UPDATE MECHANISTIC CLASSIFICATION OF THE THORACOLUMBAR SPINE FRACTURES AND A NEW THREE COLUMN CONCEPT IN SPINAL STABILITY *

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ABSTRACT:

To include all the fracture patterns and the soft tissue lesions we made a new classification system according to the mechanism of the fractures from our clinical experience in Haydarpaşa Numune Hospital. In this classification system 3 groups exist.

Group A : Fractures resulting from compression forces.

Group B : Fractures resulting from translational forces.

Group C : Fractures resulting from rotational forces.

For establishing importance of the Holdworth's posterior column and for giving a new approach to neurologic unstability in deciding operation we made a new three column concept. According to this concept; Anterior column is made up of ALL, anterior vertebral body, anterior annulus fibrosus. Middle column is made up of PLL, vertebral body, posterior annulus fibrosus, pedicle, lamina, ligamentum flavum, facets. Posterior column is made up of transverse process intertransverse ligament, spinous process, supra and infra spinous ligaments.

For deciding mechanical instability there must be lesion of the at least 3 anatomic parts in different columns or there must lesion of the at leats 2 anatomic parts in a single column. In middle column if there is lesion of the at least 2 anatomic parts than neurologic instability will develop.

Key words: *classification, spine fractures, stability*

There are 3 concepts about the thoracolumbar region fracture treatment and diagnosis which are still debated. The 1st one of them is about the classification system, the 2nd is about the stability concept and the 3rd is about the treatment concept. We have discussed in our study about the first two concepts.

First, Bohler (3) has classified the thoracolumbar region fractures in 1944 and then Nicoll added the unstability concept to this classification system. Holdsworth (9), by describing the 2 colon theory, stated that the posterior ligament complex must be involved in the unstable fractures.

Denis (3), Ferguson and Allen (6), Bucholz and Gill (2) showed that the 2 colon theory was not enough to describe the unstability complex. Mcafee has stated that the injury mechanism involves axial compression, axial distraction and translational forces and in the end unstable burst, chance, flexion-distraction or translational fractures occured (2).

Denis has evolved the three colon theory and has implied that the colon which he has added, has more role in the spinal stability than the posterior colon. This classification system has been widely accepted; but by time it is seen that this classification does not take in to consideration the soft tissue and can not explain some type of fracture mechanism (2). Because of this Dall and Stauffer, Willen, Atlas, Weidenbaum and Farcy have suggested some of the classification systems (1). At last in the year of 1994 Gertzbein (7); by making some changes in the Magerly classification system which was described in the year of 1990; has classified the thoracolumbar region fractures in 3 groups. The compression fractures were in the A group, the distraction fractures in the B group and the translational fractures were in the C group.

We have used the Denis three colon theory in the fractures we have treated in our department. However like many authors we have noticed that this classification system was not enough. Therefore we have developed a classification system which is clearly undrestood; estimates the prognosis and aids in the treatment of fractures.

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The first mistake of Denis' theory is to attempt to get in to a solution from the cause. It is not possible to get in to consideration all of the possibilities even if 40.000 CT scans are evaluated. The second mistake of this classification system is that, the soft tissues are not taken into consideration. Another mistake is the neglect of Holdsworth's posterior colon.

We have classified the thoracolumbar region vertebral fracture in 3 groups according to the type of mechanism.

Group A:

The type of fractures occuring under compression forces. This group has 3 subdivisions.

A1: Flexion type fractures.

A1, 1: In stable flexion type fractures the height loss from vertebral anterior wall is <50% and only one vertebral element is involved. This is the most common type.

A1, 2: Unstable flexion type fractures.

A1, 2a: In fractures occuring as a result of constant acceleration force, the height loss from the vertebral anterior wall is >50% and the vertebral disc has also been involved. There is no damage in vertebral posterior elements; but there is the risk of progressing kyphosis.

A1, 2b: Fractures occuring as a result of increasing acceleration force are the same as Denis' seat-belt fractures (3). These fractures are the result of the patient's body sudden flexion in an automobile decelerating in a car with high acceleration (7). All of the 3 colons are involved. The patient may have neurologic deficit and neurologic unstability is present. The injury might involve only the osseos complexes (chance fracture), only the ligamentous complexes or both of them.

In radiologic evaluation the lesion in the anterior colon and the loss of height in the anterior part of the vertebral body (except the high acceleration flexion type injuries affecting the ligamentous complexes) is pathogonomic. Depending up on the magnitude of the force; there might be a lesion in the posterior elements and the interspinous distance might have increased.

A2: Extension type fractures. These are the least understood, least diagnosed and least studied group. We believe that when the MRI becomes more common these type of fractures will be more understood.

We see the extension type fractures in the cervical region which is lordotic. It is not abnormal not to see these type of fractures in the thoracal region which is kyphotic and is supported by the thoracic cage. However; it is not logical to think that these type of fractures are not common in the lumbar region which has lordotic curve and has high flexion-extension type mobility.

