

CASE REPORTS / OPIS PRZYPADKÓW

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## **ACUTE COMPARTMENT SYNDROME AFTER INTRAMEDULLARY NAILING OF TIBIAL SHAFT FRACTURE. THREE CASE REPORTS**

### **OSTRY ZESPÓŁ CIASNOTY PRZEDZIAŁÓW POWIĘZIOWYCH PO ZESPOLENIU ZŁAMANIA TRZONU KOŚCI PISZCZELOWEJ. OPIS TRZECH PRZYPADKÓW**

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#### **S u m m a r y**

Acute compartment syndrome (ACS) is an urgent state in orthopedic surgery, which most often occurs secondarily to tibial shaft fracture. Delayed diagnosis of ACS can lead to very serious complications, including limb inefficiency or amputation. The diagnosis of ACS is based on characteristic clinical signs, like pain, paresthesia, pallor, paralysis, pulselessness, and poikilothermia. In patients with distorted logic contact diagnosis may be difficult and introduction of intercompartmental pressure measurement into diagnostic process may be useful. In this article three clinical cases of acute compartment syndrome after tibial diaphyseal fracture

treated with intramedullary reamed locking nail from Department of Trauma and Orthopedic Surgery will be presented. Profile of those patients fully corresponds to characteristic of patients that are most at risk for this type of complication. All patients were treated with urgent fasciotomy. Additionally, in treatment of wounds after fasciotomy also negative pressure wound therapy system and hyperbaric oxygen therapy were used. The final outcome of patients' treatment correlates with time elapsed since the onset of symptoms.

#### **S t r e s z c z e n i e**

Ostry zespół ciasnoty przedziałów powięziowych (ZCPP) jest uznawany za stan nagły w ortopedii, który najczęściej rozwija się wtórnie do złamań trzonu kości piszczelowej. Opóźnione rozpoznanie ZCPP prowadzić może do poważnych powikłań, jak znaczne obniżenie sprawności kończyny, czy nawet jej amputację.

Najważniejszą rolę w diagnostyce ZCPP odgrywa badanie kliniczne w oparciu o charakterystyczne objawy, takie jak ból, zaburzenia czucia, bledność, porażenie, zanik tętna i poikilotermia.

Rozpoznanie ZCPP na podstawie objawów klinicznych może być utrudnione u chorych z ograniczonym kontaktem logicznym. W takich przypadkach włączenie pomiaru ciśnienia wewnątrz przedziałów powięziowych do procesu diagnostycznego może być pomocne.

W poniższym artykule opisane zostały trzy przypadki kliniczne ostrego zespołu przedziałów powięziowych po złamaniu trzonu piszczeli leczonego zespoleniem blokowanym gwoździem śródszpikowym z Oddziału Chirurgii Urazowo-Ortopedycznej. Profil opisanych chorych w pełni odpowiada charakterystyce pacjentów najbardziej narażonych na wystąpienie tego powikłania. Wszyscy chorzy po rozpoznaniu ostrego zespołu przedziałów powięziowych poddani byli pilnej fascjotomii. Pomocniczo w leczeniu ran po fascjotomii stosowano system opatrunków podciśnieniowych i terapię tlenem hiperbarycznym. Ostateczny wynik leczenia prezentowanych pacjentów w istotny sposób korelował z czasem od wystąpienia pierwszych objawów zespołu ciasnoty przedziałów powięziowych do wykonania fascjotomii.

**Key words:** compartment syndrome, intercompartmental pressure, tibial diaphyseal fracture, fasciotomy

**Słowa kluczowe:** zespół ciasnoty przedziałów powięziowych, ciśnienie wewnątrz przedziału powięziowego, złamania trzonu piszczeli, fascjotomia

## INTRODUCTION

Acute compartment syndrome (ACS) is a rare, but very serious urgent state in orthopedic surgery. It is caused by swelling of soft tissues closed in non-adaptable compartment surrounded by fascia. As the swelling increases, blood vessels become compromised causing insufficient blood supply to muscles and nerves. ACS may develop both as a complication of various fractures and soft tissues trauma. Clinically it is generally presented by a severe pain and paresthesia that can be sometimes difficult to interpret. The only effective treatment of acute compartment syndrome is an early surgical decompression of affected compartments. In case of late diagnosis and delay of adequate treatment serious complications may occur. If the diagnosis is late, ischemia causes permanent muscular and neurological damage.

The article is a presentation and analysis of three clinical cases of acute compartment syndrome.

