

**MINISTRY OF HEALTH REPUBLIC OF UZBEKISTAN  
TASHKENT MEDICAL ACADEMY  
MEDICAL – PEDAGOGICAL FACULTY  
DEPARTMENT OF TRAUMATOLOGY, NEUROSURGERY AND MFS**

«Confirm»  
Pro-rector of the study  
Prof. \_\_\_\_\_ Teshayev O.R  
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**CASE-TECHNOLOGY**

**Theme: VERTEBRO-SPINAL INJURY**  
*(For teachers and students 5 course Medical-pedagogical faculty)*

**Tashkent-2013**

**Composed by**

Alikhodjaeva G. A. -

Ph.d. prof. Of Department of traumatology-orthopedics, neurosurgery and field military surgery of medical pedagogical faculty of TMA

Ashrapov J.R. -

M.d. Of Department of traumatology-orthopedics, neurosurgery and field military surgery of medical pedagogical faculty of TMA.

Kazakov Sh.J -

M.d. Of Department of traumatology-orthopedics, neurosurgery and field military surgery of medical pedagogical faculty of TMA.

Toshmatov Sh.N

M.d. Of Department of traumatology-orthopedics, neurosurgery and field military surgery of medical pedagogical faculty of TMA.

**Reviewers:**

Norov A.U.

Head doctor Republican Scientific Center of Neurosurgery , candidate medical science .

Eshonqulov G.S.

Docent Of Department of traumatology-orthopedics, neurosurgery and field military surgery of medical pedagogical faculty of TMA

Case

Tactics of the doctor of the general practice solves a problem, of vertebro-spinal injury.

The technology of training is confirmed:

On faculty meeting

The report № \_\_\_\_\_ from «\_\_» \_\_\_\_\_

## PEDAGOGICAL ANNOTATION

**Subject:** Neurosurgery

**Theme:** VERTEBRO-SPINAL INJURY

**Target:** to educate students to neurological examination, observing, differential diagnostics and first medical aids at traumatic brain injury. Educating the students, interpretation of X-ray, CT, and MRI.

**Planned educational results** – as a result of case technology students will gain followings:

1. Analyzing the complaints and problems of the patient.
2. Differential diagnosing the VSI with other pathologies.
3. An adequate therapeutic tactics
4. First medical aid.

**To successful solve the problems concerning with case student must:**

1. Understand the mechanisms of VSI.
2. First medical aid.
3. Differential diagnostics.
4. Drugs used in VSI.
5. Possible early and late complications.

**Sources:**

1. Watson-Jones R. *Fracture and Joint Injuries*. 3rd edn. Williams & Wilkins: Baltimore 1943.
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5. Iencean SM. The stabilizing axial spinal pillar in the lumbar spine. *Spinal Cord* 2002; **40**: 178–185. | [Article](#) |
6. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine* 1983; **8**: 817–831. | [Article](#) | [PubMed](#) | [ChemPort](#) |
7. Denis F. Spinal instability as defined by the three-column spine concept in acute spinal trauma. *Clin Orthop* 1984; **189**: 65–76. | [PubMed](#) |
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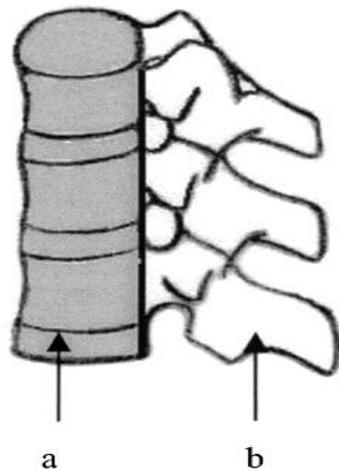
**General concepts**

The classifications of spinal injuries are related to those of spinal instability. After the introduction of the concept of spinal instability in the Watson-Jones classification of spinal

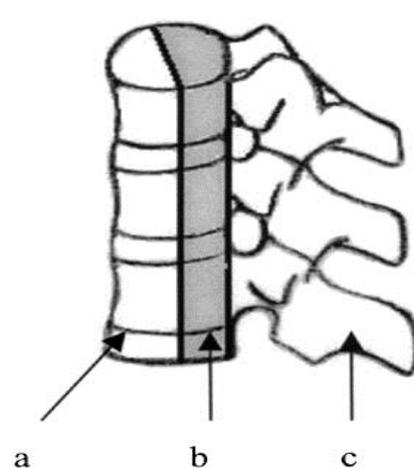
fractures, 1931, Nicoll presented, in 1949 the acute and the secondary spinal instability and later numerous studies of spinal instability were completed.

An interpretation of spinal instability based on the central axial spinal pillar pattern was recently proposed. The axial overlapping of the posterior third of the vertebral body continued by the pedicles and the articular processes, forms the central axial spinal pillar for stability and resistance. This model appears as a complete concept of Denis and Louis<sup>8</sup> models: the posterior third of vertebral body and intervertebral disc as in Denis's concept joins with the two columns of articular facets as in Louis's concept (Figure 1). The vertebral segments situated in front of the central axial pillar form the anterior secondary pillar and the overlapping of the laminae, spinous processes, connecting ligaments, etc forms the posterior secondary pillar (Figures 2 and 3). The spinal instability appears because of the disruption of the biomechanical continuity of the central axial spinal pillar.

