Journal of Orthopedic Surgery and traumatology

review article

Pelvic fractures: update

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Abstract: Pelvic fractures pose a challenge both in their diagnosis and in their treatment. The initial management of these fractures is key when it comes to the prognosis and correct subsequent treatment of these patients. In addition, they have a high morbidity and mortality that sometimes determines the definitive treatment. It is key to know the classification, to understand the mechanism of production of the fracture , since it can give us valuable information on other associated organic lesions. The treatment as early as possible when the patient's condition allows it, is key to obtaining a possible reduction of the fracture, as well as an optimal functional result. Finally, it is important not to forget the sequelae associated with these fractures, which can affect the quality of life of the patient.

Keywords: pelvis, stabilization, damage control

1. Introduction

Pelvic fractures have a demographically bimodal distribution: occur by a high-energy mechanism in young patients and by a low-energy mechanism in elderly patients.

There is a high association with lesions in the thorax (63%), in the long bones (50%) or in the spine (25%). In addition, the proximity of the osteoligamentous structures and vascular/nervous structures with respect to the pelvis facilitates the associated injuries. The importance of these fractures is that on many occasions there are injuries to internal organs, with a mortality of around 1-15% and up to 50% if the fracture is open. [1]

We must be careful with the internal bleeding associated with these fractures, since they are the most frequent cause of death. Nor should we forget that in 45-50% of cases there is an associated sacrum fracture, which can modify the type of treatment to be followed [2].

There are 3 main types of mechanisms by which a pelvic fracture occurs : -

Anteroposterior mechanism: typical of falls > 3 meters, motorcycle accidents, run overs. It is the one with the highest risk of intraperitoneal bleeding and associated abdominal visceral injuries [3]

- Lateral mechanism: most frequent mechanism in motorcycle-car. Association with TBI, chest injuries and bladder injuries. The most frequent cause of death is TBI.

- Vertical mechanism: axial forces that cause a disruption of the hemi- pelvis. Associated with intra-abdominal injuries and TCE [4]

2. Anatomy

The pelvis has a very important osteoligamentous complex, which, together with the sacroiliac joints and the pubic symphysis, allow minimal movement of the pelvic bones since it is not inherently stable.

It is a ring-shaped structure, in such a way that if the ring is broken and there is displacement , there must be another area where there is injury to allow this. The greatest transmission of loads works through the structure of the posterior ring , which gives the key with regard to pelvic stability. The pelvic bones themselves are not stable, and therefore the integrity of the ligaments is crucial for the maintenance or loss of stability [5]

Understanding the function of the ligaments is essential since if there is a rupture of the same, there will be a specific displacement of the fragments. The posterior sacroliac complex is worth noting , as it forms part of the most powerful ligaments in the body, and is more important than the anterior structures in pelvic injuries for stability [6]

-Anterior sacroiliac ligament: resists external rotation
-Sacrolilac interosseous ligaments: resists anteroposterior translation
-Posterior sacroiliac ligaments: resists cephalocaudal displacement
-iliolumbar ligaments: resist rotation

Likewise, the importance of the iliolumbar ligament must not be forgotten [7,8]. This starts from the transverse process of L5 and inserts into the iliac crest. It contributes to the stability of the sacroiliac joint and also to lumbosacral stability- cra. Avulsion of the L5 transverse process is a marker of posterior pelvic instability . [9]

Apart from the importance of the osteoligamentous structures, it is worth noting the nervous and vascular anatomy.

Regarding the nervous structures, the branch of the lumbosacral plexus crosses anterior to the sacral wing and sacroiliac joint. The L5 nerve crosses the sacral wing 2 cm medial to the sacroiliac junction. [10,11], and it is of great importance both for the proportion of associated nerve injuries and for the surgical approach.

The exit of the following nerves from the lumbosacral plexus should be noted: - Lateral femoral cutaneous nerve: wide variations, but in general it is found below the inguinal ligament 15-20 mm medial to the anterosuperior iliac spine . There is a risk of damaging it when the window of the ilioinguinal approach is performed .

- Obturator nerve: passes anterior to the transverse process of L5 and the iliolumbar ligament.

