

# Compartment Syndrome in Trauma Patients

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**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. Alertness, 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 pressure 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

**Compartment Syndrom**

## What ist compartment syndrom?

**A raising of tissue pressure**  
 leads in a  
**closed compartement**  
 to  
**less tissue perfusion.**  
 This will end in a  
**neuro-muscular malfunktion**

Tscherne 1982

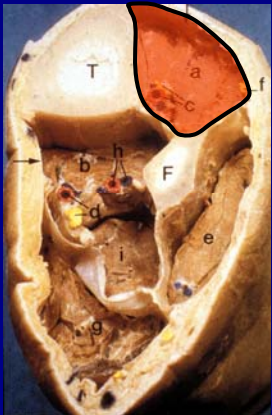
**Compartment Syndrom**

## 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

**Compartment Syndrom**

## Incidence due to fractures:



**Compartment Syndrom**

## Incidence after fractures

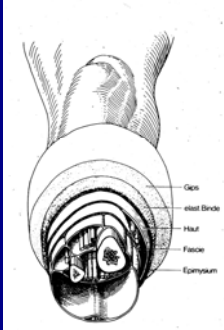
Arm	?
Forearm	?
Hand	?
Upper leg	1-2%
Lower leg	0,8 - 18,2%
feet	- 40%

Compartment Syndrom	Incidence after lower extremity fractures			
Definition		Year	n	CS (%)
Incidence	Böhler	1957	1048	4,2 (cast) 18,2 (nail)
Pathogenesis				
Pathophysiologie	Ellis	1958	343	2,5
Clinical symptoms				
Diagnostics	Nicoll	1964	241	15
Pressure				
Indication	Owen	1967	100	10
Therapy				
Summary	Heim	1972	905	0,8

Compartment Syndrom	Incidence after lower extremity fractures			
Definition		Year	n	CS (%)
Incidence	Echtermeyer	1985	782	17
Pathogenesis				
Pathophysiologie	Breitfuß	1991	56	14 (nail)
Clinical symptoms				
Diagnostics	Krettek	1994	75	2,7 (UTN)
Pressure				
Indication	Strecker	1996	162	1,2 (nail)
Therapy				
Summary	Schmickal	1998	477	10,3

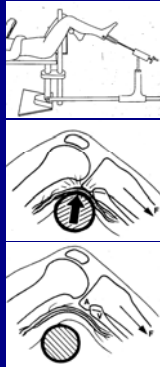
Compartment Syndrom	Increase of volume in a compartment
Definition	• <b>contusion</b>
Incidence	• <b>fracture / osteotomie</b>
Pathogenesis	• <b>venous stoppage / thrombosis</b>
Pathophysiologie	• <b>arteriell bleeding</b>
Clinical symptoms	• <b>haematoma postop. / muscle injury</b>
Diagnostics	• <b>postiscaemic swelling</b>
Pressure	• <b>muscle hypertrophia</b>
Indication	
Therapy	
Summary	

Compartment Syndrom	External compression
Definition	
Incidence	
Pathogenesis	• <b>pneumatic splint</b>
Pathophysiologie	• <b>anti shock trowsers</b>
Clinical symptoms	• <b>elastic bandage</b>
Diagnostics	• <b>closed plaster casts</b>
Pressure	• <b>tourniquet</b>
Indication	
Therapy	
Summary	

