

Acute Compartment Syndrome

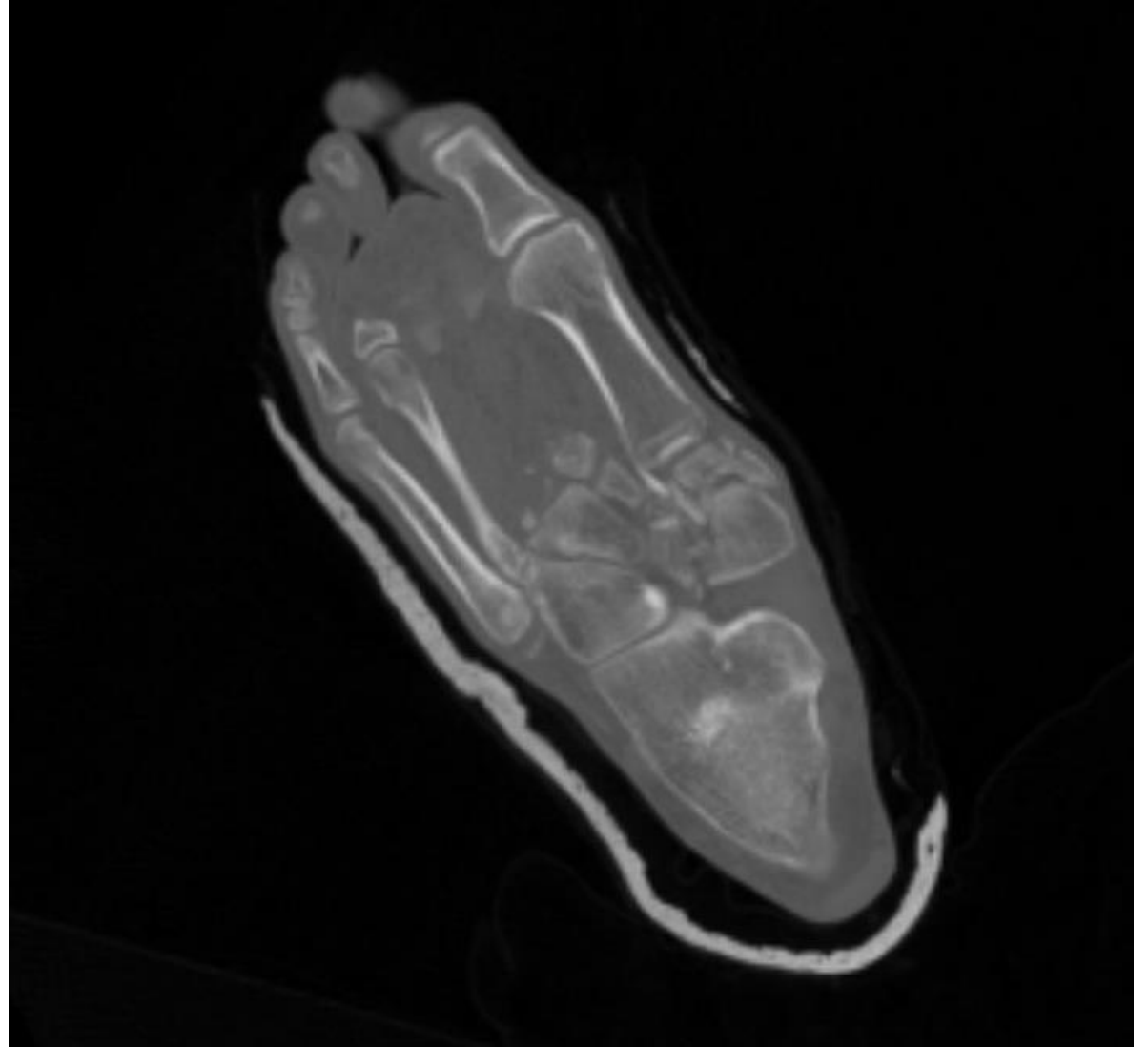
Peter Siesing-Mejer
Ortopædkirurgisk afdeling
Hillerød Hospital