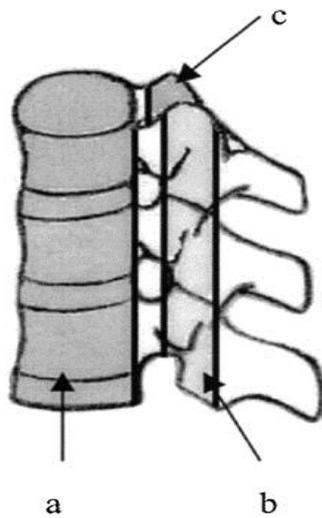
**Classification of spinal injuries based on the essential traumatic spinal**



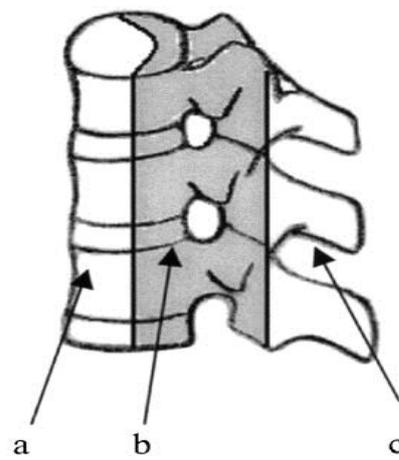
Model of Holdsworth



Model of Denis



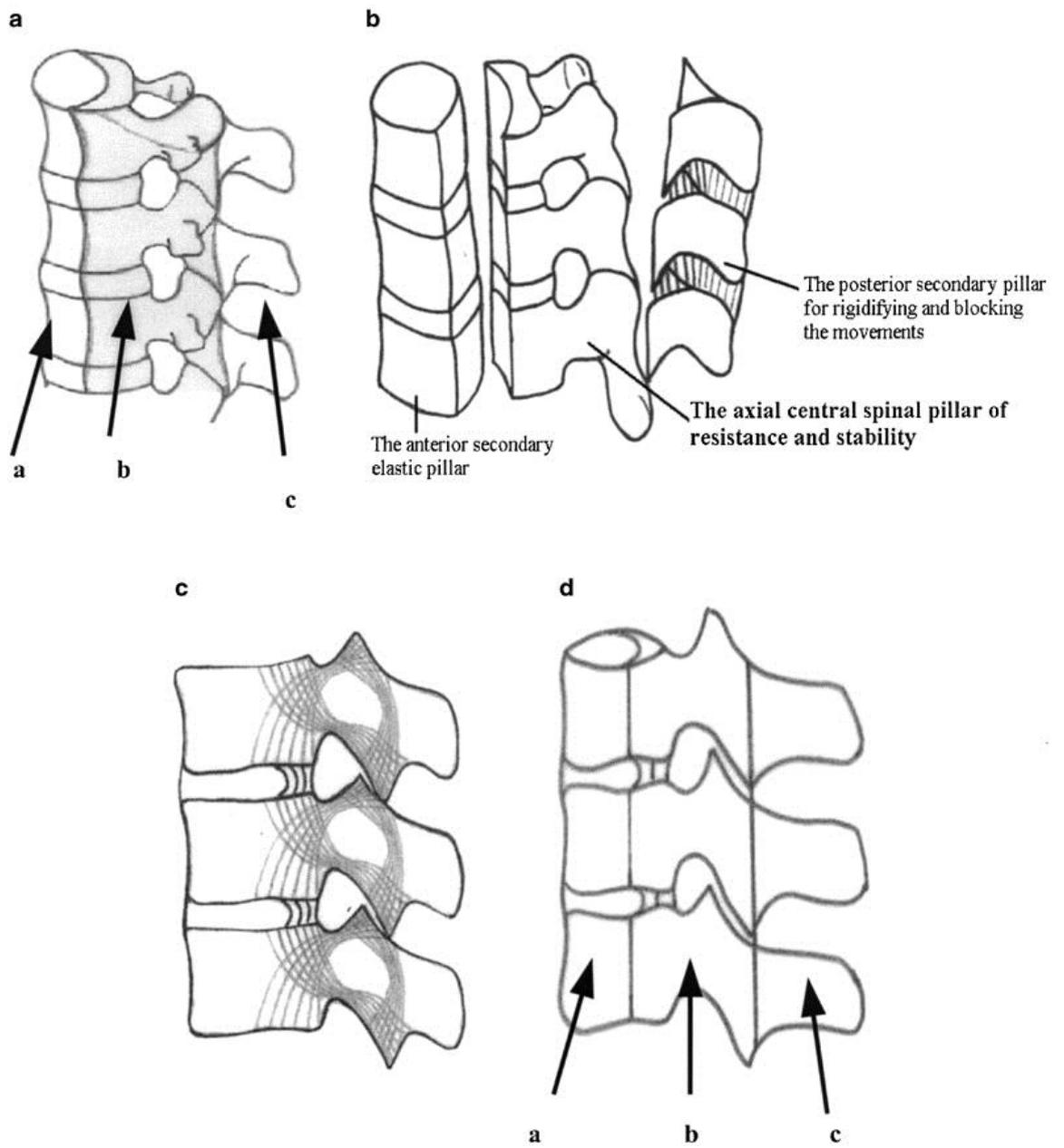
Model of Louis



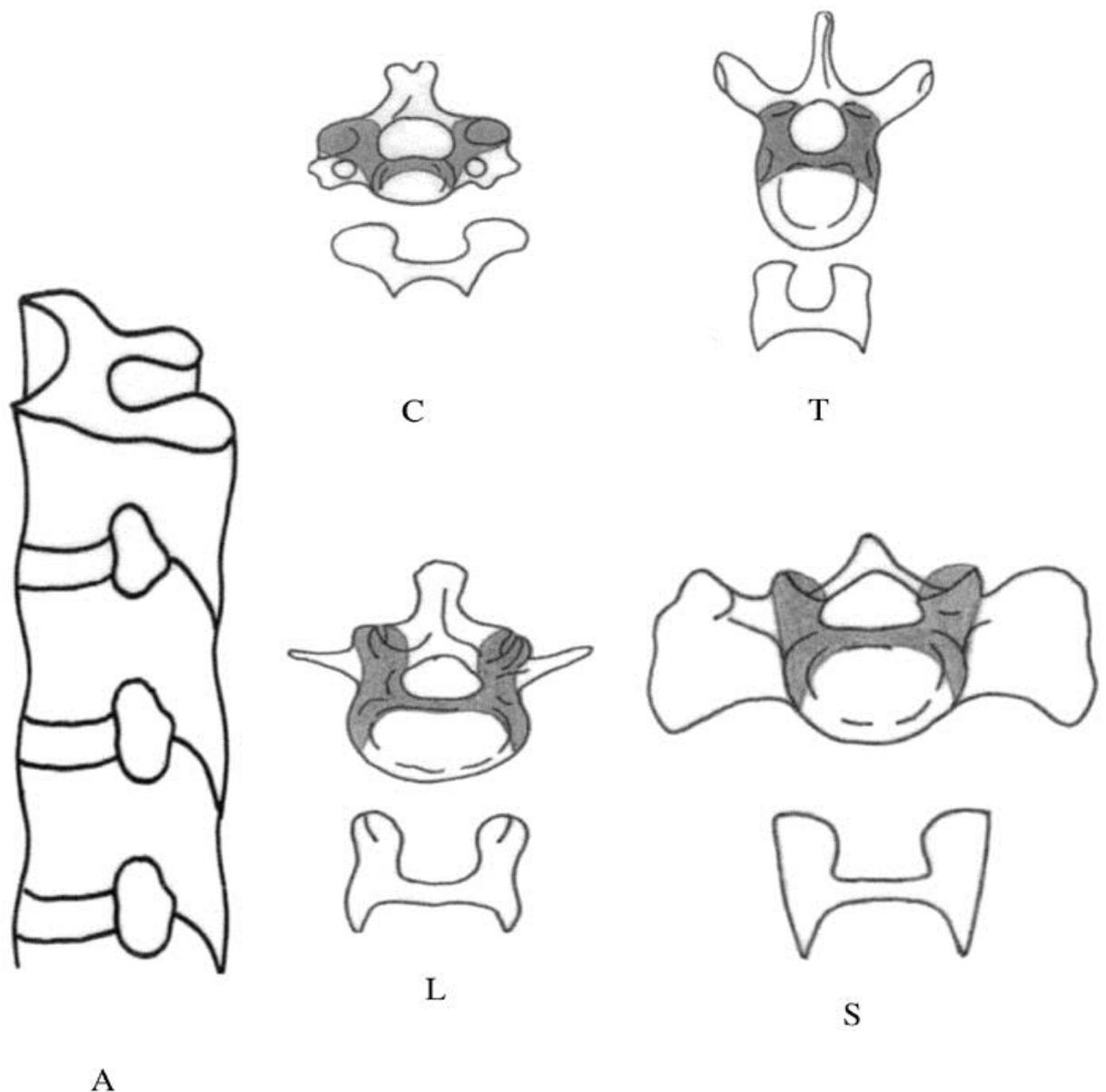
Model of central axial spinal pillar

**mechanisms**

- (a) Model of Holdsworth with two columns (a and b).
- (b) Model of Denis with three columns (a–c).
- (c) Model of Louis with three columns (a–c).
- (d) Model of three pillars with: a – central axial spinal pillar and b, c – two secondary pillars



Central axial spinal pillar of resistance and stability: (a, b) drawings, and (c, d) schemes: a – anterior secondary pillar; b – axial central spinal pillar; c – posterior secondary pillar



The central pillar of stabilization: A – lateral axial view; and cross-section at various spinal levels: C – cervical level; T – thoracic level; L – lumbar level; S – sacral level (S1)

The classical classifications of spinal injuries do not always incorporate the segmental biomechanical behavior in the spinal function as a whole or in relation with the traumatic mechanisms. A classification of spinal injuries must be based on the essential traumatic spinal mechanisms in connection with the spinal instability determined by the lesions of the central axial spinal pillar.

This paper presents a unitary biomechanical classification of spinal fractures and a definition of spinal instability based on the concept of central vertebral pillar of stability and on the analysis of instability in over 300 spinal injuries.

