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**MINIMALLY INVASIVE OSTEOSYNTHESIS IN PLEVIC TRAUMA-
APPROACHES AND VISIONS FROM CLINICAL PRACTICE**

***Abstract.** In this study, we intend to study general problems of plevic trauma, available treatment methods minimally invasive and some recommendations or else, visions to evaluate and select the optimal treatment for pelvic ring fractures, to improve quality of life of patients and to reduce the intraoperative risks and incidence of post-traumatic disability.*

***Keywords:** pelvic lesion, pelvic ring, minimally invasive osteosynthesis.*

Introduction

Pelvic trauma is one of the most difficult problems in the lesion surgery, and its frequency is 3-7% of the total number of lesions in the musculoskeletal system. The pelvic ring is a closed bony space where the organs of the genitourinary system, the organs of the gastrointestinal tract, blood vessels and nerves are located. The pelvis is composed of the anterior ring of the pubic and ischial rami connected with the symphysis pubis. A fibrocartilagenous disc separates the two pubic bodies. Posteriorly, the sacrum and the two innominate bones are joined at the sacroiliac joint by the interosseous sacroiliac ligaments, the anterior and posterior sacroiliac ligaments, the sacro-tuberous ligaments, the sacrospinous ligaments, and the associated iliolumbar ligaments. This ligamentous complex provides stability to the posterior sacroiliac complex.

X-ray investigation (radiographs and computed tomography) of pelvic ring lesions is fundamental in choosing a treatment algorithm and a particularly minimally invasive stabilization method.

Establishing the diagnosis and imaging preoperative examinations:

– *Pelvic radiography* helps identify life-threatening pelvic ring lesions. The main types of injuries associated with hemodynamic instability are sacral fractures, open book fractures and fractures with vertical displacements of the pelvis.

– *Computed tomography* (CT) is the "gold standard" for diagnosing skeletal bone lesions with increased sensitivity and specificity for pelvic fractures.

Surgical treatment of open internal osteosynthesis usually involves extensive surgical exposure of the internal anatomical structures of the pelvis, which can subsequently cause delays in wound healing, injury to vessels and nerve plexuses, and an increased incidence of infection of up to 25%. Most of these complications are mainly related to surgical exposure, rather than the initial injury. Therefore, it seems reasonable to consider less invasive alternatives whenever possible. Minimally invasive internal osteosynthesis in skeletal fractures is the present and future of traumatology. The problem is becoming more current in the pelvic fractures because it allows the patient to recover earlier, decrease the number of inpatient bed days and return to daily activity, but it is a real challenge for the

surgeon and the surgical team. A detailed knowledge of the pelvic anatomy as well as the deviations or peculiarities of each pelvis is required. This is why preoperative planning cannot be performed only on the basis of simple radiological investigations, but computed tomography is required, which is currently the "gold standard" in preoperative diagnosis. Based on computed tomography, the line of fractures, the movement of bone fragments, the need to reduce fragments, the diameter and size of metal implants expected to be used in osteosynthesis are clearly seen. Minimally invasive osteosynthesis reduces the risk of intraoperative hemorrhage and depending on the practice and skill of the surgeon decreases the duration of surgery.

Mortality, high invalidity rate and the fact that surgical treatment is not standardized, make the medical challenge even more difficult. Even the AO Foundation offers only recommendations, but the final tactic of osteosynthesis is determined by the traumatologist for each patient, and then pelvic osteosynthesis becomes an art and a mathematical calculation, in which there are many unknowns. Each pelvic region has a separate function: support, transmission of weight forces, stability, maintenance of internal organs, transit point for vessels and nerves, having physiological features at different ages and different sexes. It can be traumatized by high kinetic energy in young people, low kinetic energy in the elderly or even during childbirth. There are many aspects that can only be understood from clinical practice and deserve to be exposed. The minimally invasive osteosynthesis of the pelvic ring is part of the methods of internal fixation in the pelvic fractures and is performed under general anesthesia.