Acute Compartment Syndrome



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A surgical emergency

- Compartment syndrome may occur in any skeletal muscle surrounded by fascia
 - Lower leg
 - Forearm
 - Hand
 - Foot
 - Thigh

Etiology

	Proportion of cases (%)
Fracture	
Tibial diaphyseal fracture	36%
Distal radius fracture	10%
Diaphyseal forearm fracture	8%
Femoral diaphyseal fracture	3%
Tibial plateau fracture	3%
Soft tissue	
Soft-tissue injury	23%
Crush syndrome	8%
Other	9%

Table: Incidence of fractures and other disorders associated with acute extremity compartment syndrome

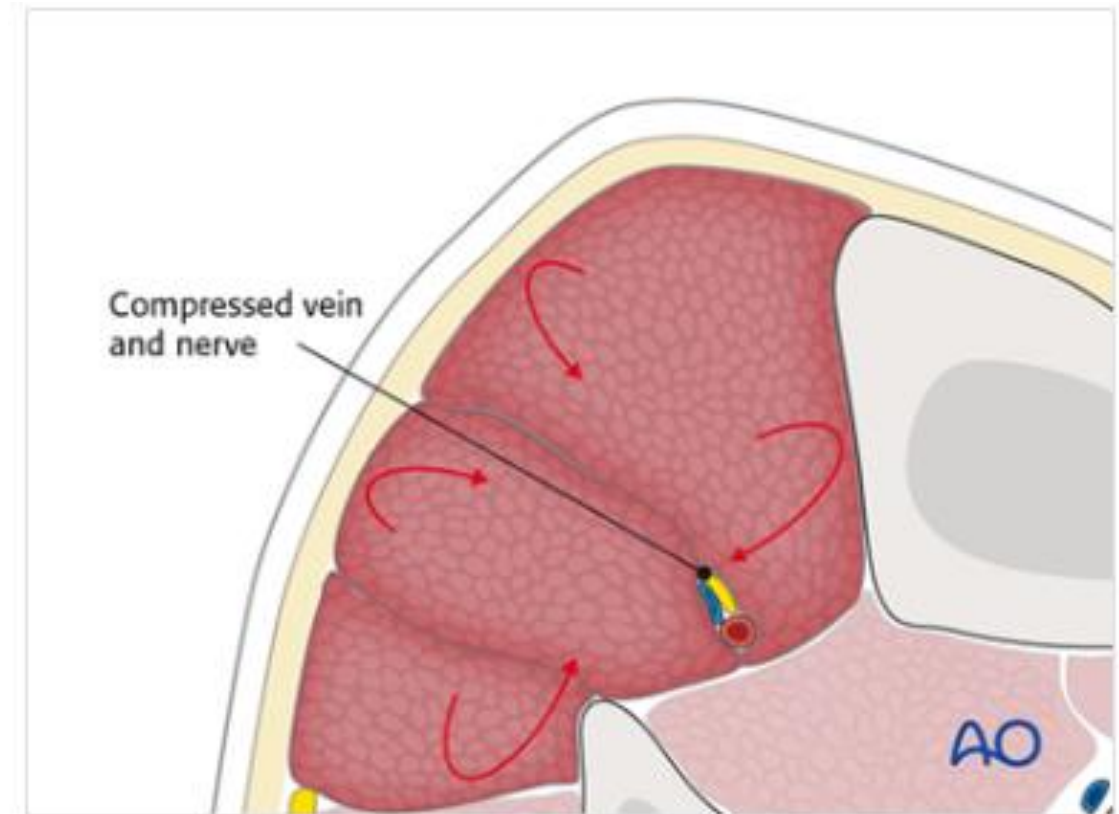
TABEL 2 Overblik over mulige ætiologier og skadesmekanismer til akut kompartmentsyndrom [2, 3, 7, 8, 10].

