



IJCRR
Section: Healthcare
Sci. Journal
Impact Factor
4.016

STUDY OF COMPARTMENT PRESSURE IN SUSPECTED CASES OF ACUTE COMPARTMENT SYNDROME IN LEG

Naresh Kumar, Sandesh Chaudhari

¹M.S. Ortho., Fellowship Joint Replacement Surgery, Assistant Professor, Department of Orthopaedics, Chandulal Chandrakar Memorial Medical College (CCMMC), Kachandur, Durg(C.G.) India, Pin 490024; ²Associate Professor, Dept. of Forensic Medicine, CCM Medical College, Durg, (C.G.) Kachandur, Durg(C.G.) India.

ABSTRACT

Background: The present study has been done on the patient with suspected cases of increased compartment pressure in leg with history of trauma, using Whiteside needle manometer technique to make early diagnosis and early intervention to save the limb¹.

Materials and Methods: The study has been conducted over 40 patients in the age range between 10-45 yrs from April 1999 to March 2000. The compartment pressure of the injured leg has been measured using Whiteside needle manometer technique from the time of admission till the pressure came to normal or till the patient need decompression of the compartments.

Result: This series shows that compartment syndrome is not an uncommon complication of leg fracture. The site of fracture found to affect more in upper third 23(57.5%) than in middle third 14(35%). In lower third 2(5%) cases and only 1(2.5%) case of segmental fracture both bone leg were affected. High energy trauma ² was the common 37(92.5%) cause of raised intracompartmental pressure than low energy trauma 3(7.5%).

Conclusion: This series shows that compartment syndrome is not an uncommon (7.5%) complication of leg fracture. The raised compartment pressure is mainly seen with the fracture affecting the upper third of leg. The patient needs to be monitored for at least 72 hr. following trauma. The critical pressure of fasciotomy is the raising value of compartment pressure of 30 mm Hg³. with clinical signs and symptoms. It is important to release of all the four compartments of leg within 6 hrs. of the diagnosis of acute compartment syndrome for better prognosis.

Key Words: Compartment pressure, Double incision fasciotomy

INTRODUCTION

Acute compartment syndrome is an orthopaedic emergency, if not diagnosed and treated in time will cause permanent functional loss of the limb ⁴. It was Volkman who drew attention to the development of ischaemic injury following trauma as early as in 1872, but in 1881⁵ he described interruption of blood supply as a cause of paralysis and contracture of muscle of the affected compartment.

A compartment syndrome as defined by Mubarak et al (1964) is any clinical condition in which increased interstitial pressure in closed osseofacial compartment result in microvascular compromise and possible muscle and nerve damage ⁶. Increasing number of vehicle on road and fast life lead to an increased in incidence and severity of fracture. Tibia be-

ing subcutaneous bone is prone to get fractured. It is the site and amount of energy that is transmitted to the limb; decide whether or not compartment syndrome will develop De Lee and Stiehl in 1981⁷.

Compartments most commonly affected are

- a. Anterior and deep posterior compartments of leg
- b. Volar compartments of forearm

However, compartment syndrome can develop anywhere, where skeletal muscle is surrounded by substantial fascia, such as in :

Buttocks, thigh, foot, shoulder, arm, hand, lumbar paraspinous muscles. The exact mechanism causing the high compartment pressure is unknown but shift of fluid between blood and tissue have been strongly implicated⁸.

Corresponding Author:

Dr. Naresh Kumar, M.S. Ortho., Fellowship Joint Replacement Surgery, Assistant Professor, Department of Orthopaedics, Chandulal Chandrakar Memorial Medical College (CCMMC), Kachandur, Durg(C.G.) India, Pin 490024; Mob: 7509628865; E-mail – nresh2013s@gmail.com

Received: 13.07.2016

Revised: 10.08.2016

Accepted: 07.09.2016

Ellis in 1958 reported a 2% incidence of ischaemic contracture in the lower extremity following tibial fracture⁹. The incidence of lower limb compartment syndrome in the adult has been reported by De Lee and Stiehl (1981)⁷ as 6% in the open fracture of the tibia and 1.2% in the closed tibial fractures. Mc Queen and Court Brown (1996)¹⁰ describe only 1.2% incidence.