This group also has 2 subdivisions.

A2, 1: In stable extension type fractures there might be side fractures in the posterior part of the vertebral body or there might be height loss in this part of the body. Because only one element is injured in the middle colon, it is considered stable.

A2, 2: Unstable extension type fracture. It has 2 subdivisions.

A2, 2a: It occurs as a result of constant acceleration. Although it is similar to the stable group, the trauma has affected the vertebral disc and for this reason; it is considered as a neurologic unstable fracture.

A2, 2b: High acceleration type fractures occurs as a result of patient's body sudden hyperextension because of high acceleration forces. Usually ALL and the vertebral disc are affected. There might be fractures in the vertebral body, pedicule, lamina, facets and the posterior elements.

Flexion and extension type fractures have compression type forces on one side of the vertebral body as a common feature. It is very logical that while compression type forces act on one side of the vertebral body, the other side is affected by tensile type forces. Therefore; we don't consider "distraction-flexion", "distraction-compression" type forces logical.

The common features in radiological evaluation is the fracture in the posterior part of vertebral body. Besides this there might be fractures in the neural arch elements and spinous process and dislocation f the faces joint. There might be even ALL and anterior annulus fibrosus tears in the presence of strong forces. However the anterior colon is not involved.

A3: Axial compression type fractures (burst) are the most common causes of the neurologic unstability. They occur as a result of axial forces on the vertebral colon and have 4 subdivisions.

A3, 1: In axial burst fracture only axial loading of force is involved. There is damage in the anterior and posterior colons. Both anterior and posterior walls are equally involved. There might be fractures in the laminas and pedicules.

A3, 2: In flexion burst fractures, because the body comes in to flexion along with axial loading type of force; a fracture type which has more loss of height in the anterior part of vertebral body occurs. The neural arch elements are relatively less involved.

A3, 3: In extension burst fractures axial type of force acts together with extension type. The loss of height in the posterior part of vertebral body is more than the anterior part. It is possible for the posterior elements of the vertebral colon to be involved in the type of burst fractures.

A3, 4: Lateral burst fracture occurs when the lateral forces forcing the body in lateral flexion acts together with the axial loading type forces. When the height on one side of the body is reserved, there is height loss on the other side. Both anterior and middle colons are involved. Like other burst fractures the interpedicular distance is increased.

In radiologic evaluation the pathognomonic sign is the increase in the interpedicular distance. There is height loss both in the anterior and the posterior part of the body.

Group B:

These are fractures or fracture dislocations occuring under the influence of translational forces. In the vertebra, being affected from the trauma, there is translation either in the horizontal or the sagittal plane. Although the type of mechanism might only involve the translation type of force; other type of forces also play a role. They are the most common cause of fracture dislocations and have 4 subdivisions.

B1: In fractures occuring only as a result of translational type of forces the vertebral body has anterior, posterior or lateral displacement. Usually all ligamentous structures are involved. There might be small vertebral body side, facet or spinous process fractures.

B2: In flexion-translation type fractures both flexion and translation type of forces act together. According to the direction of translation forces the vertebral body might displace either anteriorly or posteriorly. As avulsion fractures or ligament tears occur in the posterior part of vertebral colon by the effect of tensile forces; there is compression fracture in the anterior wall of the body which causes height loss.

B3: In extension-translation type fractures both the extension and the translation type of forces act together. According to the direction of translation forces there might be anterior or posterior displacement of the vertebral body. As fractures occur in the neural arch element and posterior part of the body there is injury in the anterior disc or anterior longutudinal ligament (extension spondylosis) (7).

B4: There is usually lateral translation in translational burst type fractures and a burst fracture occurs as a result of axial compression type of force. All ligamentous complexes are involved as in other forms. The main fracture is in the anterior and middle colons.

In radiologic evaluation the displacement of one vertebral body on the other is pathognomonic. If this displacement is more than 50% then all ligaments involving the ALL as well, might be torn (6).

Group C:

The rotational type of injuries are diagnosed by the rotation of spinous processes and pedicules in the AP x-rays. Because the ligamentous complexes cannot stand against the rotational type of forces strongly; almost all of the ligamentous complexes are injured (6).

When rotational forces are applied the vertebral colon stability is mainly maintained by the anterior colon (90%) whereas facets play a minimal role (35%) (8). These type of injuries are considered among the most common type of injuries causing unstability and are subdivided into 5 groups.

C1: The injuries occuring only as a result of rotational type of forces might either involve the ligamentous structures at the disc level; or the osseos structures at the vertebral body level (slice fracture). There is no height loss of the vertebral body.

C2: In rotational-flexion type fractures there is height loss of the anterior part of the body as well as rotational type of injury. The ALL might be spared of the injury.

