

Compartment Syndrome, Acute

Indexing Metadata/Description

- › **Title/condition:** Compartment Syndrome, Acute
- › **Synonyms:** Acute compartment syndrome; Volkmann's ischemia
- › **Anatomical location/body part affected:** Most often affects the lower leg, especially the anterior compartment, but can also affect the upper leg, foot, forearm, spine, or any other area of the body that is limited by fascia⁽⁷⁾
- › **Area(s) of specialty:** Acute Care, Home Health, Orthopedic Rehabilitation, Neurological Rehabilitation, Pediatric Rehabilitation, Wound Management
- › **Description**
 - Compartment syndrome occurs when pressure within a closed space that is restricted by fascia increases toward diastolic pressure, thereby reducing or eliminating perfusion to the muscles and nerves within that space⁽⁷⁾
 - Acute compartment syndrome (ACS)^(1,7)
 - Considered a medical emergency
 - ACS is the result of a rapid increase in pressure within a restricted space
 - Tissue necrosis/gangrene and even death can result if not corrected in a timely manner
 - Systemic involvement (e.g., kidney failure) might also occur if the syndrome is not treated promptly
 - ACS is most often seen after a traumatic event (e.g., fracture), but in 25–30% of cases there is no evidence of trauma/fracture. ACS can occur after sudden extreme exertion⁽³⁾
 - ACS should not be confused with chronic exertional compartment syndrome, which typically resolves with rest
 - Specific compartment syndromes
 - The lower leg has 4 compartments and is the most common location of ACS in the extremities, with the anterior and lateral compartments most affected⁽³⁾
 - Anterior compartment is formed by tibia, fibula, interosseous membrane, and anterior intermuscular septum and contains the tibialis anterior, extensor digitorum longus, extensor hallucis longus, and peroneus tertius muscles⁽⁷⁾
 - Lateral compartment is formed by anterior intermuscular septum, fibula, posterior intermuscular septum, and deep fascia and contains the peroneus longus and brevis muscles as well as the common peroneal nerve with its superficial and deep branches⁽⁷⁾
 - There is also a superficial and a deep posterior compartment⁽⁷⁾
 - The thigh has 3 compartments. Femur fractures associated with motor vehicle accidents are the most common cause of ACS in the thigh⁽³⁾
 - The upper arm has 2 compartments, the forearm has 3 (volar, dorsal, and lateral), and the hand has 10, with most ACS in the forearm associated with fractures, especially of the distal radius⁽³⁾
 - The definitive surgical treatment for ACS is emergency fasciotomy with fracture reduction and stabilization and vascular repair, if indicated⁽⁷⁾
 - The incidence of ACS is reported to be 3.1 per 100,000⁽⁴⁾

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› ICD-10 codes

- M62.2 ischaemic infarction of muscle
- T79.6 traumatic ischaemia of muscle
- T79.8 other early complications of trauma

(ICD codes are for the reader's reference, not for billing purposes)

› **Reimbursement:** Reimbursement for therapy will depend on insurance contract coverage; no specific issues or information regarding reimbursement has been identified

› Presentation/signs and symptoms

- ACS usually follows crushing or penetration of tissues, more commonly in closed injuries
- Presents with signs of compromise of neural and vascular function
 - The “6 Ps” have been used in diagnosis: pain, poikilothermia (i.e., change in temperature), paresthesia, paralysis, pallor, and pulselessness⁽⁷⁾
 - The emphasis should be on pain out of proportion to the extent of the known injury and often resistant to analgesia^(3,7)
 - Pain with passive stretch of muscles might be present within the affected compartment⁽³⁾
 - Pain out of proportion to injury and pain on passive stretch are the most effective clinical observations in conscious patients⁽⁴⁾
 - Paresthesia in the affected area might be present (e.g., altered sensation between first two toes as indication of deep peroneal nerve ischemia) and might be the first sign of hypoxia of the tissues⁽³⁾
 - Paralysis, pallor, and pulselessness might not be present or often can be very late signs of ACS^(3,4)
- Palpable tightness and tenderness of the compartment⁽⁷⁾
- Edematous extremity⁽¹⁾
- Not all these signs are required for the diagnosis and the clinical findings can change as the syndrome progresses
- ACS occurs in children but typical symptoms might be difficult to distinguish if child is preverbal, acutely injured, or developmentally delayed. It is suggested that clinicians use the “three As” in these situations: anxiety, agitation, and increasing analgesic requirement⁽³⁾

Causes, Pathogenesis, & Risk Factors

› Causes

- ACS can be caused by either an increase in tissue volume within a compartment or externally applied pressure compressing a compartment⁽⁷⁾
- ACS is most often caused by a traumatic injury to the involved area due to a motor vehicle accident, sports injury, crush injury, direct blow to the area, or fracture. Fractures are the cause in 75% of cases. Approximately 36% of all cases of ACS are associated with tibial fractures⁽⁷⁾
- Hemorrhage⁽¹⁾
- Burns⁽⁷⁾
- Lengthy surgery when the patient is in the lithotomy position⁽¹⁾
- Patient positioning⁽⁵⁾
- Pressure caused by casting⁽¹⁾
- Gunshot wounds
- Penetrating injuries (stab or injection)
- Infection after an injection

› Pathogenesis

- ACS of the limb occurs when increasing pressure within a muscle compartment, from bleeding or edema, reduces capillary blood flow below the level of tissue viability, leading to ischemia and necrosis^(7,8,9,10,11)

› Risk factors

- Fractures, particularly of the proximal tibia^(9,10,12)
- Crush injuries of the extremity^(10,11,14)
- Prolonged, excessive, external compression from a cast, tourniquet, or another pressure force^(8,13)

- Thirty-six percent of ACS cases are related to tibial shaft fractures, 23% of cases to soft-tissue injury, and 9% to forearm fractures⁽⁷⁾

Overall Contraindications/Precautions

- › If ACS is suspected, the patient should immediately be sent to the emergency room for further evaluation and treatment
- › Without early diagnosis and treatment, ACS of the limb is potentially limb-and life-threatening^(7,8,9,10,11)

Examination

› Contraindications/precautions to examination

- Most often, patients present to the ER when experiencing symptoms of ACS
- **If a patient is undergoing a PT/OT examination and at any point during the examination the therapist suspects ACS, the examination should be terminated and the patient sent immediately to the ER.** Early diagnosis and treatment are essential to prevent long-term damage, loss of limb, and death

› History

• History of present illness/injury

–**Mechanism of injury or etiology of illness:** Motor vehicle accident, sports injury, direct blow, crush injury

–General inquiry

- Were symptoms preceded by trauma?
- When did symptoms begin?
 - ACS can occur hours after an accident, so continued monitoring is important
- What symptoms are being experienced?

–Course of treatment

- Medical management

- Patient needs to be seen in the ER for medical management of ACS

- Surgical management

- Fasciotomy is the surgical procedure used to correct ACS; it involves cutting of the fascia to relieve pressure⁽¹⁾
- The most common surgical technique is a double-incision, four-compartment technique using two longitudinal anterolateral and posteromedial incisions⁽⁷⁾

- Medications for current illness/injury

- What pain medication has the patient taken? Pain refractory to usual doses of narcotics is an important subjective symptom
- Any use of sedation? In patients who are not alert, clinical signs might be unreliable

- Diagnostic tests completed

- ACS generally is diagnosed through patient history and clinical exam. When a patient is unable to provide a detailed history or is unable to take part in/tolerate the exam, more objective diagnostic testing is indicated
- Laboratory testing for signs of rhabdomyolysis and acute kidney injury includes urinalysis and blood work. Elevations in serum creatine phosphokinase (CPK) reflect the amount of muscular damage⁽⁷⁾
- Intracompartmental pressure measurement is the gold standard for diagnosing ACS⁽¹⁾
 - It has high sensitivity when compared to clinical findings. Fasciotomy is indicated when there is a persistent (> 2hours) differential pressure of ≥ 30 mm Hg^(6,7)
- MRI is helpful if differentiating ACS from chronic conditions or exertional compartment syndrome⁽⁷⁾
- Diagnostic ultrasound can be used as a noninvasive monitor of compartment pressures⁽⁷⁾
- Near-infrared spectroscopy (NIRS) is a technique that provides a continuous, noninvasive measure of tissue oxygenation⁽⁷⁾

- It also indicates worsening ACS but can be problematic in situations of hypoperfusion

–**Aggravating/easing factors:** In ACS, symptoms might be aggravated by volitional use of the limb or upon passive ROM/stretching of the affected muscles. Pain will not ease with rest

–**Body chart:** Use body chart to document location and nature of symptoms

- The anterior compartment of the leg and the flexor portion of the forearm are the most affected⁽⁵⁾

