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REVIEW ARTICLE

Pelvic Compartment Syndrome : A systematic review

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Study carried out at the University of Louisville, KY, USA

Bilateral ureteral obstruction due to traumatic pelvic haematoma and increased pressure in the retroperitoneal space constitute an acute pelvic compartment syndrome.

We systematically reviewed the available evidence concerning pelvic compartment syndrome using an online search of the MEDLINE databases OVID and PubMed.

There were nine cases of pelvic compartment syndrome. A motor vehicle accident was the most frequent cause of pelvic compartment syndrome. Diagnosis was made using clinical and radiological methods in all cases. Treatment was by surgical decompression in 88% of cases. Observed complications were neurological deficits (44%), muscle atrophy (33%), and renal failure (33%).

Pelvic compartment syndrome is as serious as the more common compartment syndromes, requiring high vigilance for diagnosis and surgical decompression for treatment.

Keywords : acute ; pelvic ; compartment syndrome ; trauma.

INTRODUCTION

Bilateral ureteral obstruction due to a massive pelvic haematoma and increased pressure in the retroperitoneal space has been defined as an intrapelvic compartment syndrome (5). Atraumatic causes such as prolonged compression of pelvic tissue, anticoagulation, drug and alcohol intoxication, obesity, surgery, and epidural anaesthesia have also been reported. The incidence of this injury is unknown as there are few reports describing pelvic compartment syndromes or acknowledging its existence. The purpose of this study was to review the available evidence with respect to the causes, method of diagnosis, complications, and treatment of pelvic compartment syndrome.

METHODS

An OVID MEDLINE search was performed at a level one trauma centre mapped to the medical subject headings (MeSH) "pelvis" and "compartment syndromes" yielding 16 hits. Similarly, a PubMed search using the MeSH terms "pelvic compartment syndrome" yielded 124 articles. Date of the search was May 1, 2011. Consolidation of the articles yielded 140 articles with 16 articles excluded for reasons of duplication. One hundred twenty-four articles were screened for relevance to the study aims. One hundred and nine articles were

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excluded for irrelevant textual content. Full text copies of 15 articles were obtained and assessed for eligibility. Criteria for eligibility included full text articles in the English literature, discussing two or more cases of acute/traumatic pelvic compartment syndrome, to ensure more than an isolated, single experience with this entity. Criteria for exclusion were articles discussing an abdominal or lower extremity compartment syndrome. All publications were reviewed, and relevant articles were selected. This process yielded two articles (*2,5*) which were the subject of our review.

An intrapelvic compartment syndrome was defined as a rise in the pressure of the pelvis sufficient to cause compression of its organs including vascular and myoneural contents.

RESULTS

There were nine cases of pelvic compartment syndrome in these two publications (*2,5*). Average of the mean age was 43 years (range : 16-72 years). There were eight males and one female patient. A pelvic fracture was involved in five cases (56%), whilst the use of anti-coagulation was a contributing factor in 1 case (11%) (*2,5*).

Causes

The most frequent cause of pelvic compartment syndrome was due to a motor vehicle accident (33%) (*5*). Other causes include fall (22%), crush injuries (11%), and surgery (11%) *(2)*. Atraumatic causes of pelvic compartment syndrome included infection in one case (11%) and drug/ alcohol abuse with compression injury in one case (11%) (Table I).

Diagnosis

In all cases, a diagnosis of pelvic compartment syndrome was made using a combination of clinical and radiological means.

Complications

The complications (Table III) associated with pelvic compartment syndrome included renal failure in three cases (33%) (5), pain problems in two cases (22%) (*2,5*), and muscle atrophy in three cases (33%) (*2*). Neurological deficits affecting motor and sensory function were observed in four cases (44%) (*2,5*).

Treatment

Operative treatment was carried out in 88% of cases (8 out of 9) by fasciotomy of the involved compartments and removal of haematoma. Ligation of bleeding vessels was performed in three cases (33%). One case (11%) was treated non-operatively (*2,5*).

