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IN BRIEF

Classifications in Brief

Young and Burgess Classification of Pelvic Ring Injuries

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History

To aid in rapid and appropriate treatment of pelvic ring injuries, numerous attempts to classify these injuries have been made. In 1938 Watson-Jones proposed a schema based primarily on fracture location [26]. Huittinen and Slatis noted the relationship between the direction of impact and the resulting pelvic injury pattern [6] and Trunkey et al. [25] introduced the concept of stability. Location and magnitude of the applied force, either high or low energy, have been recognized as important factors responsible for pelvic injuries [6, 7]. Stability of the ring also was identified as a critical component of pelvic ring management [10]. Pennal et al. [14] were the first to systematically describe the force vector responsible for pelvic ring injury as AP compression (APC), lateral compression (LC), or vertical shear (VS). Tile et al. [23] added the concept of stability (ie, stable, vertically stable but rotationally unstable, vertically and rotationally unstable). Acetabular fractures were considered separately in the classifications of Tile et al. (comprehensive classification) [23] and Young et al. (Young and Burgess classification) [27].

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In 1986, Young et al. described 142 patients with pelvic ring injuries and classified their injuries mechanistically [27] (Fig. 1). Using AP pelvic radiographs, pelvic injuries (fractures and joint disruptions from ligamentous injuries) were identified. These injuries appeared in patterns correlating with the direction and location of applied force. The authors cited the necessity for rapid and accurate diagnosis of pelvic injuries and correction of pelvic deformity as essential aspects of the resuscitation and treatment of patients with pelvic ring injuries.

By understanding that APC injuries result in external rotation of the hemipelvis and learning to identify this deformity on rapidly obtained AP pelvic radiographs, providers learned to apply circumferential resuscitative splints (pelvic binders or pelvic sheets) to correct this deformity, decrease intrapelvic volume, and aid in patient resuscitation. Additionally, by recognizing vertical shear injuries, traction can be applied to reduce the proximally displaced hemipelvis. These concepts were articulated by Young et al. [27] and continue to be a cornerstone in the evaluation and treatment of patients with pelvic ring injuries.

Purpose

The vector of force applied to the pelvic ring is an important determining factor in resulting injury pattern and is the foundation of the Young and Burgess classification system. AP-directed forces cause deformity or instability in a predictable pattern based on the injury and disruption of anterior and posterior pelvic structures. Originally, Bucholz [1] evaluated AP injuries and classified them in three types based on the extent of injury to the posterior pelvic elements and this concept was applied to the Young and Burgess classification [27].

