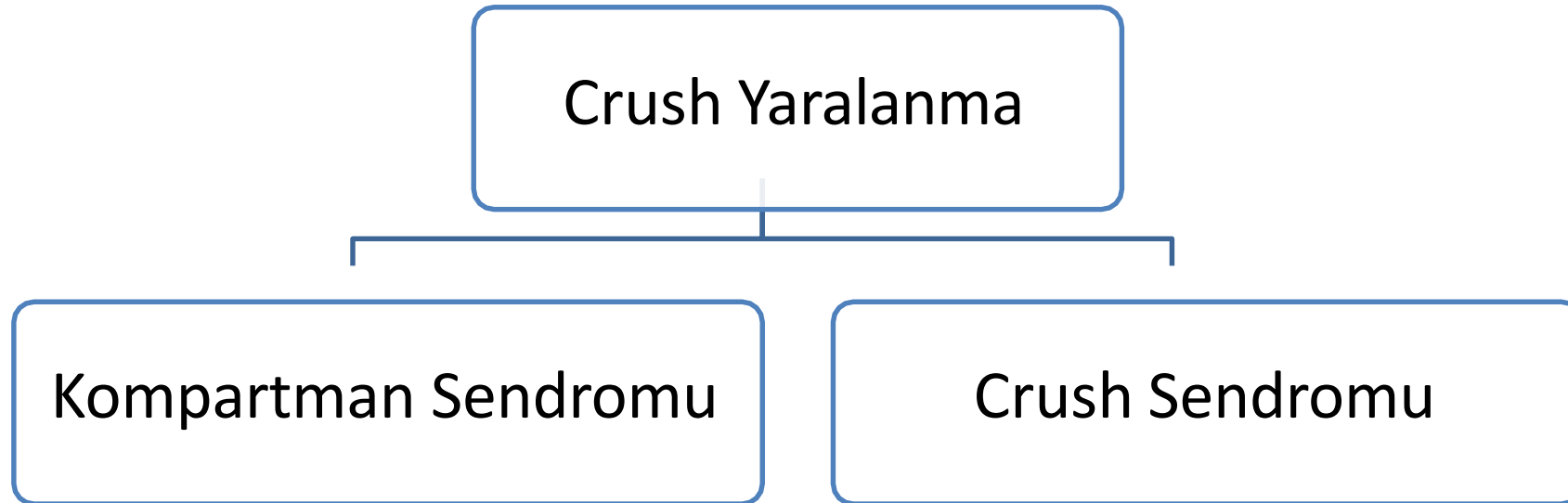


# KOMPARTMAN SENDROMU VE FASYOTOMİ

Prof. Dr. Kuzey AYDINURAZ  
Kırıkkale Üniversitesi Tıp Fakültesi Genel Cerrahi Anabilim Dalı

10.10.2017  
İstanbul



# Types of Compartment Syndrome

## ACUTE COMPARTMENT SYNDROME

The most common type of compartment syndrome, it only lasts for a limited period of time.

Develops quickly — over a few hours to a few days — and is usually caused from an injury such as broken leg or arm.

Caused by bleeding, fluid retention and increased inflammation.



## CHRONIC COMPARTMENT SYNDROME

Can last up to several weeks.

Often caused from ongoing vigorous exercise the body can't adjust to, which leads to exertional compartment syndrome.



## EXERTIONAL COMPARTMENT SYNDROME

A form of chronic compartment syndrome most common in parts of the body that are stressed most during heavy physical activities, such as the shins, knees, glutes and thighs.

The body becomes overly exerted and can't repair tissue well enough to prevent increased inflammation and pressure.



## ABDOMINAL COMPARTMENT SYNDROME

Rare but serious type that's typically caused by severe injury, surgery or illness that rapidly increases swelling.

Car accidents, trauma, infections, internal bleeding from the abdomen and pelvic fractures are common triggers.

It can be life-threatening if left untreated because it cuts off blood flow from the abdominal organs: liver, bowels and kidneys.

Usually requires hospitalization.



- Akut Kompartman Sendromu
- Kronik Kompartman Sendromu
- Zorlanmaya bağlı Kompartman Sendromu
- Abdominal Kompartman Sendromu

## Abdominal Kompartman Sendromu



## Ekstremité Kompartman Sendromu



# Kompartman Sendromu

- Kapalı bir osteofasial alanda hidrostatik basınç artışı ile ortaya çıkan kas ve sinir dokusu hipoperfüzyonu kompartman sendromu olarak adlandırılır





MÉMOIRES  
DE  
CHIRURGIE MILITAIRE,  
ET  
CAMPAGNES

DE D. J. LARREY,

Premier Chirurgien de la Garde et de l'Hôpital de la Garde de S. M. I. et R., Baron de l'Empire, Commandant de la Légion-d'Honneur, Chevalier de l'Ordre de la Couronne de Fer; Inspecteur général du service de santé des Armées; ex-Professeur au ci-devant Hôpital militaire d'instruction du Val-de-Grâce; Docteur en Chirurgie et en Médecine; Membre de l'Institut d'Égypte, des Sociétés de la Faculté de Médecine de Paris, d'Émulation, Philomatique; Associé correspondant de celles de Montpellier, de Toulouse, de Bruxelles, etc.; de l'Académie Joséphine impériale de Vienne; de celles de Turin, de Madrid, de Naples, de Munich et d'Jéna.

Eò adductus sum ut multis meorum sequacium hinc inde errantibus viam monstrarem et aliquantulum munirem. BAGL. PRAX. MED., lib. I., cap. I.

TOME I.

*Back plates*

PARIS,

Chez J. SMITH, Imprimeur-Libraire, rue de Montmorency.

1812.

# Dominique-Jean Larrey 1766 - 1842



'The worthiest man I have ever met' - Napoleon

# Richard von Volkmann, 1881



- Kapalı bir alanda artan basınca bağlı olarak dolaşım ve fonksiyon bozukluğu
- 4 saat – geri dönebilir hasar
- 8 saat – geri dönüşsüz hasar
- 4 - 8 saat – değişken



Volkmann's ischemic contracture

Ischemic muscle contracture (flexion contracture) attributable to external pressure causing irreversible necrosis of muscle tissue, usually seen in the hand, resulting in claw hand, and most frequently observed in children

Volkmann's triangle

Avulsed posterior edge of the tibia in ankle fractures

Hueter-Volkmann law

Orthopaedic concept describing growth of immature bones

Volkmann's splint

Splint used for a fracture of the lower extremity, consisting of a footpiece and two lateral supports

Volkmann's syndrome I (or Volkmann's disease)

Congenital talus luxation. Eponym used to indicate tibiotarsal dislocation causing a congenital deformity of the foot.

Volkmann's bench

For application of plaster of Paris cast

Volkmann's abscess

From tuberculosis of the cervical vertebra

Volkmann's spoon

Used in performing curettage of the above-named abscess



# London Blitz



## War Medicine Series

The paper printed below is based on a lecture which was one of a series recently given at the British Postgraduate Medical School, Hammersmith

### CRUSHING INJURY

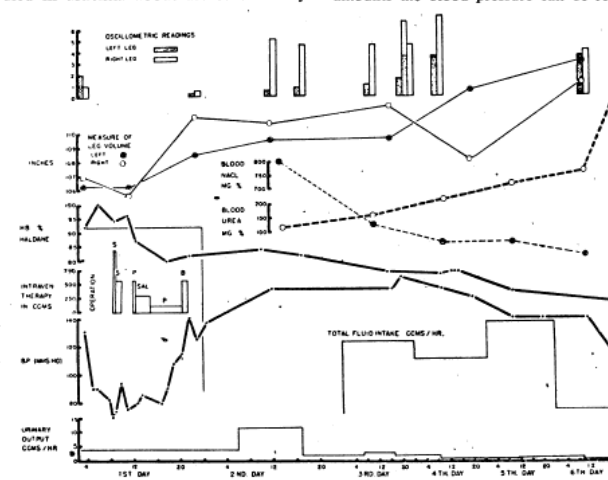
BY  
E. G. L. BYWATERS,\* M.B., M.R.C.P.