- Sciatic nerve: exits through the infrapiriform foramen - Superior gluteal nerve: anterior to the sacroiliac joint, exits through the suprapiriform foramen . Care must be taken with the insertion of percutaneous ilisacral screws due to the risk of injuring this nerve.[12]

The pelvis is surrounded by multiple arteries and veins as well as collaterals. This explains the ease with which a pelvic fracture can cause intra- intra -abdominal bleeding. Among the arteries to rule out are the inferior gluteal artery, the superior gluteal artery , the internal pudendal artery, and the obturator artery [13].

There is an important vascular anastomosis called the corona mortis, which is caused by the connection between the obturator arteries and the external iliac arteries. These anastomoses can be purely arterial, venous or well combined. [14]

The venous system is made up of multiple venous plexuses that subsequently empty into the common iliac vein. In general terms, most bleeding from unstable pelvis comes from the presacral venous plexus.

In general terms, the artery that is most damaged is the superior gluteal artery when there is an anterioposterior mechanism, since it is the longest branch . However , in lateral mechanisms, the pudendal artery is injured more frequently .

3. Evaluation in the emergency room

For the evaluation of the patients, we will always first follow the basic ABCDEs of the polytrauma patient. As soon as we can evaluate the patient, we will carry out the evaluation of the patient. [fifteen]

3.1. Exploration

Bimanual compression examination of the pelvis has poor sensitivity and may 122 break up the initial clot at the fracture site and reignite bleeding. In 123 general lines, pelvic stability maneuvers have a sensitivity of 124 31.6%, and a specificity of 92.2% [16. The “feeling” of instability on examination 125 has low sensitivity in detecting unstable pelvises. It is advocated to 126 “avoid” these maneuvers, although surgeons often prefer to 127 perform them [17-18]. If the maneuvers are carried out, it is preferable that it be done by an 128 expert person and that it be carried out only once, and without exceeding the 129 force exerted .

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Many signs of pelvic injury can be seen on simple inspection. Ecchymoses 132 on the sides of the abdomen are a sign of possible retroperitoneal 133 hematoma , as well as on the scrotum . Always look at the position of the legs. If 134 we also see blood at the urethral meatus or hematuria, we have a sign of 135 urethral injury together with pelvic injury [19-21]

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On examination, we will palpate the suprapubic area to see if there is pain, which 138 can point us towards a disruption of the symphysis or of the branches.

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We can see shortening in both lower limbs as an indirect sign, 141 and even an attitude of internal rotation (probably compression that may have existed 142 a posterior mechanism) or external rotation, (more likely a vertical mechanism or 143 that there is an open book fracture). [22]

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We must take into account that all skin lesions reported to the 146 fracture represents an open fracture.

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We must perform a neurological examination if the patient is conscious, given 149 that 10-15% of pelvic fractures have associated nerve injuries, 150 specifically to the lumbosacral plexus and especially L5-S1 due to its anatomical path 151 [2. 3]

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Digital urogenital examination is not currently recommended as it has poor 154 sensitivity. Therefore, it is recommended to limit oneself to inspection of the fibula and 155 look for signs of rectal, urethral, or vaginal bleeding.[24-26]

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3.2. Examination

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The pelvic strap is a non-invasive measure that is placed around the greater trochanters and tightened. Its function is to maintain the pelvic ring 159 and reduce bleeding and prevents the disruption of the clot that is forming. 160 For greater effectiveness, the strap must be placed on the greater trochanters with 161 internal rotation of the lower limbs, and maintain tension for 162

compression. A sheet is effective initially, but has a 163 chance of eventually dropping. It is better to keep it for 24 -48 hours but not more, 164 since it can create lesions at the skin level. If it is placed, it is better to fix the legs 165 to avoid attitude of external rotation. [27-30]

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In anteroposterior fractures, the straps reduce the transfusions needed 168 without compromising 169 rias compared with the external fixator, improves hemodynamics and , mechanical stability.[31] 170

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In lateral compression fractures, there is little evidence-based benefit 172 . The strap can stabilize the pelvis but has a risk of displacing the fracture. 173 It is good to keep the strap on any pelvic fracture, and consider loosening it 174 in patients with diagnosed LC1 and LC2 fractures. [32]

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Regarding the sheet, it is effective but has a tendency to come loose. There is a risk 177 that stabilization will mask a pelvic fracture, creating negative 178 radiographs as well as on CT

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4. Diagnosis 182

The ideal is to always request AP radiographs of the pelvis, together with a pro- 183 oblique projection at 45º. 184

There are other useful projections such as the inlet and the outlet (image 1) to 185 better determine the pelvic structures, and which are especially useful when 186 diagnosing and treating fractures surgically. 187