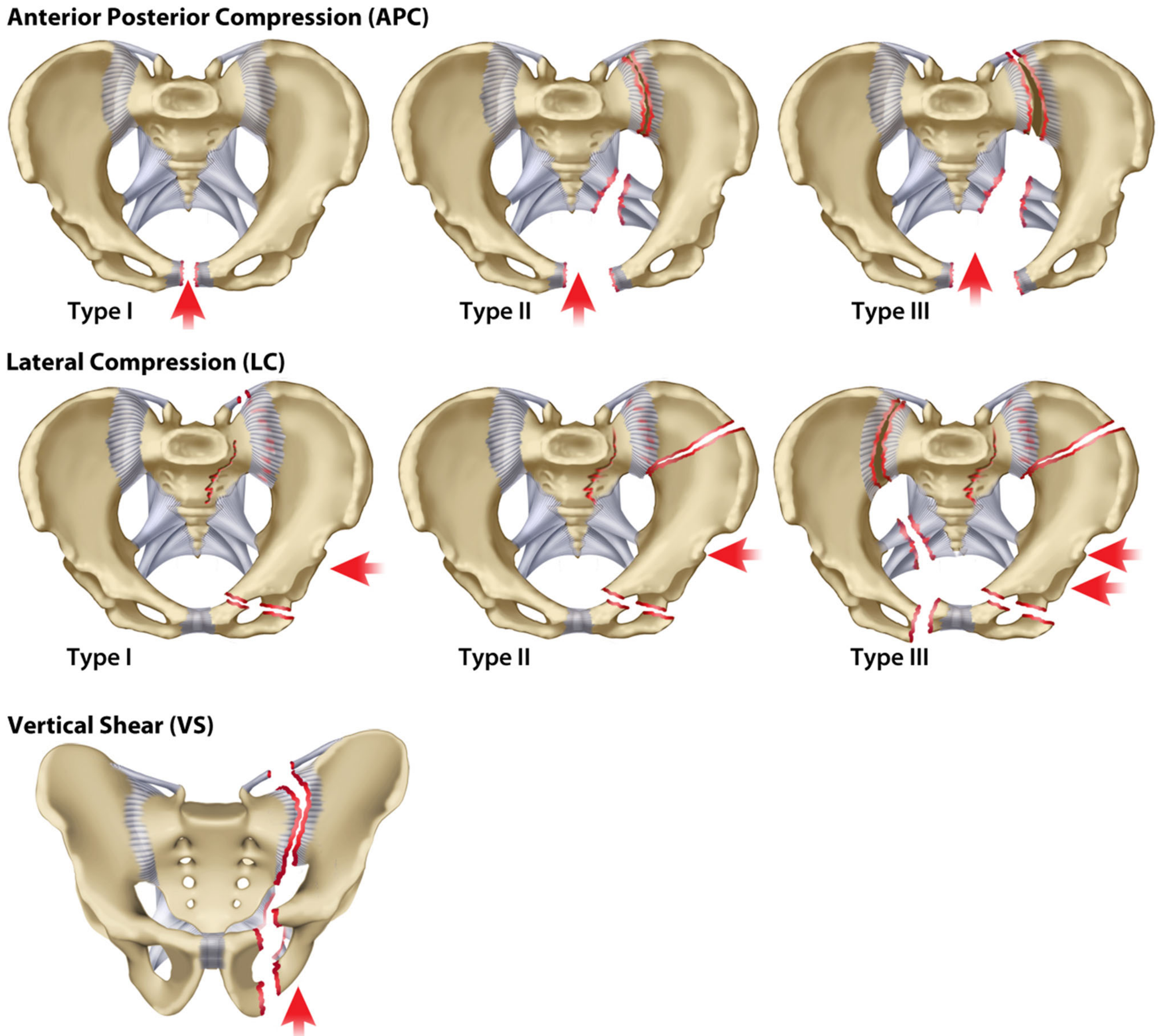

Fig. 1 The classification of pelvic disruptions as described by Young et al. [27] is shown. (Published with permission from Kate Sweeney, UW Creative, University of Washington, Seattle, WA, USA.)

Description

Anterior Posterior Compression (APC)

APC I injuries show less than 2.5 cm of symphyseal widening and have no posterior instability either clinically or radiographically [27]. APC II injuries show widening of the symphysis pubis and instability of the posterior pelvis resulting from disruption of the anterior sacroiliac complex [27]. Tile et al. [23] found that division of the anterior structures of the symphysis pubis without disruption of the posterior structures allowed the symphysis pubis to widen as much as 2.5 cm. After this point, division of the sacrospinous, sacrotuberous, and anterior sacroiliac ligaments is required for additional widening. APC III injuries can be challenging to classify and difficult to diagnose, especially in the current era of pelvic wraps where radiographic evidence of posterior injury may be difficult to see on AP images of the pelvis but are more clear on axial CT scans. In the original description by Young et al. [27], eight of the 10 APC II injuries had widening greater than 2.5 cm at the symphysis pubis, whereas the two with widening less than 2.5 cm had radiographic evidence of anterior sacroiliac joint disruptions. Type III injuries are those associated with complete posterior ligamentous disruption. While fractures are less common in APC-type injuries, when they occur, they often involve the pubic rami and are vertically oriented [27].

Lateral Compression (LC)

LC injuries result when a force, laterally based and directed medially, is applied to the pelvis. Based on the location and magnitude of the applied force, different injury patterns result [27]. Fracture is more common with LC injuries than with APC injuries. In the original description by Young et al. [27], 100% of LC injuries had ramus fractures, 88% had sacral fractures, 19% had iliac wing fractures, and 19% had central hip dislocations. Rami fractures in LC patterns are more horizontal or coronal in orientation than with APC injuries, where vertical fractures are expected [27]. LC I injuries result from a lateral force delivered over the posterior aspect of the pelvis and represent a spectrum of injury. Sacral injury severity ranges from an incomplete anterior buckle fracture to complete sacral fracture based on the amount of energy applied to the pelvis at the time of injury. The degree of pelvic instability correlates with the severity of injury [27] and there may be a role for stress radiographs in classifying this instability. LC II injuries result from a more anteriorly directed force. This causes internal rotation of the anterior hemipelvis with possible external rotation of the posterior hemipelvis with the anterior sacroiliac joint serving as a fulcrum. The resulting posterior pelvic injury in LC II patterns may be a sacral fracture, sacroiliac ligament and joint disruption, or crescent fracture-dislocation of the ilium. LC III injuries result from greater force. The internal rotation of the ipsilateral hemipelvis causes injury to the contralateral hemipelvis in the form of anterior sacroiliac ligament disruption and sacrospinous and sacrotuberous ligament injury [27].