In the heavy air raids on London in the autumn of 1940 we attended some patients who had been pinned for several hours underneath the debris of their own bombed houses. Shock was present, which responded adequately to transfusion: the limb which had been compressed was found to be swollen and sometimes pulseless. To our surprise these patients developed renal failure with casts in the scanty urine and died in uraemia about the seventh day.

This appeared to us at that time a new entity: it was described as such under the title of "Crush Injuries with Renal Impairment" (Beall *et al.*, 1941; Bywaters and Beall, 1941; Mayon-White and Solandt, 1941). Since then, however, we have discovered descriptions of it by German authors from the war of 1914-18. During that war Frankenthal (1916) and others directed attention to the local muscle damage, and it was not until later that the renal lesion was adequately emphasized (Minami,\* 1923). The condition had actually

occurred in 1909 in people buried beneath the debris of the Messina earthquake, but as the relief expedition arrived on the scene a fortnight after the eruption, only the survivors with gangrene of soft parts were seen (von Colmers, 1909).

Apart from German books on military surgery, we have found no other references to it and no further records of cases. This is curious, since, even apart from the almost continuous warfare since 1918 somewhere in the world; such accidents do occur in the mining industry and have recently been described (McClelland, 1941). Since the first few cases in air-raid casualties were published the condition has been generally recognized here. Hospitals in the Emergency Hospitals Scheme of the Ministry of Health have been asked to notify cases to the Medical Research Council, which now has records of over 70 cases. It is on this group, through the kindness of



Buried 6 hours. Note from above down:

(1) Return of circulation to legs as measured by oscillometer readings.

(2) Increase in leg volume measured by spiral bandage.

(3) Haemoconcentration and later haemodilution shown by haemoglobin level.

(4) Blood-pressure fall and restoration after transfusion.

(5) Decreased urine output with rising blood urea. Urine contained pigment granules and casts and failed to concentrate urea above 670 mg./100 c.c.m.

Necropsy showed blanching and necrosis of muscle in both legs and a typical swollen kidney.

the M.R.C. and its observers throughout the country, that the following observations are based. About 5% of air-raid casualties in an urban area may be of this type.

#### Clinical Description

The patient has usually been pinned by the limbs beneath heavy beams or pieces of masonry for a period of several hours. If seen soon after release from this compression he generally appears comparatively well, apart from other coincidental wounds, fractures, etc. Soon, however, he enters the first phase of shock, due to loss of plasma through the damaged capillary walls into the extravascular tissue spaces of the affected limb, which becomes swollen (see Chart). As a consequence, the haemoglobin and corpuscular content of the blood rises relative to the plasma, and vasoconstriction occurs to compensate for the decrease in circulating blood volume. During this first phase the skin is pale, cold, and moist, but the blood pressure is maintained at a nearly normal level. Later, however, vasoconstriction may become unable further to compensate for this leakage of plasma into the damaged area; the blood pressure then falls rapidly. This is the second phase of shock. If fluids such as serum, citrated plasma (plain or recalcified), and blood are given intravenously at this stage in adequate amounts the blood pressure can be restored to normal levels.

This is the phase of recovery from shock. There may, however, be failure to respond to intravenous protein-containing fluids if the blood pressure has been allowed to remain at too low a level—below 60 mm. Hg—for too long a time.

Thereafter the general condition of the patient causes no anxiety until the first or second urine passed is noted to be bloody and to contain a pigment in solution similar in many ways to haemoglobin and giving a positive reaction to the benzidine peroxidase test. The urine also contains albumin, creatine, pigmented granular casts, and sometimes pigmented granules somewhat resembling erythrocytes; it is highly acid (pH 4.6 to 6.0).

The daily output of urine may become very small despite an adequate fluid intake, but the pigment disappears as a rule after the second day.

Meanwhile, however, the damaged limb has swollen, is hard, tense, and cannot be indented. This swelling is usually progressive for the first four or five days, except possibly in cases associated with blood-vessel damage. The skin shows small petechial haemorrhages, erythematous wheals, and large blisters, related to the areas of direct contact pressure. These blisters are often thought to be the result of burns. They are not. They may occur in crops, related in time to the return of circulation to the damaged part. There is anaesthesia of the limb, often of a patchy distribution due to damage of the terminal nerve fibres, and sometimes of a nerve-trunk distribution. Paralysis, which may be of any severity, is usually present; in many cases arterial pulsation in the peripheral part of the limb is absent, the limb is cold and pale, and

\* Beit Memorial Fellow.

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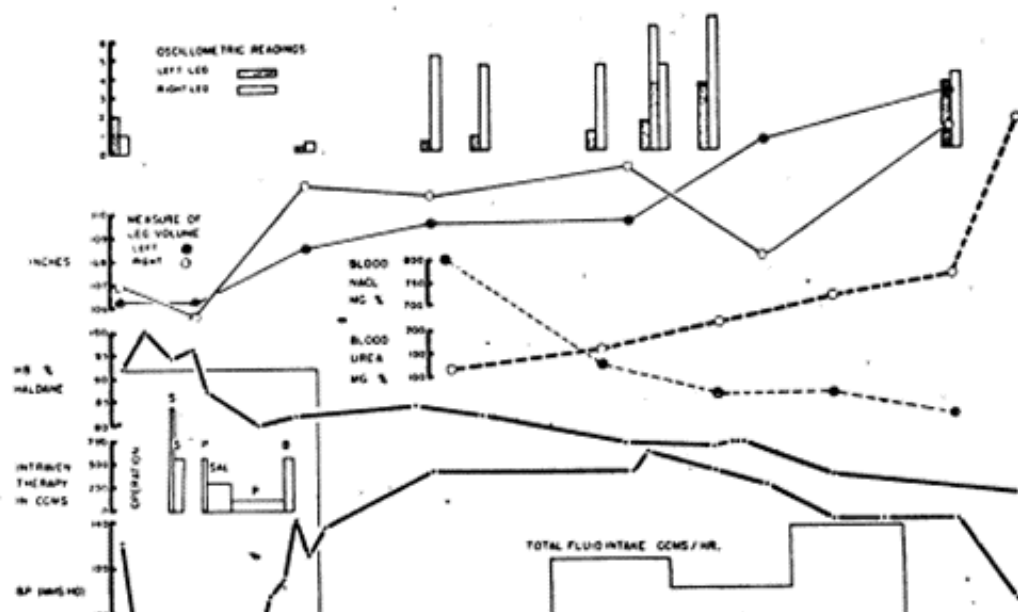
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Thereafter the general condition of the patient causes no anxiety until the first or second urine passed is noted to be bloody and to contain a pigment in



## THE CRUSH SYNDROME IN COAL MINERS

G. BENTLEY, OXFORD, and T. E. JEFFREYS, OSWESTRY, ENGLAND

*From the War Memorial Hospital, Wrexham, North Wales*

In 1941 Bywaters and Beall described a syndrome found in sixteen civilian victims of the aerial bombardment of London. The condition was described thus: " The patient has been buried for several hours with pressure on a limb. On admission he looks good except for swelling of the limb, some local anaesthesia and whealing. The haemoglobin, however, is raised, and a few hours later, despite vasoconstriction, made manifest by pallor, coldness and sweating, the blood pressure falls. This is restored to pre-shock level by (often multiple) transfusions of serum, plasma or, occasionally, blood. Anxiety may now arise concerning the circulation of the injured limb, which may show diminution of arterial pulsation distally, accompanied by all the changes of incipient gangrene. Signs of renal damage soon appear, and progress, even though the crushed limb be amputated. The urinary output, initially small, owing perhaps to the severity of the shock, diminishes further. The urine contains albumen and many dark brown or black granular casts. These later decrease in number. The patient is alternately drowsy and anxiously aware of the severity of his illness. Slight generalised oedema, thirst and incessant vomiting develop, and the blood pressure often remains slightly raised. The blood urea and potassium, raised at an early stage, become progressively higher and death occurs comparatively suddenly, frequently within a week. Necropsy reveals necrosis of muscle and, in the renal tubules, degenerative changes and casts containing brown pigment."