<i>Traumatisk</i>
Frakturer: åbne og lukkede
Bløddelsskade:
Penetrerende traumer, f.eks. skudsår, knivstik
Stumt traume, f.eks. motorcykelstyrt, påkørsel, sportstraume
<i>Atraumatisk</i>
Immobilisering, f.eks. lejrning på ekstremitet
Reperfusion af iskæmisk muskelvæv
Infektion, særligt gruppe A-streptokok
Dyb venetrombose
Overtræning
<i>Nosokomielt</i>
Postoperativ blødning
Postoperativt ødem
Lejrning under operation
Strammende gips/bandage
Penetrerende procedurer, f.eks. akupunktur, intravaskulære procedurer

Donaldson, J., Haddad, B. & Khan, W. S. The Pathophysiology, Diagnosis and Current Management of Acute Compartment Syndrome. *Open Orthop. J.* **8**, 185–193 (2014).

Mechanism

- Local trauma and soft tissue destruction ->
- Bleeding and edema ->
- Increased interstitial pressure ->
- Vascular occlusion (decreased venous outflow relative to arterial inflow)



Symptoms

- Pain out of proportion
- Pressure (palpable painful tenderness)
- Pain on passive stretch
- Paraesthesia
- Paresis
- Peripheral pulses present
- Absence of peripheral pulse is a late sign

The most important symptoms

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PAIN

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PAIN

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The most important symptoms

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PAIN

PAIN

PAIN

Children – 3 A's

Agitation



Anxiety



Analgesics



Observation and initial treatment

- Remove casts etc.
- Administer oxygen
- Administer morphine
- The patient may not have compartment syndrome yet
 - In that case observation and reassessment once every 1-2 hours
 - When the patient is admitted to further observation - no peripheral nerve blockade

When to perform fasciotomy?

[Pathophysiology and pressure measurement in compartment syndrome]

techniques are described for intracompartmental pressure monitoring. In normotensive patients, an intracompartmental pressure of more than 40 mmHg indicates "apparent" compartment syndrome, while pressures between 30 mmHg and 40 mmHg are interpreted as "imminent" compartment syndrome. In these cases therapeutic/prophylactic dermatofasciotomy is necessary. In hypotensive



Timing

In established muscle compartment syndrome, the hypoxic muscle will become necrotic within hours. It is generally accepted that after 6-8 hours of inadequate muscle perfusion pressure (MPP), extensive muscle necrosis is likely and effective release of the muscle compartments involved is unlikely to avoid severe muscle contracture. Similarly any peripheral nerve passing through the compartment is likely to suffer permanent functional impairment.

It is therefore of paramount importance that the compartment hypertension be released as an emergency intervention.

Extremity compartment syndrome: A review with a focus on non-invasive methods of diagnosis

Martin Novak¹, Marek Penhaker², Pavel Raska³, Leopold Pleva¹ and Martin Schmidt^{2*}

Frontiers in Bioengineering and Biotechnology

TYPE Review

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TABLE 1 Comparison of available diagnostic methods.

Method	Invasive	Continuous	Advantages	Disadvantages
IMP (Intramuscular Pressure)	Yes	Yes	Accurate, verified	Painful for the patient, risk of infection
Quantitative Hardness	No	No	Simple use	Low specificity, affected by the amount of subcutaneous fat
NIRS (Near Infrared Spectroscopy)	No	Yes	Simple and continuous monitoring	Depth max. 3 cm, unreliability of data acquisition, requires measurement on the control compartment, affected by pigment, skin damage, hematomas
SE (Strain Elastography)	No	No	Allows imaging of the compartment - it is not affected by hematomas and subcutaneous fat	Has not been validated in patients with ECS
SWE (Shear Wave Elastography)	No	No	Allows direct measurement of tissue stiffness	Not verified in patients with ECS, expensive, poor repeatability of measurements
PPLL (Pulsed Phase-Locked Loop)	No	Yes	Simple and continuous monitoring	Has not been verified in patients with ECS, may be affected by low blood pressure
Bioimpedance	No	Yes	Simple and continuous monitoring	Few studies performed, requiring control contralateral compartment

So when do we perform the fasciotomy?

