



## A sneaky surgical emergency: Acute compartment syndrome. Retrospective analysis of 66 closed claims, medico-legal pitfalls and damages evaluation



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### ABSTRACT

**Background:** Acute compartment syndrome (ACS) is a clinical condition with potentially dramatic consequences, therefore, it is important to recognise and treat it early. Good management of ACS minimises or avoids the sequelae associated with a late diagnosis, and may also reduce the risk of malpractice claims. The aim of this article was to evaluate different errors ascribed to the surgeon and to identify how the damage was evaluated.

**Materials and methods:** A total of 66 completed and closed ACS cases were selected. The following were analysed for each case: clinical management before and after diagnosis of ACS, imputed errors, professional fault, damage evaluation and quantification. Particular attention was paid to distinguishing between impairment because of primary injury and iatrogenic impairment. Statistical analyses were performed using Fisher's exact test and Pearson's correlation.

**Results:** The most common presenting symptom was pain. Delay in the diagnosis, and hence delay in decompression, was common in the study. A total of 48 out of 66 cases resolved with the verdict of iatrogenic damage, which varied from 12% to 75% of global capability of the person. A total of \$394,780 out of \$574,680 (average payment) derived from a medical error.

**Conclusions:** ACS is a clinical emergency that requires continuous clinical surveillance from both medical and nursing staff. The related damage should be evaluated in two parts: damage deriving from the trauma, so that it is considered inevitable and independent from the surgeon's conduct, and damage deriving from a surgeon's error, which is eligible for an indemnity payment.

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### Introduction

Acute compartment syndrome (ACS) is a clinical condition that can be caused by several pathological conditions, such as fractures, soft-tissue injuries, burns or circumferential dressings.

The treatment of ACS often comprises plastic surgery, traumatology and other main surgeries, including general or vascular surgery. Furthermore, as plastic surgeons are soft tissue 'experts', they are frequently consulted by colleagues to assess a patient's risk of developing ACS at the injured extremity. Sometimes there is a delay in this professional consultation,

which has negative effects on patient outcome and on the surgeon's therapeutic chances. Consequently, among the various medical and surgical procedures that are the object of litigation, ACS still represents a high-risk situation for both the patient and the healthcare provider. This syndrome develops rapidly from the onset of symptoms to the establishment of irreversible damage, but clinicians may change the pathological evolution of the syndrome by adopting certain strategies. This requires a thorough and up-to-date knowledge of ACS.

The causes of ischaemia in Volkmann's contracture were debated for many decades. Matsen [1] and other authors led to the present unified concept of raised intra-compartment pressure (ICP) inside a fascial or osteofascial compartment, which compromised microcirculatory perfusion, and lead ultimately to macro-circulatory arterial occlusion. This condition, if not immediately treated, can lead to ischaemia and necrosis, with consequent fibrous tissue degeneration of the involved body structures and functional damage. The final result is a fibrous retraction with a variable degree of contracture of the involved muscles and, in extreme cases, amputation of the injured limb is necessary. In some cases, fibrous retraction may cause a compression of nervous structures [2]. A rare complication is acute renal failure caused by myoglobinuria, which can be fatal [3].

Regarding risk factors, ACS particularly affects young people (under 35 years old), because they have stronger fascial structures and more frequently develop high-energy injuries compared with older individuals [4]. The most common cause of ACS is fracture of the tibia: the literature indicates an incidence of compartment syndrome from 2.6% to 9% in tibial fractures [5]. There are several risk factors, which can be divided into two groups:

- Factors that cause reduction of compartment volume: these include burns [6], casts [7], skin [8] and skeletal traction [9], incorrect patient position during operation (lithotomy, hemilithotomy, lateral, supine, Trendelenburg) [10–14], and prolonged immobilisation due to other causes [15].
- Factors that cause increase in compartment content: these include fractures [5], blunt soft-tissue injuries [16], sport/exercises [17], intramuscular haematomas [18], snake bites [19], infections [20], osteotomies [21], vascular procedures [22], intraosseous [23] or intravenous [24] infusions, drugs [25], minor procedures (e.g. punch biopsy [26], electromyography [27]), extravasations of contrast media [28], and haematological diseases [29].

