Trauma Tips and Tricks: Measurement and Management of Compartment Syndrome

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Acute Compartment Syndrome (ACS) results when an enclosed fascial compartment surrounding skeletal muscle experiences pressure sufficient to decrease tissue perfusion. While most commonly seen following fractures, it can be seen in many clinical conditions, including but not limited to blunt trauma, crush injuries, iatrogenically from tight wrappings such as casts and splints, arterial injuries, reperfusion following ischemia, and fluid extravasation. Furthermore, it is most commonly encountered in the clinical setting in the lower leg compartments, but can occur in any osseo-fascial compartment.

Compartment syndrome is considered a surgical emergency, as the inability to properly decompress fascial compartments and permit tissue perfusion can result in permanent and irreversible damage to muscle and nerves. Typically, this is a clinical diagnosis, and is characterized by the famed "6 P's." These include Pain, Passive stretch, Paresthesias, Poikilothermia, Pallor, and Pulselessness. Recent studies have shown that manual palpation of compartments is not an effective method of determining compartment tenseness. While this physical exam finding may play a part in the diagnostic process, it cannot be reliably used to confirm or rule out acute compartment syndrome.

It is important to note that many of these "6 P" findings are unreliable, and may only be present after compartment syndrome has been present for a significant amount of time. However, pain with passive stretch, disproportionate pain, and loss of two point discrimination are early signs of acute compartment syndrome that may be used to aid in clinical diagnosis. In pediatric populations, an increased pain medication requirement may be the only indication of impending compartment syndrome.

Physical exam, while a mainstay in the diagnosis of compartment syndrome, is often not possible. This is especially true in the case of comatose or obtunded patients, the mentally ill or demented population, and pediatric patients. In such cases, the use of an inter-compartmental pressure device may be helpful in the diagnosis of impending compartment syndrome and the need for intervention. While significant controversy still exists, recent evidence supports the usage of an absolute Intra-Compartmental Pressure (ICP) $>$ 30 mm Hg or within 30 mm Hg of the resting diastolic blood pressure (ΔP = Diastolic BP - ICP). Diastolic blood pressure measurements should be prior to anesthesia induction, as anesthetics can artificially lower the diastolic blood pressure.

One of the popular devices used at our institution for ICP measurements is the Stryker Intra-Compartmental Pressure Monitor (Figure 1). This device involves the usage of a pressure monitor attached to a small needle and syringe. By introducing a small of amount of fluid into individual compartments, the device is able to measure the pressure of the compartment. This gives the user the ability to gain objective data supporting, or refuting, the diagnosis of possible compartment syndrome.

The use of the Stryker Monitor does have several important considerations, however. First, the disposable needle, chamber and pre-filled syringe should be assembled and placed correctly into the device. Assembly instructions should be referenced. Proper technique is crucial to obtain accurate measurements. Once trajectory is decided, the device should be held at a constant angle with the horizon at all times when measuring. Some prefer keeping the device parallel with the ground for consistent measurements. Prior to measuring pressures, the device needs to be calibrated. While in the trajectory for measurement, a small drop of water should be expressed from the needle tip to create a continuous column of water within the bevel. Then the zero button is pressed, and a "0" on the screen is confirmed prior to measurement.

Depending on the location of investigation, every compartment should be separately

Figure 1. Stryker Monitor.

investigated, as ACS can occur in single or multiple compartments. Consequently, a firm understanding of the anatomy of the various compartments of the body is paramount in the investigation of compartment syndrome. For example, in the lower leg, the anterior, lateral and superficial posterior compartment are measured based on external anatomy and their superficial location. The deep posterior compartment is measured by a medial approach, having the needle hug the posterior tibia to avoid the neurovascular bundle. Measurements should be performed within 5 cm of the fracture, if one is present, as it is the location of the highest compartment pressures. Fracture hematoma can give false pressure reading and should be avoided. Finally, the amount of fluid injected is user dependent, and should be kept consistent. Ideally, less than 0.5 cc of fluid is injected for each measurement, but is dependent on the model used and the compartment being investigated. Injecting excess fluid can result in falsely elevated readings. Multiple measurements in each compartment should be performed to confirm accuracy.

In the treatment of acute compartment syndrome, a thoughtful history and attentive physical exam should remain the mainstay of diagnosis. However, certain patient populations may not be amenable to such investigation; in such cases, the treating physician may require the use of intra-compartmental measuring devices. It also remains a useful adjunct to unclear physical exam findings. Such devices remain a powerful tool in the armamentarium of clinicians that may encounter acute compartment syndrome.

References

1. Yadav, A, *et al.* Quantitative measurement of intra-compartmental pressure of the leg in acute traumatic injury: As a routine trend. *J Clin Orthop Trauma.* 2015 Dec;6(4):230-5.

2. Park, S, *et al.* Compartment syndrome in tibial fractures. *J Orthop Trauma.* 2009 Aug;23(7):514-8.

3. Heppenstall, RB, *et al.* The compartment syndrome. An experimental and clinical study of muscular energy metabolism using phosphorus nuclear magnetic resonance spectroscopy. *Clin Orthop Relat Res.* 1988 Jan;(226): 138-55.