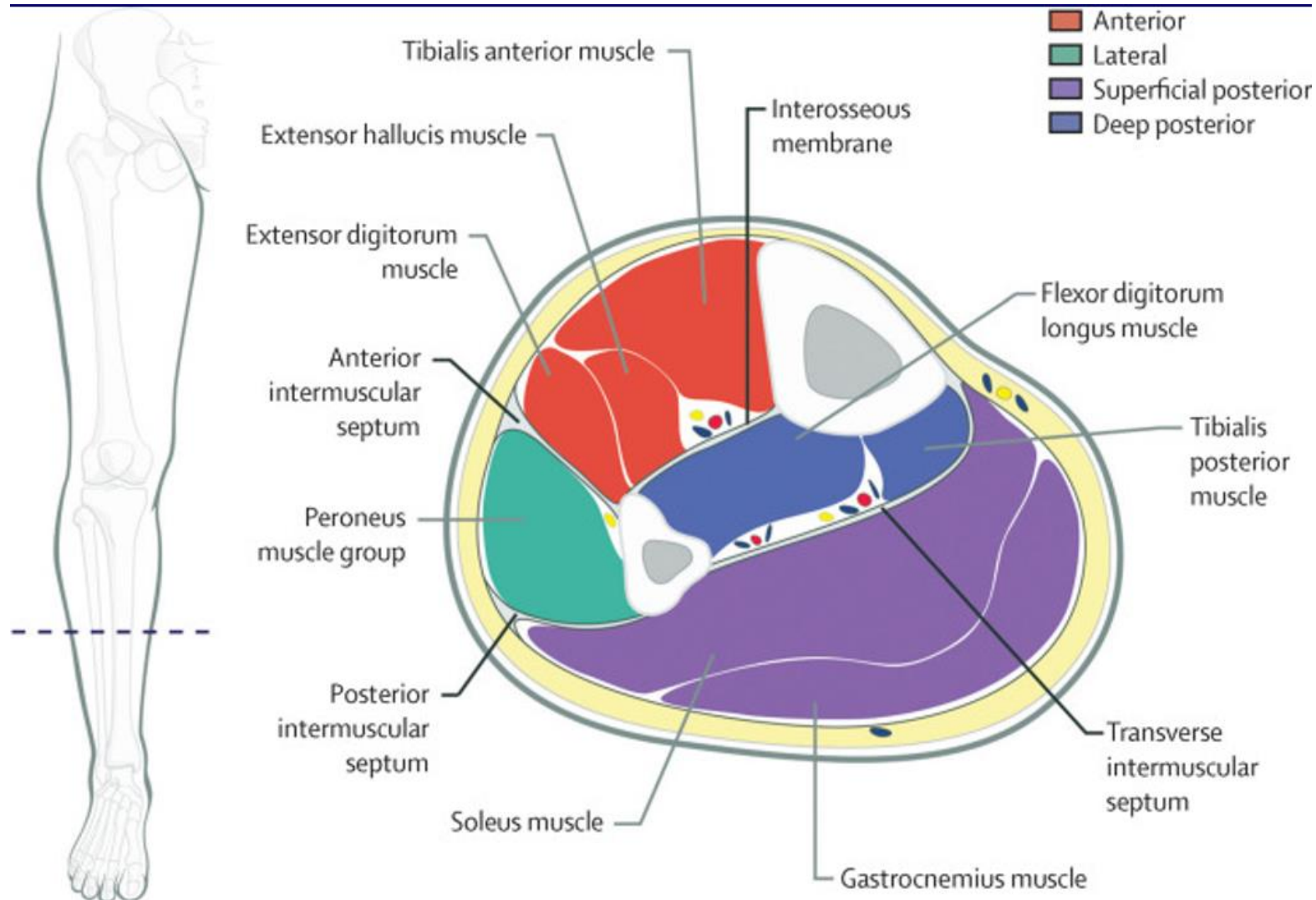
- The patient's presentation leaves no doubt about the diagnosis
- Measurement of compartmental pressure above 40 mmHg
- When in doubt – do the fasciotomy !!!