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Inlet: allows observation of the pelvic ring Outlet: allows 189

observation of lesions in the sacrum, pubic ramus, or obturator foramen. 190

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Image 1: Inlet can be seen on the left and outlet on the right

CT should always be performed in a pelvic fracture to analyze the mechanism , the lesion, and the comminution of the fracture. Even so, we must not forget that CT does not replace conventional radiographs, since the classifications of pelvic fractures are based on them [33]

5. Classification

5.1. Pelvis

5.1.1 Young-Burguess

This is the most useful classification for emergencies, and allows bleeding to be directed, since when a patient is seen bleeding with an AP (anteroposterior) type lesion, it is more likely that they are bleeding of the pelvis and that hemodynamic instability occurs. [3. 4]

Injury that is lateral compression (LC) is more likely to cause bleeding from an abdominal, chest, or abdominal injury, rather than from the pelvis.

Lateral fractures compress the sacrum and pubis and produce fractures of the 211 sacrum and pubic rami [LC1]. When there is more force, the sacrum acts as a 212 pivot around and the hemipelvis rotates inward, producing a 213 iliac wing (LC2) fracture. If there is even more force, the compressive force becomes distracting 214 in the contralateral hemipelvis, and produces external rotation 215 resulting in an opening of the contralateral sacroiliac wing and disruption of the 216 symphysis (LC3)

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The anteroposterior force of the pelvis produces an external rotation force, 219 resulting in injury to the pubic symphysis. A low-energy force diastases the 220 symphysis but leaves the sacroiliac ligaments intact (AP1). If the force continues, the 221 sacroiliac ligaments (AP2) are torn, and if it increases, the posterior sacroiliac ligaments (AP3) 222 eventually rupture. [35]

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Vertical forces rupture all the ligaments of the sacroiliac complex , 225 pelvic floor, and pubic symphitis, resulting in a vertical injury. The 226 hemipelvis will move vertically, with a subuxation of the sacroiliac 227 joint , or a vertical sacral fracture combined with a 228 rupture of the pubic symphysis will occur.

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5.1.2 Tile

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This classification assesses the mechanism and instability of the pelvic ring.[36,37] 232

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Type A (they have no equivalent in Young-Burgess) are stable, therefore , the pelvic ring cannot be displaced and is intact.

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Type Bs are rotationally unstable but vertically stable. Type Cs are

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unstable both vertically and horizontally.

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5.1.3 AO Classification

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It tries to combine both classifications (Young-Burgess and Tile), however, 240 is usually less used than those previously described.

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We must not forget sacral fractures as there is a high rate of association 243 between pelvic and sacral fractures.

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5.2. Sacrum

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5.2.1 AO Classification

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They are classified into low sacral fractures (A), posterior pelvic injuries (B) 247 and finally spinopelvic injuries (C). In the case of spinopelvic 248 injuries , it is important to detect them correctly since their treatment 249 changes depending on the type and severity that it presents, being in some cases 250

required triangular fixation to the lower lumbar vertebrae by spinopelvic dissociation . [38]

5.2.2 Denis Classification

It is another type of classification of sacral fractures. Its importance lies because zone II fractures pass through the nerve holes. They are second in frequency (34% of the fractures in the original series by Denis et al.). [39]

28% are accompanied by unilateral involvement of the L5, S1 or S2 roots.

Zone II fractures can be unstable if there is displacement in the injury or if the fracture is comminuted. [40]

6. Emergency treatment

Treatment protocol:

ÿ Protection of the initial clot with placement of a preventive sheet-strap. ÿ Early transfusion, plasma, platelets... ÿ Prevention of hypothermia and acidosis (triad)

If the fracture causes hemodynamic instability, the following questions:

ÿ Is there a pelvic fracture with pelvic instability? ÿ Is there hemodynamic instability? ÿ Is there intra-abdominal bleeding?

For emergency treatment of pelvic fracture, we must determine whether we are dealing with a stable, unstable pelvis, or one associated with hemodynamic instability .

