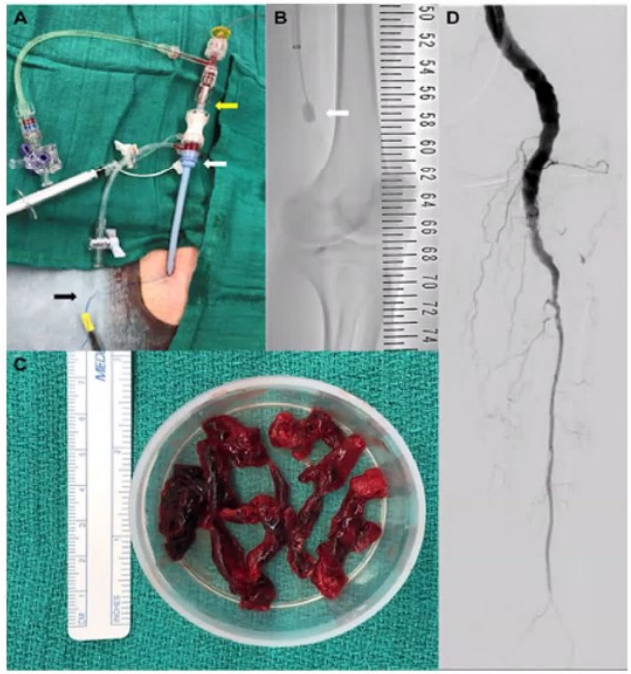
- CONVENTIONAL, &
- OVER-THE-WIRE (STEERABLE)

ARTERIAL EMBOLECTOMY CATHETER

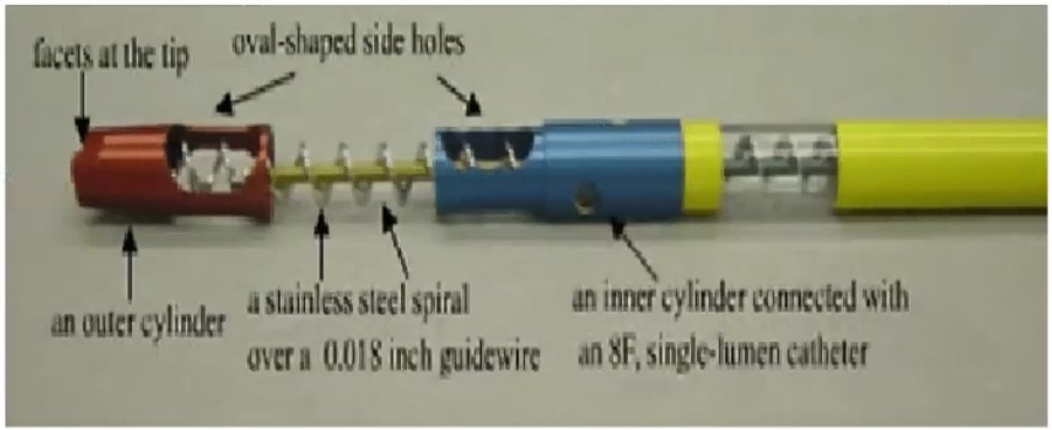


FOGARTY THROMBOEMBOLECTOMY





ASPIREX® ROTATIONAL MT DEVICE



ANGIOJET® RHEOLYTIC PMT DEVICE

Saline jets travel backwards at high speed to create a negative pressure zone (less than -600 mmHg) causing a powerful vacuum effect.

Cross-Stream™ windows optimize the fluid flow for more effective thrombus removal.

Thrombus is drawn into the catheter where it is fragmented by the jets and evacuated from the body.