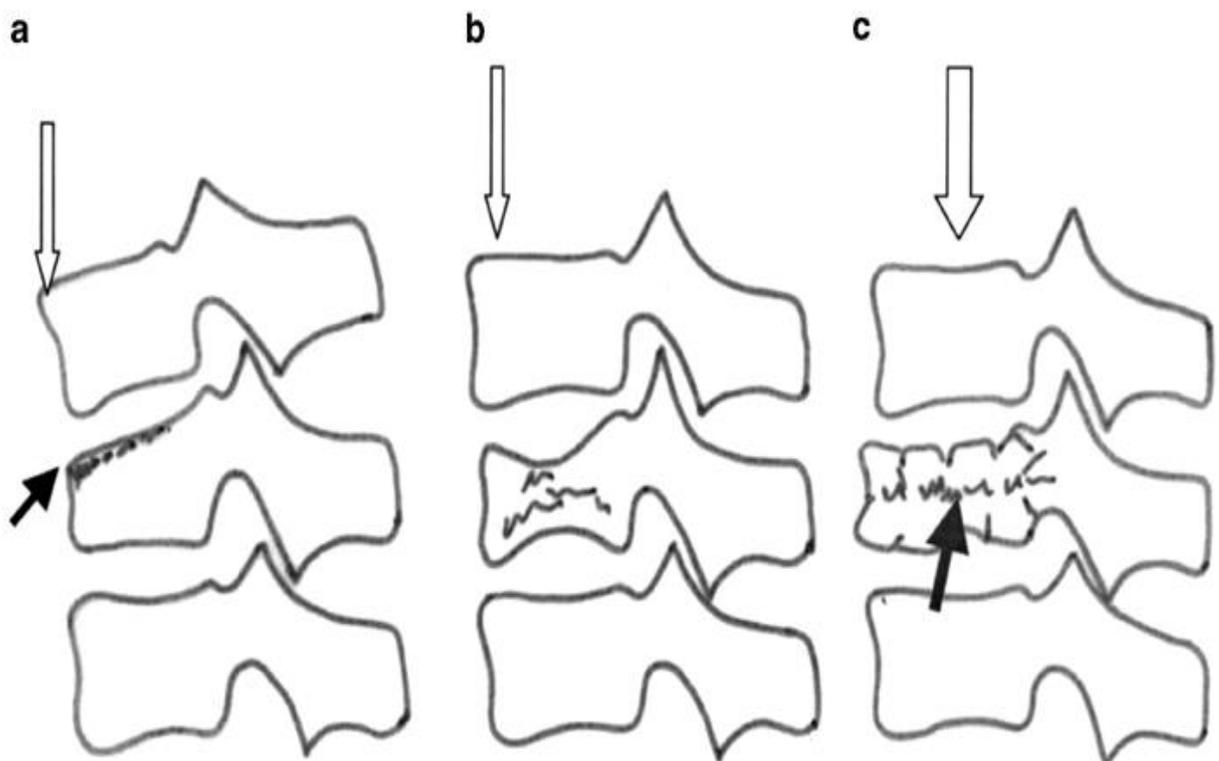
#### ***Essential mechanisms of spinal injuries***

The mechanisms of spinal injury production are related to the possibility of the exaggerated motions to produce fractures of the vertebrae. The analysis of the spinal segmental movements and of the spinal combined movements, according to the Cartesian coordinate system for the human spine, shows that different possible spinal lesions occur because of an exaggerated movement in one of the directions: axial (along the spine), axial spinal rotation, transversal as a segmental translation or combined mechanisms.

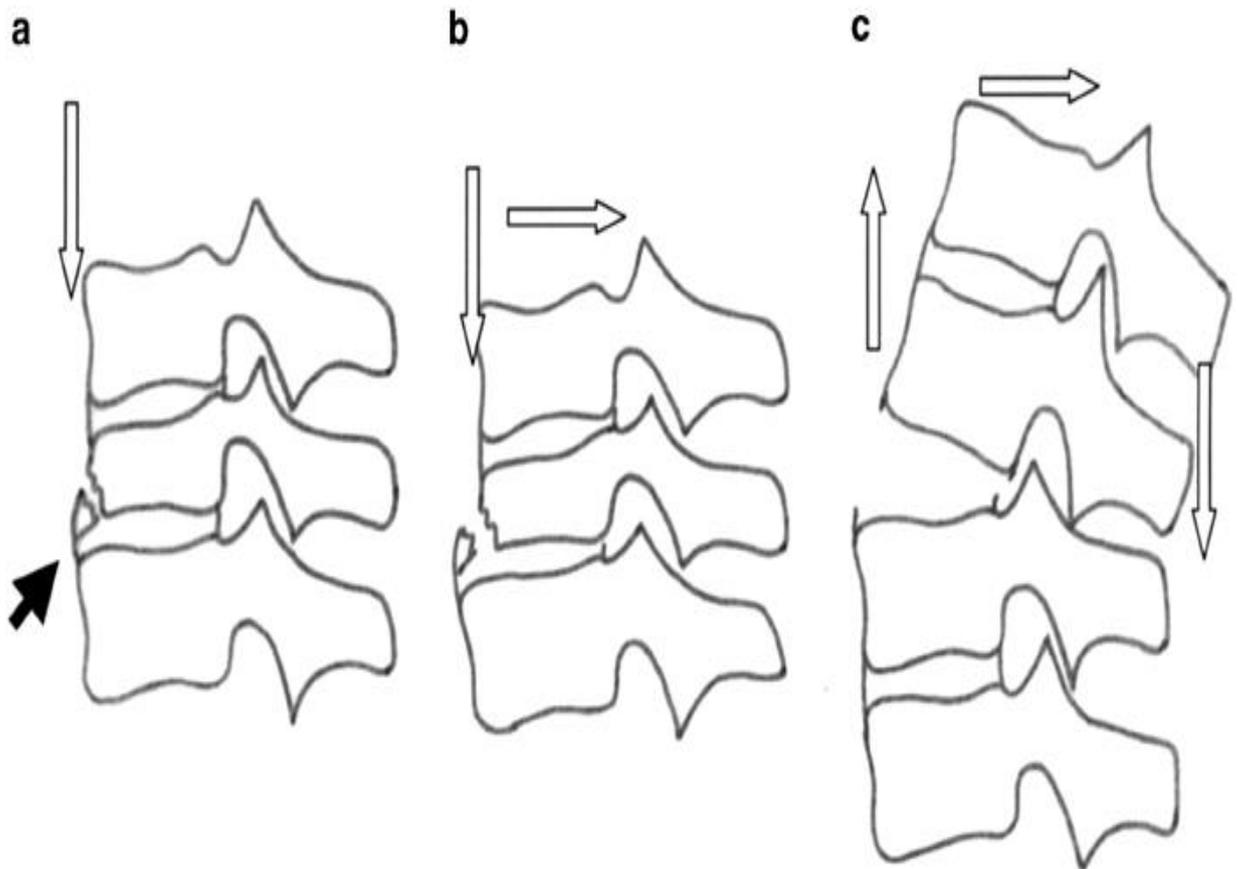
Therefore, the classification used is:

