10.5005/jp-journals-10039-1004

CLINICAL STUDY

Reliability of the Column Theory to Evaluate Thoracolumbar Spinal Instability

[1]Tarek Aly, [2]El-Sayed

ABSTRACT

The concept of spinal instability is still evolving. Instability is mechanical terms means decreased stiffness of the functional spinal unit, increased mobility, or abnormal motion, and alterations in spinal mechanics place the neurological structures at risk. The column theory was used to evaluate the spinal instability.

Aim: In this study, we try to correlate the column theory of the spine with the preoperative and postoperative clinical and radiological findings.

Patients and methods: One hundred and twenty-two patients with unstable thoracolumbar or lumbar spine treated surgically were studied. The patients were classified according to their pathogenesis into three groups (trauma, 75 patients, tumor, 30 patients and infection, 17 patients, groups). All patients were also classified according to the three column theory. Detailed radiographic analysis of the vertebra (e) involved was done at admission, at mobilization, and at follow-up. Neurologic assessment was performed using modified Frankel grading scale.

Results: The results of this study did not support the column theory for evaluation of spinal instability. Comparing each group separately does not reveal any significant relationship between the number of the columns involved and radiographic or neurologic findings either before or after surgery.

Conclusion: Spine instability concept is still dilemma and evolving matter. More research is required for better understanding of the nature of the spine and its loading characters.

Keywords: Column, Theory, Spine, Instability-3.

How to cite this article: Aly T, Sayed E. Reliability of the Column Theory to Evaluate Thoracolumbar Spinal Instability. J Spinal Surg 2014;1(1):25-27.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The concept of spinal instability is still evolving. At the most simple level, instability is a lack of stability, which in mechanical terms decreased stiffness of the functional spinal unit, increased mobility, or abnormal motion and alterations in spinal mechanics place the neurological structures at risk. This mechanical situation occurs in spinal trauma, and where tumors and infections have caused extensive anterior bone loss.

The column theory was used to evaluate the spinal instability. Holdsworth[1] divided the spine into two columns: anterior (structures lie between anterior and posterior longitudinal ligaments) and posterior (structures posterior to the posterior longitudinal ligament). He considered that the spine is unstable if the posterior column is disrupted.

Denis[2,3] introduced third or middle column consisted of posterior vertebral body, posterior annulus fibrosus, and posterior longitudinal ligament and he stated that failure of the middle column is necessary to induce instability.

Since the introduction of the three column, many investigators explained their findings according to it but most of these studies did not correlate it with the postoperative neurologic and radiographic findings.

In this study, we try to correlate the column theory of the spine with the preoperative and postoperative clinical and radiological findings.

PATIENTS AND METHODS

One hundred and twenty-two patients with unstable thoracolumbar or lumbar spine treated surgically were studied. The patients were classified according to their pathogenesis into three groups:

1. *Trauma patients:* Fifty-four males and 21 females. Their mean age was 39 years (average 17-73 years).
2. *Tumors patients:* Fifteen males and 15 females. Their mean age was 44 years (average 7-68 years).
3. *Infections patients:* Nine males and 8 females. Their mean age was 57 years (average 21-75 years). Tuberculosis was the main cause of infection were it affected 14 patients.

All patients were also classified according to the three column theory:

1. *One column involvement:* Only one tumor patient.
2. *Two columns involvement:* Seventeen patients (23%) of trauma group, 11 patients (37%) in tumors group and 13 patients (77%) in the infections group.
3. *Three columns involvement:* Fiftyeight patients (77%) in the trauma group, in 18 patients (80%) in the tumors group, and in 4 patients (23%) in the infections group.

[1,2]Department of Orthopedics, School of Medicine, Tanta University, Tanta, Egypt

Corresponding Author: Tarek Aly, Department of Orthopedics 48th, Sarwat Steet, Tanta-31111, Egypt, e-mail: elphara3on@hotmail.com

All patients had anteroposterior and lateral radiographs, preoperative myelography, tomography and myelographic computed tomography. Magnetic resonance imaging were done in 65 patients (31 patients of trauma group, 22 patients of tumors group and 12 patients of infections group).

Detailed radiographic analysis of the vertebra (e) involved was done at admission, at mobilization and at follow-up. The kyphotic angle was measured according to Cobb method.[4]

Neurologic assessment was performed using modified Frankel grading scale[5] preoperatively, postoperatively and at the final follow-up.

Thirty-three of the patients were treated through anterior approach (31 of the trauma group and 2 of the infection group). Sixty-nine were treated through posterior approach (44 of trauma group, 17 of tumors group and 8 of infection group). Twenty were treated through combined (anterior and posterior) approach (13 of tumors group and 7 of infection group).

RESULTS

Trauma Group

Neurologically: Twenty-seven percent were intact preoperatively in the two columns injured patients while 26% were intact in the three columns injury patients. This was statistically insignificant (ANOVA: p = 0.4965). Postoperatively, 50% of the patients with two columns injury showed neurological improvement between 1~2 Frankel grades and 44% of the patients with three columns injury showed neurologic improvement 1~3 Frankel grades. This was also statistically insignificant (ANOVA: p = 0.3361).

Radiologically: The mean preoperative kyphotic angle was 19º in the two columns injured patients and was 21º in patients with three columns injury. This was found to be statistically insignificant (Student`s t-test: p = 0.1605), and also postoperatively no statistically significant relationship was found between the change in the kyphotic angle and number of injured columns (Student`s t-test: p = 0.6381).

Tumors Group

Neurologically: The only patient with one column involvement was Frankel grade D3 and he did not show any change after surgery. Forty-four percent of the patients with two columns involvement and 50% of the patients with three columns involvement showed neurologic improvement postoperatively but this correlation was found to be statistically insignificant (ANOVA: p = 0.4013).

Radiologically: The mean preoperative kyphotic angle in patients with two columns involvement was 3º and in patients with three columns involvement was – 5º (ANOVA: p = 0.8780). Postoperatively, the mean kyphotic angle was – 2º in both groups (ANOVA: p = 0.6969).

Infections Group

Neurologically: Forty-three percent of the patients with two columns involvement and 25% of the patients with three columns involvement were intact neurologically before surgery (ANOVA: p = 0.2499). Also, no significant statistical correlation was found between postoperative neurologic improvement and number of columns involved (ANOVA: p = 0.5633).

Radiologically: The preoperative kyphotic angle was 3º in the two columns involved patients and 2º in the three columns involved patients. The postoperative kyphotic angle was –6 and –13 in the two groups respectively. The change in kyphotic angle was found to be statistically insignificant in correlation with the number of involved columns (Mann-Whitney`s test: p = 0.6485).

DISCUSSION

Many researchers have attempted to define spinal instability.[6-10] The American Academy of Orthopedic Surgeons defined instability as an abnormal response to applied loads characterized by movement in the motion segment beyond normal constraints.[11] White and Panjabi [12] defined spinal instability as the ability of the spine, under physiologic loads, to maintain its pattern of displacement so that there is no damage or irritation to the neural elements and to prevent incapacitating deformity or pain due to structural changes.

The question of whether the spine is stable or not is evaluated using the column theories, first proposed by Holdsworth[1] and then modified by Denis[2,3] and McAfee.[13] For evaluation of this theory, the most important parameters to be checked are kyphotic deformity and neurologic function. In other word, the number of involved columns should be reflected on the severity of radiographic and neurologic findings preoperatively and also on the postoperative and final follow-up results. In this study, we broaden the concept of the column theory to include not only the fractured spine but also the spine involved with primary or metastatic tumors and infections as a main causes of spinal instability.

The results of this study did not support the column theory for evaluation of spinal instability. