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Percutaneous Stabilization of The Anterior Pelvic Ring In Pelvic Ring Trauma - A Novel Technique

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Introduction

Pelvic fractures usually result from high-energy trauma and are often associated with several other injuries. During the acute phase of management, the orthopedic surgeon will often combine efforts with other specialists, particularly the general surgeon and the urologist. Management of the commonly associated internal blood loss is paramount during the initial period. Steps taken to manage blood loss can include the administration of intravenous crystalloid solution with the possible addition of whole blood. Provisional stabilization of the pelvic ring with an external fixator can restore a distorted pelvic ring to a roughly normal configuration and thereby aid in tamponade in case of bleeding with persistent haemorrhage [1,2].

Angiography may be employed with the possibility of angiographic embolization or surgical intervention if the source of the bleeding is the external or internal iliac arterial system [3]. Open pelvic injuries are often associated with rectal or peroneal lacerations thereby increasing the risk for morbidity and mortality multifold [4].

These should be recognized immediately and treated by irrigation and debridement of the fracture as well as by a diverting colostomy. Urologic injuries are commonly associated with pelvic fractures; therefore, an intravenous pyelogram, as well as a dynamic retrograde urethrogram, should be performed when significant anterior pelvic disruptions are present. A thorough initial neurologic examination should be performed whenever possible. Associated lesions of the lumbar and sacral nerve roots, the lumbosacral plexus, or their peripheral nerves are quite common. Late diagnosis of these lesions will introduce the question of whether the neurologic lesion was caused by the injury or was iatrogenic.

Beside general measures of circulatory stabilisation, reconstruction of pelvic anatomy and thereby restoration of a stable, non-expandable compartment is the main goal in patient management; especially the reconstruction of the posterior pelvic ring is of great importance as it is a major contributor to the stability of the pelvic ring. On the other hand, biomechanical studies have also shown that additional osteosynthesis of anterior lesions significantly improves stability. It seems that the structures of the abdominal wall inserting at the anterior structures of the pelvic ring mainly account for this instability [5]. For this reason, it has been proven necessary to re-establish the integrity of the anterior pelvic ring as well especially in case of an unstable type C lesion.

In addition to diagnosis and treatment of these several acute problems associated with pelvic ring injuries, the surgeon must also simultaneously treat the problems related to the bony disruption itself. The treatment should be directed toward correction of significant deformity, prevention of late non-union and instability, and ensuring a pain-free, satisfactory function.

Complications of External Fixator

The complications associated with external pelvic frames include pin tract infection in 2.5% to 50% of patients, osteomyelitis in 0% to 7% aseptic loosening in 0% to 19% and loss of reduction in 0% to 33% of rotationally unstable injuries treated with a standard anterior external fixator [6-17]. Loss of reduction in vertically unstable pelvic injuries treated with an isolated anterior external fixator is reported as high as 95% and as low as 0% to 8% when combined with posterior fixation.

Compression of the skin and subcutaneous tissues against the fixator frame has been documented in up to 8% and nerve damage in 0% to 7% of these patients [7-9,11,14]. An anterior pelvic external fixator limits patient mobility, especially when sitting and when being rolled from side to side. In obese patients, external fixation is particularly difficult because the

distance from the pelvis to the bar clamp can be 10 to 15cm, which decreases the stability of the construct and makes large, gaping pin tracts. The external fixator is convenient for the surgeon but is unsightly and cumbersome for the patient. Several articles have advocated constructs with a single pin in the dense supraacetabular region of each ilium. One biomechanical study suggests these anteroinferior pins produce more stable constructs than conventional anterosuperior or iliac pins in rotationally and vertically unstable fracture patterns. The pins are then connected to an external bar or a femoral distractor, which can help reduce the anterior pelvic injury.

The anterior subcutaneous pelvic external fixator is a novel technique for stabilization of the pelvic ring in such patients.

Anterior Subcutaneous Pelvic Internal Fixator Application

Operation technique

The following instruments are required:

a. Long, thick K-wire

b. Small Langenbach retractors

c. Wire / rod cutters

d. Screwdriver

e. Two iliac screws 6.5mm

f. Flexible titanium connecting therod

g. Standard tubular rods as back up

h. Rod bending devices

i. Crew caps for pedicle screws or indigenous caps for the Schanz pins and

j. Holding theinstrument for the bending rod.