If compartment syndrome is not recognised or the diagnosis is delayed it lead to serious complications. This study has been undertaken to identify the patients at risk and to avoid the complications of compartment syndrome like;

- a. Ischaemic necrosis of muscles
- b. Neurological deficit
- c. Volkmann's contracture ,and
- d. Amputation

MATERIALS AND METHODS

The study has been conducted over 40 patients in the age range between 10-45 yrs from April 1999 to March 2000 , in the department of orthopaedics Hamidia Hospital Bhopal. These were the patients who were suspected to develop Compartment syndrome.

Right leg 26(65%) of the patient was affected more than the Left leg 14(35%) with male is to female ratio 19: 1.

The number of cases with open (Gustilo G-1) were 24 (60%) and 14 (40%)cases were closed fractures. The site of fracture found to affect more in upper third 23(57.5%) than in the middle third 14(35%).In lower third 2(5%) cases and only 1(2.5%) case of segmental fracture both bone leg were affected. In our study only 6 (15%) cases were having associated orthopaedic injuries.

The compartment pressure of the injured leg has been measured from the time of admission till the pressure came to normal or till the patient need release of all the compartments. Preoperative radiograph were taken in all patients and associated orthopaedic injuries were noted. Inclusion criteria for this study were ; Acute trauma causing leg fracture within 72 hrs. of injury , tense swelling in leg and knee; blisters on the skin and stretch pain on passive dorsiflexion of toes, paresthesia over the area supplied by peroneal nerve and status of peripheral circulation of leg. Cases not included in our study are Gustilo Anderson Grade 2 and above.

Strict limb elevation, serial compartment pressure monitoring using Whiteside technique and frequent clinical examination was done to identify the signs of compartment syndrome. Patient with impending compartment syndrome were operated within 6 hours of raised compartment pressure and clinical appearance of signs and symptoms using double in-

cision technique.

Material used are one triway stopcock, one 20ml syringe, two 18 guage needle, two i.v. plastic extension tubes, one bottle of bacteriostatic normal saline and one mercury manometer.

Steps used in the technique:

Clean and prepare the extremity to be evaluated.

Break the vacuum in a sterile saline bottle with a sterile needle.

Assemble 20 ml. syringe with the plunger at the 15ml. mark, a 3- way stopcock, a plastic i.v. extension tube and a 18 guage needle.

Insert the tip of 18 gauge needle into the saline and aspirate the saline without bubble into approx. half of the length of extension tube. Turn the 3- way stopcock to close this tube so that the saline is not lost during transfer of the needle.

Insert the 18 gauge needle into the muscle of the compartment in question. Connect the second extension tube to the manometer at one end and to the 3-way stopcock at the other. Turn the stopcock so that the syringe is open to both the extension tubes forming a "T" connection. This produce a closed system in which the air flow into both the extension tubes as the pressure within the system is increased.

Increase the pressure in the above closed system by slowly pressing the plunger of the syringe at the same time watch the movement of the saline column in the extension tube. The mercury in the manometer will rise as the pressure within the system rises. When the pressure in the system just crosses the tissue pressure surrounding the needle, small amount of the saline will be injected into the tissue and the saline column will move in the extension tube. When the column moves, stop the pressure on the syringe plunger and read the level of the column in manometer. The manometer reading at the time saline column moves, is the tissue pressure in "mm" of mercury of the involve compartment.

Serial measurement of compartment pressure in the Anterior compartment of the leg and blood pressure (in mm Hg.) was taken every 4 hourly and the clinical findings noted till the critical pressure of 30 mmHg. or more was reached or compartment pressure started decreasing.

The cases with compartment pressure between 19- 29 mmHg. were grouped as transient compartment syndrome. These patients were observed very closely. The treatment given in suspected cases of acute compartment syndrome are :

1. All the suspected cases of closed or open fractures were immobilized in toe to groin slab, proper limb elevation was done and toe movement advised.

2. All the cases of compound fracture were given injectable antibiotic.
3. All the cases were given Tab. Serratiopeptidase 10 mg. TID orally.
4. The cases were kept under closed observation.

The cases having compartment pressure greater than 30 mmHg or differential pressure less than 30 mmHg. were taken as the candidate for the decompression. The operative technique used in this study was double incision fasciotomy ¹¹.