6.1. Hemodynamically unstable patient

Hemodynamic instability despite correct fluid therapy is a alarm sign. Pelvic fractures result in hemorrhage of both bone and vascular structures . The venous plexus is responsible for up to 80% of internal bleeding in unstable fractures. Due to bone fractures and ligamentous injuries, there is no "physiologic buffer", therefore there may be exsanguination in the retroperitoneal space. [41,42]

The abdominal examination can mislead us; a normal abdominal examination does not exclude retroperitoneal hemorrhage. There are false negatives with the ECO-FAST, of

hence the importance of TC. If the patient has a SBP < 70 mmHg, it is an indication 290 to take to the operating room. [fifteen]

Bleeding can be controlled by interventional radiology, angiography, or 293 embolization. The decision between using packing or angiography depends 294 on many factors, and there is currently no recommendation due to a lack of 295 trials . In many cases, if the patient is bleeding from the pelvis but with adequate 296 tension, embolization can be performed. When there is significant 297 hypotension, bleeding can be controlled with extraperitoneal packing.[43]

Anterial embolization (image 2) can be used to stop bleeding. Ideally, a selective embolization should be performed in the arterial bleeding vessel. The 301 arterial bleeding is 10% and has high mortality [44]

Nonselective internal iliac artery embolization can be used to control up to 304 up to 85-100% of bleeding. But on many occasions there may be 305 necrosis of the bladder and gluteal muscle. That is why it should be used as the last option. 306 [45]

Image 2: arteriography and embolization

Packing is useful in a hemodynamically unstable patient, with a previously stabilized 311 pelvis . It is also an option if angiography fails. It better controls 312 venous bleeding. In supine, an incision is made centered on the pelvic region 313 and below the midline 8 cm is made. Due to the disruption, on many occasions 314 it is possible to directly access the right and left paravesical space 315

below the presacral region without the need for dissection. Arterial bleeding is checked, 316 and packing is placed, followed by ligation, clamping, or vascular repair. On 317 many occasions, the bleeding comes from the sacral and periveical venous plexus and the 318 origin cannot be established [45-46] 319

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At the end of the procedure, the anterior pelvic ring is stabilized with the strap or 321 either a symphysis plate or an external fixator. The packing is left for 24-48 hours 322 and removed. Angiography/embolization is recommended if there is still bleeding after tamponade 323. [47,48] 324

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The REBOA (resuscitative endovascular balloon occlusion of the aorta) is a method that is 326 used in cases *in extremis* or when all previous options fail. 327 It consists of a balloon that inflates inside the aorta It can be applied in zones 328 I and III but should be avoided in zone II 329

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6.2. Hemodynamically unstable patient 331

This is the situation that we will most frequently observe. In the hemodynamically stable 332 patient , detailed evaluation is necessary before deciding 333 the indications.

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There are different options for emergency fixation of pelvic fracture: 336

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Sheet / pelvic girth: already explained previously. 338

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The external fixator: it is a widely known device that is placed in 340 operating rooms. In the case of pelvic fractures, it is not being used as before 341 but it is effective in "open book" fractures. Anterior pins can 342 be placed on top of the superior iliac crest, above the ASIS (anterior superior- 343 rior iliac spine), or between the ASIS and the anterior inferior iliac spine. 344 FE has the advantage that by providing stability, a laparotomy can be performed. 3. 4. 5

346

The supraacetabular fixator gets better fixation, better rotational control, better 347 tolerance, and one tab is more than enough. But it is technically difficult and requires 348 more time to install. Requires copy [49.50] 349

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There is a risk of displacement of pelvic fractures when there is a 351 vertical mechanism and in some cases of internal rotation. For this reason, the external fixator 352 of the pelvis is especially indicated in those fractures with displacement in 353 external rotation.[51,52]

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When a well-placed strap is not capable of hemodynamically stabilizing 356 the patient, it is unusual for an external fixator to be able to improve it. 357

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Recently, the external fixator has been used in different positions 359 to try to solve the problem of displacement / increased compression 360 existing in lateral mechanism fractures. Among them is the option of 361 placing the external fixator in an oblique position, thus allowing the 362 vector force to enter obliquely to reduce fractures. [52] 363

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Pelvic external fixation together with skeletal traction in the lower limbs 365 can re-establish and maintain unstable pelvic fractures by vertical mechanism 366 [53] 367

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Clamp: Very little used. Only useful in type C (posterior) instabilities and 369 patients in extremis. High complication rate, since it is sometimes placed “blindly” 370 without copy control, and it is easy for the pins to not be placed in the proper 371 position. [54] 372