# Epidemiyoloji

## Travma Dışı

- Sert bir yüzeyde >1 saat immobil kalmak
  - İlaç ya da alkol intoksikasyonu
  - Karbon monoksit entoksikasyonu
  - Serebrovasküler olay
  - Kafa travması ve bilinç kaybı
  - Yaşlı, kalça kırığı olan hasta
  - Cerrahi sırasında hastaya uygun pozisyon verilememesi
  - Darp
  - MAST giysisi

## Travma

- Deprem
- Bina çökmesi
- Bomba patlaması
- Toprak kayması
- İnşaat kazaları
- Maden kazaları

# Etiyoloji

- Kırıklar
- Crush yaralanma
- Arter hasarı
  - Post iskemik ödem: İskemi ile birlikte hücre bütünlüğünün bozulması
  - Reperfüzyon hasarı
- Yanıklar



# Patofizyoloji

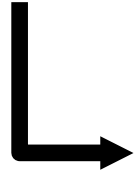
- Direkt olarak iskemiye bağlı değildir
- Kas sarkolemmasının gerilmesi ana nedendir
- Sarkolemma geçirgenliği artar
- Sodyum, su ve ekstrasellüler kalsiyum hücre içine girer
- Hücre şişer, hücre içi kalsiyum artar
- Hücresel fonksiyonlar ve solunum bozulur
- ATP üretimi azalır
- Kas ölür

# Patofizyoloji

- Ortaya çıkan kas şişmesi erken ya da geç dönemde kompartman sendromuna neden olur
- Kas hücrelerinin ölümü sonrası hücre içi metabolitlerin sistemik dolaşıma girmesi ile reperfüzyon hasarı oluşur
- Ortaya çıkan süperoksit anyon yani serbest radikaller hücre zarını daha da hasara uğratar
- Reperfüzyon hasarı sıkışan vücut kısmı serbestlendikten sonra klinik olarak ortaya çıkar

Lokal Kan Akımı =  $P_a - P_v / R$  (A-V Gradient)

Artmış kompartman basıncı



Artmış venöz basınç



Azalmış kan akımı

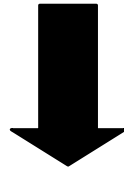


Azalmış perfüzyon

Kasta artmış şişlik



Geçirgenlikte artış



Artmış kompartman basıncı

# Kompartman Sendromu

- Kapalı bir osteofasial alanda hidrostatik basınç artışı ile ortaya çıkan kas ve sinir dokusu hipoperfüzyonu
- Normal kompartman basıncı  $< 15$  mmHg
- $> 30$  mmHg basınç kasta iskemi yapar
- Basınç sürekli bu değerin üstünde kalır ise fasyotomi gereği vardır
  - Geri dönüşsüz kas hasarı 6 saatte
  - Geri dönüşsüz sinir hasarı 4 saatte



# Doku Basıncı

- Normal kas içi basıncı
  - 0-4 mmHg
  - 8-10 mmHg (kas kasıldığında)
- Basınç artışı teorisi
  - 30 mm Hg (Mubarak)
  - 45 mm Hg (Matsen)
- Basınç gradienti teorisi
  - Diastolik basınca göre değerlendirme ( $< 20$  mm Hg -  $<30$  mm Hg )



# İskemi

## Kas İskemisi

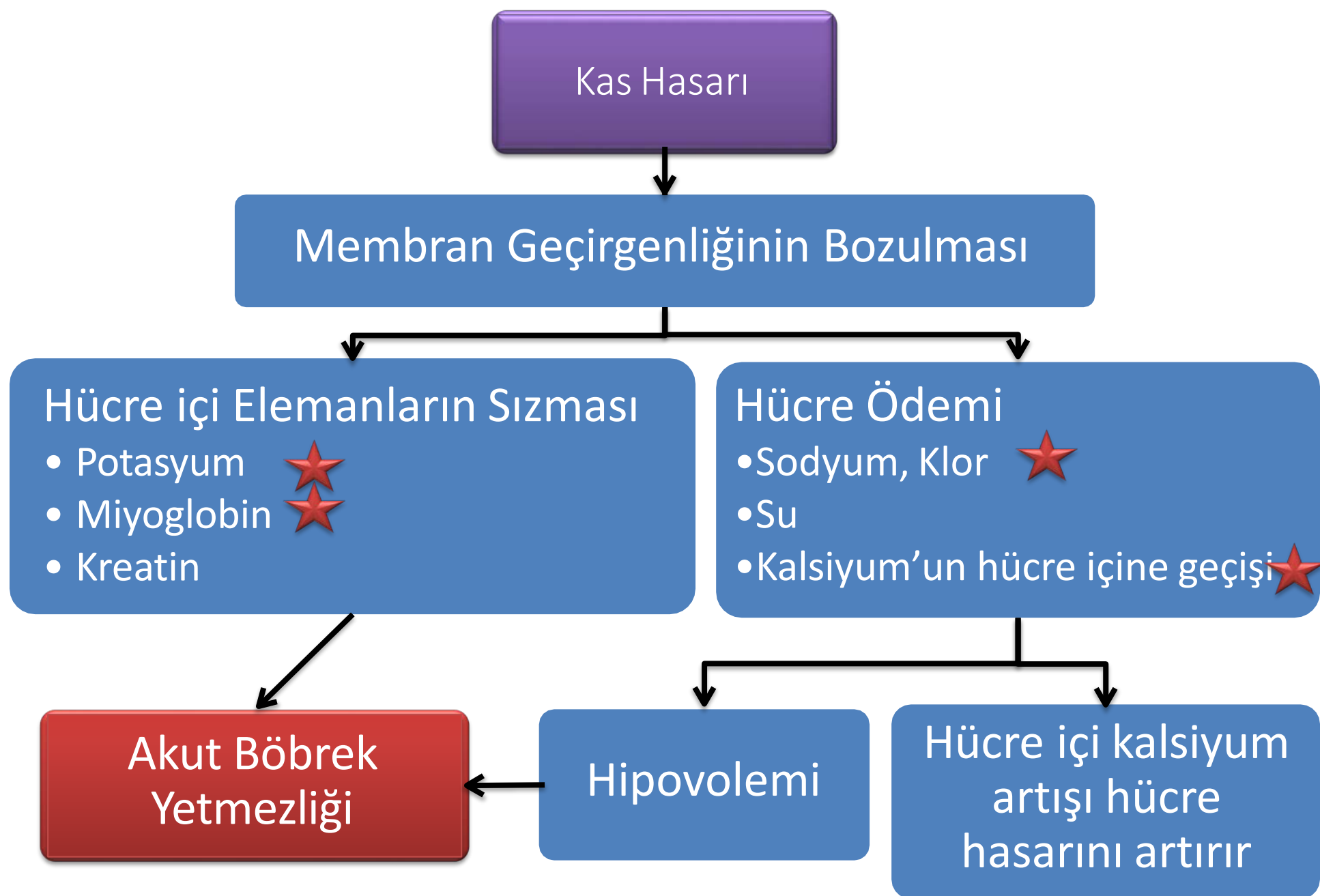
- 4 saatten sonra miyoglobinüri
- Böbrek yetmezliği
- İdrar çıkışı yüksek tutulmalı
- İdrar alkali hale getirilmeli

## Sinir İskemisi

- İlk 1 saatte iletim normal
- 1- 4. saatler – nöropraksik hasar (reversibl)
- 8 saat - axonotmesis ve irreversibl hasar

# Eşlik Eden Diğer Tablolar

- Diğer ekstremitelerde kırık ve lacerasyonlar
- Abdomen sıkıştığında intraabdominal organ yaralanmaları
- Toraksın sıkıştığı durumlarda travmatik asfiksi
- Toz inhalasyonu, duman inhalasyonu
- Yanıklar
- Karbon monoksit zehirlenmesi
- Hipotermi ve hipertermi



# Ana Bozukluklar

- Hipovolemi : Zarar görmüş kas içine sıvı sekestrasyonu
- Hiperkalemi
- Hipokalsemi: Kalsiyum kas dokusu içinde birikir
- Hiperfosfatemi
- Metabolik asidoz
- Miyoglobinemiyi / miyoglobininüri



