Injury, Int. J. Care Injured 49 (2018) 449–456

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Editorial

Spinopelvic injuries. Facts and controversies

ARTICLE INFO

Keywords:
Spinopelvic instrumentation
Spinal-pelvic instrumentation
Spinopelvic fixation
Bilateral lumbopelvic fixation
Sacroiliac screws
Lumbosacral fixation
Iliac screw
Iliac fixation
Spondylopelvic dissociation
Sacral kyphotic deformity

ABSTRACT

Spinopelvic injuries result from high energy trauma with overloading through the sacrum. These lesions can accomplish either bone fractures, ligament injuries or, most commonly, both. They may be accompanied with other associated life threatening injuries and cause biomechanical instability with potential fracture non-union, mal-union and subsequent lifetime pain and disability. Surgical stabilization of spinopelvic injuries requires planning in order to apply the appropriate osteosynthesis principles (compression; neutralization; buttressing and tension band).

In general terms simple sacral fractures can be treated under compression by iliosacral screws. However, as more complex ones cannot be compressed, they need vertical support and neutralization of shearing forces (neutralization and buttressing principles). For that purpose, spinopelvic instrumentations appear to be the current appropriate technique of stabilization. In the herein paper the general principles of sacral fracture osteosynthesis are discussed, as well as its application to spinopelvic injuries. Controversies on positioning, surgical approach, per-operative traction, sacral laminectomy, type of biomechanical construct, length of fixation, screws length, mode of weight bearing, and osteosynthesis hardware removal are discussed.

Introduction

Spinopelvic injuries are characterized by biomechanical instability between the spine and the pelvis, and result from high energy trauma with overloading through the sacrum [1–4]. These lesions lead to either bone fractures, ligament injuries or, most commonly, both. In addition, due to the severity of trauma sustained usually other life threatening injuries may be present [5,6].

Apart from the urgent diagnosis and treatment of the severe general polytrauma condition in the emergency room (Algorithm 1) [5,6], once the patient is physiologically stable, in order to achieve a good functional outcome the biomechanical instability created by the lesion needs to be corrected since the spine and pelvis are considered a unique functional biomechanical unit [4,7]. The anterior and the sagittal alignment of the lumbar spine, of the sacrum and of both iliac bones is essential to be addressed. Otherwise, secondary displacement, non-union, malunion and subsequent lifetime pain and disability may be the outcome [1–3].

Type of spinopelvic lesion

Based on X-rays, CT-scan, magnetic resonance and laboratory biomechanical studies, many attempts have been made to characterize and classify these injuries, with the intention of elucidating what treatment is best for each lesion type. Lately, classifications have evolved from pure morphological concepts to more functional stability conception by considering lumbo-sacrum-iliac bones alignment as a very important issue [1,3,7].

Dennis classification, after studying X-ray coronal planes of sacral fractures, launches a correlation between the risk of neurological root damage and the site of the fracture tract, in relation to sacral foramen [8]. However, this too brief scheme does not take into account that fractures are multiplanar and also does not consider the spine, sacrum, and iliac bones segments as a uniform biomechanical unit. The same applies with the most used classification by Roy-Camille [9] which evaluates the relationship between the proximal and the distal sacral fragments but does not consider the level at which this transverse fracture occurs, therefore, lacking in the consideration of the value of this parameter on the lumbopelvic stability [10]. Isler classification was the first in highlighting that fractures exiting medial to the L5-S1 facet (type III) are associated with significant instability, considering bilateral type III fracture as spinopelvic dissociation [11] since spondylopelvic stability depends on the posterior lumbosacral ligamentous structures, also on the integrity L5-S1 facet joints, and on the level of transverse fracture [2–4,10].

Finally, the Lumbosacral Injury Classification System (LSICS) takes into account spinal canal compromise and neurological status [12].

These classifications have tried to describe the instability but focused on the diagnosis, failing to provide advice as to what kind