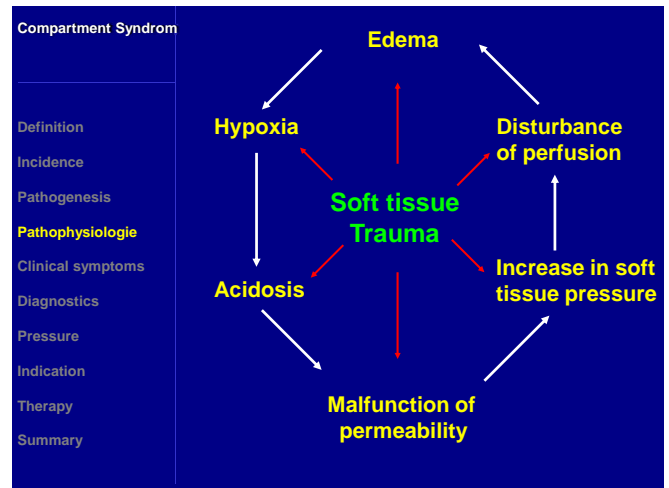


Compartment Syndrom	External compression
Definition	Increase of pressure (mmHg)
Incidence	
Pathogenesis	1 elastic bandage
Pathophysiologie	without tension 5
Clinical symptoms	light stretching 10
Diagnostics	
Pressure	2 elastic bandages 20
Indication	
Therapy	
Summary	Tourniquet 35

Compartment Syndrom	External compression
Definition	
Incidence	• <b>Extensions</b>
Pathogenesis	• <b>Mistakes in resting patients during operation</b>
Pathophysiologie	• <b>Closing of fascial gaps</b>
Clinical symptoms	• <b>Spill trauma</b>
Diagnostics	• <b>Circular burns</b>
Pressure	
Indication	
Therapy	
Summary	



Compartment Syndrom	<b>Decrease of art. blood pressure (p<sub>art</sub> local)</b>
Definition	
Incidence	
Pathogenesis	
<b>Pathophysiologie</b>	<ul style="list-style-type: none"> <li>• shock</li> <li>• elevation of extremity</li> </ul>
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	



Compartment Syndrom	
Definition	
Incidence	
Pathogenesis	
<b>Pathophysiologie</b>	$LBF = \frac{P_{ART} - P_{VEN}}{R}$
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	

**LBF local blood flow**

**P<sub>ART</sub> local arterial blood pressure**

**P<sub>VEN</sub> local venous pressure (=soft tissue pressure)**

**R local vascular resistance**

Compartment Syndrom									
Definition									
Incidence									
Pathogenesis									
<b>Pathophysiologie</b>	<table border="1"> <tr> <th>Tissue pressure (mmHg)</th> <th></th> </tr> <tr> <td>normal</td> <td>&lt;10</td> </tr> <tr> <td>latent CS</td> <td>30-40</td> </tr> <tr> <td>manifest CS</td> <td>&gt;40</td> </tr> </table>	Tissue pressure (mmHg)		normal	<10	latent CS	30-40	manifest CS	>40
Tissue pressure (mmHg)									
normal	<10								
latent CS	30-40								
manifest CS	>40								
Clinical symptoms									
Diagnostics									
Pressure									
Indication									
Therapy									
Summary									

Compartment Syndrom	<b>Differential Diagnosis</b>
Definition	
Incidence	
Pathogenesis	
<b>Pathophysiologie</b>	
Clinical symptoms	<ul style="list-style-type: none"> <li>• (1) acute Phlebothrombosis</li> <li>• (2) central / peripheral neural lesion</li> <li>• (3) Infection</li> </ul>
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	

• Ergotism

• Tendosynovitis

• Sore muscles

• March syndrom

• Periostitis


• Algodystrophia

Compartment Syndrom	<b>How do I recognize compartment syndrome?</b>
Definition	
Incidence	
Pathogenesis	
<b>Pathophysiologie</b>	
Clinical symptoms	<ul style="list-style-type: none"> <li>• Pain</li> <li>• Paresthesia</li> <li>• Pallor</li> <li>• Paralysis</li> <li>• Pulse loss (late)</li> </ul>
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	

• Tissue pressure > 35 to 45 mm Hg

Compartment Syndrom	<b>Symptoms</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
<b>Clinical symptoms</b>	<ul style="list-style-type: none"> <li>• Heavy pain attacks</li> <li>• Paraesthesia / Hypaesthesia</li> <li>• Malfunction of muscle</li> </ul>
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	

