The Value of Compartment Pressure Monitoring for Tibial Fracture

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Abstract:

Routine compartment pressure monitoring in alert patients has been questioned. The current paper explores the value of this procedure

Patients and Methods: In between 2007-2012, 125 patients with tibial fracture underwent monitoring of the compartment in the postoperative period. Medical notes and X-rays were studied.

Results: Fourteen of these patients underwent compartment decompression for high readings of the monitoring in 10 of them, the high readings ware based on clinical notes, in (3) others they ware based on measurement bases, and in the last one they ware because of reading problems.

Conclusion: The current study does not favour the use of monitoring and does not condemn it. However, clinical judgement remains to be superior while compartment measurement may have caused some unnecessary decompressions.

Key words: Compartment, Syndrome, Tibial, Fracture, Monitoring, Decompression, Diaphysis, Value, Alert, Clinical.

Introduction:

Compartment syndrome is a devastating complication of tibial fractures. The rate of compartment syndrome is highest in the diaphyseal group (8.1%, $P < 0.05$) followed by proximal (1.6%) and distal (1.4%) groups. Young patients with diaphyseal fractures are at risk for developing this complication and warrant increased vigilance and suspicion for compartment syndrome [(1)]. A Medline (PubMed) search of the English literature extending from 1950 to May 2007 was performed using "compartment syndromes" as the main key word. Among 577 articles related to the diagnosis of compartment syndromes of the leg, sixty-six articles were found to be relevant to diagnostic techniques for compartment syndrome in the leg and formed the basis of this review. Intracompartmental pressure measurement can confirm the diagnosis in suspected patients and may have a role in the diagnosis of this condition in unconscious patients or those who are unable to cooperate. The main line of diagnosis remains clinical. Access to a precise, reliable, and non-invasive method for early diagnosis of ACS would be a landmark achievement in orthopaedic and emergency medicine [(2)]. Many surgeon use 30 mm Hg as the cut off for performing fasciotomy; compartment measurements within 20 mm Hg of diastolic pressure is an indication for fasciotomy (hence, DBP-compartment pressure is a relative indicator of tissue

perfusion). Some authors cite a difference of 20-30 as a relative indication for compartment syndrome. In contrast, differences (DBP-CP) of greater than 30, tend to indicate that compartment syndrome is not present; compartment pressure measurements should be taken as close to the fracture site as possible (since these will give the highest readings) [3].

The current study explores the benefit of the compartment pressure, monitoring in acute tibial fracture management, in the Norfolk Norwich teaching hospital and to report on the local experience.

Patients and Methods:

Between March 2007 and May 2012, 154 patients were treated in the Norfolk Norwich teaching hospital in England for tibial fracture using intramdedullary nail. The data was collected from the hospital electronic record (Bluespiers). The mean age was 47 years (26-67 years). Male to female ratio was 97:57.

The mechanism of injury was sports related, fall, and road traffic accidents. The inclusion criteria were acute tibial fracture treated by intramedullary nail that has had perioperative compartment pressure monitoring. The following patients were excluded from the study: Three patients who had intramedullary tibial nail for nonunion, ten patients who have had no compartment monitoring, Five patients who have had fasciotomy at the time of nail insertion. Five Patients, who have had external fixator of the tibia before tibial nailing, tow children, hind foot ankle nail, one revision nail, and one tibial nailing for pathological fracture; were also excluded.

Total number of patients included, therefore, became 125 patients.

Patients with closed tibial fracture, according to hospital the policy would be taken to clean theatre environment and have long compartment monitor needle inserted under aseptic condition. The needle is passed to the level of fracture, as close as possible. The end of the needle is attached to a transducer and manometer. Hourly monitoring for compartment pressure and blood pressure is recorded on the ward. Abnormal compartment pressure reading is considered if the pressure is within the 30 mmHg of the diastolic pressure. The on call team will be called if so and immediate compartment decompression is to be carried out. Once tibial nail is performed, the compartment monitoring will continue for another 24 hours, and if all is well, the catheter in removed on the ward.

Results:

Out of 125 patients diagnosed with compartment syndrome fasciotomy was performed for 14 patients (11.2%). Among these, 12 of the fracture were closed (85.7%). In 8 (57.1%), the fracture was in the mid-shaft in the distal part in 5, the proximal part of tibia in one. The mechanism of injury among those who have had the fasciomoty was (6) sports related, (5) road traffic accident and (3) of fall.

The 14 patients who have had compartment decompression had their tibial nailing within 3 to 18 hours of injury. The tibial nailing was performed by using traction for 6 patients (42%) and free handed for the remaining (8) patients. All these patients underwent tibial reaming.

