

Compartment Syndrome, A Neglected Diagnosis

Muhammad Inam, Mohammad Arif, Abdul Satar, Mohammad Saeed

ABSTRACT

Objective To find out the frequency of compartment syndrome in extremities using Whitesides' infusion technique.

Study design Descriptive case series.

Place & Duration of study Orthopedic Department of Hayatabad Medical Complex Peshawar, from April 2008 to April 2010.

Methodology All patients with fractures, either open or closed, were clinically evaluated for compartment syndrome initially. All clinically suspected cases then underwent measurement of compartment pressure by Whitesides' infusion technique.

Results There were thirty six patients in the study. Minimum age was 3 years and maximum 45 years with median age of 30 years. There were 25 (69.45%) males and 11 (30.55%) female patients. There were only two (2.77%) open fractures in this series. Two (5.55%) patients had femur fracture, 4 (11.11%) had radius/ulna fracture, one (3.33%) had supracondylar fracture of humerus and 24 (66.66%) tibia fracture. Five (13.88%) patients had injury to the foot. Minimum compartment pressure was 35 mmHg and maximum was 55 mmHg with a mean of 40 mm Hg.

Conclusions Traumatized limbs have high risk of developing compartment syndrome. A careful clinical examination at the time of admission and diligence with serial examinations of the extremity at risk, may identify majority of compartment syndrome patients. The pressure should then be measured to confirm compartment syndrome.

Key words Compartment syndrome, Fracture, Trauma, External compression, Tibia.

INTRODUCTION:

Compartment syndrome (CS) is a condition in which the perfusion pressure falls below the tissue pressure in a closed anatomic space, with subsequent compromise of tissue circulation and function. Each muscle or muscle group is enclosed in a compartment enclosed by relatively rigid walls of bone and fascia. The compartments of the lower leg and the volar forearm are particularly prone to develop elevated compartment pressures.¹

The compartment syndrome has been documented in 1881 by Richard Volkmann² and in 1906 the name, Volkmann's ischemic contracture, has been given to the after effects of compartment syndrome.³ Compartment syndrome may result from fractures, soft tissue injuries, limb compression, burns, post ischemic swelling, constrictive dressing and tight casts. Compartment syndrome can be a life or limb threatening emergency, therefore, early diagnosis is important for prevention of morbidity and mortality.^{4,5} It has been documented that the total ischemia of 6 hours duration results in complete irreversible muscle and nerves changes.^{6,7} Most of the morbidities develop when it is not treated with in first few hours.⁸

Correspondence:

Dr. Muhammad Inam
Orthopedic Department
Postgraduate Medical Institute
Hayatabad Medical Complex
Peshawar
E mail: dr_mohammadinam@yahoo.com.uk

The compartment syndrome may be diagnosed clinically by finding the six P's (pain, pulselessness, parasthesia, pallor, paralysis and perishing cold),⁹

but these signs and symptoms are present in full blown compartment syndrome in which fasciotomies usually do not save the limbs. Also in unconscious patients, the pain, parasthesia and paralysis can not be elicited and the clinical diagnosis of compartment syndrome may be missed.⁹ In such circumstances compartment pressure measurement is the most reliable and objective method for early detection of the compartment syndrome which significantly reduces delay in fasciotomy and the incidence of complications.

There are different methods of tissue pressure measurement like Whitesides' infusion technique,¹⁰ the solid-state transducer intracompartmental (STIC) catheter technique,¹¹ the Wick catheter¹² and the slit catheter technique,¹³ but the simplest technique is the Whitesides' infusion method. The purpose of this study was to find out the frequency of compartment syndrome in extremities using Whitesides' infusion technique.

METHODOLOGY:

The study was conducted in Orthopedic Department of Hayatabad Medical Complex Peshawar, from April 2008 to April 2010. All the patient with fracture either open or closed, were evaluated for compartment syndrome by Whitesides' infusion technique. All those patients with fracture reporting to orthopedic department were admitted. Assessment of these patients followed the traditional methodological system for evaluation of all trauma patients. After achieving hemodynamic stability, the patients' personal information was taken, and inquiries made regarding the time, place, type and mechanism of trauma. The variables noted were intensity of forces that caused the fracture, time elapsed since injury, any vascular trauma etc. Sensation of the fractured limb was checked because absence of sensation represents nerve injury, progressive ischemia or both.

Patients then underwent a thorough physical and radiographic evaluation to assess fully, their injuries. Impaired perfusion of the injured limb was indicated by skin pallor, coolness, absence of venous and capillary filling and absence or significant diminution of palpable pulses. When the patients were stabilized then the purpose of the study was explained to them and informed consent taken. The compartment pressure was then measured. Data were collected using different variables.