Vertical Shear (VS)

VS injuries result from an axially loaded force delivered over one or both hemipelves lateral to the midline. Significant force, such as being struck by falling trees on the head or upper torso or a jump or fall from height, is required to generate a VS pelvic injury [27]. The sacrum is driven down, relative to the iliac wing, resulting in complete ligamentous injury and disruption of the sacrospinous, sacrotuberous, anterior, and posterior sacroiliac ligaments on the injured side. Fracture of the pelvic ring may be present instead of ligamentous injury [27].

Complex

Complex injury patterns are a combination of any three primary patterns (APC, LC, or VS). The majority of the complex injury patterns originally described by Young et al. [27] resulted from LC injuries being combined with AP or VS patterns.

In addition to describing injury patterns, the Young and Burgess classification correlates with extrapelvic injuries. Dalal et al. [2] showed that death in patients with pelvic ring injuries often is attributable to other, extrapelvic injuries and highlighted that the mechanical force type and resulting pelvic deformity can indicate expected organ injuries, resuscitation needs, and mortality rates.

Reliability

Young et al. [27] were able to correctly diagnose injuries based on AP radiographs of the pelvis in 94% of cases. CT scans were used secondarily to evaluate posterior pelvic ligamentous injuries, sacral fractures, and acetabular fractures but had little role in the initial evaluation and stabilization of their severely injured patients [27].

Koo et al. [9] compared the interobserver reliability of three radiographs (AP, inlet, outlet) and CT scans for applying the Young and Burgess and Tile comprehensive classification [9]. Thirty patients were selected for review from a trauma database. The kappa value for experienced pelvic/acetabular surgeons was 0.85 (range, 0.71–0.92) with agreement on 70% of presented cases. As experience increased, so too did the kappa values [9]. CT scans did not statistically improve the reliability of this system but did aid in the determination of pelvic stability, with kappa values increasing from 0.59 (moderate) to 0.93 (excellent) [9]. They found the Tile comprehensive classification to have a kappa value of 0.30 for pelvic AP radiographs, improving to 0.33 with the addition of two-dimensional axial CT scans [9].

In a similar study, Furey et al. [3] reported on 89 patients with pelvic fractures. Five experienced orthopaedic surgeons evaluated the AP pelvic radiographs and two-dimensional axial CT scans and calculated the kappa value for the Young and Burgess classification system to be 0.72. The Tile comprehensive classification kappa value was 0.47 [3].

Gabbe et al. [4] evaluated interobserver reliability of experienced orthopaedic trauma surgeons using the Young and Burgess classification system in 187 pelvic fractures treated at two Level 1 trauma centers in Victoria, Australia. Preintervention (before placement of a pelvic binder or external fixation device) pelvic AP radiographs and three-dimensional pelvic CT scans were evaluated and the kappa value was found to be quite low at 0.09 to 0.21 [4]. They questioned the utility of this classification system for clinical and research applications but the vast differences in their classification of even major categories is remarkable. For example one surgeon classified 30% of fractures as VS while others assigned only 1% and 8% to this group. They also found the Tile comprehensive classification to have a poor kappa (0.10 to 0.17) [4].

This discrepancy in kappa values can be explained in part by selection bias as Furey et al. [3] and Koo et al. [9] were specific with their inclusion criteria, only selecting patients with adequate radiographs and CT scans available for review. Additionally, all their reviewers were from the same institution. Gabbe et al. [4] reviewed a larger, more heterogenous sample, with more severe injuries and used evaluators from three different institutions. However, they did not evaluate intraobserver reliability [4].

Other Schemes

In 2007 the AO and Orthopaedic Trauma Association (OTA) agreed to combine their classification schema and accepted the AO/OTA classification for pelvic ring injuries [12]. This system separates pelvic ring injuries based on anatomic location and stability (stable, partially stable and unstable). The Young and Burgess classification is referenced in subgroups where appropriate.

The comprehensive classification, as described by Tile et al. [23] for pelvic ring injuries, also is widely used and is similar to the AO/OTA schema with only minor differences.