# Sıvı Desteği

- Herhangi bir ekstremiteye ulaşıldığında hemen sıvı infüzyonuna başlanmalıdır.
  - 0.9 %'luk izotonik sodyum solüsyonu tercih edilir
  - Ringer laktat 4 mEq/lit potasyum içerdiğinden hiperkalsemiyi kötüleştirir
  - Ringer laktat kalsiyum içerir
  - Sıvı resusitasyonuna erken başlandığında, özellikle de yaralı sıkıştığı yerden çıkmadan başlandığında böbrek yetmezliği engellenebilir

# Önerilen IV Sıvı Miktarları

- Çocuklarda 20 cc/kg/saat
- Genç erişkinlerde saatte 1-1.5 lt/saat
- Erişkinlerde 10 cc/kg/saat
  - Olabildiğince erken idrar sondası konmalıdır
- Hedeflenen idrar çıkışı
  - Erişkinlerde > 50 cc/saat
  - Çocuklarda > 2 cc/ kg/saat

# Hiperkalemi

- Yaralı sıkıştığı yerden çıkarıldıktan hemen sonra ortaya çıkar
- Hızla ölüme neden olabilir
- Böbrek yetmezliğinden önce ortaya çıkar
- Belirgin kompartman sendromu belirti ve bulguları ortaya çıkmadan da gelişebilir
- Hastane öncesi acil tedavi gerektirebilir
- İntravenöz serum fizyolojik bolus olarak verilir
- 50-100 mEq IV  $\text{NaHCO}_3$  verilir
- Albuterol aerosol (2.5 mg/3 cc)
- Daha az etkili ve daha az pratik
  - IV dekstroz (25 gram) ve insulin (5 ünite IV)
  - PO kayeksalat
- Acil hemodializ gerekebilir

# Crush Sendromunda IV Bikarbonat Kullanımı

- Amaç idrarı alkali yapmaktır
  - Bolus olarak verilen serum fizyolojik solüsyonuna 50 mEq bikarbonat eklenir
  - 24 saatte 300 mEq verilebilir
  - %5 dekstroz solüsyonuna (1000 cc ) 150 mEq bikarbonat eklenerek bolus olarak gönderilir

# Crush Sendromunda Mannitol Kullanımı

- Miyoglobinin böbrekten elimine edilmesine yardım ederek böbrek yetmezliğini engelleyebilir
- Yeterince sıvı verilen ancak idrar çıkımı az olan ( $<2$  cc /kg/saat ) hastalarda ya da sıvı tedavisi başladıktan 4 saat sonra halen idrar çıkışı olmayan hastalarda idrar çıkışını arttırmak için kullanılır
- Serbest radikalleri bağlayarak kas nekrozunu sınırlayabilir
- Kalp üzerinde pozitif inotropik etkisi vardır
- **Hasar görmüş kas dokusundan sıvıyı mobilize ederek kompartmandaki sıvıyı azaltır ve fasyotomi gereksinimini azaltabilir**
- %20'lik mannitol solüsyonundan 0.25 g/kg IV, 10-30 dakikada verilir
- Diürez 15-30 dakikada başlamalıdır
- İdrar çıkışı mannitol sonrası düşer ise sıvı replasmanı şarttır
- Günlük maksimum doz 2 g/kg dır

# Tanı

## Klinik

- Şüphe etmek
- Öykü
- Fizik inceleme

## Klasik 5 P????

- Pain (ağrı)\*\*\*
- Pallor (solukluk)
- Paralysis (paralizi)
- Pulselessness (atım alamama)
- Paresthesias (parestezi)

# Fasyotomi Zamanlaması

- Rutin geç fasyotominin yeri yoktur
- Yaralı yaralandıktan en geç 6 saat içerisinde kurtarılabilecek ve tedavi alabilecek ise olay yerinde fasyotomi anlamlıdır
- Ölçülen ilk basınçlar normal iken daha sonra yükselir ise fasyotomi gereği vardır
- Kompartman basıncı hastanın diastolik kan basıncından 20 mmH düşük olduğunda fasyotomi düşünülmelidir
- Hasta hipotansif ise, düşük kompartman basınçlarında da belirgin iskemi oluşabilir



# Diğer Yapılabilecekler

- Yaralıya oksijen verilmesi
- Ağrının kesilmesi
- Tetanoz ve enfeksiyon profilaksisi
- Diüretik verilmesi: Furosemid idrarı asit hale getirir!!!
- Asetazolamid verilmesi: İdrarı alkali hale getirir

# En sık görüldüğü yerler

- Bacak: Derin posterior ve anterior kompartmanlar
- Önkol: Volar kompartman özellikle de derin fleksor alan
- Derin kaslar her zaman daha çok etkilenir
- Kırığa yakın kaslar her zaman daha çok etkilenir

# Tedavi

- Akut kompartman sendromunun tek etkili tedavisi fasyotomidir



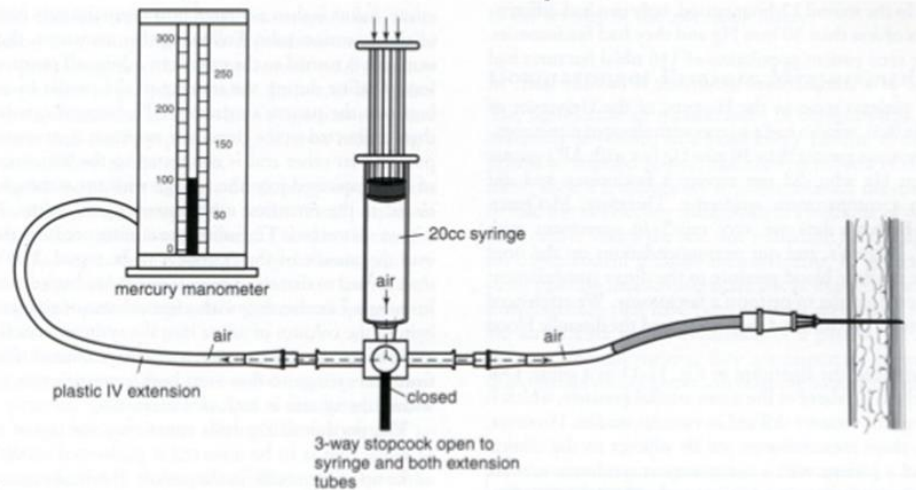
# Ekstremitelerde kompartmanlar

- Kol: 2
- Önkol: 4
- El: 4
- Uyluk: 3
- Bacak: 4
- Ayak: 9



# Kompartman Basıncının Ölçülmesi

## Whiteside Technique



## Measurement of Compartment pressures

### • Devices



Stryker hand-held system



Stryker slit catheter

# Etkilenen Sinirler

## Üst Ekstremité

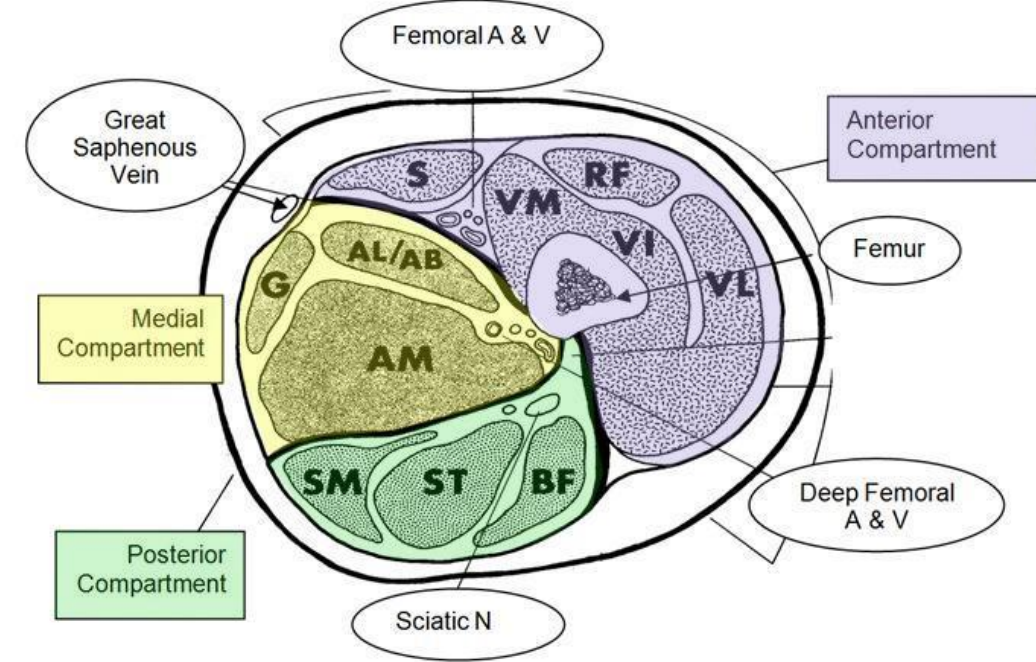
- Kol
  - Anterior: N.ulnaris, N.medianus
  - Posterior: N.radialis
- Önkol
  - Derin ve yüzeysel volar: N.ulnaris, N.medianus
  - Dorsal: N.radialis

