

Compartment Syndrome Diagnosis

Compartment Syndrome Pressure Measurements and Diagnosis

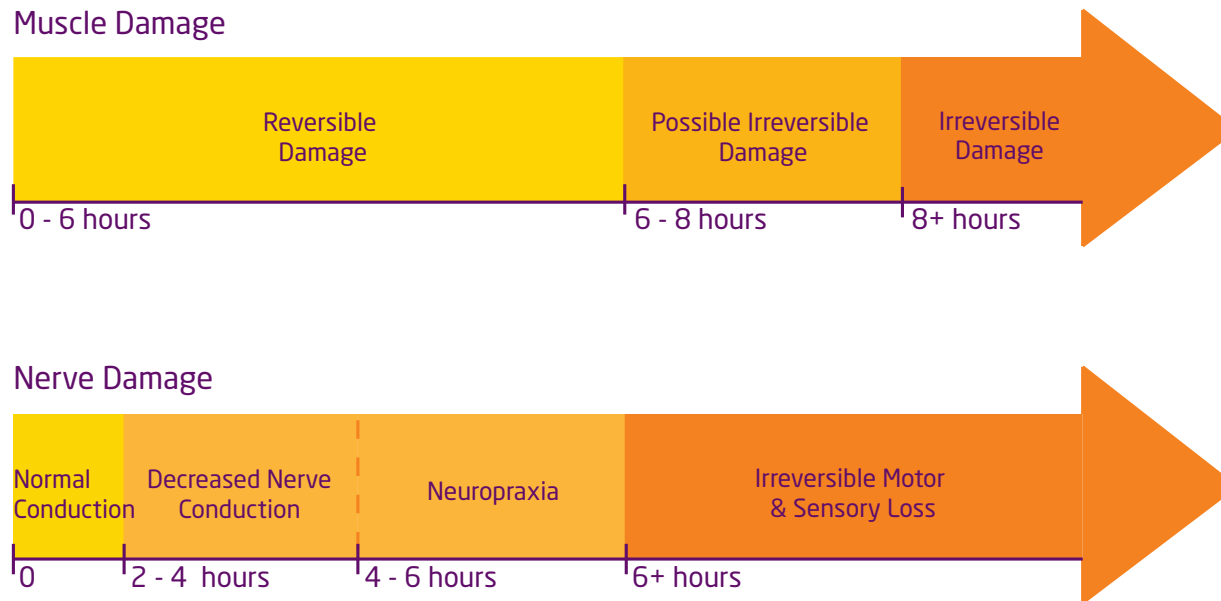
Acute compartment syndrome is considered a surgical emergency that, if not treated immediately, can lead to devastating disabilities, amputation, or even death. Compartment syndrome is diagnosed when interstitial pressure inside a muscle compartment is elevated to a point that exceeds capillary blood pressure. Resting pressures in healthy tissue are normally around 0-10 mmHg; pressures above 20 mmHg are considered elevated, and pressures where the differential from diastolic pressure is ≤ 30 mmHg for 2 or more hours are diagnostic of compartment syndrome¹.

The surgical treatment for compartment syndrome is typically a fasciotomy and is an effective treatment if a diagnosis can be made in a timely manner².

Prior physical examination reveals pain in excess of what is to be expected that is provoked with stretching. However, injuries may obscure pain perception and pain management may mask the symptoms. If the patient is unconscious, it is vitally important to diagnose the development of compartment syndrome.

Timely application of a fasciotomy for treatment of compartment syndrome is critical³. If properly diagnosed within 2 to 3 hours of its development, compartment syndrome can usually be alleviated and muscle tissue preserved through fasciotomy. Fasciotomy however can be associated with morbidity and should not be performed unless there is clear evidence of impending tissue damage from elevations in compartmental pressure. Therefore, correct diagnosis of compartment syndrome is important.

The Progression of Muscle and Nerve Damage



Compartment Syndrome Diagnosis

Challenge: Current technology makes diagnosis difficult

Unfortunately, accurate measurement of pressure within muscular compartments with currently available devices is complicated. The majority of devices currently available use a fluid-filled needle coupled to a remote pressure sensor and as such the measurement needs to be performed under specific conditions. Prior to use, the equipment needs to be properly assembled and air bubbles flushed out of the fluid filled needle. The device should be placed in the same angle that is to be inserted into the muscle and calibrated to zero. During use, the patients need to be supine (fluid-filled lines to pressure sensors are susceptible to the effects of gravity), the correct amount of saline is to be injected into the area, and for repeated measurements, the catheter needs to be checked for patency and re-zeroed prior to taking the measurement. These requirements mean additional training needs to be undertaken by staff and extra time required during monitoring of each patient. Overall the currently available technology has a range of shortfalls which mean that surgeons often err on the side of diagnosing increased pressure and perform a fasciotomy rather than risk a false negative result and with subsequent limb amputation⁴.

