ACUTE COMPARTMENT SYNDROME

EFFECT OF DERMOTOMY ON FASCIAL DECOMPRESSION IN THE LEG

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Prompt surgical decompression is the only means of preventing the late sequelae of ischaemic contracture in post-traumatic compartment syndromes. However, controversy exists regarding the length of dermatomy required for adequate decompression in the lower extremity. This study investigated the skin envelope as a potential contributing factor.

Wide fascial releases were performed through limited 8 cm incisions in eight cases of post-traumatic lower extremity compartment syndrome. In nine of 29 compartments the pressure remained greater than 30 mmHg. Lengthening the skin incisions to an average of 16 cm decreased intracompartmental pressures significantly.

This study documents the skin envelope as a contributing factor in acute compartment syndromes of the leg. The use of generous skin incisions is supported and the need for intra-operative compartment pressure measurements in the treatment of this condition is emphasised.

Prompt fascial release is the recognised treatment for acute compartment syndromes. However, controversy exists regarding the length of dermatomy required for adequate decompression in the lower extremity. Some authors have favoured limited incisions, claiming low morbidity as an advantage (Patman, Poulos and Shires 1964; Rosato et al 1966; Gaspar et al 1968; Bate 1972; Gaspard, Cohen and Gaspar 1972; Patman, Thompson and Persson 1973; Gaspard and Kohl 1975; Patman 1975; Hoopes and Maxwell 1979). Others have stated that long skin incisions are required to decompress affected compartments adequately (Mubarak and Owen 1977; Matsen, Winquist and Krugmire 1980; DeLee and Stiehl 1981; Rollins, Bernhard and Towne 1981; Hyde, Peck and Powell 1983; Mubarak and Hargens 1983; Bess 1984; Rorabeck 1984; Blick et al 1986; Noble and Banks 1986). Several instances in which the skin continued to cause compression after fasciotomy through short incisions have been reported (Gaspard et al 1972; Gaspard

and Kohl 1975), but measurements of intracompartmental pressure were not recorded in these cases.

This study was undertaken to determine the effect of the length of the skin incision in post-traumatic compartment syndromes of the lower extremity treated by fascial decompression. Intracompartmental pressures were measured using a wick catheter, which is known to give reliable and reproducible measurements (Mubarak et al 1976, 1978; Koman, Hardaker and Goldner 1981; Russell, Apyan and Burns 1985).

MATERIALS AND METHODS

Eight patients with lower extremity compartment syndromes were studied; their ages ranged from 19 to 64 years (mean 34). All had suspected compartment syndromes following lower extremity trauma. Pressure measurements were made using a wick catheter (Cutter Biomedical, San Diego). The indications for pressure measurements were painful swelling of the limb and a palpably tense compartment, usually with distal hypoaesthesia (Mubarak et al 1978; Mubarak 1984). An intracompartmental pressure greater than 30 mmHg was recorded in all patients. We and others have chosen this pressure as an indication for decompressive fasciotomy (Mubarak and Owen 1977; Mubarak et al 1978; Saffle, Zeluff and Warden 1980; Koman et al 1981; Hyde et al 1983; Bess 1984; Rorabeck 1984; Russell et al 1985; Blick et al 1986; Gershuni et al 1987; Siverhus and Amis 1988; Vitale et al 1988).

The injuries associated with the compartment

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syndromes were: closed proximal fracture of the tibia (with or without fibular fracture) in four patients; bilateral fibular fractures in one; a low velocity gunshot injury in one; and closed trauma to the leg without fracture in one patient with haemophilia.

Surgical decompression of the leg was performed using the double-incision technique, which employs an anterolateral and a posteromedial incision (Dennis 1945; DeBakey and Simeone 1946; Mubarak and Owen 1977) (Fig. 1). All affected osteofascial compartments were initially released through 8 cm-long skin incisions. Such incisions were considered adequate to allow complete proximal and distal fascial release. After the fasciotomy the compartment pressures were again measured. The pressure was recorded when equilibrium had been reached, usually five to 10 minutes after fasciotomy.

The anterolateral skin incision was then enlarged, in 2 cm increments, and the pressure was recorded after each extension until the readings showed no further change. The dermatomy extensions were necessarily performed without undue delay, to avoid the adverse effects of prolonged elevation of the intracompartmental pressure.

The posteromedial incision was enlarged only if the pressure in the posterior compartment was greater than or near to the critical level of 30 mmHg (25 to 30).

In all cases the fascial release performed through the limited skin incisions was adequate and at no time was additional incision of the fascia required during the extension of the dermatomies.

The compartment pressures before and after lengthening the skin incisions were compared using the paired Student's *t*-test.

RESULTS

The results are given in Table I. Pre-operatively, all patients had pressure greater than 30 mmHg in at least one compartment (mean 48 mmHg, SD $\pm$ 12). Following

Fig. 1

Cross-section at the level of the middle and distal thirds of the leg to illustrate decompression of the four fascial compartments using the double-incision technique.

fascial release, through the limited 8 cm incisions, the compartment pressures decreased to a mean 25 mmHg, SD $\pm$ 11.

However, in nine of 29 compartments the pressure remained above 30 mmHg. Four of these compartments were anterior, four lateral, and one was a deep-posterior compartment.