## Alt ekstremité

- Uyluk
  - Anterior: N.femoralis, N.saphenous
  - Posterior: N.ischiadicus
  - Medial: N.Obturatorius
- Bacak
  - Anterior: N.peroneus profundus
  - Lateral: N.peroneous superficialis
  - Posterior derin: N.tibialis
  - Posterior yüzeysel: -



# Uyluk Kompartmanları ve Fasyotomi

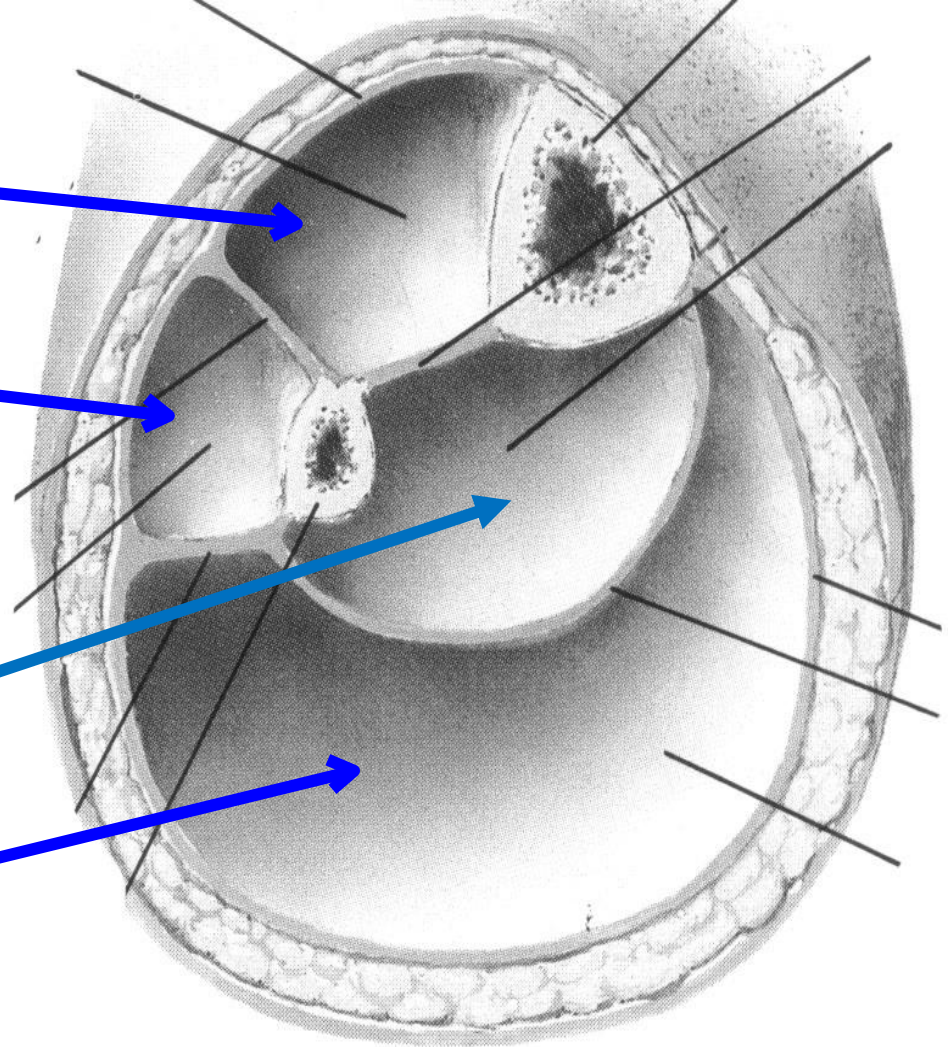


Genelde femur kırığı eşlik eder  
Quadriceps ve Hamstring kasları etkilendiği için tek bir lateral kesi yeterli olacaktır

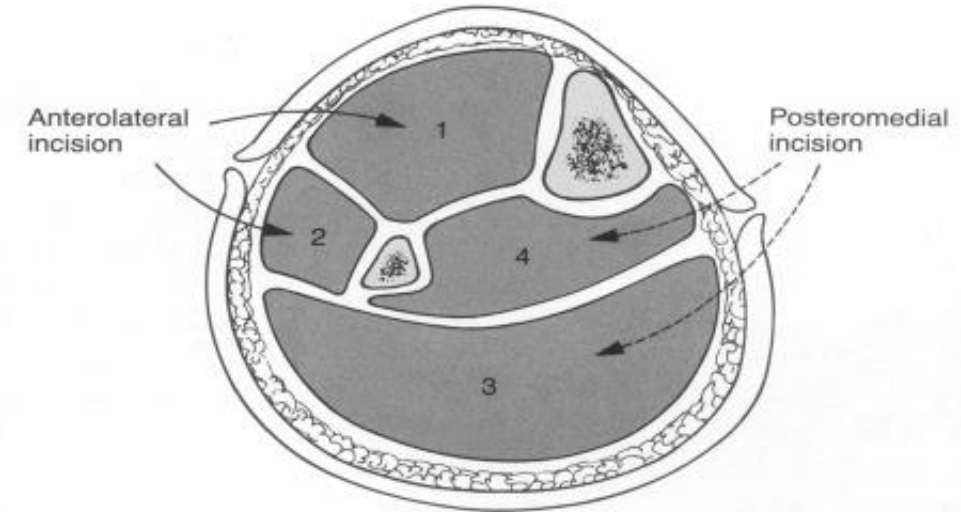
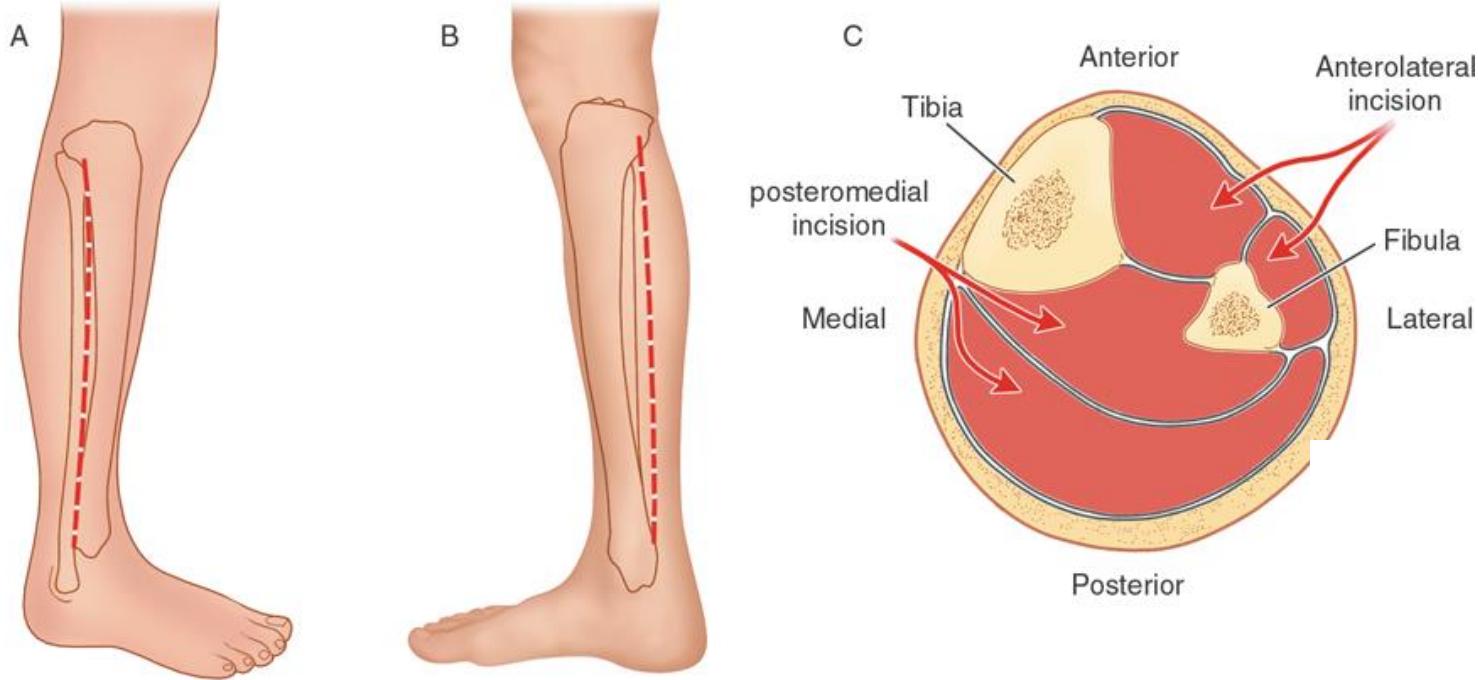