The apparatus for pressure measurement (Fig I) in compartments was constructed from two drip sets, a blood pressure mercury manometer, a 20 cc syringe, a 20-gauge needle and a three way

stopcock. One drip set was connected to the manometer and other to 20-gauge needle, half filled with saline. The plunger of the syringe was then withdrawn to the 15 ml mark. The syringe and drip sets were then connected to the stopcock. After preparation of the leg, the needle was inserted into the muscle compartment. When the plunger on the syringe was depressed, the mercury column in manometer began to rise. When the saline started flowing into the compartment, the manometer rises and measurement of the compartment pressure done.

In this study pressure of more than 30 mmHg was counted as significant. If pressure was equal to thirty or less, then no surgical intervention was done but the patient was kept under vigilant observation for any increase in pressure. The diastolic blood pressure of the patient was checked to find out the differential pressure.

RESULTS:

There were thirty six patients in this study. Minimum age was 3 years and maximum 45 years with median of 30 years. There were 25 (69.45%) male and 11 (30.55%) female patients. There were two (2.77%) patients with open fracture and the remaining were of closed type. Two (5.55%) patients had femur fracture, 4 (11.11%) had radius/ulna fracture, one (3.33%) was with supracondylar fracture of humerus and 24 (66.66%) tibia fractures. Five (13.88%) patients had injury to the foot.

Six patients were brought after 48 hours with gangrenous changes of the limb. All these patients had received treatment by quacks who had applied cast. One (3.33%) patient had femur fracture which was treated by applying above knee cast. Another three patients had compartment syndrome as a result of radius, ulna fracture in whom above elbow cast was applied by the quack. The remaining 30 (83.33%) patients were diagnosed by Whitesides' infusion technique. Most of the patients with compartment syndrome had tibial shaft fracture. The age and compartment pressures are given in table I.

In our study six (16.88%) patients underwent amputations and the remaining were treated with fasciotomy. Later on skin grafting was performed.

DISCUSSION:

The normal resting intramuscular pressure is 0-8 mmHg. Pain and parasthesia occurs at 20-30 mmHg.¹⁴ An intracompartmental pressure (ICP) of 30 mmHg is often used as a basis for performing a fasciotomy. Whitesides et al⁸ and later Court-Brown,⁶

Table I: Compartment Pressure and Age Statistics (n=36)			
	Age (years)	Compartment Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Mean	35.03	42.33	77.33
Median	30.00	40.00	77.50
Mode	25	35.00	70.00
Standard Deviation	12.26	06.12	07.04
Minimum	03	35.00	65.00
Maximum	45	55.00	90.00



Fig I: Photograph of Whitesides' Apparatus

however use a differential between diastolic pressure and ICP of 10-30 mmHg as the threshold for doing so. This method reduces the number of patients that undergo fasciotomy without endangering those who do not.¹⁴ Tiwari et al suggest that fasciotomy should be performed when Delta P is ~ 30 mmHg.¹⁵ If ICP exceeds 30 mmHg and observations are compatible with compartment syndrome, prompt therapies to decrease the pressure such as removal or opening of casts, skeletal fixation of unstable fractures, maximizing local arterial pressure, placing the limb at a level with the heart or in some instances anticoagulation to prevent complications, are necessary. If ICP exceeds 40 mmHg, emergency treatment is needed because blood flow through the capillaries and therefore oxygen delivery will cease.¹⁵

Ovre S et al studied 63 patients in whom eighteen legs were treated with decompressive fasciotomy, three on clinical findings alone, and 15 after measurement of a pressure higher than 30 mmHg.¹⁴ They did not measure the differential pressure (Delta P) which is the more accurate diagnostic tool. Kashuk et al¹⁶ studied eighty-three (10 female, 73 male) cases. Mean age was 33.3 years (range 1–78 years). Five (6.0%) had amputations and 7 (8.4%) died.

Fractures occurred in 68.7% (n 57), and vascular injuries were present in 38.6% (n 32). In 7 patients (8.4%), a delayed compartment release resulted in muscle necrosis requiring multiple debridements, subsequent wound closure problems, and long term disability.¹⁶ While in our study six (16.88%) patients had amputations and the remaining were treated with fasciotomy and later on skin grafting.

In Kanlic et al study the patients developing CS were young (average 35.4 years) and likely to have a vascular injury on presentation (57.7%).¹⁷ A tense and edematous thigh was the most consistent clinical examination finding leading to fasciotomy (69.5%). Average time from admission to the operating room was 18 + 4.3 hours and 8 (34.8%) were noted to have ischemic muscle changes at the time of release. Half of those patients developed local complications requiring limb amputations while in our study the frequency of amputation was 16.88%. In our study the most obvious cause of established compartment syndrome was tight cast that had been applied previously by quacks.

CONCLUSIONS:

In the multisystem injured patient, compartment syndrome remains a major diagnostic and treatment challenge with significant risks of limb loss as well as complications from decompressive fasciotomy. Whitesides' apparatus is a simple and effective apparatus that can easily be construed with the materials available in any hospital ward. Moreover, it is inexpensive, safe, reproducible and most important being ideal for use in any hospital.

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