http://dx.doi.org/10.1016/j.injury.2018.03.001
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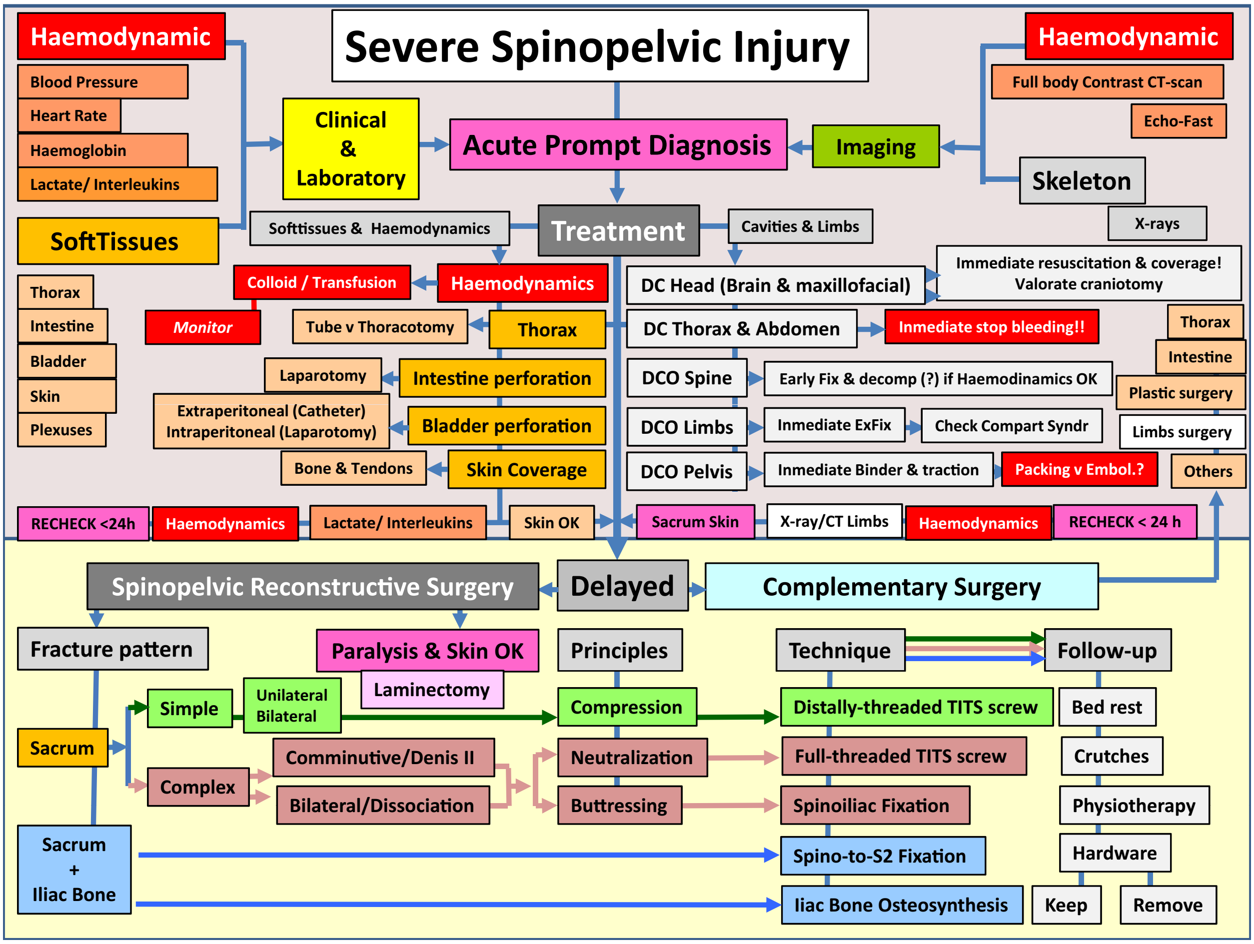

of principles of osteosynthesis should be applied during the operation. When planning the surgical procedure this is of overwhelming importance.

Principles of osteosynthesis for spinopelvic injuries

Any immobilizing treatment of bones, including surgical osteosynthesis, can be included within four biomechanics principles: Compression, neutralization – also called protection –, buttressing, and tension band (Fig. 1). These principles can be applied either isolated or in combination with each other.

1. *Compression*: Compression forces consist of two strength vectors acting in 180° against to each other. By compression forces, bone fragments indent one into the other, making the fracture site very stable (Fig. 1). Shearing forces are neutralized and breakage of this stability requires the bone strength to be less that the rotational force, so that stability is lost only by microfracture of bone fragments. Compression forces accomplishing full fracture stability are considered to be the gold standard of osteosynthesis. However, compression forces are absorbed by bone fragments elasticity within three to four weeks, possibly before full consolidation takes place [13]. Therefore, shearing and rotational forces must be neutralized by a more robust complementary construct, particularly in more complex fracture patterns. In a long bone osteosynthesis with plate, lag screws for compression are complemented with a long neutralization plate (Fig. 2). That is the reason why iliosacral screws, particularly when are not compressing the fracture – in case of complex fracture patterns or through the sacrum foramen – should be complemented with spinopelvic instrumentation providing a buttressing function (Figs. 3–7). However, transilio-transsacral screws can be indicated in case of simple sacral fracture pattern with its tract out of the foramen, as not only the fracture tract has some inherent stability in case of irregular fracture line with bone fragments indentation but also compression would not be absorbed before some callus formation takes place (Figs. 8 and 9); this treatment is preferable to spinopelvic instrumentation as its potential morbidity is much less.
2. *Neutralization*: Neutralization is characterized by the strong inactivation of shearing and rotating forces. For that purpose, neutralization requires solid proximal and distal to the fracture, osteosynthesis anchorage. As in any long bone, diaphyseal plating requires several screws purchased above and below the fracture (Figs. 1 and 2). For a better neutralization in spinopelvic fixation, more than one lumbar level would be required proximally (Figs. 4 and 7). In case of a unique proximal L5 fixation, shearing and rotating forces can loosen the pedicular screw purchase, as it is commonly seen. This can be palliated by connecting both rods with a cross link.
3. *Buttressing*: Any unstable or comminute fracture pattern can shorten the fractured bone length. The principle applied to maintain its length is called buttressing or support (Figs. 1, 4, and 7). That is the case of vertical fracture tracts in the sacrum as well as of spinopelvic instability. All of them are submitted to shearing forces shortening the length between the lumbar spine