The internal fixation of pelvic ring fractures

Unstable posterior semi-ring lesions, rotational or vertically unstable lesions are an indication for open reduction and internal fixation. In some cases of pelvic injury with lateral impact, with rotational instability, a temporary external fixation is required followed by the internal fixation of the semi-rings both anteriorly and posteriorly. Methods of fixing pelvic semi-rings are still the subject of discussion. The osteosynthesis method is selected individually. Minimally invasive percutaneous fixation is indicated for unstable fractures in which fragments have

been reduced either by non-invasive orthopedic procedures or by invasive methods of reduction and external fixation and allow early loading of body weight. Minimally invasive percutaneous fixation per primam can be performed only in the case of hemodynamically stable and mechanically unstable lesions.

Anatomical reduction and stable fixation of rotational and vertically unstable pelvic lesions are a necessary condition for early functional rehabilitation. In many clinics it is unanimously accepted that pelvic bone fractures with posterior seminal ring instability require internal fixation. Classifications based on the mechanism of trauma allow the determination of indications for surgical treatment. Several methods of internal fracture fixation are known: open reduction and fixation of the pubic joint with plaque, minimally invasive percutaneous fixation or spino-pelvic fixation of unstable sacral bone lesions and sacroiliac joint disjunction, plaque iliac wing osteosynthesis, combined osteosynthesis or posterior plate osteosynthesis for posterior semi-ring lesions, including vertically unstable sacral fractures. In some cases, lateral compression fractures are fixed with an additional external fixator for a period of 6 weeks, which prevents rotational instability in the anterior semi-ring. A minimally invasive "internal fixation" of the anterior semi-ring may be an alternative. Finally, the goal of internal fixation of unstable pelvic lesions is the possibility of early functional rehabilitation, reduction of disability, reduction of chronic pain and complications that are traditionally associated with long-term immobilization.

The percutaneous approach to pelvic fractures has gained popularity and has been adopted by many pelvic surgeons due to the following rationale:

1. In spite of the pelvis's complex structure, a pelvic ring fracture is not an intraarticular fracture in which a perfect reduction needs to be achieved by almost all means. The surgeon often gives up absolute anatomical reconstruction to avoid extensive exposure, and might accept "near anatomical" reconstruction without significantly affecting the clinical outcome.

2. The percutaneous approach does not entirely eliminate the need for a more "open" traditional approach but rather complements it and can be used to minimize open approaches in certain areas where it can be safely implemented.

In case of percutaneous surgery of pelvic fractures, the same rules apply as for percutaneous long bone fracture fixation; surgery should be performed according to a combination of the following three stages: understanding the different fracture components including preoperative planning, indirect reduction techniques, and percutaneous fixation.

The intraoperative features

The radiology

Intraoperatively, the key element is the radiological guidance, which is why the assistant radiologist-assistant plays a key role in the surgical workforce. The role of radiologist assistant can be fulfilled both by the radiologist laboratory and by the assistant surgeon who has skills and knowledge in handling the Rhenghen TV device located in the operating room. The mobile C arm allows obtaining the necessary radiological images that are different for each pelvic anatomical segment.

Percutaneous surgery requires a profound understanding of pelvic anatomy as well as the utilization of imaging and percutaneous reduction and fixation techniques. These are totally different and more complex than those required for long bone fixation.

Fixation treatment is recommended to be started with the posterior semi-ring for which the greatest role is assigned in 70% stability but also by the fact that if the surgical treatment will be divided into several stages due to hemodynamic instability of the patient under anesthesia.

Types of minimally invasive percutaneous internal osteosynthesis

– percutaneous fixation with ilio-sacral screws

Roult et al. described percutaneous fixation with iliosacral screws, for sacroiliac dislocation, and sacral fractures, demonstrating it to be a safe, reproducible method which is biomechanically stable with reduced blood loss and infection. Mears et al. have shown in vitro that mechanically a single screw offers the same biomechanical stability than an intact basin. Yinger K and Van Zwiennen CM, in their two comparative studies indicate a high biomechanical stability with double sacroiliac screw in fractures with vertical instability.