1. Axial deformation with two possible variants:
  - a. Compression, centric but most often eccentric owing to the physiological curvatures and especially because of the specific posture in the moment of impact. The eccentric compression injury causes a flexion on one side of the spine and extension on the other side, thus including the compression in flexion or extension.
  - b. Spinal elongation, which occurs most often at the cervical spine level; the elongation can also be axial centric (distraction) or more frequently axial eccentric, thus resulting in a flexion–distraction injury or an extension–distraction injury of the spine
2. Torsion or axial rotation.
3. Segmental translation (transversal or cross-translation), with a shearing version for the double or repeated translation (with a 'to and fro' motion).
4. *Combined mechanisms*: at the same time or in a very rapid sequence; this is the most frequent situation.

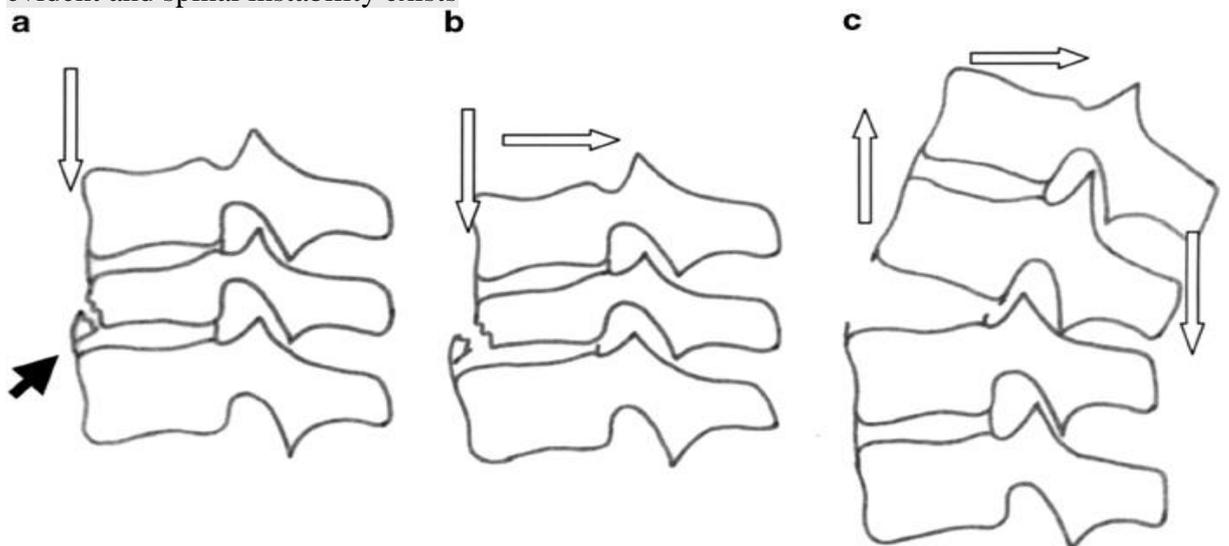
Schematic drawings of some types of spine injuries are given in Figures 4, 5 and 6. These 314 cases of spinal injuries were systemized based on the above classification (Table 2 ) and a correlation between the type of mechanism injury, the spinal instability and the lesion of the central axial spinal pillar was investigated.



Schematic drawings of some types of spine injuries: **(a)** axial deformation through eccentric compression resulting in a superior wedge fracture; **(b)** axial deformation with eccentric compression and vertebral body collapse; **(a and b)** situation with an unaffected central axial spinal pillar and without spinal instability; **(c)** axial deformation through centric compression and burst fracture with partial lesion of the central axial spinal pillar and latent spinal instability



Schematic drawings of some types of spine injuries: **(a)** axial deformation through eccentric compression resulting in a partial anterior inferior body fracture but integrity of the central axial spinal pillar; **(b)** a combined mechanism through eccentric compression, posterior translation and with lesion of the axial spinal pillar and spinal instability; **(c)** axial deformation with eccentric distraction and posterior translation, lesion of axial spinal pillar is evident and spinal instability exists



Schematic drawings of some types of spine injuries: **(a)** axial deformation through eccentric compression resulting in a partial anterior inferior body fracture but integrity of the central axial spinal pillar; **(b)** a combined mechanism through eccentric compression, posterior translation and with lesion of the axial spinal pillar and spinal instability; **(c)** axial deformation with eccentric distraction and posterior translation, lesion of axial spinal pillar is evident and spinal instability exists

A classification of spinal injuries must identify common injury patterns, determine prognosis by the presence or the possibility of spinal instability and assist in the treatment.