Recent studies indicate that compartment syndrome can develop slowly, over a 24 hour period, sometimes up to 48 to 72 hours after injury. Current clinical practice guidelines recommend assessment for clinical signs in alert patients, or to measure compartment pressure in unconscious patients or patients with impaired consciousness,

References

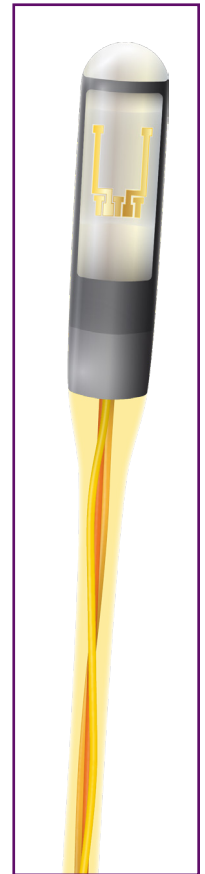
1. Duckworth AD, McQueen MM. Continuous intracompartmental pressure monitoring for acute compartment syndrome. *JBJS Essent Surg Tech.* 3(3):e13 2014.
2. Rorabeck, C. H. The treatment of compartment syndromes of the leg. *The Journal of bone and joint surgery.* British volume 66, 93-97, 1984.
3. Olson, S. A. & Glasgow, R. R. Acute compartment syndrome in lower extremity musculoskeletal trauma. *The Journal of the American Academy of Orthopaedic Surgeons* 13, 436-444, 2005.
4. Boody, A. R. & Wongworawat, M. D. Accuracy in the measurement of compartment pressures: a comparison of three commonly used devices. *J Bone Joint Surg Am* 87, 2415-2422, 2005.
5. Wall, C. J. et al. Clinical practice guidelines for the management of acute limb compartment syndrome following trauma. *ANZ journal of surgery* 80, 151-156, 2010.
6. Kakagia, D. How to Close a Limb Fasciotomy Wound: An Overview of Current Techniques. *The international journal of lower extremity wounds* 14, 268-276, 2015.
7. Roscoe, D., Roberts, A. J. & Hulse, D. Intramuscular Compartment Pressure Measurement in Chronic Exertional Compartment Syndrome. *The American Journal of Sports Medicine* 43, 392-398, 2015.

every 4 hours for a minimum of 24 hours for suspected cases of compartment pressure syndrome^{5,6}. Some clinicians suggest more frequent monitoring of compartment pressure for early detection of progressive development of compartment syndrome, monitoring every 30 minutes to 2 hours.

Solution: Bring Solid-State Sensor Accuracy into Compartment Pressure Diagnosis

Millar, Inc. has been at the forefront in the use of MEMS pressure sensor technology for the past 45 years. Ultraminiature sensors (down to 170 μm or .007 in) placed at the end of catheters provide highly accurate measurements of pressure. These have been used to monitor signals such as intracranial pressure, pulmonary pressure, cardiac pressures and arterial pressure in a wide variety of clinical applications from head trauma to cardiology. Now, these sensors and technology are available for the diagnosis of compartment syndrome.

The Millar Mikro-Cath Pressure Catheter has been used to assess chronic exertional compartment syndrome. Studies have demonstrated that these sensors work well to measure compartment pressure while subjects are supine as well as during treadmill exercise with a military backpack⁷. The sensors are well-tolerated, and the flexible cable allows walking and running on a treadmill. The pressure sensor at the tip of the catheter and no fluid means no measurement artifacts and a quick easy setup and collection of pressure.



Millar Solid State Pressure Sensor

Actual Mikro-Cath Tip Diameter = 1.167 mm (image not to scale)

For increased accuracy of compartment pressure measurements, please contact us:

Millar, Inc. | 6001-A Gulf Freeway | Houston, TX 77023 USA
Ph. +1-832-667-7000 | 1-800-669-2343 (in USA)
insights@millar.com | millar.com