Compartment Syndrom		
Definition		
Incidence		
Pathogenesis		
Pathophysiologie		
<b>Clinical symptoms</b>	<ul style="list-style-type: none"> <li>• <b>anamnesis</b></li> <li>• <b>clinic</b></li> <li>inadaequate pain</li> <li>swelling</li> <li>sensible deficit</li> <li>motoric deficit</li> </ul>	
Diagnostics		
Pressure		
Indication		
Therapy		
Summary		
		• <b>subfasziale Druckmessung</b>

Compartment Syndrom	<b>How do I recognize compartment syndrome?</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
<b>Diagnostics</b>	
Pressure	
Indication	
Therapy	
Summary	

Compartment Syndrom	<b>Latent compartment syndrome</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
<b>Diagnostics</b>	<ul style="list-style-type: none"> <li>• acute, inadaequate heavy pain</li> <li>• swelling and shining skin</li> <li>• local pain while pushing</li> <li>• pressure <b>30-40 mmHg</b></li> </ul>
Pressure	
Indication	
Therapy	
Summary	

Compartment Syndrom	<b>Latent Compartment syndrome</b>
	<b>Prevention</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
Therapy	
Summary	
	<ul style="list-style-type: none"> <li>• Resting max. 10cm over heart level</li> <li>• no external compression</li> <li>• cooling ???</li> <li>• aggressively volume substitution</li> <li>• medicamental decongestant</li> </ul>

Compartment Syndrom	<b>Manifest compartment syndrome</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
<b>Diagnostics</b>	<ul style="list-style-type: none"> <li>• sensible deficit</li> <li>• muscular deficit</li> <li>passively pain in muscle stretching</li> <li>muscles solid to hard like stone</li> <li>• pulses often palpable</li> <li>• pressure <b>&gt;40 mmHg</b></li> </ul>
Pressure	
Indication	
Therapy	
Summary	

**Compartment Syndrom**

**Manifest Compartment syndrom**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
Pressure  
Indication  
Therapy  
Summary

**Compartment Syndrom**

**Indication for pressure measurement**

- clinical suspicion
- uncompliance of patient
- unconsciousness

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
**Diagnostics**  
Pressure  
Indication  
Therapy  
Summary

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

**Compartment Syndrom**

**Technique of pressure measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary

**Compartment Syndrom**

**Technique of pressure measurement**

- Skin disinfection
- 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

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary

**Compartment Syndrom**

**Technique of pressure measurement**

**Tap points for measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary

**Compartment Syndrom**


**Technique of pressure measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary

**Compartment Syndrom**

**Technique of pressure measurement**

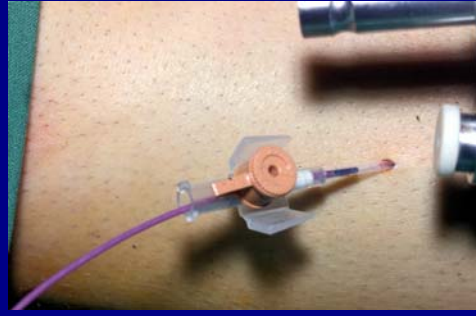
Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary



**Compartment Syndrom**

**Technique of pressure measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary



**Compartment Syndrom**

**Technique of pressure measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary



**Compartment Syndrom**

**Technique of pressure measurement**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
**Pressure**  
Indication  
Therapy  
Summary




**But you also can use system for CVP-Measurement**

**Compartment Syndrom**

**Micro - Tip**

- easy and fast application
- easy offset
- high precision
- continous measurement possible
- Storage of min / max - data




Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
Pressure  
Indication  
Therapy  
Summary