MANAGEMENT OF COMPLICATIONS

- **Compartment syndrome**
  - → **four-compartment fasciotomy**
    - * **muscle viability?**
    - * **relieve pressure**
  - → 1. pre-emptive
    2. emergent

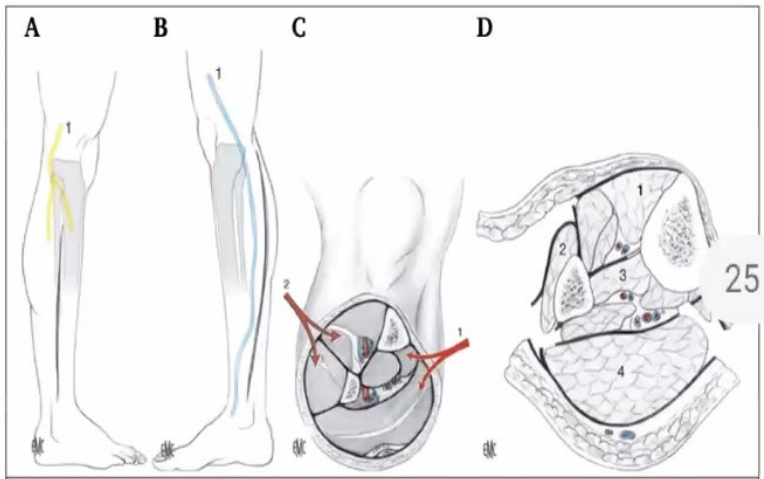


Figure 10. Fasciotomies of the leg: a full four compartment fasciotomy is recommended, which is typically achieved with two incisions. (A) Lateral incision (1 = peroneal nerve). (B) Medial incision (1 = great saphenous vein). (C) Fasciotomies of the superficial posterior and deep posterior compartments (1). Fasciotomies of the anterior and lateral compartments (2). (D) Four compartment fasciotomy, with the wounds left open (1 = anterior compartment; 2 = lateral compartment; 3 = deep posterior compartment; 4 = superficial posterior compartment). Reproduced with permission from Ricco *et al.*[202]

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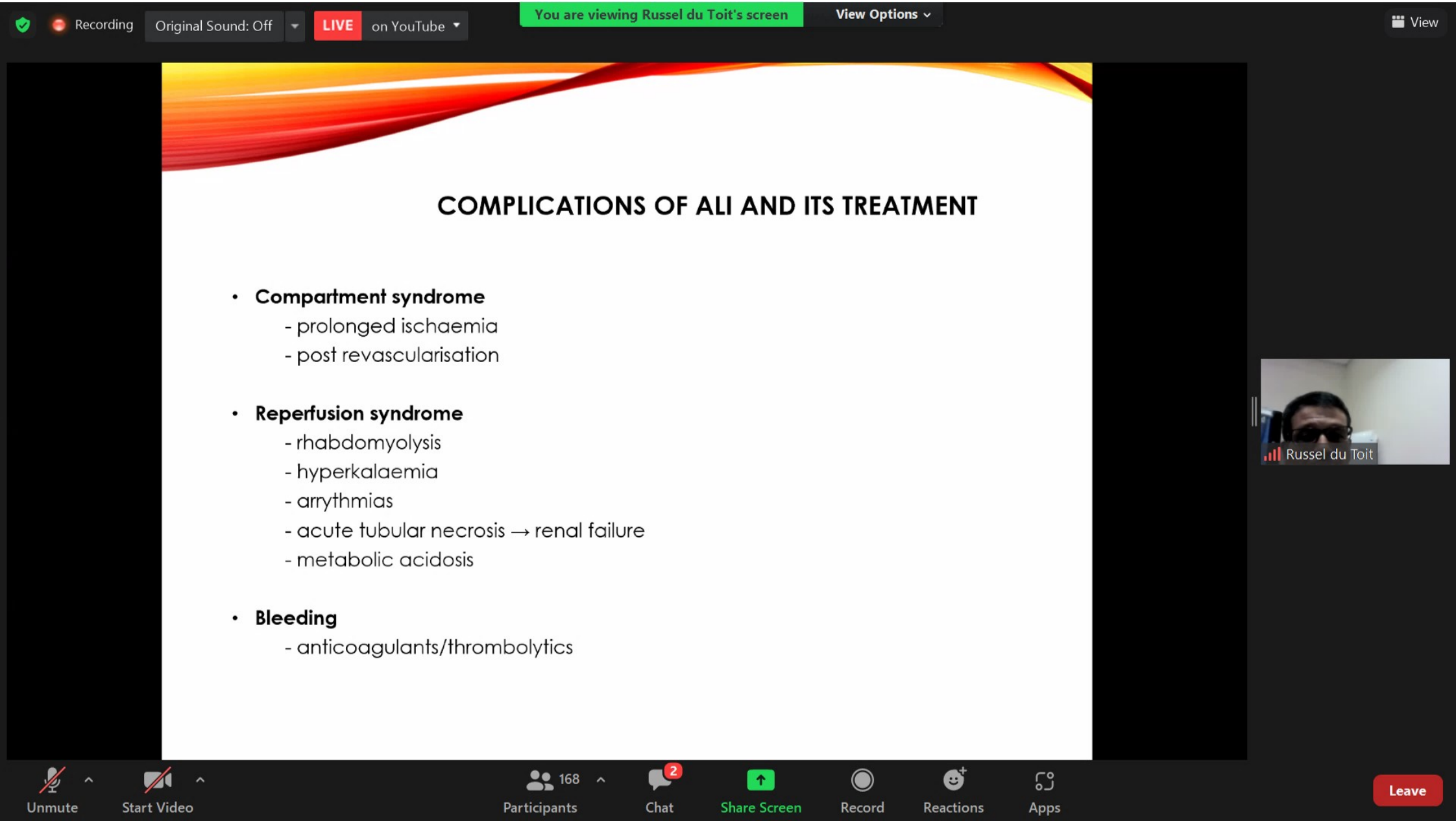
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COMPLICATIONS OF ALI AND ITS TREATMENT
• Compartment syndrome
- prolonged ischaemia
- post revascularisation
• Reperfusion syndrome
- rhabdomyolysis
- hyperkalaemia
- arrythmias
- acute tubular necrosis → renal failure
- metabolic acidosis
• Bleeding
- anticoagulants/thrombolytics
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MANAGEMENT OF COMPLICATIONS