Surgical steps

With the use of fluoroscopy, the first step is to mark the entry points for the iliac screws, which could be 3.5 mm poly axial pedicle screws or the standard Schanz pins, whose position should be located in the centre of the supra-acetabular triangle. For this, the fluoroscope needs to be directed roughly 30° caudally and at 30° inclination in thelatero medial direction in order to obtain an outlet- and obturator oblique view. The safest screw placement occurs when the screws are placed in the centre of the teardrop as visualized on the obturator oblique outlet view. Skin incisions are performed on both sides roughly 3cm medial and 4cm distal of the easily palpable anterior superior iliac spine. Blunt dissection is performed up to the anterior inferior iliac spine. During dissection, extra care needs to be taken to not injure the lateral cutaneous nerve of thigh. A security margin of at least 1.5-2.0cm to the radiological hip joint line is to be adhered to since the insertion of the hip capsule is in close proximity to the trajectory of the screw. As a general guideline, drilling direction should be aimed 20 degrees craniocaudal and 30 degrees medial. The correct position of the supracetabular screw should be confirmed by one of two parameters; first by the feel of bone while performing the drilling of the screw in a start-stop fashion and secondly by observing the intrabony positioning of the screw on obturator oblique inlet view. Supra-acetabular K-wire placement as also the placement of the iliac bone screw is ensured through fluoroscopic control as the wire is advanced towards the ipsilateral sacroiliac joint.

The stabilization of the correctly placed screws in the bilateral iliac crest can be performed by either by using the connecting rods as in the 3.5mm pedicle screws or by tubular clamps if Schanz pins are utilized for supracetabular fixation.

Placement of percutaneous connecting rod under fluoroscopic guidance

It is important that a distance of roughly 2cm is kept between the bone and screw head in order to avoid later vessel compression following the introduction of the trans fixation rod. A flexible test rod (preferably made of titanium) is used to connect the two supracetabular screws. For easier fixation, the rod is preventing to enable smoother seating and to avoid irritation of the structures in the inguinal region through which it is passed. The rod is inserted through one of the supra-acetabular incisions and gently advanced in the subcutaneous layer. The risk of rod malpositioning can be minimized as correct rod advancement is ensured by placing one hand on the patient's abdominal wall for palpation. When the rod has reached the contralateral side, it can be grasped with the rod grasping forceps and is then guided through the hole in the iliac screw. Correct rod positioning is then verified and documented fluoroscopically. Care is taken that the rods do not violate the femoral neurovascular structures and a portable Doppler may be used to ensure the same.

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The rod is inserted through one of the supra-acetabular incisions and gently advanced in the subcutaneous layer. When the desired position of the rod is achieved, it is fixed to the iliac screw on one side. Following this, the pelvic ring injury is reduced through lateral compression and if necessary leg traction and internal rotation. The assistant manually maintains reduction as the surgeon fixes the rod to the iliac screw again using the top screws or nuts in case of the pedicle screw system or a tubular rod in case the standard tubular rod system is utilized for stabilization.

The indication for this surgery is an unstable pelvic fracture which requires stabilization of the anterior pelvic ring. The contraindications to performing the procedure in isolation are hemodynamically unstable patients, patients with significant posterior instability and patients with Morel Lavalle lesions. The procedure can, however, safely be performed in patients in

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whom the posterior pelvic ring has been stabilized by alternative methods of stabilization viz. iliosacral screws.

Postoperatively, these patients can be toe-touch weight bearing on the side of the posterior injury and weight bearing as tolerated on the side without a posterior injury. Patients with bilateral posterior pelvic injuries remain non-weight-bearing. The weight-bearing protocol is usually dependent upon the personality of the injury and can be started at 8 to 12 weeks post-injury depending on radiographic evidence of healing of fractures, patient tolerance and advanced as tolerated.

Patients are invariably reviewed on an outpatient basis at 6 weeks, 3 months, 6 months, 1 year, and at latest follow up. The patients are interviewed about their ability to sit, trouble with ambulation, impingement and discomfort because of the implant. The patients stabilized with pedicle screws and subcutaneously tunnelled rods usually have a better function than do patients in whom the traditional method of external fixation is used.

Common complications include loss of fixation or reduction, infection, heterotopic ossification, and lateral femoral cutaneous nerve irritation. (paraesthesia, numbness, or pain that disappeared) or injury (paraesthesia, numbness, or pain that was persistent).

The radiographic images at eachfollow-up visit include an Anteroposterior pelvis and inlet and outlet views. Healing is determined by a progression of callus formation until theradiographic union and the ability to weight bear without pain. Loss of reduction is determined by failure of the implants to hold the reduction obtained, and failure of fixation is assessed by implant breakage or loosening at the screw-bone interface.

The percutaneous external fixator is intended as a temporary treatment with removal typically performed after 12 weeks. The technique involves stabilization of the anterior pelvic ring allowing the pelvic and/or associated acetabular fractures to heal without the morbidity of a formal open procedure. The technique requires fixation using a subcutaneous fixator or a standard Schanz pin external fixator. The subcutaneous device requires removal in the operating room, unlike an external fixator that may be removed in an outpatient setting. Disruptions of the pelvic ring are complex injuries and should be managed on a case-specific basis. Several complications, including technical errors, can be avoided by adhering to a proper technique and being familiar with the implants. Infection rates (3%) and pin loosening (0%) all of which are low but heterotopic ossification and irritation of the lateral femoral cutaneous nerve are common.

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