### Case 1

A 20-year old male was admitted to the Department of Trauma and Orthopedic Surgery in Copernicus Hospital with a fracture of both bones of left lower leg sustained in a fall while practicing gymnastics. Day after admission surgical procedure was performed—closed reduction, internal fixation with use of intramedullary reamed nail. The perioperative period was uneventful. Day after surgery patient reported increasing pain at fracture level unresponding to painkillers and paresthesia on dorsal surface of his left foot. After medical examination fasciotomy of left lower leg through medial and lateral approach (all four compartments were released) was performed. The wound was managed with a negative pressure wound therapy system. Antibiotic therapy was implemented. After fasciotomy patient reported a significant reduction of pain and paresthesia. 2 days after intervention hyperbaric oxygen therapy was introduced. The wound was revised every second day with change of negative pressure wound dressing. As the swelling decreased, the wound was gradually closed until 13<sup>th</sup> day after fasciotomy, when residual skin loss was covered with a free skin graft, closing the wound completely. After the last surgery the patient was hospitalized for another 7 days, still continuing hyperbaric oxygen therapy. On 22<sup>nd</sup> day after first surgery he was released from our department. At the

end of hospitalization he was able to walk with crutches without any neurological deficit within his left leg.



Fig. 1. 6 days after fasciotomy-wound tissue swelling and skin tension did not allow to close the wound. Stitches approaching edges of the wound were founded. Lateral side view

Ryc. 1. 6 dni po fascjotomii obrzęk tkanek miękkich i napięcie skóry nie pozwoliły na zamknięcie rany. Założono szwy zbliżające brzoży rany. Widok od strony bocznej



Fig. 2. Medial side

Ryc. 2. Widok od strony przyśrodkowej

During follow up the patient was making a good rehabilitation progress and did not report any neurological deficits. 8 months after surgery flexion contracture and arthrosis of IP joint of hallux and DIP joints of II and III toes were noticed. Patient returned to work. 1.5 year after fasciotomy contractures of DIP II, III withdrew after rehabilitation, contracture of hallux was treated with arthrodesis.

### Case 2

A 27-year old male was admitted to the Department of Trauma and Orthopedic Surgery in Copernicus Hospital with a fracture of both bones of left lower leg

sustained in a traffic accident. During traffic accident patient also suffered chest, abdominal and cranial injuries. He was surgically consulted in emergency department and did not require any further treatment apart from osteosynthesis. At the time of admission, skeletal traction was implemented. 2 days after admission closed reduction and internal fixation with use of intramedullary reamed tibial nail was performed. On the day of surgery patient did not report any complaints. In the morning after surgery patient reported increasing pain in the area of fracture and paresthesia in the area of innervation of deep peroneal nerve. Compartmental pressure was measured with a use of arterial line manometer with a result of 37mmHg. Urgent fasciotomy was performed through lateral approach, releasing anterior and lateral compartment of lower leg. The wound was protected with a negative pressure wound therapy system. At the day of surgery patient reported a significant pain relief. Paresthesia on the dorsal surface of left foot were still present. The wound was inspected every second day during change of VAC dressing and partial wound closure as swelling decreased. 9 days after fasciotomy the wound was closed. The patient was able to walk with crutches. 11 days after fasciotomy he was released from hospital with no pain and little paresthesia of dorsal surface of his left foot.

Follow up and rehabilitation was continued for a year after surgery, until complete bone union was confirmed. At the end of treatment patient still had little persistent paresthesia on dorsal surface of his left foot.

### Case 3

A 24-year old male was admitted to Department of Trauma and Orthopedic Surgery in Copernicus Hospital with an open (Gustilo Andersson I) fracture of both bones of right lower leg sustained as a result of a fall (circumstances unknown-patient under influence of alcohol). At admission the wound was disinfected, antibiotic therapy and skeletal traction were introduced. Two days after admission closed reduction and internal fixation with intramedullary tibial nail was performed. At the day of surgery the patient did not report any complaint. On the day after surgery swelling of lower leg increased. He reported pain at active movement, during palpation at the level of fracture and slight paresthesia on dorsal surface of right foot, denied pain at rest. Increased dose of low molecular weight

heparin, forced diuresis, and ice packs were introduced. 2 days after surgery the patient reported decrease of pain and paresthesia, with persistent massive swelling of right lower leg. 3 days after surgery, after verticalisation he reported increase of pain and paresthesia, and weakness of dorsiflexion of toes. Compartment pressure measurement was performed with result-36mmHg. Urgent fasciotomy was performed. Partial necrosis of anterior tibial muscle was noted intraoperatively. After the surgery pain level decreased, neurological state did not change. Hiperbaric oxygen therapy was introduced. The wound was inspected every second day with resection of necrotic tissue and VAC dressing change. With every revision of the wound part of necrotic muscles were resected. In summary-wound was revised 10 times. In last surgery description-“in anterior compartment of lower leg empty space filled with fibrin and partially preserved tendon of anterior tibial muscle”. The wound was closed 26 days after fasciotomy. The patient was released from hospital 40 days after admission. At the end of hospitalization he was able to walk with crutches with right foot fitted with orthosis because of drop foot.



Fig. 3. *First inspection of wound after fasciotomy-focal necrosis of muscles in anterior compartment is visible*

Ryc. 3. *Rana po fasciotomii przy pierwszej zmianie opatrunku VAC. Widoczna ogniskowa martwica mięśni przedziału przedniego podudzia*

Follow up continued until 6 months after surgery, when patient decided to return to work. After 6 months of rehabilitation he was able to walk without crutches, without falling foot, which was probably a result of partially efficient extensor muscles.