- **Reperfusion syndrome**
  - iv fluid resuscitation : normal saline (*patient's cardiac function)
  - preload intraoperative prior to reperfusion
  - intravenous potassium shifting
    - * actrapid in DW
    - * calcium carbonate
  - intravenous sodium bicarbonate
  - refractory hyperkalaemia &/or acidosis
    - * reassess muscle viability
    - * urgent haemodialysis

MANAGEMENT OF COMPLICATIONS

- **Bleeding**
  - active oozing
  - expanding haematoma
  - significant reduction in Hb (>1.5g/dl)
  - fibrinogen < 2g/dl

→ STOP ANTICOAGULANT
or THROMBOLYTIC

  - check coagulation profile or TEG
    * administer blood &/or bloodproducts

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CASES

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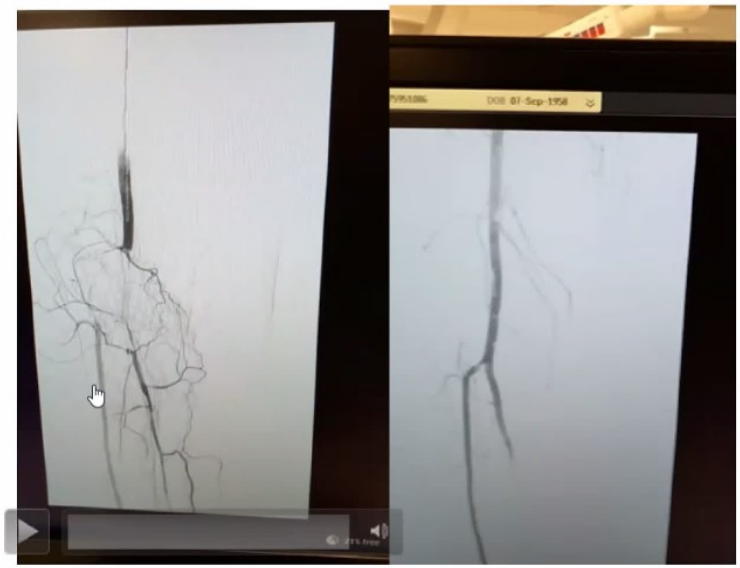