- The indications for fasciotomy based on the monitoring was performed for (7) patients, and those based on clinical and monitor reading were performed

for (2), and solely on clinical grounds (1). The latter patient had normal reading on the monitor, however, the patient had severe pain; the decision for decompression was on clinical grounds. The monitoring was considered to be inaccurate in four patients.

- Patients' requring fasciotomy had this done within first 24 hours after IM nailing.

One patient who had decompression developed delayed union of the tibial fracture and this eventually healed.

Table (1): Demography of the patients with compartment syndrome.

Number of patients with compartment syndrome	Number of patients diagnosed to have compartment syndrome	% of closed fracture	Location of fracture	Mechanism of injury (fasciotomy patients)
14/125	14 (11.2%)	(12/14 patients) 85.7%	Midshaft 8 (57.1%) Distal part 5 (35%) Proximal tibia 1(7%)	Sports (42%) RTA 35% Fall 23%

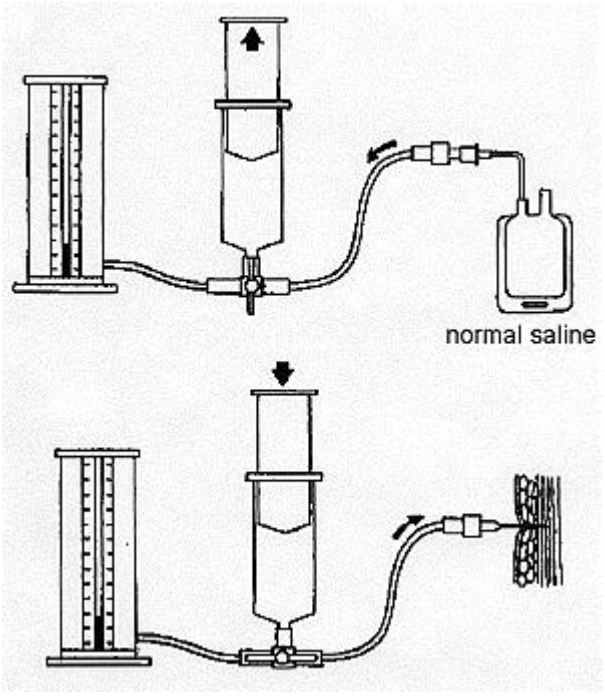

Figure (1): classic way of mointouring compartment pressure.

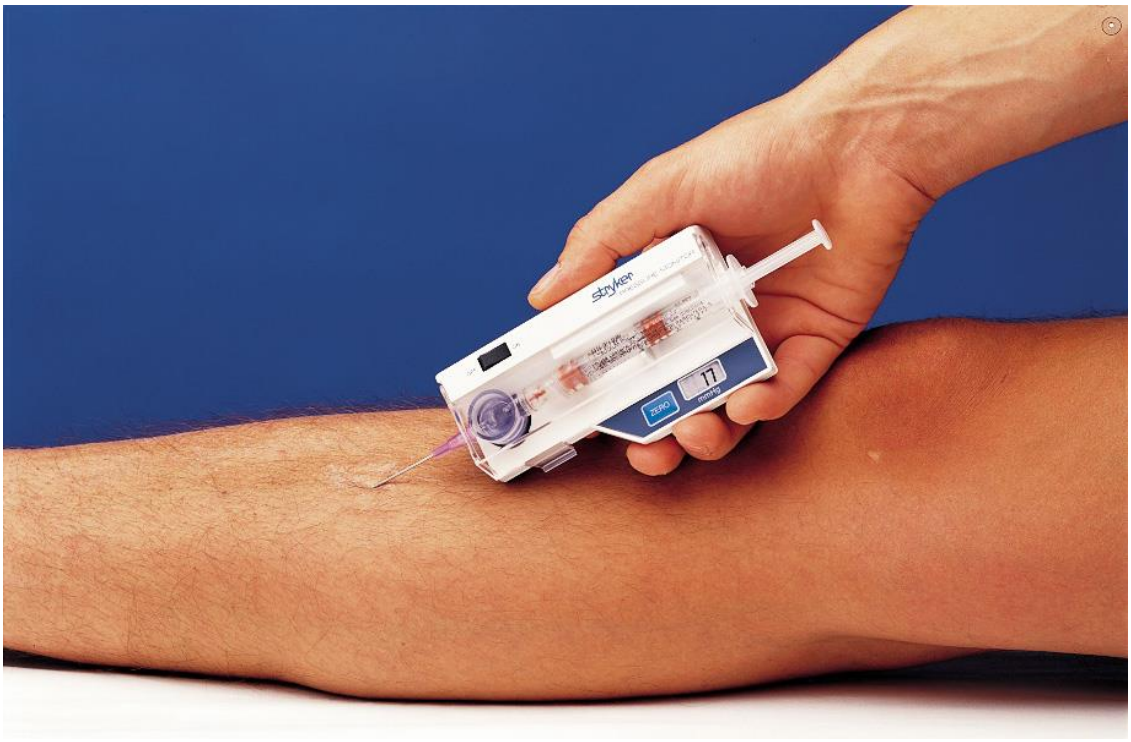

Figure (2): Modern compartment pressure monitoring.