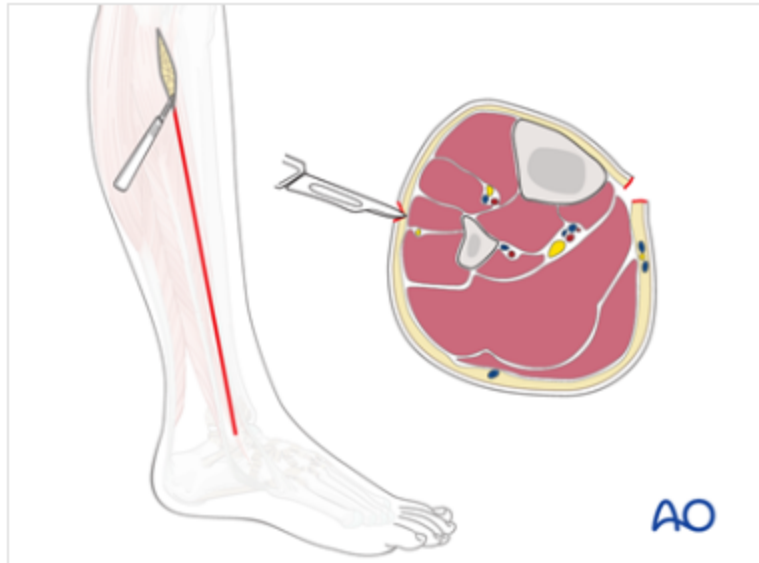
Table 1.

Anatomical compartments and surgical approaches.

Anatomical region	Compartments	Surgical approach
Forearm	Three: volar, dorsal, lateral.	Volar incision.
	The volar compartment is the most frequently involved.	Dorsal incisions.
Hand	Ten:	Two longitudinal incisions over 2nd and 4th metacarpals.
	Hypothenar;	Longitudinal incision radial side of 1st metacarpal.
	Thenar;	Longitudinal incision over ulnar side of 5th metacarpal.
	Adductor pollicis,	Carpal tunnel decompression.
	N.4 dorsal interosseus,	
	N.3 palmar interosseus.	
Thigh	Two: anterior and posterior	Single lateral incision.
Leg	Four:	Two incisions, medial and lateral, of a minimum of 15 cm.
	Anterior,	Some surgeons propose a singular lateral approach.
	Lateral,	
Foot	Posterior (superficial and deep).	
	Nine:	Two dorsal incision, dorsomedial and dorsolateral.
	Medial (abductor hallucis and flexor hallucis brevis)	A single medial incision is used by some authors to release all nine compartments.
	Lateral (abductor digiti minimi and flexor digiti minimi brevis)	
	N. 4 interosseus	
	N. 3 central (superficial, central and deep)	