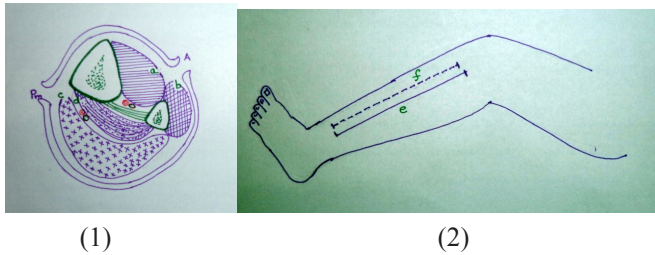


Diagram showing double incision fasciotomy ; Cross section (1) All four compartments released- (a)Anterior(b),Lateral(c),Superficial posterior and (d) Deep posterior group of muscles. (2) Line of Incision (e)Anterolateral and (f) Posteromedial.

Double incision fasciotomy:

The patient was taken in operation theater, kept in supine position and using aseptic precaution the affected limb was prepared and draped. The first incision was the anterior incision that was centred over the anterior intermuscular septum, and the second incision was posteromedial incision that was centered 1 cm. or so behind the posteromedial border of the tibia. The anterior incision was made and the intermuscular septum is identified. It is important to identify the intermuscular septum because the terminal branch of the deep peroneal nerve perforate the septum in the distal one-third of the lower leg and this could be cut if not identified. The anterior and lateral compartments are then released by doing fasciotomy 1cm. in front and behind the anterior intermuscular septum. The deep compartments are exposed through the posteromedial incision by retracting the saphenous vein and nerve and releasing the fascia over the superficial posterior compartment. In order to decompress the deep posterior compartment, it is necessary to detached the soleal bridge which is then retracted to expose the fascia covering the flexor digitorum longus and tibialis posterior muscles.

The condition of the muscles in all the four compartments were noted for color, contractibility and circulation. The non-viable muscles were debrided and muscles with doubtful viability left as such, sterile dressing done and toe to groin slab was applied.

Postoperative protocol

A second examination performed 24-48 hrs. after fasciotomy at which time all the non viable muscles were debrided and after 10-15 days as the wound improved, split thickness graft was applied. When graft was accepted toe to groin cast was applied under general anaesthesia and patient is discharged with advised for follow up.

All patient were advised to attend orthopaedic out patient department on a fixed date at regular interval on each occasion status of union and functional evaluation and complication if any where assessed in the following manner:

1. Patients were asked about any subjective complain like pus discharge, fever, pain, swelling, range of movement, loss of function, etc.
2. Movement of knee, ankle, foot and toes checked.
3. Standard anteroposterior and lateral X-ray were to asses the radiological union.
4. Any complication like residual deficit was noted.

RESULTS

In our study out of 40 patient, 10 (25.5%) cases reached stage of transient compartment syndrome out of which 2(20%) developed compartment syndrome. Each of the 2 cases were closed fracture both bone leg (one oblique fracture upper third and one middle third respectively)

One case was open compound comminuted fracture both bone leg who came late as 48 hrs., following injury with full blown signs and symptom of compartment syndrome and was decompressed within one hour of arrival in hospital but ended up with foot drop and infection. Two cases were monitored closely and undergone double incision fasciotomy within 6 hours of reaching peak intercompartment pressure greater than 30mmHg. These two patient showed only mild limb residual deficit in late follow up.

Right leg 26(65%) of the patient was affected more than the Left leg 14(35%). The number of cases with open (Gustilo G-1) were 24 (60%) and 14 (40%)cases were closed fractures. The site of fracture found to affect more in upper third 23(57.5%) than in the middle third 14(35%). In lower third 2(5%) cases and only 1(2.5%) case of segmental fracture both bone leg were affected. In our study only 6 (15%) cases were having associated orthopaedic injuries. The male to female ratio is 19: 1.

All those cases who underwent fasciotomy were assessed according to limb residual deficit. The “Limb Residual Deficit “ was measured using classification proposed by Scott Mubarak and Charles Owen (1975) ¹² as :

- 01- **Mild** – Residual deficit consisted only of slight intrinsic contract with intact motor and sensory function.

- 02- **Moderate**- Limbs with digital hyperesthesia, intrinsic paralysis and contracture of only the muscles of deep compartment.
- 03- **Severe** – Limbs with marked sensory and motor loss with severe contracture (classical Volkmann's Contracture)

DISCUSSION

In present series one patient reached the peak pressure of 24 mmHg.(transient compartment syndrome) at 49 hrs. and started decreasing after 65 hrs. following injury. After 50 hours 12.5% patient required compartment pressure monitoring and only 5.1% patients after 60 hours. None of our patients required monitoring after 72 hrs. following injury. This series shows that compartment syndrome is not a uncommon(7.5%) complication of leg fracture. The raised compartment pressure is mainly associated with the fracture affecting the upper third of leg.