Ilio-sacral screws can be inserted S1, S2 and even S3. The surgical technique being the same. Depending on the bone stock. The planing, the direction of the diameter and the length of the screws, the level of osteosynthesis are performed based on computed tomography and differ from case to case. One of the key elements of success is finding the correct entry point as well as the correct radiological image inlet view and outlet view. The “inlet” incidence is obtained by rotating the device at cranial 40°. This can demonstrate sacral fractures, anteroposterior displacements of the pelvic ring and the degree of rotational displacement of the affected hemipelvis. Also, sacroiliac and pubic disjunctions are well visualized on this incident. The "outlet" incidence is obtained by rotating the radiological apparatus at 45° caudal. This incidence highlights the fractures of the iliac wings and of the hamstring branches. And at the end, the image that shows us that the nut of the cannulated screw was placed on the bone allowing the compression of the displaced fractured fragments is crucial. In the osteosynthesis of the posterior fragments, both screws in S1 and in S2 are recommended in order not to allow subsequent rotational movements.

– *antegrade and retrograde intramedullary pubic ramus screws*

The retrograde or antegrade pubic screw fixation is also technically demanding and risks screw misplacement even with intraoperative image intensification and should be performed with caution. When the canal diameter at the acetabulum is extremely narrow, this type of surgery should not be performed. The organs at risk include the bladder, iliac artery, and iliac vein that are close to the pubis. Placement of a urinary catheter affects the distance from the pubis to the bladder. To avoid injuring the iliac artery or vein, the screw should not protrude posteriorly in the parasymphyseal area and superiorly around the medial margin of the acetabulum.

Medullary screw fixation of the superior pubic ramus is inserted either “retrograde” from the pubic tubercle directed posterior-cranial-lateral, or “antegrade” beginning in the superior-posterior acetabular area and directed anterior-caudal-medial. The incision is made only after the perfect starting point and aim are established, using a small-diameter wire and image intensifier guidance. The

skin incision for a retrograde screw is located on the contralateral side, lateral to the midline and caudal to the pubic tubercle.

In the osteosynthesis of the pelvic branch according to the surgical practice we have, it is recommended either 2 Rx tv in 2 projections (The inlet view is used to ensure that the drill and later the screw do not penetrate the inner cortex of the ramus. The obturator oblique view is used to ensure that the drill and later the screw do not penetrate the acetabulum.) fie CT intraoperator. The diameter of the screws is recommended 3.2. And the length calculated depending on the CT.

– *iliac wing screws*

– *transverse screws*

Indications, contraindications, limits

Unstable pelvic ring injuries, especially in polytraumatized patients, require anatomical reconstruction and stable fixation to allow for early function. The surrounding anatomical vicinity is characterized by vital and vulnerable structures, and therefore the percutaneous surgical approach becomes an attractive option for the treatment of these injuries. Percutaneous techniques may offer a shorter surgical time, reduce exposure-related hazards and decrease soft-tissue disruption. The soft-tissue planes remain undisturbed. In patients with severe comminution and osteopenia, the percutaneous technique is useful as a means of preserving bone stock. It does not decompress the pelvic hematoma and therefore surgical stabilization is possible without the risk of additional hemorrhage.

Percutaneous fixation is recommended when a number of essential criteria are met and only after an accurate reduction has been achieved, avoiding residual displacement which can endanger the adjacent neural and vascular structures associated with compromised outcomes and function. The use of the technique is precluded in displaced fractures which are irreducible by closed means, sacral dysmorphism, and other unusual pelvic anatomical variations. Safe insertion of an iliosacral screw is impossible in such patients and is determined by the preoperative radiological studies. The method cannot be used if intraoperative image intensification is inadequate because of morbid obesity or intraabdominal contrast agents.

Together with understanding the 3-D structure of the pelvis, the surgeon performing minimally invasive pelvic surgery must recognize the adjacent susceptible organs found within the pelvis and around it. Percutaneous surgery demands total comprehension and recognition of the specific safe zones of each one of the screws. The concept of osseous fixation pathway (OFP) determines the specific safe zones of each part of the pelvic ring and helps the surgeon to recognize not only dysmorphic pathways but also to plan the direction of an implant and its possible dimensions .

Summary

Percutaneous screw fixation of fractures of the pelvis is a relatively new procedure and the indications for its use are not yet fully defined. Only experienced surgeons with a thorough knowledge of the bony and soft-tissue anatomy of the pelvis should undertake these techniques. The surgeon must always be prepared to convert to a formal open approach in the event of inadequate imaging or reduction by a percutaneous technique. Although inadequately reduced fractures treated by the percutaneous technique are unlikely to have a better outcome compared with anatomical open reduction, the decreased complication rate may compensate for this and allow the surgeon to accept slightly more articular displacement.

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