The body sites more commonly affected by the development of ACS are the extremities of the limbs [30]; more rarely ACS develops in the abdomen or in orbital cavities [31].

Clinical diagnosis of ACS is classically based on several elements: a severe pain that is out of proportion to the apparent injury is often the main presenting symptom. The pain is usually increasing and resistant to analgesic drugs, even if in some cases it may be obfuscated by pain deriving from associated injuries [32], such as a fracture. Pallor, paresthesia, paresis, pain on passive flexion or extension, palpably swollen or tense compartments and finally pulselessness may appear, particularly when compartmental ischaemia has already developed. Detection of worsening symptoms depends on careful and sequential clinical examination, which should be ideally performed by the same physician.

A useful technical examination to improve diagnostic capability is the measurement of ICP, which normally varies from 0 to 8 mmHg. The first clinical symptoms of ischaemia appear at an ICP of 20–30 mmHg. At an ICP of 30–33 mmHg the fascial membranes usually reach the maximum tolerable stretch. Some surgeons consider an ICP of greater than 30 mmHg in any compartment to be an indication for fasciotomy, while others consider a threshold for

surgical intervention is when ICP is within 30 mmHg of the patient's diastolic blood pressure [33]. Even if various examinations to aid clinical diagnosis of compartment syndrome are available, measurement of ICP is still the most useful method. Nevertheless, recent studies have demonstrated that ICP data, particularly single readings, must be interpreted in view of clinical findings, and clinical assessment is still the diagnostic cornerstone of ACS [34].

From the medico-legal point of view, the evaluation of Personal Injury due to ACS is still an important concern. The first issue that any evaluations system has to solve is to define the object it wants to evaluate. Damage to the patient may be both economic (e.g. lost wages, past and future healthcare expenses) and non-economic (e.g. psycho-physical harm, severe pain, emotional distress, reduced enjoyment of life).

In the USA, the American Medical Association (AMA) defines impairment as "an alteration of an individual's health status; a deviation from normal in a body part or organ system and its functioning" and disability as "an alteration of an individual's capacity to meet personal, social, or occupational demands because of an impairment". In Italy, impairment and disability are blended in a unique concept, called "biological damage", which is defined as "injury to physical or mental integrity of the person susceptible to medico-legal assessment". It includes physio-anatomical and psychological abnormalities and their repercussions on daily activities and the individual's capacity to meet personal-social demands.

There are many systems for measuring impairment, including scientific society guidelines (e.g. AMA) and workers' compensation programmes. The ratings shown in this paper are based on the Luvoni–Bernardi–Mangili Guide [35], which provides structured evaluation categories aimed at reducing variability in impairment ratings in Italy. Similar to other guidelines, it is a standardised tool that can be used to convert medical data into numerical values (whole-person impairment percentages).

The rating of impairment/disability due to ACS can be difficult because ACS is a complication that often develops from a previous injury. The rating is therefore in two parts: damage deriving from the primary injury, so that it is considered inevitable and independent from medical conduct, and damage deriving from physician error.

Therefore, in evaluating damages the medical expert should attempt to reconstruct the pre-existing condition, its natural evolution and consequences, based on reasonable medical probability, and give it a separate percentage impairment rating. This should be deducted from the whole-person impairment to arrive at the differential (apportioned) rating that is attributable to the ACS.

This distinction is very important because it is used to share out the burden of compensation (i.e. the so-called "apportionment"; in Italy "differential damage").

## Materials and method

Out of 1859 cases of claims in surgical specialties that were analysed by the Chair of Legal and Insurances Medicine of the University of Milano-Bicocca from 2000 to 2010, 66 completed and closed cases were studied. Each case was a patient who developed an ACS after a trauma or a major operation.

The following factors were analysed for each case: age of patient, aetiology, time between trauma/operation and onset of presenting symptoms, time between onset of presenting symptoms and fasciotomy, patient complaints and type of error, if any, and the presence or absence of the misconduct ascribed to the surgeon and the liability profile. The informed consent and any related protests were also considered.

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