- Nature of symptoms:** Document nature of symptoms (e.g., constant vs. intermittent, sharp, dull, aching, burning, numbness, tingling). The pain is often described as excruciating, deep, and rapidly progressive. Patient will experience pain with passive stretching and might have numbness or hypesthesia
- Rating of symptoms:** Use a visual analog scale (VAS) or 0–10 scale to assess symptoms at their best, at their worst, and at the moment
- Sleep disturbance:** Document number of wakings/night that are related to the condition, if applicable
- **Medical history**
 - Past medical history**
 - **Comorbid diagnoses:** Ask patient about other problems, including diabetes, cancer, heart disease, complications of pregnancy, psychiatric disorders, and orthopedic disorders
 - **Medications previously prescribed:** Obtain a comprehensive list of medications prescribed and/or being taken (including OTC drugs)
 - **Other symptoms:** Ask patient about other symptoms he or she is experiencing
- **Social/occupational history**
 - Vocation/avocation and associated repetitive behaviors, if any:** Does the patient participate in recreational or competitive sports? Has there been a rapid increase in activity?
 - Functional limitations/assistance with ADLs/adaptive equipment:** ADLs will be impacted by ACS; extent of impact depends on location of ACS
 - Living environment:** Document any pertinent information about the patient’s living (e.g., stairs, number of floors in home, who lives with the patient)
- › **Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting. Less invasive testing should be performed first.) If at any point during the examination the physical therapist suspects ACS, the examination should be terminated and the patient sent immediately to the emergency department**
- **Anthropometric characteristics:** Circumferential measurements might be used to assess for edema; comparison to contralateral extremity might be helpful
- **Assistive and adaptive devices:** Document use of any adaptive or assistive devices; evaluate ability of patient to use device safely/correctly
- **Circulation**
 - Capillary refill time typically is normal unless exceedingly high pressures are present⁽¹⁾
 - Pulse typically is normal unless exceedingly high pressures are present⁽¹⁾
- **Gait/locomotion:** If ACS is suspected, patient should not ambulate
- **Muscle strength**
 - Assess muscles within compartment for loss of strength. Muscle strength is difficult to judge in patients with traumatic injuries and might be limited by pain due to those injuries
 - Assess musculature of adjacent compartments to assess whether more than one compartment is involved
 - Weakness, if apparent, will indicate anatomical compartment that is involved
 - Anterior compartment syndrome: toe extensor weakness will be present
 - Deep posterior compartment syndrome: weakness in toe flexors
 - Lateral compartment syndrome: weakness of foot eversion
- **Observation/inspection/palpation (including skin assessment)**
 - Pallor (paleness of the skin) might be present but is a rare finding as it occurs only when arterial flow is dramatically reduced⁽²⁾
 - Might have palpable tenseness
 - Assess for tenderness, edema, and open wounds related to injury
- **Range of motion:** Assess surrounding joints. Passive stretching of affected musculature will likely be painful
 - Anterior compartment syndrome: passive stretch of tibialis anterior, extensor hallucis longus, and extensor digitorum longus is painful
 - Lateral compartment syndrome: pain with passive inversion
- **Reflex testing:** Reflexes innervated by nerves passing through affected compartment might be impaired
- **Sensory testing:** Dermatomes innervated by nerves passing through the affected compartment should be assessed
 - Anterior compartment syndrome: Numbness in the 1st web space of the foot (deep peroneal nerve)
 - Deep posterior compartment syndrome: Hypesthesia on sole of foot

–Lateral compartment syndrome: Sensory loss on lateral dorsum of foot (superficial peroneal nerve)

Assessment/Plan of Care

- › **Contraindications/precautions:** Physical therapy is contraindicated in patients with ACS
- › **Diagnosis/need for treatment:** Immediate surgical treatment is required; patient should be directed immediately to emergency services. Physical therapy may be recommended after surgery to address any limitations in movement or strength after fasciotomy
- › **Rule out**
 - Arterial occlusion
 - Neuropraxia of the common, deep, or superficial peroneal or tibial nerves
 - DVT
 - Cellulitis
 - Severe contusion
 - Chronic exertional compartment syndrome
 - Musculoskeletal dysfunction (e.g., shin splints)
- › **Prognosis**
 - Good prognosis is dependent on timely diagnosis and successful surgical treatment with fasciotomy. Without treatment, tissue and cellular necrosis and irreversible death of tissues will result⁽⁷⁾
- › **Referral to other disciplines:** ER; typically referred to vascular, orthopedic, or plastic surgery
- › **Treatment:** No specific physical therapy treatment is suggested. Elevation of the extremity no higher than the level of the heart helps with venous flow⁽⁷⁾

Problem	Goal	Intervention	Expected Progression	Home Program
ACS might lead to loss of limb and is a life-threatening condition	N/A	<p><u>Therapeutic intervention</u></p> <p>Immediate referral to emergency department is needed to evaluate further and provide surgical intervention as indicated. The only acceptable treatment for ACS at this time is fasciotomy of the affected compartment</p>	N/A	N/A

Desired Outcomes/Outcome Measures

- › Following fasciotomy for ACS, nerve and muscle function should be evaluated to determine extent of tissue injury

Maintenance or Prevention

- › There is no proven method of preventing ACS⁽²⁾
 - Clinical practice guidelines based on findings of experimental studies in humans and animals with artificially raised compartment pressure and expert consensus recommend the following measures for high-risk patients:⁽²⁾
 - Circumferential bandages removed and plaster casts split
 - Affected limbs positioned at heart level
 - Ankle maintained in neutral position if leg affected
 - Patient kept normotensive
 - High-flow oxygen if oxygen saturation poor

Patient Education

› Information about ACS can be found on the OrthoInfo website presented by the American Academy of Orthopaedic Surgeons: <https://orthoinfo.aaos.org/en/diseases--conditions/compartiment-syndrome/>

Coding Matrix

References are rated using the following codes, listed in order of strength:

M Published meta-analysis	RV Published review of the literature	PP Policies, procedures, protocols
SR Published systematic or integrative literature review	RU Published research utilization report	X Practice exemplars, stories, opinions
RCT Published research (randomized controlled trial)	QI Published quality improvement report	GI General or background information/texts/reports
R Published research (not randomized controlled trial)	L Legislation	U Unpublished research, reviews, poster presentations or other such materials
C Case histories, case studies	PGR Published government report	CP Conference proceedings, abstracts, presentation
G Published guidelines	PFR Published funded report	

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