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Measurement of compartment pressure in closed tibia fracture using white side's technique

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Abstract

Introduction: Tibia fractures account for 40% of acute compartment syndrome. Measurement of compartment pressure in high energy trauma, complex fractures, unconscious patient, poly trauma, severe soft tissue injury avoids morbidity and permanent disability by timely fasciotomy. Whiteside's method of needle manometer technique is a accepted method of invasive technique of compartment syndrome measurement.

Materials and Methods: Patients admitted in vydehi institute of medical science hospital with closed tibia fractures during Jan 2019 to Dec 2019 were included after consent. Anterior compartment of leg was chosen and site of measurement was 5 cm from fracture. Differential pressure was also recorded and cut off for fasciotomy was 30 mm Hg.

Results: 60 patients with closed tibia fractures were included in the study. 5 patients underwent fasciotomy and all patients had delta pressure less than 30 mm Hg before fasciotomy.

Conclusion: Whiteside's technique is a safe, easily assembled, inexpensive method of intra compartment pressure measurement and differential pressure is a reliable guide for decision of fasciotomy compared absolute pressure.

Keywords: Tibia fractures, whiteside's method, intra compartment pressure, differential pressure or delta pressure

1. Introduction

Acute compartment syndrome is defined as the elevation of intra compartment pressures to a level and for duration that without decompression will cause tissue ischemia and necrosis [1]. Compartment syndrome can be a life or limb threatening emergency. Early diagnosis is important for the prevention of disability [2]. Approximately 40% of all compartment syndromes occur after fracture of tibia shaft [3]. Common causes of acute compartment syndrome are fractures, soft tissue injury, and ischemia – reperfusion injury, haemorrhage, crush injury, arterial injury, burns, intravenous / intra-arterial, drug injection, drug abuse.

Measurement of compartment pressure is an objective way of assessment of compartment syndrome. Subjective ways of assessment include clinical examination of 5 P's – Pallor, Pulselessness, Paraesthesia, Paralysis and Pain. Other methods include checking of tightness of compartment of leg, pulse oximetry and pain in excess for passive stretch. But measurement of compartment pressure has been recommended to be the basis of decision for fasciotomy. Assessment of differential pressure (Diastolic blood pressure – intra compartment pressure) is preferred over absolute pressure for deciding the need of fasciotomy [12, 13]. Compartment pressure can be assessed by several techniques. Whiteside's *et al.* introduced needle manometry. Since then other methods have been developed such as Wick catheter, the slit catheter, the solid state transducer intra-compartment catheter, the Stryker device [6-10]. However Whiteside's manometry method is easy, economical and reliable in measuring ICP [11]. The aim of this perspective study is to assess the ICP in closed tibia fractures using Whiteside's method and determining the critical compartment pressure as a guide to fasciotomy using needle manometry.

2. Materials and methods

All the patients were evaluated for the presence of any associated life-threatening emergency and as such resuscitation was carried out for these patients.

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A careful physical examination was carried out to look for the clinical features of compartment syndrome including pain out of proportion with firmness of the compartment, pain on passive stretching of the involved muscles as well as paralysis, paraesthesia and pulselessness. Proper radiographs of the involved extremities were taken. Anterior compartment pressures of the injured extremities were measured using the Whitesides' infusion technique [6].

Whitesides' technique employs the following materials - i) One mercury manometer, ii) Two plastic intravenous extension tubes, iii) Two 18-gauge needles, iv) One 20-cc syringe, v) one three-way stopcock, vi) One bottle of bacteriostatic normal saline. The extremity to be measured is cleaned and sterility prepped. Sterile saline is drawn into the 20 ml syringe, which is attached to the three-way stopcock. A single intravenous extension tube is attached to the stopcock and a second 18-gauge needle is attached to its other end. The third unused portion of the stopcock is closed off temporarily. The 18-gauge needle at the end of the extension tube attached to the stopcock is then inserted into the bottle of the saline. Saline is then aspirated without the bubbles into approximately half the length of the extension tube. The three-way stopcock is turned to close off this tube so that the saline is not lost during transfer of the needle. The second extension tube is then connected to the three-way stopcock at its remaining open part and its other end is connected to the manometer. The saline-containing needle is then inserted into the muscle of the extremity to be tested. The stopcock is then turned so that the syringe is opened to both extension tubes, forming a T-connection with a free column of air extending from behind the column of saline into the syringe as well as into the manometer. Pressure is increased in the system gradually by slowly depressing the plunger of the syringe while watching the column of saline. As the plunger is depressed, the saline meniscus will be altered from a convex configuration to a flat configuration, when the air pressure in the system equals the interstitial pressure in the patient's examined tissue. The manometer reading at this time is the tissue pressure in mm Hg. Precautions were taken not to depress the syringe plunger too rapidly or placing the needle into the tendon, as these may give a false high reading. A new needle was used for each measurement in order to assure accuracy.