The Tile classification originally was described in 1980 [14, 21, 24] and subsequently modified to what is commonly referred to as the "comprehensive classification" [23]. It uses the concept of pelvic ring stability to differentiate injuries in three primary categories, each with subsets of injury patterns. Type A injuries are considered stable and do not disrupt the pelvic ring. They include injuries such as sacrococcygeal dislocations and ischial avulsion injuries. Type B injuries are vertically stable but rotationally unstable while Type C injuries are vertically and rotationally unstable.

Other classification systems for pelvic ring injuries have been introduced since the introduction of the Young and Burgess classification, but none is used with the same frequency and uniformity [2, 8, 13]. The concept of stability plays a central role in the treatment of pelvic injuries, even predicting transfusion rates and mortality [11], and is a fundamental aspect of each of these classification systems. While the Young and Burgess classification highlights the importance of properly identifying injuries and displacement patterns on AP pelvis radiographs, many surgeons use multiple classification systems and imaging modalities such as CT scans and stress radiographs when developing treatment plans and planning surgical interventions.

Limitations

Radiographic evaluation of pelvic ring injuries is limited because these are unstressed, single images of complex injury patterns, often with significant soft tissue disruptions. Because these radiographs image bones and not soft tissues, the position of the osseous structures does not necessarily capture the full extent of ligamentous injury. This is true with all classification systems based on radiographic findings, plain radiographs, and CT scans.

In the original description by Young et al. [27], a 2.5-cm diastasis at the symphysis pubis was the criterion to differentiate APC I from APC II injuries, this was confirmed by Tile [22]. This measurement is made off a single, static radiograph at one time. However, Gardner et al. [5] showed pelvic ring injuries recoil and the displacement seen on pelvic AP radiographs often underrepresent the actual degree of injury as the pelvis may have "sprung back" or it may be reduced by a pelvic binder or sheet.

Orthopaedists struggle to differentiate APC I from APC II and APC II from APC III injuries. Suzuki et al. [20] identified "occult APC II injuries" in four of 20 injuries. Presumed APC I patterns were evaluated with dynamic stress fluoroscopy with the patient anesthetized, and indicated more displacement, consistent with APC II patterns [20]. Sagi et al. [18] identified "occult APC III injuries" at a rate of 39% with similar methods. These data suggest that unstressed imaging may underrepresent the degree of injury and true pelvic instability. There may be a role for stress radiographs in the diagnosis and management of these injuries; however, the specific indication for these studies is yet to be defined.

The Young and Burgess classification system also is limited as it provides little guidance for treatment. The concept of stability, central to the AO/OTA classification system, is not a part of the Young and Burgess classification. The role for anesthetized stress radiographs for evaluation of pelvic stability also is not addressed [18].

At the time of publication of the Young and Burgess classification, surgical interventions of the posterior ring were limited, as iliosacral screw fixation of the posterior pelvis was not common practice. More recently, with the advent of iliosacral, transiliac-transsacral screws, and a better understanding of safe pelvic osseous corridors, percutaneous fixation is more widely accepted and more frequently used for pelvic ring fractures [16, 17]. Additionally, the technique for fixation of APC injuries remains debated. In 2008, Sagi and Papp [19] showed multiple-hole anterior plates to be superior to two-hole plates for anterior pelvic fixation for pelvic ring injuries. They also found an unexpectedly high rate of fixation failure with loss of reduction of 22% for isolated APC II pelvic ring injuries treated with anterior multiple-hole plate fixation alone [19]. Putnis et al. [15] also found six of 43 patients treated surgically for APC injuries had anterior fixation failure and loss of reduction; all of these were APC II injuries treated with isolated anterior fixation and no posterior iliosacral screws. The role for posterior pelvic fixation with APC II pelvic fractures remains unclear and debated [18].

Conclusions

Young et al. [27] identified recurring fracture patterns and ligamentous injuries evident on AP pelvic radiographs and correlated these with applied vectors of force to the pelvis, creating a mechanistic classification of pelvic ring injuries. They described four patterns, APC, LC, VS, and combined injuries. This classification system is limited in its description of posterior ring injuries, particularly in APC patterns. Interobserver reliability is less than ideal. Treatment of the posterior pelvic ring and the clinical significance of the degree of posterior pelvic injury remain debated. Futures studies correlating specific surgical interventions for different Young and Burgess classification injury patterns with long-term outcomes would be beneficial.

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