C3: In rotational extension type injuries both rotational and extension type of fractures act together. The ALL is torn and there might be a fracture in the posterior part of vertebral body, neural arch elements or facets.

C4: In rotational burst type injury there is increase in the interpedicular distance besides rotation. There is height loss both in the anterior and posterior of the vertebral body. The trauma mainly affects the osseos structures (7).

C5: In rotational translation type fractures there is translation in the vertebral body besides rotation. Almost all the time; there is dislocation or fracture-dislocation.

In this classification system we have classified the pathology in an increasing order in a simple and systematic fracture causing mechanism. Although the unstability is possible in all groups, it is most common in rotational-translation type fractures and least common in flexion type fractures. According to this classification system of the 45 cases who are operated in our

department, 39 cases fall into the burst type, 2 into translational flexion type, 1 into the translational-burst, 2 into the rotational-burst and 1 into the rotational-translation type fracture.

Whiteside describes the stable vertebral colon as a colon which stands against the progressing deformity or neurologic deficit (12). White and Panjabi has accepted the posterior part of PLL as posterior colon and the anterior part of PLL as anterior colon, as a result of their experimental study. They have stated that the vertebral colon has become unstable when they have injured the posterior ligaments plus one anterior ligament and when they have injured the anterior ligaments plus one posterior ligament. According to this authors two side facet, lamina and pedicule fractures and multiple laminectomy cause unstability in the posterior colon (11).

Farcy has developed the sagittal index theory in his clinical studies by dividing the ligamentous structures of 3 colons in to 6 elements, 2 elements in each colon. This index is 5° in the thoracic vertebra, 0° in the thoracolumbar region and –10° in the lumbar vertebra. If the SI≥15° and there is injury in 3 or more elements in the colons than there is unstability in the vertebral colon (5).

Olof Perey has stated that the mobile spinal segment consist of 2 vertebral body and the vertebral disc in between (6).

The mobile spinal segment consists of 2 joints one in between the bodies and one in between the facets. We believe that the unstability in the vertebral colon depends upon the extent of involvement in these 2 joints. White and Panjabi also have divided the vertebral colon in 2 at the level of PLL in their experimental study (11).

It is Robert and Curtis who have described the acute and choronic unstability concept for the first time (10). By this definition many discussions have been introduced into this area. Especially, under which circumstances does chronic unstability develop and which one of them does require surgery still remains controversy. For this reason we believe that unstability forms at the moment of trauma and such a definition as chronice and acute unstability is not necessary. It is obvious that all of the unstablities occuring at the moment of trauma, unless they are treated, will from chronic unstability in the future. Unstability forms during the trauma and in order to operate this unstability some criteria must be met. We are in total agreement with Denis' definition of mechanical and neurological unstability (4).

We want to discuss about the middle colon which plays a significant role in the spinal stability and the spinal stability itself, without forgeting that the spinal segment consists of 2 joints and the unstability forms around these joints. Because the middle colon plays a significant role in spinal stability, we might consider the Holdsworth's posterior ligament complex involving ligamentum flavum and facet joints as a part of the middle colon. According to us the middle colon must be wide enough to surround the spinal cord and must play the major role in spinal stability. In other terms the anterior colon consist of ALL, the anterior part of the vertebral body and anterior annulus fibrosis as Denis has described. The middle colon consists of posterior annulus fibrosis, the posterior part of the vertebral body, PLL, pedicules and laminas, ligamentum flavum, facet joints, capsule and the ligaments. Finally the posterior colon consist of transverse processes, the intertransverse ligament, spinous process and supra and infraspinous ligaments.

In order to decide about a mechanical unstability during a trauma, at least 3 elements in different colons, or at least 2 elements in one colon must be injured. If at least 2 elements in the middle colon are injured, it means that the vertebral colon is unstable neurologically. In other terms when the vertebral colon is unstable neurologically, it is also unstable mechanically. Here the pedicules, laminas, infra and supraspinous ligaments, the intertransvers ligament, the transverse processes must be considered as one element.

For example in a flexion type fracture if there is injury in the anterior annulus fibrosis or supra-infra spinous ligaments as well as a compression type fracture in the anterior part of the body the fracture is mechanically unstable. Or in an extension type fracture if there is an injury in the posterior annulus fibrosis or in the posterior part of the vertebral body besides the bilateral lamina fracture, this type of fracture is unstable both mechanically and neurologically. In burst type fractures if there is an injury in posterior annulus fibrosis or PLL or a fracture in facet or laminas as well as a fracture in the posterior part of the body, this type of fracture is unstable both mechanically and neurologically. Translation and rotation type injuries occur as a result of serious trauma and several type of different forces may act upon the vertebral colon. For this rea-

son these injuries are unstable almost all the time and need surgical intervention.

Here we must emphasize one point. We haven't done any biomechanical studies to support the stability criteria we have just described. But we are planning to do research about this in the future.

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