DISCUSSION

The intrapelvic compartment lies in continuity with the posterior abdominal wall at the intercristal line (L4), and is limited distally by its inferior musculoskeletal boundaries. The dense, unyielding fascia over the iliopsoas provides attachment and support for the parietal peritoneum and retroperitoneal structures. Blood supply to the pelvis through the branches of the internal iliac and exter-

Table I. — Causes of Pelvic Compartment syndrome

Author	Infection	Surgery	Fall	Crush injury	MVA	Drug/EtOH related	Traumatic	Atraumatic
Bosch and Tscherne 1992	1	1	2	1	–	1	5	1
Hessman and Rommens 1998	–	–	–	–	3	–	3	–
Total	1 (11%)	1 (11%)	2 (22%)	1 (11%)	3 (33%)	1 (11%)	8 (89%)	1 (11%)

MVA : motor vehicle accident ; EtOH : ethanol

Table II. — Diagnostic pearls for pelvic compartment syndrome

Clinical History	Clinical Features
History of trauma or pelvic fracture	Cardiovascular : Hypotension, pulselessness, pallor
History of anti-coagulation or haemophilia	Abdominal : palpable lower abdominal mass
	Musculoskeletal : pelvic fracture, pelvic surgery
	Genitourinary : decreased urine output
	CNS : decreased reflexes, decreased sensation, paraplegia, residual nerve deficits, pain with passive muscle stretch

Table III. — Complications

Authors	Infection	Pain	Muscle Atrophy	Sensory and motor deficits	Renal Failure
Bosch and Tscherne 1992	2	2	3	3	–
Hessman and Rommens 1998	–	–	–	–	3
Total	2 (22%)	2 (22%)	3 (33%)	3 (33%)	3 (33%)

nal iliac arteries provide a rich network of vessels that produce massive bleeding when disrupted. The pelvic vessels commonly injured in pelvic trauma are the superior and inferior gluteal vessels, iliolumbar vessels, lateral sacral, obturator, and vesical vessels. The ureters descend retroperitoneally into the pelvis over the psoas muscle, medial to the lumbar vertebrae transverse processes, cross the sacro-iliac joint anteriorly over the internal iliac artery branches to enter into the base of the bladder. The sciatic nerve, femoral nerve, and obturator nerves (due to their anatomical positions in the pelvis) could be affected by increased pressures in the pelvis. The femoral nerve is formed from the L2-L4 nerve roots within the fibers of the iliopsoas. The iliopsoas muscle with the femoral nerve lies tightly covered by the iliac fascia over the iliac bone and is easily compressed by haematoma formation deep in the psoas muscle. Associated obturator nerve injury could also occur due to sacroiliac trauma as the nerve crosses anterior to the sacral ala or ischaemic injury from a psoas muscle haematoma compressing the nerve as it exits medially through the psoas muscle fibres running along the lateral pelvic wall.

Pelvic compartment syndrome due to increased pressure in a packed pelvis often leads to myoneural necrosis and organ failure. Trauma to the pelvis including unstable pelvic fractures easily leads to vascular compromise and significant pelvic bleeding causing compressive symptoms of pelvic organs. Anti-coagulant therapy in the presence of pelvic fracture may be an important association (*8*). The femoral nerve and lateral femoral cutaneous nerves are susceptible to stretching and compression by a haematoma within the iliac muscle due to disruption of the branches of the ilolumbar artery by trauma (*7*). The cord-like tubular ureter is susceptible to kinking and compression due to stretching of the bladder and ureter by haematoma or an intra-mural compression within the bladder (*5*).

The advent of hip arthroscopy has also raised awareness of pelvic compartment syndrome. Extravasation of fluid from the joint capsule along the iliopsoas muscle into the retroperitoneum during hip joint arthroscopy could lead to a compartment syndrome. Traumatic or operative tears of the joint capsule, high irrigation pressures, prolonged surgery time, extra-articular surgery have been identified as some of the contributing factors (*1,4,10,12*). Spine and pelvic surgery, obesity and epidural anaesthesia also contribute.

Burning pain, tenderness of the pelvis, pelvic instability, lower extremity and pelvic muscle weakness, swelling of the buttocks, renal failure with relevant causative history could be tell-tale signs of pelvic compartment syndrome. Other typical symptoms of a compartment syndrome-

pain with passive stretch, pallor, pulselesness, and paraesthesia may be present (Table II). Worsening haemodynamic signs in a patient with pelvic fractures may represent a rapidly expanding haematoma and an increased risk of pelvic compartment syndrome.