Analysis of normal spinal movements can indicate possible spinal injury patterns. The normal spinal motions have their directions on the axes of motions and the postures resulting through motion combinations can be analysed on an axis parallel to the spine and a transversal plane of a functional spinal unit (the vertical axis of the spine and the cross-planes of the spine).

The translations along the vertical spinal axis are axial centric deformations, while flexions-extensions and lateral bendings are axial eccentric deformations of the spine. Other postures are also caused by axial spinal rotation (torsion), by the spinal translations and by all possible combinations of these mechanisms.

Spinal traumas cause direct osteoligamentary injuries if the lesion focus is at the level of impact, or indirect ones when the traumatic impact, is away from the lesion focus.

The direct spinal injury can be regarded as an immense spinal strain for a segmental intervertebral movement or a colossal spinal stress of loading for a vertebral segment or a combination of the two. The indirect spinal injury is also a nonphysiological excessive spinal requirement (or spinal strain) of loading or of movement. The direct or indirect spinal injury induces an anomalous movement and in this way the vertebral resistance is exceeded and the spinal injury occurs.

Therefore, the spinal injury occurs through a nonphysiological posture strain (or posture stress). These nonphysiological postures can result through exaggerated axial spinal deformations: centric compressions or centric distractions and eccentric compressions or eccentric elongations. Also, other pathological postures can result from exaggerated axial spinal rotations, abnormal spinal translations and all possible combinations of the above pathological mechanisms.

These pathological postures are the result of direct or indirect spinal trauma interpreted as spinal strain by motion or spinal loading stress.

The spinal deformation is the repercussion of the spinal over taxation (as a overphysiological spinal requirement) and this spinal deformation is higher than the normal resistance of spinal osteoarticular and ligamentary elements. The consequence of the traumatic incident depends on the position of the spine at the time of injury.

The classification of spinal injuries used is primarily based on the biomechanical mechanisms of the spinal injuries and the categories are formed in concordance with the same mechanisms of lesions. This classification defines spinal injuries in groups based on the essential spinal injury mechanisms (Table 2); each spinal injury is shown by exhibiting the pathological morphology of spinal lesion and of the spinal level.

The mechanisms are: (1) axial deformation injuries with two categories: (a) compressive, centric or eccentric injuries (Figures 4a–c and 6a) and (b) spinal elongation, centric or distraction and eccentric elongation (Figure 6b); (2) axial rotation or torsion (about the vertical spinal axis), which can induce an injury through rotational translation on the cross-plane of the spine; and (3) segmental translation on the spinal cross-plane or on an oblique-plane, which causes transverse or oblique disruptions. The mechanism of shearing is a repeated segmental translation with 'to and fro' motion; this shearing can also occur in an oblique or a quasivertical plane, especially at the posterior vertebral arch. These mechanisms can be combined simultaneously or successively in a very quick sequence and the multiple combinations of the injury forces (compressive,

distractive, rotational, shear forces, etc) can induce different stages of spinal injuries; these combined mechanisms are the fourth type in this classification (Figures 5b, c).

As a rule, the indirect traumatic impact has produced vertebral injury by compression (in flexion or in extension) or by torsion and in the direct traumatic impact the injury occurred through translation (or shearing) or through combined mechanisms.

The axial central spinal pillar maintains the orthostatic posture and transmits elastically and plastically the spinal stress conditions and the secondary pillars take over the loading elastically (the anterior pillar) and limit the movements' amplitude (posterior pillar) in order to protect the axial pillar.<sup>5</sup> The vertical division of the central spinal pillar decreases spinal rigidity and increases overall spinal flexibility while at the same time reducing the loading shock by gradually lessening the impact acceleration.

The spinal instability analysis based on the diagnosis criteria of clinical instability has shown that the lesions of the two anterior thirds of vertebral body, that is, equivalent to the anterior secondary pillar, did not determine spinal instability, in 39 cases; and also an absence of instability in 29 cases with the lesions of the vertebral body without the posterior cortical layer. But in five cases with the same lesions of the vertebral body without the posterior cortical layer, spinal instability which was absent at the beginning has occurred gradually as late instability; the points value of clinical instability were 5–6 four –six months later, and this late instability was determined by a secondary intervertebral disc narrowing with a late radiculopathy (Table 4).

The injuries of the laminae with or without the spinous processes, and/or of the posterior connecting ligaments did not determine spinal instability; therefore, the injury of the posterior secondary pillar did not induce spinal instability. The complete injuries of the vertebral body (including a lesion of the vertebral posterior ligament) or extended lesions of the vertebral body including pedicles and facets have caused instability in all cases: instantaneous instability in 31 cases and precocious instability in nine cases. Full lesion of the posterior third of the vertebral body with pedicles and facets with injuries of the anterior and posterior pillars determined instantaneous instability in 46 cases (Figures 9, 10, 11 and 12).

Lesions of facets and pedicles bilaterally caused a precocious gradual instability in 14 cases and the bilateral facet injuries produced a late gradual instability in 29 cases (Figures 8 and 10).

The lesions of the central axial spinal pillar have determined spinal instability in all cases.<sup>5,28</sup>

However, in 31 cases, bilateral lesions of the facets with the lesions of the secondary posterior pillar did not induce spinal instability as compared to 29 cases with the same lesions and with late spinal instability. This late instability was determined often by a late radiculopathy, by a late kyphotic angulation, by a widening of the interspinous space or of the interpedicle distance.

The injuries of the central spinal pillar have always been accompanied by a lesion of the secondary pillar, but the lesions of the secondary pillars could be isolated, partially or completely, according to the mechanisms of injuries.