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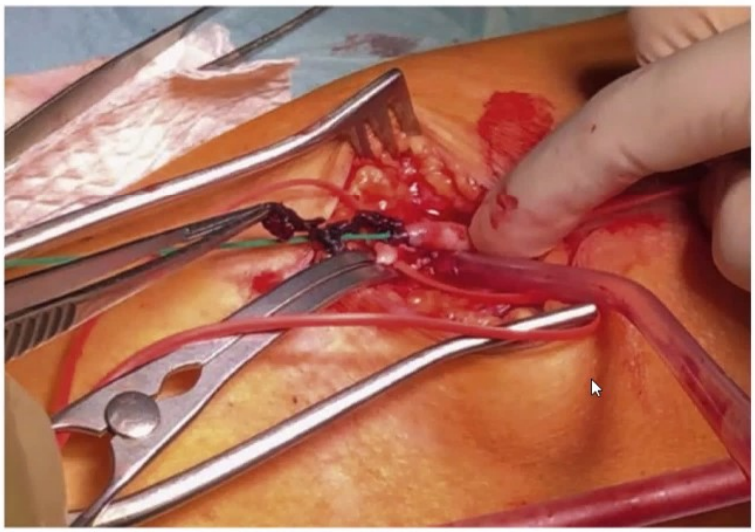


Figure 12. Thrombectomy of the brachial artery using a Fogarty catheter.

Figure 1 An elderly woman with history of atrial fibrillation presented with painful and cold left hand and absent brachial and wrist pulses. Initial angiography from a left CFA approach showed tandem emboli in the (A) proximal and (B) distal left brachial artery. Following 36-hour infusion of alteplase at 1.0 mg/h divided between a 5F multi-side hole infusion catheter and a 3F microcatheter, with heparin at 300 U/h, there was no residual embolus in the (C) left upper arm or (D) the left forearm.

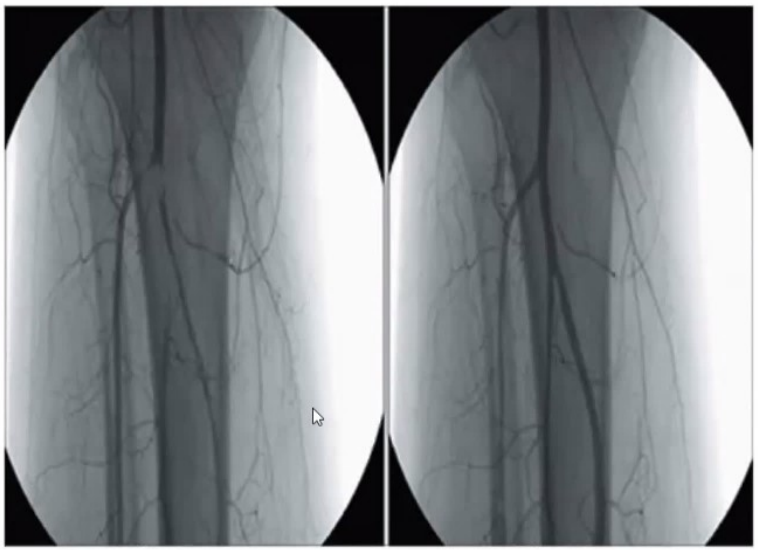
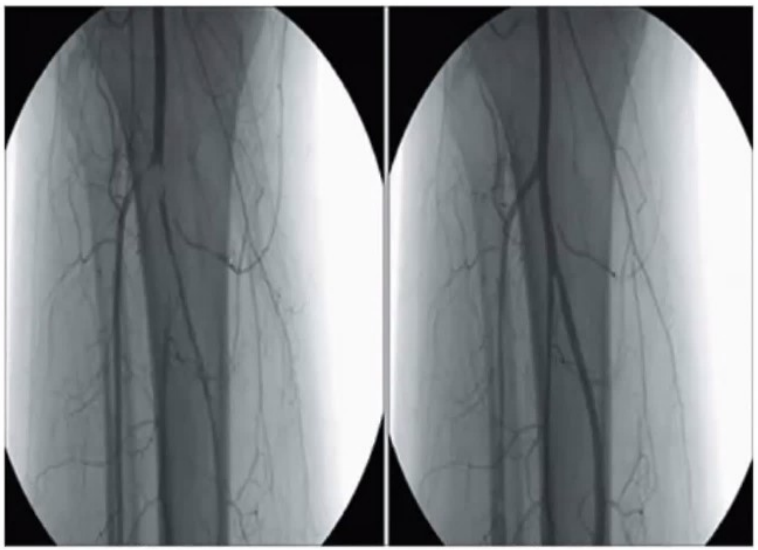