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Infix (image 3): it is a method that is currently on the rise. It is an alternative 374 to the external fixator and is removed after 3-6 months. The infix is placed percutaneously 375 and the pelvis is fixed with pedicle screws under scope. It has the advantage 376 that it allows ambulation as soon as it is tolerated. [55] 377

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Among its most frequent complications is lesion of the 379 lateral femoral cutaneous nerve that resolves at the time the external fixator is withdrawn 380 [we must not forget that the lateral cutaneous femoral nerve is 2.2 381 cm from the INFIX pedicle screws and therefore there is a high rate of irritation] 382 and the most feared, femoral nerve injury. To try to reduce the rate of 383 complications, it is ideal to place the screws and the rod above the fascia, 384 keeping it away from the bone. [56] 385

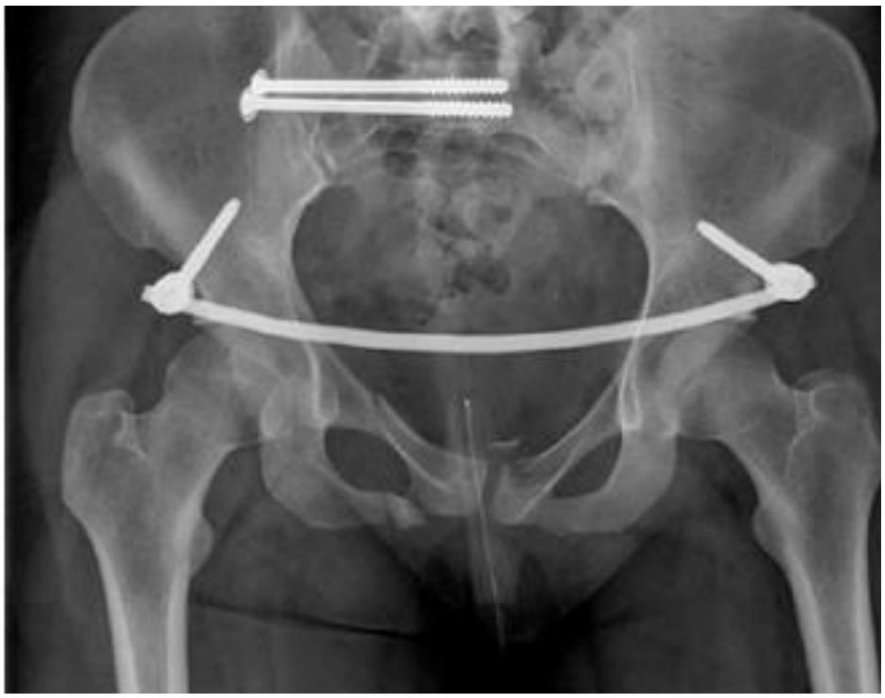

Image 3: infix

6.3. Hemodynamically unstable patient

6.3.1 Urethral injury

They are rare, and when they occur there are very important associated injuries. Urological injuries are potentially fatal and can result in injuries with co- morbidity.

The use of a catheterization by expert hands can be attempted. If there is blood , a retrograde cystography should be performed. If the catheter does not pass, the balloon should not be inflated , but a retrograde ureterogram should be performed. If catheterization is not possible, a suprapubic catheter can be used. [57]

In the case of unstable pelvic fracture, it is recommended that the reduction of the fracture and fixation occurs along with subsequent repair of the bladder.

Patients who have previous pelvic fractures or urethral injuries have a high incidence of sexual and urinary dysfunction. [58]

6.3.2 Open fractures

The open fracture of the pelvis is determined when there are

ÿ Communicating lesions with the pelvic fracture and hematoma. ÿ Perineal injuries or close to the rectum.

All skin lesions communicating with the fracture represent a 410 open fracture. Primary washing and closure on many occasions is sufficient, with anti- 411 biotherapy. However, open injuries involving the perineum are more dangerous- 412 sas. On many occasions, the pelvic lesion is unstable, will require fixation, and the 413 lesion may communicate with the rectum directly, or so close, and therefore 414 has a high probability of contamination. [59-60] 415

7. Definitive treatment 416

We must consider whether our patient is a candidate for definitive 417 pelvic stabilization treatment. In general terms: 418