**Compartment Syndrom**

**Indication for fasciotomie**

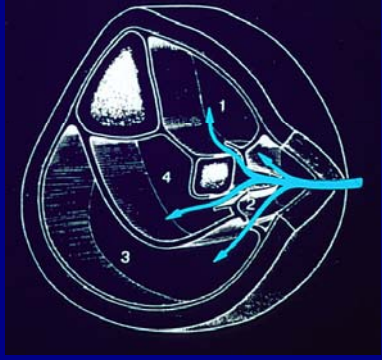
**P<sub>ART</sub> diast - P<sub>IM</sub>**  
**< 20 mmHg**

Definition  
Incidence  
Pathogenesis  
Pathophysiologie  
Clinical symptoms  
Diagnostics  
Pressure  
**Indication**  
Therapy  
Summary


Compartment Syndrom	<h2 style="text-align: center;">How do I treat compartment syndrome?</h2> 
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2 style="text-align: center;">Therapy and Operation</h2> <ul style="list-style-type: none"> <li>• no tournique</li> <li>• no elevation of extremity</li> <li>• no extensions</li> <li>• complete dermatofasciotomie</li> <li>• no primary scin closure</li> <li>• vacuseal</li> <li>• second look</li> </ul>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

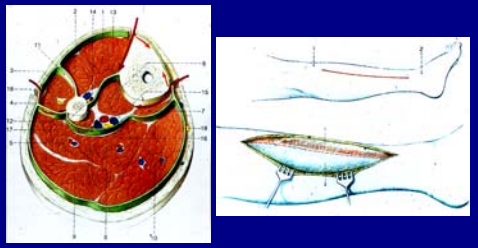
Compartment Syndrom	<h2 style="text-align: center;">Operation</h2> 
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2 style="text-align: center;">Operation</h2> <ul style="list-style-type: none"> <li>• Parafibular 4-compartments opening</li> </ul> 
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2 style="text-align: center;">Operation</h2> 
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2 style="text-align: center;">Operation</h2>  <p style="text-align: center;">...after vacuseal</p>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<b>Therapy</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	
	...final result

Compartment Syndrom	<b>Operation</b>
	<b>Isolated CS of Tibialis anterior muscle</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	


Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

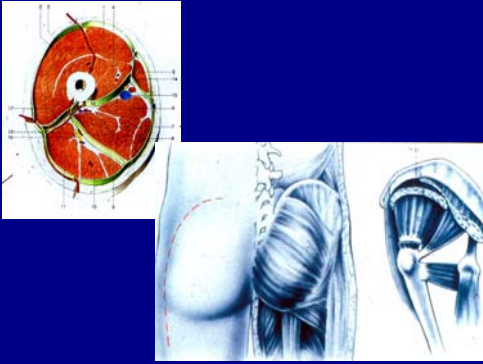
Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

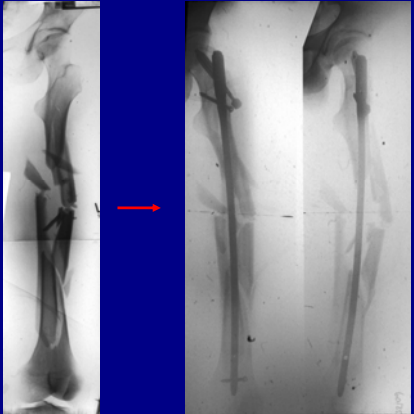



Compartment Syndrom	Operation
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

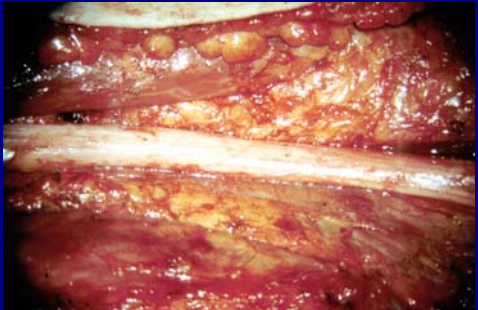
**Skin grafting or secondary closure**

Compartment Syndrom	Operation
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	Operation
	<b>Femoral Compartment syndrom</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	Operation
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	Operation
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