# Bacak Kompartmanları

- Anterior
- Lateral
- Posterior
  - Derin
  - Yüzeyel

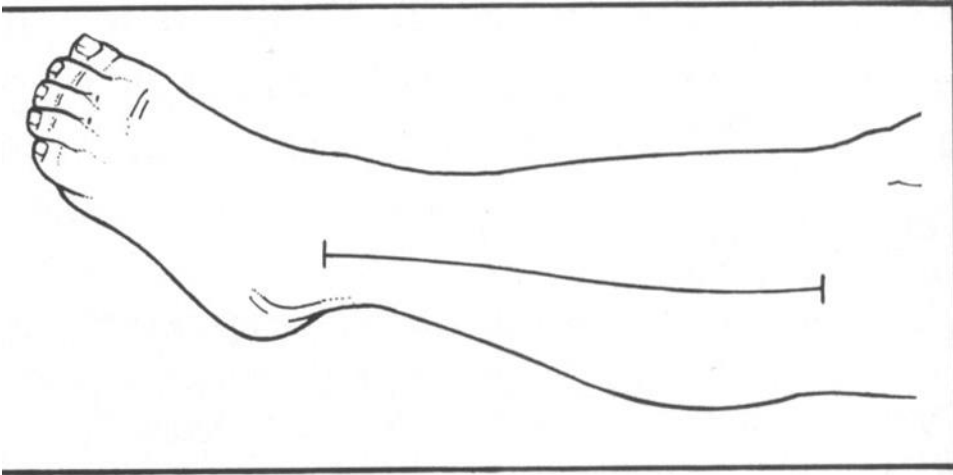


# Her 4 kompartmana ulaşılmalıdır

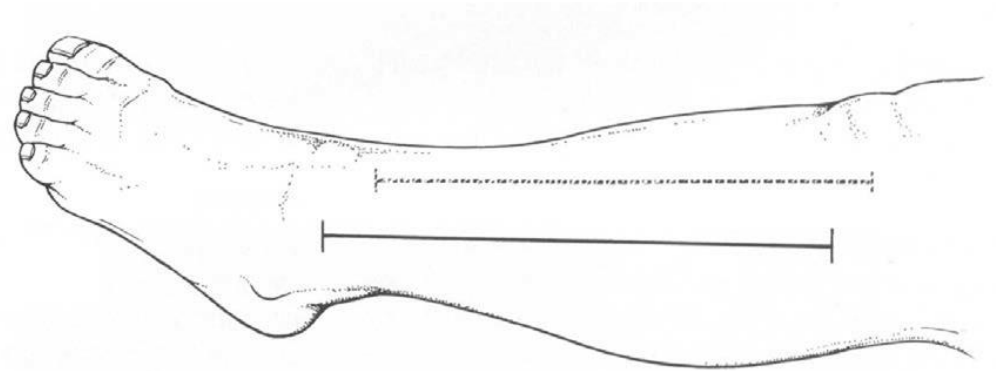


# Fasyotomi

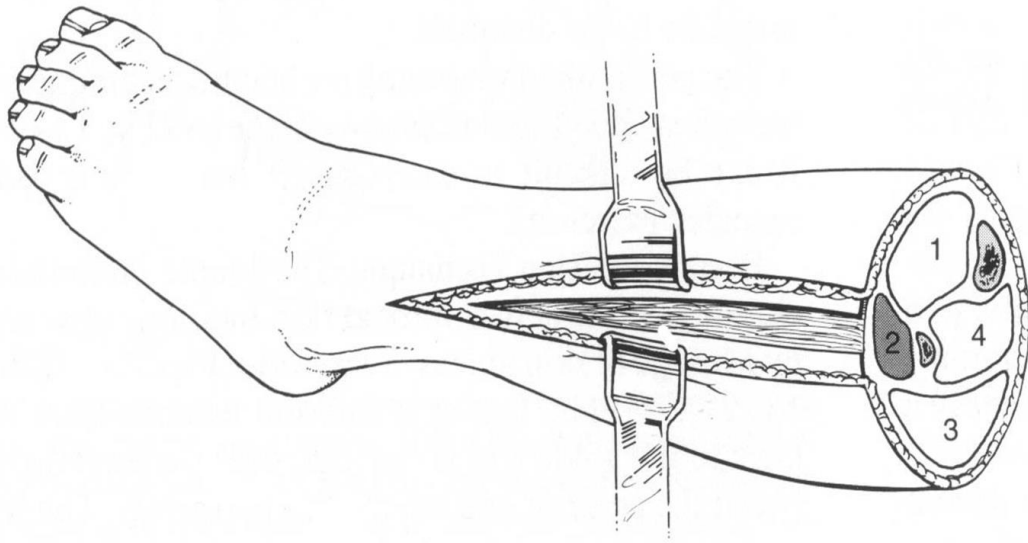
**Tek insizyon ile ( $\pm$  fibulektomi)**