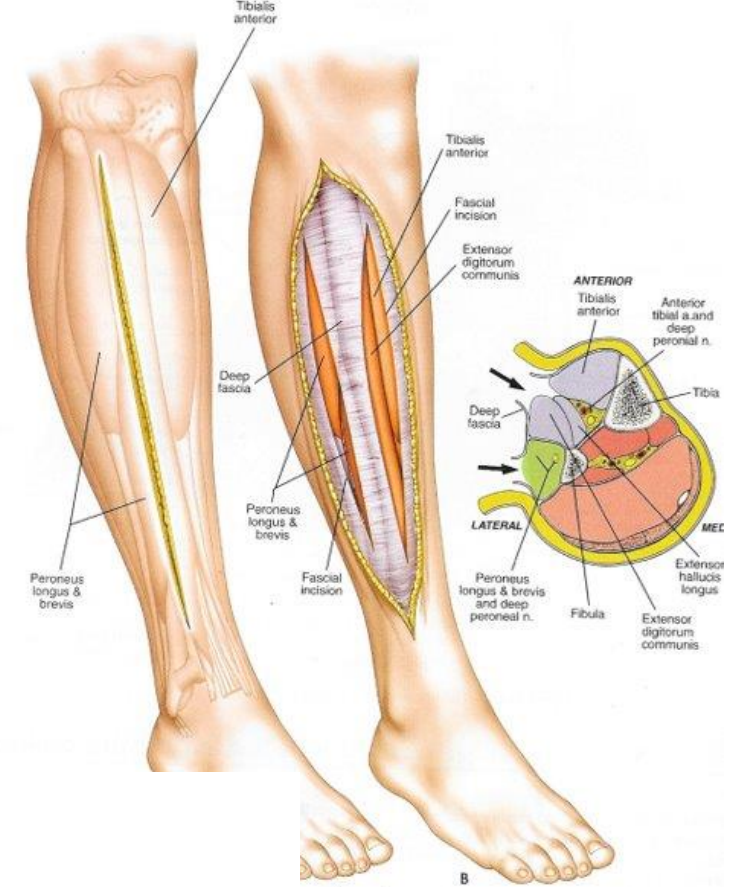
Surgical technique lower leg





Anterolateral incision

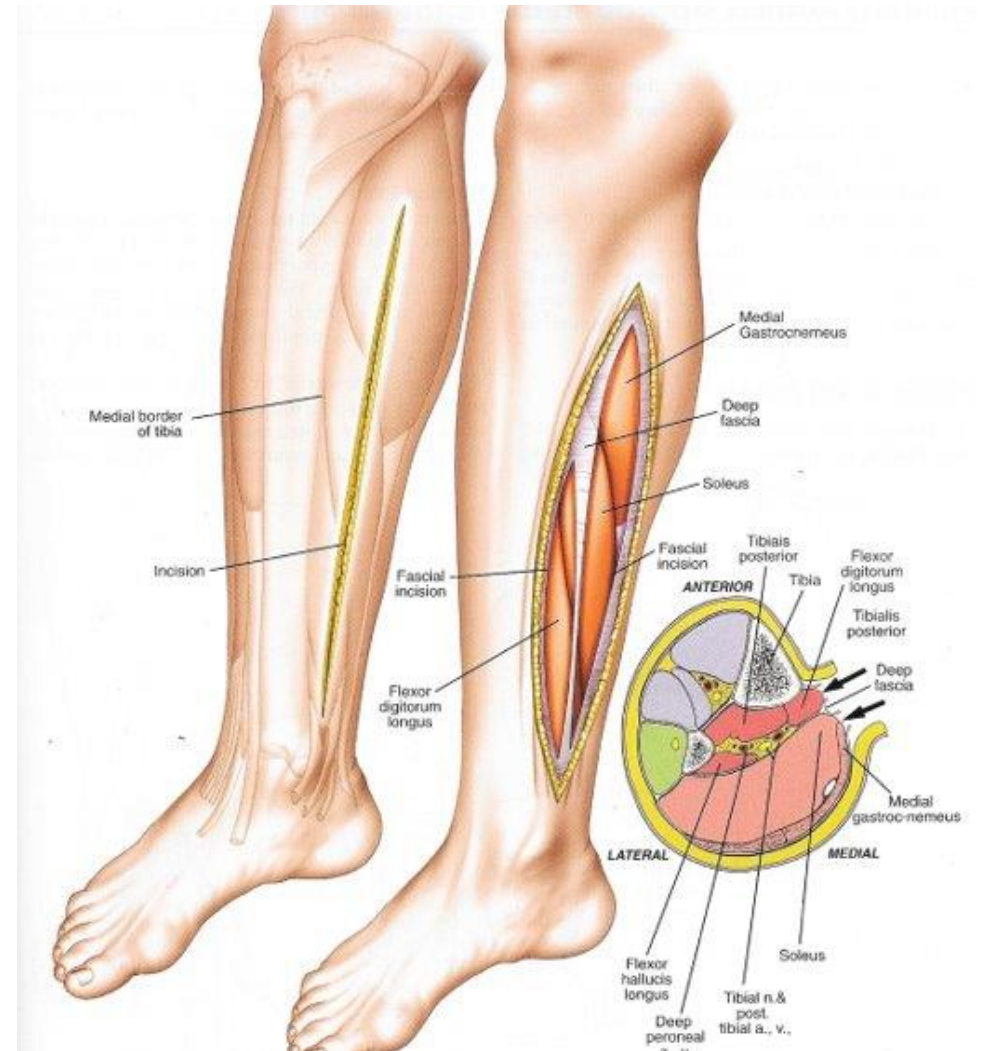
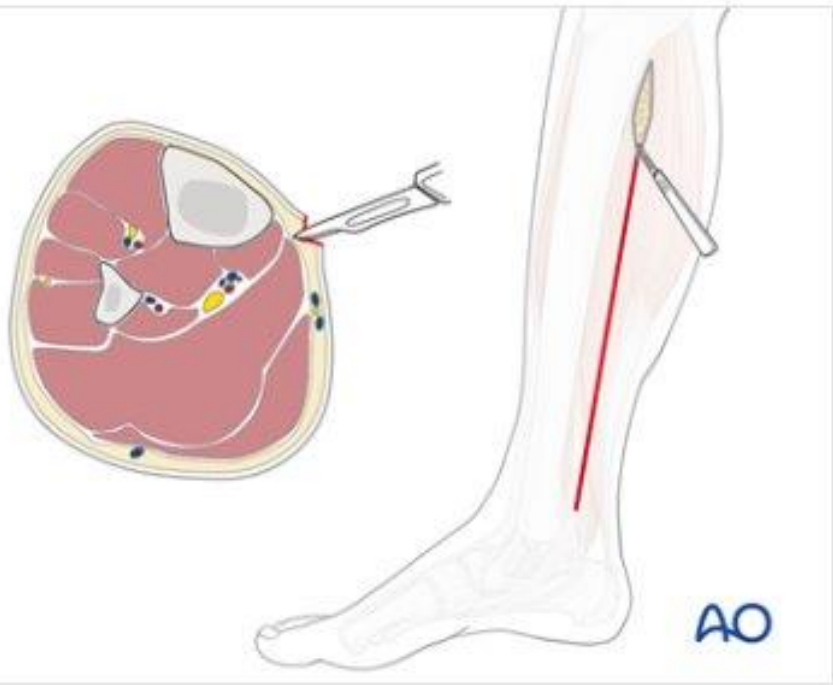
The anterior and lateral compartments are approached through a single longitudinal incision on the outer aspect of the leg, two centimeters anterior to the fibular shaft and long enough to expose the whole length of the compartments. The incision lies approximately over the anterior intermuscular septum that divides the anterior and lateral compartments and allows easy access to both.