The patient need to be monitored for at least 72 hrs. following trauma. The critical pressure of fasciotomy is raising value of compartment pressure of 30 mmHg. with clinical signs and symptoms. It is mandatory to release all the four compartments of leg within 6 hrs. of diagnosis of acute compartment syndrome for favorable outcome.

TRANSIENT COMPARTMENT PRESSURE AND CRITICAL PRESSURE

Depending on severity of injury the patient are prone to develop compartment syndrome. In our present series 10 patients reached peak absolute pressure between 19 -29 mmHg. These patients were taken as having transient or impending compartment syndrome, out of which two (20%) developed compartment syndrome. The absolute pressure of 30 mmHg. in association with clinical findings was taken as critical pressure of fasciotomy. There was no correlation found between diastolic blood pressure and development of compartment syndrome, may be because none of the patient were hypotensive.

TIME INTERVAL BETWEEN INJURY AND FASCIOTOMY

In two cases, fasciotomy was performed within 3hrs. of reaching critical compartment pressure of 30 mmHg. In all the three cases double incision fasciotomy was done two of which developed mild squeal and came up with good result because of operating within 6 hrs. One case ended up with poor results because of delay in coming to the hospital hence delay in diagnosis and treatment.

It has been noted that delay of even 6-12 hrs. between onset of symptoms and treatment ends up with poor result as advised by Whiteside, Harada (1971), Ashton and Heath ¹¹.

CONCLUSION

The raised compartment pressure is mainly associated with the fracture affecting the upper third of leg. The patient need to be monitored for at least 72 hrs. following trauma. The critical pressure of fasciotomy is the raising value of compartment pressure of 30 mmHg. with clinical signs and symptoms. Release of all the four compartments of leg within 6 hrs. of diagnosis of compartment syndrome is required for favorable outcome.

ACKNOWLEDGEMENT

Authors acknowledge the immense help received from the scholars whose articles are cited and included in the references of this manuscript. The authors are also grateful to authors /editor/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

REFERENCES

1. Whitesides TE Jr, Haney TC, Morimoto K; Harda H: Tissue pressure measurement as a determinants for the need of fasciotomy, Clin Orthop 113:43,1975.
2. Watson JT. High energy fractures of the tibial plateau Orthop Clin North. Am 1994; 25:723-52.
3. Whitesides TE Jr, Haney TC, Morimoto K; Harda H: Tissue pressure measurement as a determinants for the need of fasciotomy,Clin Orthop 113:43,1975.
4. Child, C.G.III Noninfective Gangrene following fracture of lower leg Ann. Surg. 116:721-728, 1942.
5. Volkmann, R.V. Die ischaemischen muskellahmungen and Kontracturen.z. chir. 5 1, 1881.
6. Mubarak. S.J., and Hargens, A.R : Compartment Syndrome and Volkmann's Contracture . Philadelphia, W.B. Saunders,1981.
7. De Lee & StiehlClin Orthop Relat Res. 1981 Oct;(160):175-84.
8. Hargens, A.R.; Akeson ,W.H. Mubarak, S.J.; Owen; C.A.; Evans, K.L.,Garetto, L.P. ; Gonsalves, M.R.; and Schmidh, D.A. fluid Balance within the Canine Anterolateral compartment pressure and its relationship to compartment syndrome. J. Bone and Joint Surg. 60A: 505 1978.
9. Ellis, H.: Disabilities after tibial shaft fracture with special reference to Volkmann's ischaemic contracture J.Bone & Joint Surg. 40-B: 190-197, 1958.
10. Mc Queen, M.M., J. Christie, C.M. Court Brown.: Acute compartment syndrome in tibial diaphyseal fractures, J. Bone and Joint Surg., 78 B., No. 1 ,1996.
11. Scott J. Mubarak,M.D.,and Charles A. Owen.M.D., J. Bone and Joint Surg.,Vol. 59-A No. 2, pp. 184-187, March 1977.
12. Mubarak, Scott and Owen C.A.: Compartment Syndrome and its relation to the Crush Syndrome: A Spectrum of Disease. A Review of 11 cases of Prolonged Limb Compression. Clin. Orthop., 113: 81- 89, 1975.