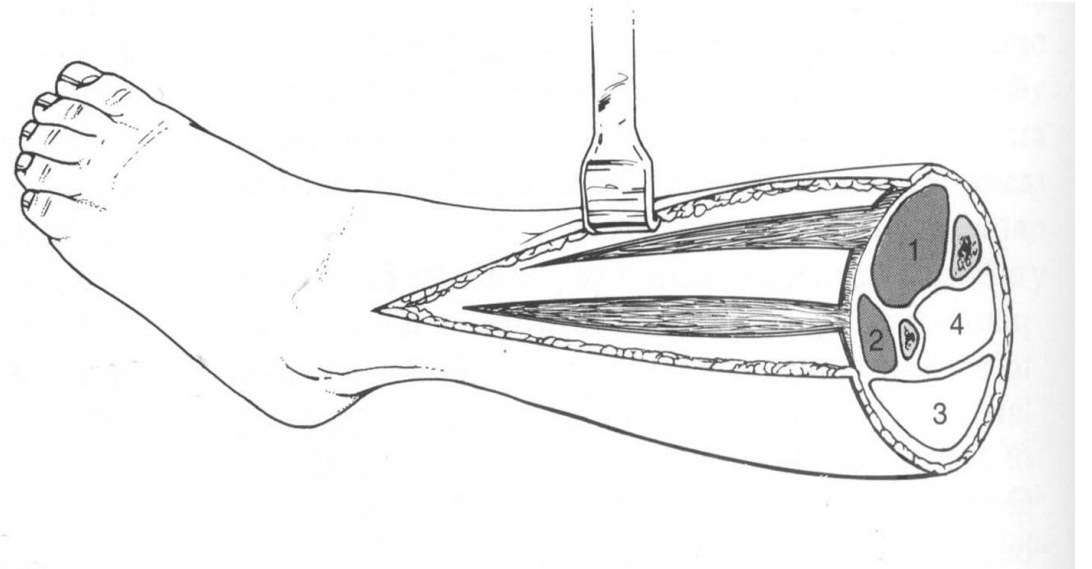
**Çift insizyon ile**



## Lateral kompartman



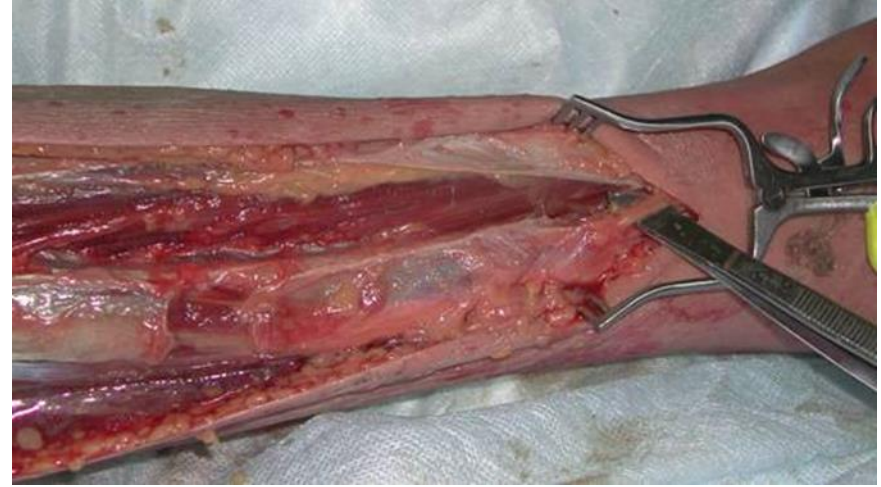
## Anterior kompartman





# Çift İnsizyon

- Her iki vertikal kesinin arasında en az 8 cm lik bir cilt köprüsü bulunmalıdır
- Anterolateral İnsizyon: Dizden ayak bileğine kadar , anterior ve lateral kompartmanlar arasından yapılır



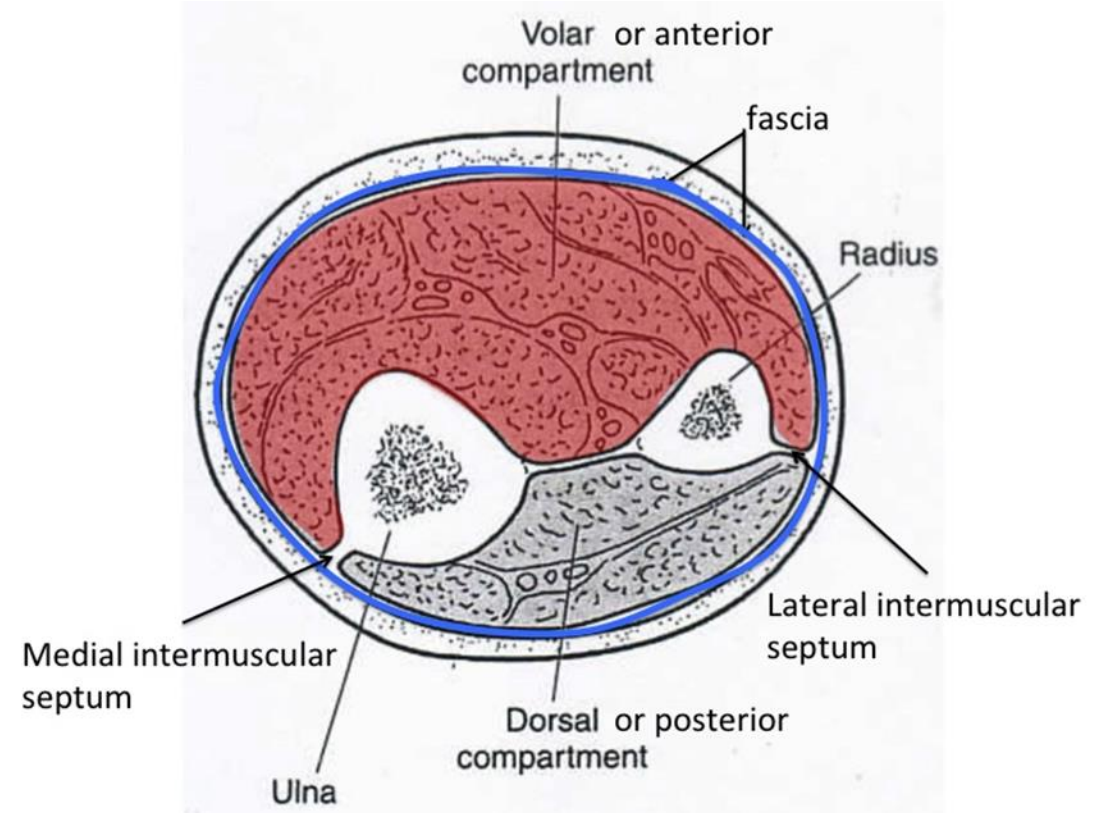
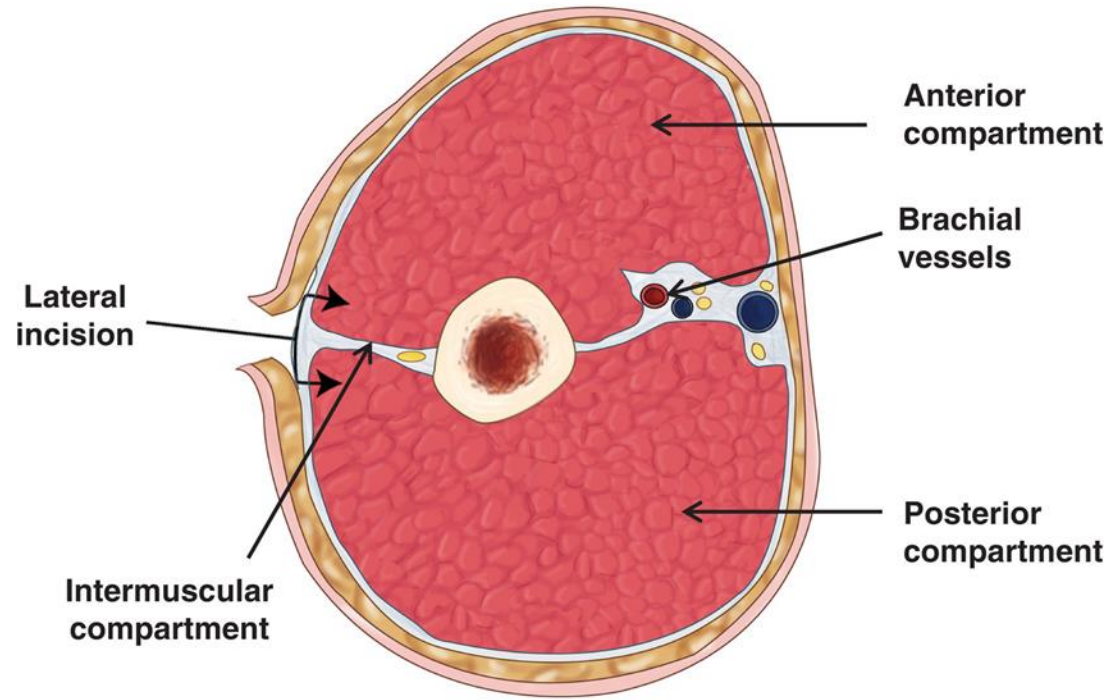
# Çift İnsizyon

- Posteromedial İnsizyon: Tibianın posteromedial sınırının 1-2 cm arkasından yapılmalıdır
- Derin posterior kompartmanı dekomprese edebilmek için soleus kası ayrılmalıdır