Fig. 1. Angio-imaging of the popliteal trifurcation before and after selective balloon embolectomy.



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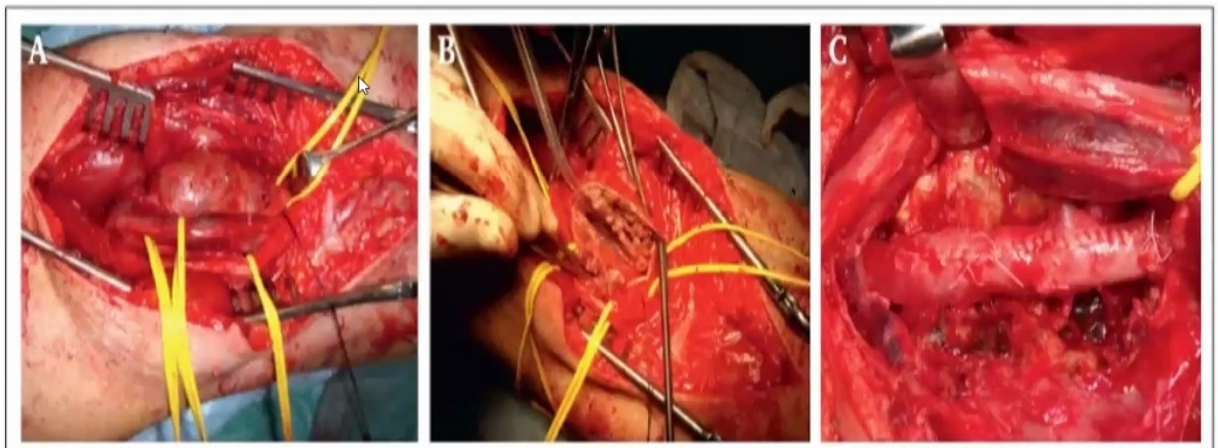

Figure 9. (A) Thrombosed popliteal artery aneurysm (PA). (B) Opened PA showing thrombus. (C) Reconstruction with a doubled vein graft.

SUMMARY

- 1. ALI is a surgical emergency
  - early recognition can be limb- &/or lifesaving
- 2. Public/patient awareness and education is needed
- 3. Generally the patients have a high comorbidity profile
  - cardiac, vasculopaths, COPD, renal
- 4. Discussion and consensus with patient and family is essential
- 5. Effective treatments are available and often multimodal
  - minimally-invasive options especially for unfit patients
- 6. Imaging is central to effective management
- 7. Challenges in SA
  - distances to a few dedicated centres
  - transport (road, air)
  - pragmatic approach needed in certain cases
  - communication (telephonic advice, telemedicine)

REFERENCES

- 1. European Society for Vascular Surgery 2020 Clinical Practice Guidelines on the Management of Acute Limb Ischaemia
- 2. STILE Investigators. Results of a prospective randomised trial evaluating Surgery versus Thrombolysis for Ischaemia of the Lower Extremity. Ann Surg 1994; 220(3):251-268.
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