Discussion:

Bhattacharyya reviewed all malpractice claims related to acute compartment syndrome (ACS) filed with a large insurer over a 23 year period [4]. The data show that (6%) of all malpractice claims against orthopaedic surgeons are related to ACS and greater than (50%) are ruled in favour of the patient. This is significantly greater than the (25%) of overall claims against orthopaedic surgeons that resolve in favour of the patient. There is also a linear relationship between the number of cardinal signs and the time from presentation to fasciotomy and payment size. In addition, Shadgan et al, suggest that poor communication between physicians, nursing staff, and the patient is associated with unfavourable outcomes [5]. Clinical compartment monitoring is highly variable across examiners and is not always reliable in the diagnosis of ACS [6]. (Figure 1, 2).

Published reports on the clinical diagnosis of compartment syndrome suggest that sensitivity of clinical findings for diagnosing compartment syndrome is low, as is the positive predictive value. Clinical features of compartment syndrome are more suggestive in their absence in ruling out the diagnosis than in confirming the diagnosis by their presence [7].

In a prospective randomized study of the readings of compartment pressure in isolated lower limb fracture, the readings did not reach the threshold for surgery compared to the normal side readings. Issues like the difference of the reading with the diastolic blood pressure or the mean arterial pressure (delta P) reliability were questioned. It was concluded that the existing thresholds and formulations to determine the diagnosis of compartment syndrome may not accurately reflect a true existence of the syndrome [3, 8].

The type of the needle used and the distance to the fracture site is investigated. Moed and Thorderson (1993) compared three methods of measurements: (the simple-needle technique, the use of the slit catheter, and the use of the side-ported needle.). The side-ported needle appeared to be as accurate as the slit catheter for the measurement of compartment pressures ($p = 0.355$, 1-beta = 0.9). The values obtained with the use of simple needle were consistently higher than those obtained with other 2 methods ($p < 0.001$). An average of 18.3 millimetres of mercury higher than the values measured with slit catheter and 19.3 millimetres of mercury higher than those measured with the side-ported needle. The use of the simple 18-gauge needle is not recommended for this purpose [(3)].

The researchers are not aware of the existence of validated compartment measurement tool, which is reliable, and overall, there is resistance for using this tool in alert patients [(9)]. The technique is also invasive, and alternative tools have been investigated. Near infrared spectroscopy (NIRS) is a technique that is both noninvasive and continuous and has been adapted to aid in the diagnosis of ACS. Monitoring is based on the transmission and absorption of light in the near-infrared spectrum at wavelengths that correspond with the absorption of oxygenated and deoxygenated hemoglobin. Tissue oxygenation is assessed by comparing the concentrations of venous blood oxyhemoglobin and deoxyhemoglobin.

Garr et al showed an inverse correlation between compartment pressure and oxygenation as well as a correlation between perfusion pressure and oxygenation in an animal model. These indicate that oxygenation surveillance by NIRS may ultimately be an effective tool to monitor patients with increased compartment pressure and evolving compartment syndrome [(10)].Furthermore, NIRS is able to identify decreased tissue perfusion secondary to increased compartment pressure even in the setting of hypotension and hypoxemia, making NIRS useful in the setting of critically ill patients [(11)].

These tools are still under investigation and pending validation, until then, compartment monitoring is the only possible tool. There are benefits f the routine use of this monitoring, namely frequent check up of the compartment pressure and the early pick up of the condition. Obviously, when established, the earlier the compartment is decomporessed, the better the outcome. The current review has highlighted the same problems in relation to the routine monitoring. The tool can get faulty, and fail to monitor properly. This was noticed in few of the series. The underlying cause can be mechanical failure. Also, the location of the tip of the needles; the closer the better to the fracture site; however, it is hard to appreciate the site of the tip of needle with percutanous insertion.

Conclusion:

A validated compartment pressure monitoring is a helpful tool for early diagnosis and management of compartment pressure in the extremity following long bone fractures. It may add to the already pressurized nursing staff, it provides a safe method of early management to prevent disability. There are however, technical problems with the monitoring and clinicians have to rely on the clinical acumen when in doubt.

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