Fig. 4. *Ten days after fasciotomy-after partial resection of necrotic tissue*

Ryc. 4. *Dziesięć dni po fascjotomii-po usunięciu martwiczonych mięśni*



Fig. 5. *Eighteen days after fasciotomy-after partial wound closure*

Ryc. 5. *Osiemnaście dni po fascjotomii-po częściowym zamknięciu rany*

## DISCUSSION

Acute compartment syndrome can be caused by fractures or soft tissue injuries. Most commonly ACS is associated with tibial diaphyseal fracture (36%) [1], due to specific anatomy of lower leg compartments (strong muscles closed in stiff and inflexible fascias). This type of fracture is even more predisposed to this kind of complication after treatment with a reamed intramedullary nail(2)-as it happened in all three described cases. In the literature it is explained by increase of intercompartmental pressure during reaming of medullary canal. According to McQueen et al. [1], second cause of ACS is injury of soft tissue without a fracture, but it is definitely less common. When ACS appears, early diagnosis and urgent treatment implementation is very important. Delayed diagnose of ACS can lead to serious complications, including neurovascular disorders, limb amputation, or even multiorgan failure and septicemia [3]. Diagnosis is very difficult and based mostly on patients' subjective complaints. Many technological devices have been invented to help clinicians with early diagnosis, but still the clinical demonstrations remain

crucial(4). The most typical complaints are: a) Inproportional pain, unresponding to treatment with painkillers; b) Paresthesia related to nerve ischemia; c) Pallor and Poikilothermia; and late signs, that are not helpful in prevention of tissue morbidity, like: d) lack, or weak pulse on arteries located distally from fracture level, e) paralysis of affected nerves. The diagnose of ACS is even more difficult in intubated patients, the ones with limited logical contact or in altered sensorium. Devices able to measure intercompartmental pressure can be helpful in making the decision about the treatment, when clinical signs are not clear [5]. There is still lack of clear guidelines and algorithms about which measurement (absolute or related to haemodynamic parameters) [6] and level of pressure should be a standard level for fasciotomy. In most of available literature it is recommended to diagnose ACS on the basis of clinical signs and intercompartmental pressure should be used as additional support in certain situations [7], like: patients with tibial diaphyseal fracture, patients with high-energy tibial pilon and plateau fractures, young patients with high-energy forearm or femoral injuries, with or without an associated fracture, patients with soft tissue swelling suggestive of compartment syndrome, irrespective of age, gender or causality and patients at risk who are unable to co-operate with clinical assessment (e.g. patients with polytrauma, ventilated patients, children).

All our patients were young male, who suffered from ACS as a result of tibial diaphyseal fracture treated with an intramedullary nail-what fully coincides with major risk factors of ACS(1). First two cases were diagnosed early enough to prevent tissue necrosis. Time of diagnose strongly correlated with soft tissue damage and secondary complications (Table I). First two cases were diagnosed early enough to prevent important damage of muscles and nerves. In the third case-the diagnose was late probably due to incorrect interpretation of patients complaints. In such cases clinical signs have been increased by verticalisation of the patient. Intercompartmental pressure measuring with use of arterial line manometer was very usefull and helped us to confirm the diagnosis in cases, as clinical signs were not clear enough.

Also hyperbaric oxygen therapy had a very positive impact on patients' outcome. According to the literature, it is recommended to improve the wound healing and reduce swelling [8]. All our patients were

Table I. Correlation between time of surgery, time of fasciotomy, duration of hospitalization, and secondary complications

Tabela I. Zależność pomiędzy czasem wykonania zabiegu, czasem wykonania fascjotomii, czasem trwania hospitalizacji i wystąpieniem wtórnych powikłań

Patient	Time admission-surgery	Inercompartmental pressure measurement/blood pressure	Time surgery-fasciotomy	Time fasciotomy-wound closure	Time fasciotomy-release	Secondary complications
I	10 hours	-	24 hours	13 days	22 days	Hallux DIP contracture
II	38 hours	37 mmHg/ 140/70 mmHg	21 hours	9 days	11 days	Paresthesia-deep peroneal nerve
III	35 hours	36 mmHg/ 130/60 mmHg	21 hours	26 days	40 days	Anterior compartment muscles necrosis, falling foot, dysesthesia of deep peroneal nerve

treated with negative pressure wound therapy to improve wound healing conditions and prevent infection. It is proven that negative pressure wound therapy accelerates wound closure and healing [9] and can prevent regeneration of muscles to fiber tissue [10].

## CONCLUSIONS

Acute compartment syndrome is a rare complication but should be always considered in certain clinical cases. The most important aspect in treatment of ACS is to diagnose and treat it as quickly as possible. As clinical signs are partially associated with patients subjective complaints, they can be sometimes misinterpreted. In certain situations, intercompartmental pressure measuring may be helpful to confirm the diagnose.

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