Theoretically an isolated lesion of the central axial spinal pillar can be thought to be able to appear through possible mechanisms such as torsion with bilateral facets injury, bilateral traumatic isthmic injuries, bilateral fractures of the pedicles, etc; in this study the lesions of central axial spinal pillar were accompanied always by lesions of the secondary pillars. Injuries of the secondary pillars can be thought to not cause biomechanical instability; injuries of the posterior arch could produce spinal cord compression, although the spine could be stable.

The lesions of the secondary posterior pillar and partially of the central spinal pillar have caused: late gradual instability in the facets bilateral lesions, precocious gradual instability in the facets and pedicles bilateral lesions, and instantaneous instability in full lesions of the central axial spinal pillar.

The essential mechanisms of spinal injuries presented above are in concordance with the types of spinal lesions, and this spinal injuries classification included all the spinal injury cases which were studied.

The lack of spinal central pillar lesions was correlated with spinal stability and the lesions of the central axial spinal pillar have determined spinal instability in all cases, therefore the spinal instability can be considered to be determined by the central spinal pillar injury.<sup>5</sup>

The surgical approach in traumatic spinal instability must be reconsidered according to this biomechanical concept of the central axial spinal pillar of stability. Thus the fixations on anterior or posterior approach must stabilize the spine by stabilization of this central spinal pillar.

## Conclusion

The first objective of a neurologic examination of the patient with spinal injury is to establish if spinal cord/roots injury exists and secondly if spinal injury is stable or unstable. Traumatic spinal instability is caused by the discontinuity of the central axial spinal pillar. It occurs when the lesion of the central spinal pillar exceeds a limit value in cross-section and height: full lesions of the central axial spinal pillar determine instantaneous instability, facets and pedicles bilateral lesions cause precocious gradual instability and the facets bilateral lesions induce late gradual instability.

The mechanisms of the central axial spinal pillar lesions are the essential traumatic spinal mechanisms.

The proposed classification of the spinal injuries is based on these abnormal forces acting on the central axial spinal pillar and determining exaggerated movements:

1. Axial deformation with two variants:
  - a. *Compression*: Centric or most often eccentric; the eccentric compression injury includes the compression in flexion or in extension.
  - b. *Spinal elongation*: The centric (distraction) or more frequently eccentric elongation causes flexion- or extension-distraction injuries.
2. Torsion or axial rotation.
3. Segmental translation, with a shearing version for the repeated translation.
4. The three above mechanisms combined, simultaneous or successive.

Each spinal injury is shown by exhibiting the pathological morphology of spinal lesion and of the spinal level.

This classification of spinal injury is unitary and can be applied to the whole spine.

The injuries of the central spinal pillar have always been accompanied by a lesion of the secondary pillar. Injuries of the secondary pillars do not cause biomechanical instability; injuries of the posterior arch can produce spinal cord compression, although the spine can be stable.

The treatment in spinal injuries is made in connection with the spinal cord compression and the stabilization of the unstable spine must restore the continuity of the central axial spinal pillar.

## Instructions for independent work

### The list for analyzing the situation

Stages	Recommendations
1. acquaintance	Get acquainted with case. <ul style="list-style-type: none"> <li>• Read only, do not analyze</li> </ul>
2. situation	Read paragraphs that seemed important for you. Try to characterize the situation. find out what is important in there, and what is seemed secondary.
3. forming the problem, sub-problem	Problem: Choosing the way of tactics, helping, solving the problem
4. diagnostics of situation	<b>Answer the following questions:</b> -what kind of complaints are characterizing as a major problem in patients with VSI? -how to take an anamnesis more efficiently; -what kind of instrumental methods of diagnostics are used for patients with VSI? -main clinical features of the patients with VSI?
5. explanation of the solution of the problem	Give all possible versions of solutions for the present problem
6. problem solution	Diagnosing and treatment principles.

### III. The Variant of the decision of a case the teacher – keysologist.

#### 1. What variants of a current of disease are possible?

- Danger syndrome, danger in it consists compression a spine cord.
- Untimely rendering assistance can lead to consciousness and infringement infringement vital to function.
- One of urgent surgical action be imposings long external drenation on Rent.
- The complications observed at treatment. Damages of an obverse nerve. Infectious complication.

#### 2. What methods of diagnostics are necessary for applying, make and prove the inspection plan at level of clinical hospital.

1. The anamnesis.
2. Survey of integuments and visible mucous, places of possible formation .
3. Haemodynamics indicators: A/Д, pulse, temperature.
4. Neurologic inspections.
5. Kliniko-laboratory inspections (the general analysis of blood and urine, researches of blood).

Spinal injury and spinal cord, occurs much less frequently, we grasses of the brain and in peacetime is 1-4% of the total grass-matizma.

Spinal cord injury is divided into an open (in violation of the integrity of the skin at the site of injury) and closed (without violating the integrity of the skin), the latter is most injuries of this kind.

In relation to the spinal cord injury is divided into three groups: the damage to system without spinal abnormalities in the spinal cord injury with spinal cord dysfunction, spinal cord injury without spinal injury.