Technique

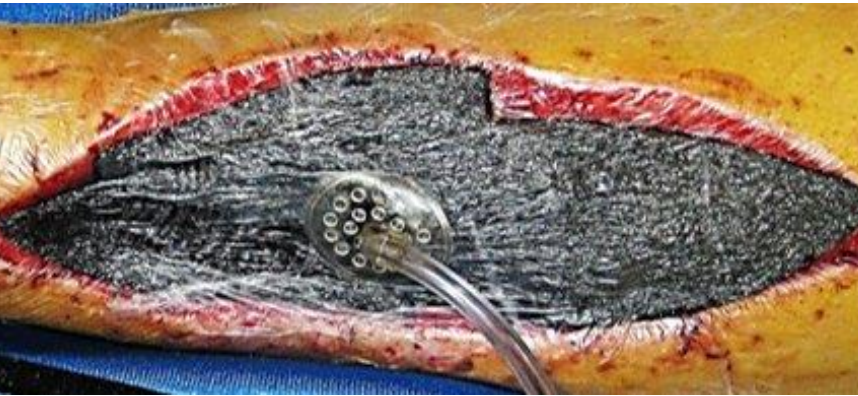
Posteromedial Incision

The two posterior compartments are approached through a single longitudinal incision in the lower leg, two centimeters behind the palpable posteromedial edge of the tibia.



After the fasciotomy

- Second look after 24-48 hours
- Apply rubber bands
 - In shoelace configuration
- Adapt rubber bands every 24-48 hours
- Goal is direct closure
- VAC / Split skin / Flap can be necessary



A



SYSTEMATIC REVIEW

Factors Associated with Development of Traumatic Acute Compartment Syndrome: A Systematic Review and Meta-analysis

Sharri J. Mortensen, MD^{1*}; Sebastian Orman, MD^{2*}; Joseph Serino, MD^{3*}; Amin Mohamadi, MD, MPH¹;
Ara Nazarian, PhD^{1,5,6**}; Arvind von Keudell, MD^{4,5**}

Research performed at Brigham and Women's Hospital, Boston, MA, USA

Young

Male

Vascular laesion

High energy trauma



Initial treatment

- Fasciotomy of the lower leg
- External fixation of the fracture
- Reposition of the Lisfranc fracture
- Second look after 48 hours