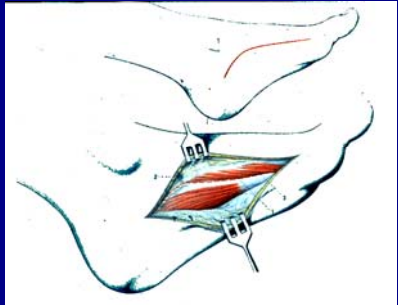
Compartment Syndrom	Operation
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

**Postischaemic Ischiadic nerv**

Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

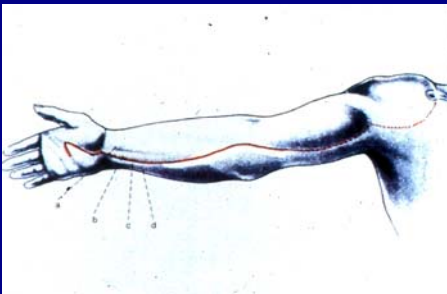
Compartment Syndrom	<b>Operation</b> <b>Compartment syndrom Foot</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

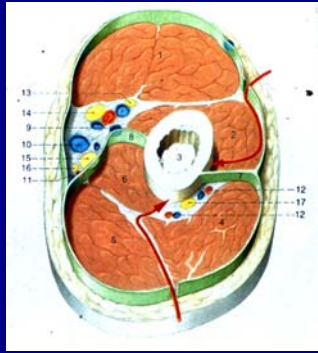
Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

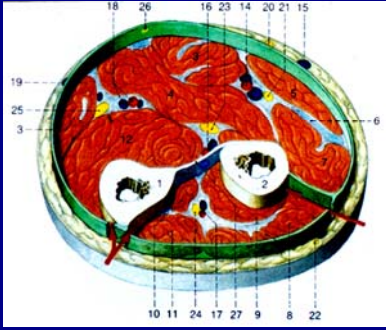
Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

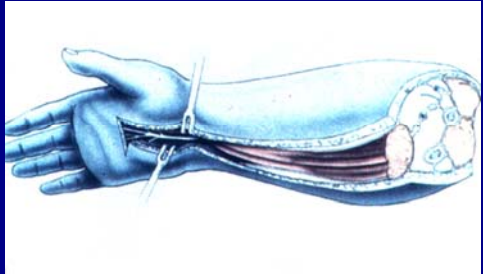
Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

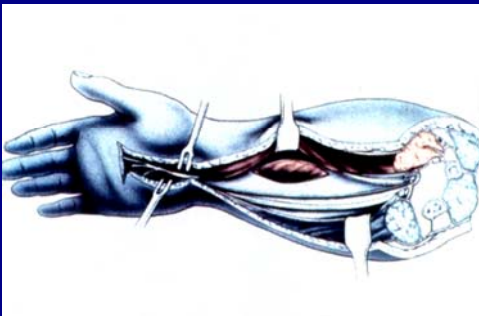
Compartment Syndrom	<b>Operation</b>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Operation</h2> <h3>Compartment syndrom Arm</h3>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Operation</h2> <h3>Compartment syndrom Upper arm</h3>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Operation</h2> <h3>Compartment syndrom Lower arm</h3>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Operation</h2>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Operation</h2>
Definition	
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
<b>Therapy</b>	
Summary	

Compartment Syndrom	<h2>Prinziples in Compartment Syndrom</h2>
Definition	<ul style="list-style-type: none"> <li>• Think on it !!!</li> <li>• CS is a clinical diagnosis</li> <li>• In doubt: <u>Cut !</u></li> <li>• Act consequently</li> <li>• Vacuum sealing</li> <li>• Recognize vascular compromise</li> <li>• Avoid delays in management</li> </ul>
Incidence	
Pathogenesis	
Pathophysiologie	
Clinical symptoms	
Diagnostics	
Pressure	
Indication	
Therapy	
<b>Conclusion</b>	