Anuria and renal failure following pelvic trauma and massive retroperitoneal bleeding may not be fully accounted for by hypovolaemic shock (*13*). A differential diagnosis of pelvic compartment syndrome should be explored with ultrasonography or CT scans, especially when poor renal function persists despite aggressive fluid resuscitation and red cell transfusion. A compressive cause of anuria may be specifically suggested by a high blood urea nitrogen to creatinine ratio, distended bladder and renal calyces on bladder or pelvic scan, large pelvic haematoma on CT scan, and intra-operative findings of urinary obstruction. Inability to distend the hip joint, higher than usual fluid requirements, frequent cut-off of irrigation pump systems, enlarging thigh-abdomen areas during hip arthroscopic surgery may signal rising pelvic compartment pressures.

Pelvic CT scan or ultrasound may demonstrate sub-fascial haematoma and diffuse muscle oedema. Gd-DTPA-enhanced T1-weighted MR images with fat suppression increases contrast between bright enhancing areas and non-enhancing normal tissue (*9*). In obtunded or sedated polytrauma patients, a high index of clinical suspicion, close monitoring of renal function and radiological signs help to make a diagnosis of pelvic compartment syndrome. There are no studies demonstrating the effective pressures at which ureteral flow is diminished by rising pelvic pressures.

Delayed diagnosis of compartment syndrome frequently leads to local ischaemic changes, acidosis, muscle necrosis and renal failure. Myoglobin released from traumatised pelvic musculature and filtered by the kidneys could induce toxic changes within renal tubules leading to renal failure too. Deep pelvic infection as a fall out of prolonged haematoma formation could also occur. Gluteal muscle atrophy, gait abnormalities, varying degrees of paraesthesia involving the gluteal area and the lower extremities has been described. Femoral ischaemic neuropathy could lead to groin pain, hip flexion contractures, anterior thigh paraesthesia, weakness and atrophy of the quadriceps muscle (*11*). Recovery from neurological deficits may be incomplete, requiring the use of walking aids (*8*). Rapidly developing pelvic compartment syndrome could lead to an abdominal compartment syndrome as a break in the continuity of the iliopsoas fascia due to injury (fracture fragments) or surgery could lead to a breach in peritoneum. We demonstrate an infection rate of 22%, neurological deficits of 33%, and a renal failure rate of 33% (Table III). Causes of mortality include sepsis-induced multi-organ damage, ventricular fibrillation, and renal failure.

Surgical decompression of pelvic compartment syndrome through early fasciotomy and haematoma evacuation prevents further hemodynamic and neurological complications. Bleeding from a ruptured superior gluteal vessel may be difficult to arrest or visualise directly during surgery ; therefore, radiological location of pelvic arterial bleed positively assists successful pelvic bone surgery (*3*). Percutaneous drainage of iliopsoas haematoma could be utilized in femoral nerve decompression. Pelvic arterial embolisation following angiography may be required prior to decompression if an active bleed is suspected. Stabilisation of pelvic fractures with external fixation also helps control bleeding. Fasciotomy often reveals soft tissue swelling with or without frank muscle necrosis. All necrotic tissue needs to be excised. The proximity of open wounds from surgical decompression to the groin area increases the risk of contamination by urinary and fecal flora. Early closure is advocated to prevent infection. Concerns of sepsis require pelvic lavage and washout (*5*). Serial CT or ultrasound evaluation of the pelvis may evaluate resolution of the haematoma. Other reports describe conservative management of femoral nerve compression neuropathy (*6*). Bosch *et al* described no loss of gluteal function despite decrease in muscle bulk and strength in 50% of cases following pelvic compartment syndrome (*2*). Morbidity could be significant. Nowadays, early stabilization of pelvic fractures and more urgent control of haemorrhage have helped reduce the impact and prevalence of a pelvic compartment syndrome.

CONCLUSIONS

Pelvic compartment syndromes are rare but just as serious as the more common compartment syndromes. More large scale studies are needed to further determine management guidelines for pelvic compartment syndrome. The number of reported cases and available evidence are extremely limited.

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