419

ÿ AP1 and mild LC1: Surgical stabilization is rarely needed. ÿ AP2: stabilization of the anterior part of 420

the isolated pelvic ring is normal 421

badly enough. 422

ÿ AP2,AP3,LC2,LC3,VS: reduction and stabilization of the anterior ring and 423

posterior is normally required [61] 424

425

The indications are: 426

• Diastasis of the symphysis > 2.5 cm 427

• SI displacement > 1 cm • Sacral 428

fracture displacement > 1 cm • Hemipelvis 429

displacement or rotation • Open fracture 430

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7.1 Preparation and 432

times Due to the anatomy there is a great risk of additional damage (vascular, 433 neurological...). 434

The basic rules for the management of pelvic trauma are mandatory; must 435

there will be an ICU, a prepared team, and a radiolucent table. 436

437

The decision of the definitive surgical time is conditioned by the state of the 438 patient. The application of the strap and the control of the bleeding allow a 439 control of approximately 12-36 hours and the improvement of the general state of the 440 patient . Because they are polytraumatized patients, on many occasions they have other 441 injuries, and therefore definitive fixation and stabilization will have a positive 442 effect on these patients and on their prognosis. In hemodynamically stable 443 patients , **definitive surgery should be performed between 2-5 days after** 444 **surgery, and clearly before 14 days from the injury.** Stabilization of 445 an unstable pelvis allows for better management of other injuries. [62] 446

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After 14 days, anatomical reduction becomes difficult, leading to poor 448 **reduction of the fragments. To prevent malunion or nonunion ,** 449 **you should try to stabilize as early as possible. [63]** 450

451

In surgery, the beam is important and to obtain the necessary images at 45º for 452 to be able to observe well both the pubic symphysis and the sacroiliac joint. 453

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456

Preference for the use of bindings 457

Internal stabilization techniques are diverse and varied, and will depend on the 458 type of injury the patient has. 459

It should be noted that there is currently no consensus on the optimal 460 treatment of pelvic fractures, nor on whether it is preferable to initiate 461 fixation in the anterior or posterior area.[64-66] 462

7.1.1 Fixation of anterior injuries: symphysis disruption The 463

standard method of fixation is open reduction with a 4-hole plate. 464 A specialized symphyseal plate is usually used. Indirect stabilization methods 465 such as the Infix are not sufficient for ligamentous injuries. 466 To obtain optimal reduction, carefully place the screws 467 in a craniocaudal direction, trying to have as much bone contact with 468 the pubis.

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Care must be taken, since when there is an anteroposterior 471 lesion [APC], the previously described conventional plate acts as a tension band 472 mechanism . In the case of lateral mechanisms, more anterior fixation 473 is required , either a plate with 6 holes or two plates, to protect the symphysis 474 from shearing forces. For this reason, in these cases, a 4-hole 475 plate is insufficient.[68,70]

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It has been seen in certain series that the anterior approach does not increase stability 478 when there is fixation of the posterior pelvis and therefore, it is not always 479 necessary to perform a double approach to increase stability [71]. 480

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7.1.2 Fixation of anterior lesions: branches 482

Isolated branches are not fixed, it is only necessary to take into account that they 483 bleed especially in older patients. 484

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On other occasions they are part of more complex fractures (LC1, LC2) in 486 where the ring can be unstable. In this case when there is instability of 487

the pubic ramus can be stabilized with an extra long screw [3.5 or 4.5 mm 488 cortical or 7.3 cannulated] in the pubic ramus. Beware of possible penetration of the 489 screw into the hip joint [72] 490

491

In the case of lateral compression with multiple fractures, we can find 492 fractures of the four branches. These are best stabilized with the 493 Anterior Internal Fixator or Infix Fixator. This allows internal rotation of the anterior ring 494 to distract. [73] 495

7.1.3 Fixation of lateral injuries: iliac wing instability In 496

many cases these fractures are LC2 type. Transiliac fractures have a great 497 variability of patterns. In the iliac crest, the use of 3-5mm pulling 498 bottom screws are an option. However, an LC-DCP plate is used at the base of the iliac blade . Fractures are fixed depending on the degree of displacement and 500 association of fractures that they present[74,75]. 501

502

Longitudinal fractures of the iliac blade usually have a high rate of 503 vascular complications and soft tissue injuries. [76] 504

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In LC2 types, the fracture may involve the sacroiliac joint. 506

7.1.4 Fixation of posterior injuries: sacroiliac disruption 507

Most frequently, this injury is produced by an APC2 type fracture, in 508 which ends up opening the posterior part. To treat it, a 7.3 mm percutaneous 509 cannulated screw is used , which passes through the body of the sacrum. This can be performed 510 percutaneously when an adequate closed reduction can be 511 obtained . [77-78] 512