Pressure measurements were taken at the level of fracture and at 5 cm and 10 cm away from the fracture site proximally and distally. Differential pressures were calculated by subtracting the absolute tissue pressure from the patients' diastolic blood pressure.

Patients with high absolute tissue pressure (>50 mm Hg) were subjected to repeat measurements after one or two hours. The diagnosis of impending compartment syndrome was made when the differential pressure was less than 30 mm Hg.

3. Results

In our study, majority of patients with closed tibia fractures were in age group of 30 – 40 years with road traffic accidents being common mode of injury. Out of 60 patients, 53 were male patients and 7 were female patients.

Out of 60 patients, 5 underwent fasciotomy within first 24 hr of injury. All the patients who underwent fasciotomy had delta pressure less than 30 mm Hg with mean of 17.2 mm Hg. In our study 22 patients had absolute pressure above 30 mm Hg at the time of presentation. The normal tissue pressure was measured simultaneously in the uninvolved extremity. Pressures ranged from 6 mm Hg – 18 mm Hg (average 9.7 mm Hg).

4. Discussion

Compartment syndrome is a surgical emergency. Delay in diagnosis and treatment causes' severe morbidity and mortality.

Diagnosis cannot be relied only on clinical assessment. Clinical assessment requires conscious patient but could be missed in children and poly traumatised patients as "what" physical assessment is less sensitive and specific. Invasive methods for assessment of ICP are objective and decision for fasciotomy can be made based on absolute pressure and differential pressure or delta pressure.

The absolute pressure methods uses values above 30 mm Hg, 40 mm Hg, and 50 mm Hg as cut off for fasciotomy according to various recommendation [15-17].

The differential pressures method uses values lower than 30 mm Hg as an indication for fasciotomy. The differential pressure method relies on Whiteside's theory which states that blood pressure can increase or decrease the effect of ICP on the tissue perfusion [12, 13].

Compartment pressure measurement is the most reliable and objective method for early diagnosis. Various instruments available for measurement like Wick catheter, Stryker hand held instrument, side porter needle, fibre optic transducer are either expensive [6-10] or nor easily available in developing countries.

Whiteside's method is one of the devices used for measurement of tissue pressure. The apparatus is simple and effective and can be assembled with the materials easily available in hospital. It is inexpensive, safe, reproducible and most importantly ideal for the use of peripheral hospitals [18].

In our study we used differential pressure as a guideline for decision of fasciotomy and pressure below 30 mm Hg and clinical features substantiating the need for fasciotomy underwent decompression.

It was demonstrated that many unnecessary fasciotomies based on absolute pressure method were avoided because of differential pressure. Patients who had high absolute pressure but differential pressure above 30 mm Hg were observed and none of the patients had adverse outcome for avoiding fasciotomy.

Had we used absolute pressure more than 30 mm Hg, 22 patients out of 60 patients would have undergone fasciotomy. This proves that not a single case of compartment syndrome remains undiagnosed on taking differential pressure less than 30 mm Hg as the criterion for diagnosing Acute compartment syndrome.

From our study we conclude that intra compartment pressure monitoring is a reliable and objective method for early diagnosing of compartment syndrome.

Early diagnosis decreases morbidity, mortality and soft tissue damage. We therefore believe that all patients with closed fractures of leg should have routine anterior compartment pressure measurement and Whiteside's method is a safe, inexpensive, easily assembled and reliable method for assessment of ICP in the peripheral set up of developing nations. Differential pressure is better method for identifying the need for fasciotomy compared to absolute pressure.

Conflicts of Interest: The authors have none to declare.

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