The anterolateral skin incisions were extended in them all and the posteromedial incisions in three. The final length of the extended incisions averaged 16 cm $\pm$ 4. The mean final pressure in the compartments which required extended incisions was 13 mmHg, SD $\pm$ 6. This was significantly less than the mean pressure recorded in these compartments before the skin incisions were extended ($p < 0.002$, Fig. 2).

DISCUSSION

Prompt surgical decompression is the only means of preventing the late sequelae of ischaemic contracture in post-traumatic compartment syndrome. In circumferential burns of the limbs, the skin is recognised to be the primary constricting envelope, and generous escharotomy is the treatment of choice (Kaplan and White 1961; Pruitt, Dowling and Moncrief 1968; Asch, Flemma and Pruitt 1969; Justis, Law and MacMillan 1976; Saffle et al 1980). However, in the traumatised limb, it is the strong fascial compartment boundaries which are the least responsive to internal pressure gradients, and all authors agree on the need for wide fascial release. Controversy exists only with regard to the length of the skin incisions.

The proponents of limited dermatomy (4 to 8 cm) cite as advantages a decreased risk of infection, shorter

Fig. 2

Pressure measurements (mean $\pm$ SEM) in 21 lower extremity compartments initially treated by fascial decompression through limited 8 cm incisions. Extension of the skin incisions to a mean of 16 cm resulted in a significant decrease in compartment pressures ($p < 0.002$).

healing time, better scars, and easier secondary wound closure. Long incisions have been said to cause more bleeding and to prejudice the distal circulation in the limb by damaging collateral vessels (Patman et al 1973; Patman 1975).

Others have recommended long skin incisions (15 to 30 cm) in all cases, using either a single lateral incision (Matsen and Clawson 1975; Nghiem and Boland 1980; DeLee and Stiehl 1981; Rollins et al 1981) or a double-

Long skin incisions are stated to add little to the morbidity and they eliminate the risk of the skin acting as an unrecognised compartment envelope. This is especially important in the hyperaemic period following decompression of an ischaemic compartment (Matsen and Clawson 1975; Whitesides et al 1977; Matsen et al 1980).

Sheridan and Matsen (1976) reviewed 46 cases of upper and lower extremity compartment syndrome treated either by 'open' fasciotomy (31 limbs) or 'closed'

Table I. Details of pressure measurements in eight patients with compartment syndrome

Case	Age/ Sex	Injury	Compartment*	Pressure in mmHg			
				Before operation	After fasciotomy through 8-cm skin incision	After extension of skin incision	Final length of skin incision (cm)
1	19/M	Closed fibular fracture	ANT	50	37	20	
			LAT	55	35	20	14
			SP	45	10		
			DP	55	17		8
2	19/M	Closed fibular fracture	ANT	46	34	21	
			LAT	40	37	16	16
			SP	50	22		
			DP	55	22		8
3	47/F	Soft-tissue	ANT	75	35	9	
			LAT	60	24	4	24
			SP	20	15	7	
			DP	55	10	20	14
4	64/M	Closed proximal tibial fracture	NT	65	5	5	
			LAT	55	25	10	12
			SP	45	18		
			DP	55	21		8
5	26/F	Closed proximal tibial/fibular fracture	ANT	35	20	15	
			LAT	35	16	10	12
			SP	45	26	20	
			DP	50	28	12	12
6	36/M	Closed proximal tibial fracture	ANT	65	45	17	
			LAT	55	32	12	18
			SP	30	16		8
			DP	35	22		
7	28/M	Low-velocity gunshot	ANT	60	18	7	14
			LAT	—	—		
			SP	—	—		
			DP	—	—		
8	14/M	Closed proximal tibial/fibular fracture	ANT	50	26	8	
			LAT	50	36	18	20
			SP	30	10	6	
			DP	32	25	9	16

* fascial compartments: ANT, anterior; LAT, lateral; SP, superficial posterior; DP, deep posterior

incision technique (Dennis 1945; Mubarak and Owen 1977; Whitesides, Harada and Morimoto 1977; Hyde et al 1983; Mubarak and Hargens 1983; Rorabeck 1983; Bess 1984; Blick et al 1986; Noble and Banks 1986). These authors thought that long incisions were necessary to allow adequate inspection and decompression of the compartments of the leg. A long anterolateral incision may also minimise the risk of injury to the superficial peroneal nerve, and a long posteromedial incision provides better access to the deep posterior compartment.

fasciotomy (15 limbs). The size of the dermatomy was found to influence neither the complication rate nor the late functional result. However, the two groups were not strictly comparable and intracompartmental pressures were not measured. Gaspard et al (1972) described two patients with lower extremity compartment syndromes who failed to improve clinically, despite adequate fasciotomies through limited incisions (5 cm). Both responded favourably to wide dermatomies of the calf.

Our study confirms that the skin is a potential

contributing factor in compartment syndrome. Though wide fascial releases were carried out in all patients, nine of 29 compartments remained under pressures greater than 30 mmHg. Lengthening the skin incisions significantly decreased the pressures.

Though we cannot predict what would have been the outcome in the limbs with 'limited' dermatomies, this study documents the potential contribution of the skin envelope in lower extremity compartment syndrome. The use of generous skin incisions is supported and the need for intra-operative measurement of the compartment pressures in the treatment of this condition is emphasised.

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