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In more complex patterns, such as the AP3 type where there is complete 514 disruption , an anterior approach is necessary. The anterolateral approach to the iliac fossa 515 allows complete exposure of the S1 joint. 516

7.1.5 Fixation of posterior injuries: sacral fractures 517

It is almost always seen as part of type LC1 (lateral compression) fractures but 518

they can be seen in some rare occasions as in vertical fractures. 519

The more “soft” type LC1 fractures are stable fractures that can mobilize early, 520 a pattern typically seen in older patients. 521 An anterosuperior "crushing" of the sacrum and minimal branches are seen . [79] 522

523

The most severe LC1 fractures have complete sacral fractures, and in many 524 occasions they are displaced posteriorly. On the AP radiograph, due to the anterior tilt 525 of the pelvis, the posterior displacement appears to be a superior migration, 526 and therefore a severe LC1 type fracture can be confused with a 527 type.

vertical. The mechanism of injury and the vision in the operating room will give the clue. Severe bilateral fractures can also 528 occur in LC1 type injuries. 529

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The neurological injuries can be high and the treatment has to be also 531
well focused on early recognition of neurological injuries. [80] 532

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Early placement of traction on the affected leg is vital to maintain 534 reduction in the supine position to allow placement of percutaneous transsacral 535 screws . A prone approach can also be used to directly observe the fracture 536 as well as decompress the sacral plexus. 537

7.1.6 Fixation of posterior injuries: vertical unstable mechanism Injuries 538

that are rare and result from patients who have fallen. Severe 539 type LC1 fractures are often confused with this type of fracture. Fractures 540 by purely vertical mechanism require much more posterior instrumentation 541 as well as spinopelvic fixation. [79, 81]. 542

543

We must not forget the importance of the orientation of the screws, since 544 the placement of the screw varies significantly depending on whether we are 545 facing an affectation of the sacroiliac joint or a fracture of 546

sacrum. 547

548

The sacrum is involved in 50% of pelvic fractures and is of great 549 importance, since it can modify the definitive treatment. We must not 550 forget that sacrum fractures greater than C0 (according to the 551 AO classification) are associated with spinopelvic dissociation with displacement of the hemipelvis 552 on many occasions and therefore require triangular osteosynthesis. 553 In the event of a fracture of the transverse process of L4 or L5, we must rule out 554 spinopelvic dissociation due to rupture of the iliolumbar ligaments. [82,83] 555

8. Postoperative 556

management The goal of early stabilization is also the early mobilization of these 557 patients. The limitation of the load should not go beyond 8 weeks, 558 and if the injury allows it, it should start at 4-6 weeks [84]. On many 559 occasions it is not necessary to remove the osteosynthesis material. Yes, she usually tries to 560 remove the pubic symphysis plates since it can avoid the use of a subsequent 561 caesarean section in those young patients who want to become a mother. 562

9. Complications and 563

pearls There is a high risk of thromboembolism in these patients. Up to 564 can be seen in 35-61% of patients, so prophylaxis must be maintained at least 565 during the first 4 weeks. 566

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The use of antibiotics is recommended to reduce the risk of infections.

The failures of these fractures are the bad classification, as well as the bad surgical planning that exists.

On many occasions there is sacrospinous instability, which is usually underdiagnosed . These fractures can be confused with simple LC1 fractures, when in fact they are part of a spectrum of sacral injuries with H-patterns and J. Sometimes they require posterior spinopelvic instrumentation to reduce them adequately. [85]

To stabilize complex fractures: ÿ Initial surgical reduction and stabilization reduces the difficulty of tad at the time of reduction

ÿ The posterior ring must be adequately reduced ÿ Anterior implants of the pelvic ring added to the plates will not com- think of posterior ring injury when it does not reduce properly

10. Long-term results Up to 80% of unstable pelvic fractures can be reduced anatomically . However, good results are observed in less than 60%, given that sometimes there are neurological and urological lesions. On many occasions there is pain in the posterior area of the pelvic ring, and in the lower lumbar area, and there are patients who complain of sexual dysfunction. [86]

60% of male patients may end up having sexual dysfunction after a pelvic fracture, and 20% may have impotence, just as women may suffer from dyspaneuria. [87]

Pelvic stable fractures may end with a better recovery than com- stop with the unstable.

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