## IV case – The Case – technology of training on practical employment

### 4.1. Model of technology of training

Subject	Traumatic injury of the spinal cord, vertebral column. Etiology, pathogenesis, clinical presentation. Prognosing the complications	
Study hours – 4 hrs	Amount of students: 11-12	
Form of the lesson	Seminar	
Plan	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Actual problems</li> <li>3. Case-technology</li> <li>4. Presenting the results</li> <li>5. discussion, evaluating and choosing the best variant of solution</li> <li>6. Conclusion. Evaluating the groups activity, extent of the succeeding.</li> </ol>	
target: -		
Goals of the instructor:	Results of educational activity:	
<ul style="list-style-type: none"> <li>• Consolidate and deepen the knowledge's of history taking.</li> <li>• Work out how to a diagnose in a right algorithm.</li> </ul> <p>to Develop skills of the emergency help</p>	<p>To acquaint students with the basic complaints characteristic for patients about traumatic damages of a backbone and a spinal cord.</p> <p>To learn how correctly to collect the anamnesis of the patient, to acquaint students objective and clinical methods of research which spend the patient about traumatic damages of a backbone and a spinal cord, to give the information to students about clinical signs characteristic for patients about traumatic damages of a backbone and a spinal cord.</p>	
Methods	Case-study, discussion	
Facilities	Methodical recommendations	
Форма обучения	Individual, frontal, in a groups	
Условия обучения	Audience with a hardware, adapted for work in groups	
Monitoring	Supervision, blitz interrogation, presentation, an estimation	

### 4.2. A technological card of the educational employment based on a case.

Stages	Activity	
	Instructor	Student
<b>Warm up</b>	Explains appointment a case - stages and its influence on development of a professional knowledge. Distributes materials of a case and acquaints with a situation analysis algorithm (Methodical instructions for students see).	Listening Independently study the maintenance of a case and individually fill sheet of the analysis of a situation.

	Gives the task independently to carry out the analysis and to bring results in «Sheet of the analysis of a situation	
<b>I. Intro (10-15 min)</b>	<p>1.1. Name an employment theme, the plan, its purpose, problems and planned result of educational activity.</p> <p>1.2. Acquaints with an operating mode on employment and criteria of an estimation of results (instructions for students see)</p>	<p>Listening</p> <p>Taking notes</p>
<b>II этап Basic 60 min</b>	<p>2.1. Proves statement of a problem and a situation choice - an urgency. Spends a blitz-interrogation on purpose to make active knowledge trained on a theme (the appendix №1):</p> <ul style="list-style-type: none"> <li>-What complaints are characteristic for patients about traumatic damages of a backbone and a spinal cord.</li> </ul> <p>How to collect the anamnesis of the patient;</p> <ul style="list-style-type: none"> <li>-What objective and clinical methods of research spend the patient about traumatic damages of a backbone and a spinal cord;</li> <li>-What clinical signs are characteristic for patients about traumatic damages of a backbone and a spinal cord.</li> </ul> <p>2.2. Divides students into groups. Reminds the maintenance and case problems. Acquaints (reminds) with work rules in group and discussion rules.</p> <p>2.3. Gives the task, specifies correctness of perception of the task (the appendix №2):</p> <p>With what нозологиями it is necessary to carry out differential diagnostics and to define the most probable reasons of occurrence at presence traumatic damages of a backbone and a spinal cord. The methods of diagnostics applied at traumatic damage of a backbone and a spinal cord.</p> <p>Conducting tactics</p> <p>2.4. Co-ordinates, advises, directs educational activity.</p> <p>Estimates results of individual work: Sheets of the analysis of a situation.</p> <p>2.5. Will organise presentations following the results of the done work under the case decision, discussion.</p> <p>The organizer of discussion: sets questions, remarks, reminds a theoretical material</p> <p>2.6. An organizer - algorithm of actions of the student in the given situation (the appendix №3)</p> <p>2.7. Informs the variant of the decision of a case (The appendix №4)</p>	<p>Answering the questions</p> <p>Work in a groups</p> <p>Discuss, carry out the joint analysis of an individual problem, define the major aspects of a situation, the basic problems and ways of their decision, make out results of the decision</p> <p>Represent variants of the decision of a problem of 10-15 mines Questions after the presentation termination, choose an optimum variant</p> <p>Develop uniform system, discussion</p>

<b>III conclusion 20 min</b>	3.1. Generalises results of educational activity, declares estimations individual from teamwork. Analyzes and estimates group, marks the positive and negative moments. 3.2. Underlines value a case - stages and its influence on development of the future expert	Listening . Self-control, self-estimation  Each says his/her opinion

The table of an estimation of individual work with a case

Participants	Criteria				
	Analyzing max 1,0	Evidence giving max 0,5	Choice of ways and means of the decision of a problem max 0,5	Detailed working out of measures on decision realisation Choice of ways and means of the decision of a problem max 0,5	Total (max 2,5)*
1.					
2.					
№					

\* 2,0 – 2,5 pts – «excellent», 1,5 – 2,0 балла – «good»,  
1,0 – 1,5 балла – «fair»,  
менее 1,0 балла – «bad»

### System of an estimation of variants of the group decision of a problem.

1. Each group receives two estimated points. It can give them at once all to one variant of the decision or divide on two (1:1; 0,5:1,5; etc.), not including an estimation of own variant of the decision.
2. All received points by each variant of the decision develop. Wins the decision which has typed the greatest quantity of points. In disputable cases it is possible to take voting.

The table of an estimation of variants of the group decision of a problem, point

Group	Alternative solution			
	1	2	3	№
1.				
2.				
№				
Overall				

### Estimation of presentation of the offered decision

Group	Completeness and clearness of presentation (1 – 20)	Demonstrative presentation (1 – 20)	Activity (1 – 20)	Originality (1 – 20)	eligibility (1 – 20)	Overall pts (max 100)
1.						
2.						
№						

#### The recommended literature

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