Compartment Syndrome in Trauma Patients

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Abstract:
Acute limb compartment syndrome (LCS) is a limb-threatening and occasionally life-threatening condition caused by bleeding or edema in a closed muscle compartment surrounded by fascia and bone, which leads to muscle and nerve ischemia. Well-known causative factors are acute trauma and reperfusion after treatment for acute arterial obstruction. Untreated compartment syndrome usually leads to muscle necrosis, limb amputation, and, if severe, in large compartments, renal failure and death. Alarmness, clinical suspicion of the possibility of LCS, and occasionally intracompartmental pressure (ICP) measurement are required to avoid a delay in diagnosis or missed diagnosis. Open fasciotomy, by incising both skin and fascia, is the most reliable method for adequate compartment decompression. The techniques of measuring ICP have advantages and disadvantages, whereas the pressure level that mandates fasciotomy is controversial. Increased awareness of the syndrome and the advent of measurements of ICP have raised the possibility of early diagnosis and treatment. This presentation reports LCS, including etiology, diagnosis, ICP measurement, management, and outcome.

KEY WORDS: LIMB COMPARTMENT SYNDROME, DIAGNOSIS, TREATMENT

What is compartment syndrome?
A raising of tissue pressure leads in a closed compartment to less tissue perfusion. This will end in a neuro-muscular malfunction
Tscherne 1982

What injuries may cause compartment syndrome?
- Tibia and forearm fractures
- Vascular and bony injuries
- Injuries immobilized in tight dressings or casts
- Severe crush injuries to muscle
- Burns

Incidence due to fractures:

<table>
<thead>
<tr>
<th>Incidence after fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm</td>
</tr>
<tr>
<td>Forearm</td>
</tr>
<tr>
<td>Hand</td>
</tr>
<tr>
<td>Upper leg</td>
</tr>
<tr>
<td>Lower leg</td>
</tr>
<tr>
<td>Feet</td>
</tr>
</tbody>
</table>
### Compartment Syndrome

#### Incidence after lower extremity fractures

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>CS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Böhler 1957</td>
<td>1048</td>
<td>4.2 (cast) 18.2 (nail)</td>
</tr>
<tr>
<td>Ellis 1958</td>
<td>343</td>
<td>2.5</td>
</tr>
<tr>
<td>Nicoll 1964</td>
<td>241</td>
<td>15</td>
</tr>
<tr>
<td>Owen 1967</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>Heim 1972</td>
<td>905</td>
<td>0.8</td>
</tr>
</tbody>
</table>

#### Clinical symptoms

- contusion
- fracture / osteotomy
- venous stoppage / thrombosis
- arteriell bleeding
- haematoma postop. / muscle injury
- postiscaemic swelling
- muscle hypertrophia

#### External compression

- pneumatic splint
- anti shock trousers
- elastic bandage
- closed plaster casts
- tourniquet

<table>
<thead>
<tr>
<th>Increase of pressure (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 elastic bandage</td>
</tr>
<tr>
<td>without tension 5</td>
</tr>
<tr>
<td>light stretching 10</td>
</tr>
<tr>
<td>2 elastic bandages 20</td>
</tr>
<tr>
<td>Tournique 35</td>
</tr>
</tbody>
</table>


### Compartment Syndrome

**Definition**
- Decrease of art. blood pressure (p<sub>art</sub> local)
  - Shock
  - Elevation of extremity

**Pathophysiology**
- Edema
  - Hypoxia
  - Disturbance of perfusion
  - Acidosis
  - Trauma

**Clinical Symptoms**
- Malfunction of permeability

**Diagnostics**
- Pressure

**Pressure Indication**
- LBF = \( \frac{p_{ART} - p_{VEN}}{R} \)
  - LBF: local blood flow
  - \( p_{ART} \): local arterial blood pressure
  - \( p_{VEN} \): local venous pressure (=soft tissue pressure)
  - R: local vascular resistance

**Therapy**
- normal < 10
- latent CS 30-40
- manifest CS > 40

**Summary**
- (1) acute Phlebothrombosis
- (2) central / peripheral nervous lesion
- (3) Infection
- Ergotism
- Tendosynovitis
- Sore muscles
- March syndrom
- Periostitis
- Algodystrophia

**Differential Diagnosis**
- Pain
- Paresthesia
- Pallor
- Paralysis
- Pulse loss (late)
- Tissue pressure > 35 to 45 mm Hg

**How do I recognize compartment syndrome?**
### Symptoms
- Heavy pain attacks
- Paraesthesia / Hypaesthesia
- Malfunction of muscle

### How do I recognize compartment syndrome?

#### Latent compartment syndrome
- **Prevention**
  - Resting max. 10cm over heart level
  - no external compression
  - cooling ???
  - aggressively volume substitution
  - medicamental decongestant

#### Manifest compartment syndrome
- **sensible deficit**
- muscular deficit
  - passively pain in muscle stretching
  - muscles solid to hard like stone
- **pressure** >40 mmHg

### Latent compartment syndrome
- **pressure** 30-40 mmHg
- acute, inadaequat heavy pain
- swelling and shining skin
- local pain while pushing

### Compartment Syndrom
**Definition**
- Incidence
- Pathogenesis
- Pathophysiologie

**Clinical symptoms**
- Diagnostics
- Pressure
- Indication
- Therapy
- Summary

**Diagnostics**
- Pressure
- Indication
- Therapy
- Summary

**Therapy**

**Summary**

---

### Heavy pain attacks

### Incidence

### Pathogenesis

### Pathophysiologie

### Clinical symptoms
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### Indication

### Therapy

### Summary

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### anamnesis

### clinic
- inadaequate pain
- swelling
- sensible deficit
- motoric deficit

### subfasziale Druckmessung

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### Therapy

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**Compartment Syndrome**

**Manifest Compartment Syndrome**

Pos. Doppler
kein
Compartment-syndrom

**Indication for pressure measurement**

- clinical suspicion
- uncompliance of patient
- unconsciousness

The diagnosis of CS is always a **clinical diagnosis**, pressure measurement is additional information.

**Technique of pressure measurement**

Skin desinfection

Subfascial tap

Introduce venous catheter in tissue, insert tip: automatic pressure offset

Pull back tip in catheter and again and pressure offset

Push tip in tissue and measure

**Tap points for measurement**
Compartment Syndrome

Definition

Incidence

Pathogenesis

Pathophysiology

Clinical symptoms

Diagnostics

Pressure

Indication

Therapy

Summary

Technique of pressure measurement

But you also can use system for CVP-Measurement

• easy and fast application

• easy offset

• high precision

• continuous measurement possible

• Storage of min / max - data

Indication for fasciotomy

\[ P_{ART \ diast} - P_m < 20 \text{ mmHg} \]
How do I treat compartment syndrome?

**Definition**

- no tourniquet
- no elevation of extremity
- no extensions
- complete dermatofasciotomy
- no primary skin closure
- vacuuseal
- second look

**Therapy and Operation**

- Complete dermatofasciotomy
- no primary skin closure
- vacuuseal
- second look

**Operation**

- Parafibular 4-comparts opening
- ...after vacuuseal
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Definition
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Compartment syndrome Arm

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Principles in Compartment Syndrome

• Think on it !!!
• CS is a clinical diagnosis
• In doubt: Cut !
• Act consequently
• Vacuum sealing
• Recognize vascular compromise
• Avoid delays in management

Articole Multimedia
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