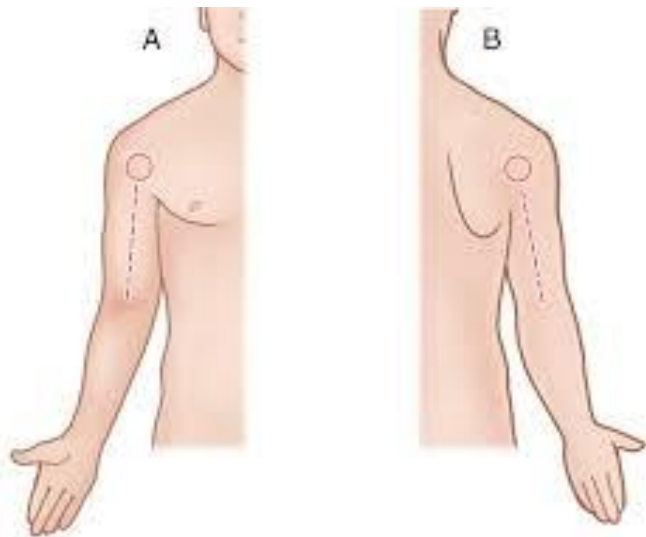


# Kol ve Önkolun Kompartmanları

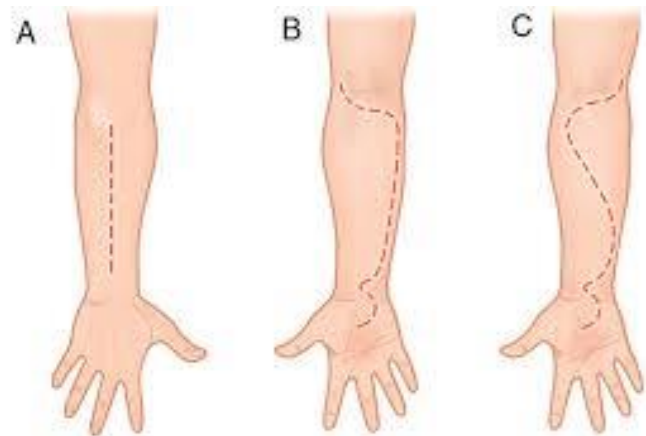
(b)







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# Fasyotomi Sonrasında

- Kemik stabilize edilmelidir
- 48 saat sonra tekrar debride edilmelidir
- Xeroform, negatif basınçlı tedavi uygulanabilir
- Fasyotomiden 3-7 gün sonra cilt kapatılmalı ya da greftlenmelidir
- Ekstremité elevasyonu gereklidir



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## Acute compartment syndrome



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Perfusion pressure

### ABSTRACT

Acute compartment syndrome is a well-known complication of tibial fractures, yet it remains difficult to diagnose and the only effective treatment is surgical fasciotomy. Delayed fasciotomy is the most important factor contributing to poor outcomes, and as a result, treatment is biased towards performing early fasciotomy. Current diagnosis of ACS is based on clinical findings and intramuscular pressure (IMP) measurement, and is targeted at identifying safe thresholds for when fasciotomy can be avoided. Since clinical findings are variable and difficult to quantify, measurement of IMP – ideally continuously – is the cornerstone of surgical decision – making. Numerous investigators are searching for less invasive and more direct measurements of tissue ischemia, including measurement of oxygenation, biomarkers, and even neurologic monitoring. This article provides a brief but thorough review of the current state of the art in compartment syndrome diagnosis and treatment.

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**Table 1**

Summary of the reported incidence of acute compartment syndrome related to various patterns and mechanism of injury and presence of clinical examination findings.

Risk Factor/Clinical Finding	Risk of CS
<b>Fracture Pattern</b>	
Segmental tibia Fracture	48% [6]
Bicondylar Tibial Plateau Fracture	18% [7]
Medial Knee Fracture-Dislocation	53% [7]
<b>Mechanism of Injury</b>	
Tibia fracture during sport	20% [5]
Soccer	55% [9]
Football	27% [9]
Ballistic Injury Proximal-third tibia or fibula	21% [8]
<b>Clinical Exam Findings</b> (pain, paresthesias, pain with passive stretch, paresis) [17]	
<i>One clinical finding</i>	
Pain	25%
Paresthesias	26%
Pain with passive stretch	25%
Paresis	19%
<i>Two clinical findings</i>	
Pain and pain with passive stretch	68%
<i>Three clinical findings</i>	
Pain, pain with passive stretch, paresis	93%
<i>All four clinical findings</i>	98%

## Predicting Acute Compartment Syndrome (PACS): The Role of Continuous Monitoring

*Andrew H. Schmidt, MD,\* Michael J. Bosse, MD,† Katherine P. Frey, RN, MPH,‡  
Robert V. O'Toole, MD,§ Daniel J. Stinner, MD,||¶ Daniel O. Scharfstein, ScD,\*\*  
Vadim Zipunnikov, PhD,\*\* Ellen J. MacKenzie, PhD,‡ and METRC*

- Kan basıncının ölçülmesi
- Ağrı şiddetinin ölçülmesi
- Nabız, pasif germe ile ağrı, kas gücü, duyu muayenesi (her 4 saatte bir)
- Günlük kreatinin fosfokinaz ölçümü
- Kas içi basınç ve doku oksijenizasyonunun sürekli olarak monitorize edilmesi

# Daha az invaziv daha direkt tanı yöntemleri

- Near-infrared spektroskopi
- pH ölçümü
  - pH'nın sürekli ölçümü
- Biomarkerlar
  - İntramüsküler glukoz düzeyi

Surgical management of closed crush injury-induced compartment syndrome after earthquakes in resource-scarce settings

Martin Gerdin, Andreas Wladis, MD, PhD, and Johan von Schreeb, MD, PhD, Stockholm, Sweden

TABLE 3. Treatment Suggestions for Closed Crush-Induced Compartment Syndrome After Earthquakes in Resource-Scarce Settings

Treatment Option	Time After Extraction (h)		
	0–6	6–12	[mt]12
Mannitol <sup>a</sup>	++	++	++
Fasciotomy <sup>b</sup>	++	+	[minus]
Amputation <sup>c</sup>	[minus]	[minus]	[minus]

++, may be applied; +, apply carefully; and [minus], do not apply.

<sup>a</sup> Contraindicated in oligouric and anuric patients and patients with ARF. Give at a dose of 1-2 g/kg body weight over 4 h as 20% infusion. Maximum daily dose is 200 g.

<sup>b</sup> Take into consideration the growing literature stating that there is no place at all for fasciotomy in closed crush-induced compartment syndrome.

<sup>c</sup> Apply only as a last resort.

Fasciotomy

Fasciotomy is the conventional surgical intervention for compartment syndrome and decompresses the compartment by incisions through the skin and fascia.<sup>11,12</sup> We found that the use of fasciotomy in closed crush-induced compartment syndrome after earthquakes is controversial,<sup>8</sup> mainly because of the increased risk for infection when a closed injury is turned into an open wound.<sup>10,13</sup> Sepsis and death have been reported as complications of fasciotomy.<sup>7,16,17</sup> In nine reviews, fasciotomy is recommended after closed crush injury-induced compartment syndrome.<sup>11–13,15–20</sup> In five of these nine reviews, a distinction is made between early and late fasciotomy.<sup>8,11,13,15,17,20</sup> The definition of “late” ranges between 6 to 12 hours after extrication. In these five reviews, early fasciotomy is recommended, whereas late fasciotomy is advised against as muscle and nerve damage would be too extensive to be reversed.

In one review,<sup>7</sup> a difference in pathophysiology between crush-induced and ischemia-induced compartment syndrome is described (Text box 1). The difference would be that in ischemia-induced compartment syndrome, the raised compartment pressure is the cause of muscle death. In contrast, in crush-induced compartment syndrome, the muscle necrosis causes the raised compartment pressure. On the basis of this difference that review concludes that there is no place for fasciotomy in crush-induced compartment syndrome because the muscle is already dead.



# Komplikasyonlar

- Kronik şişlik
- Kronik ağrı
- Kontraktür
- Kas güçsüzlüğü
- Sinir hasarı
- Ampütasyon
- Kozmetik sorunlar





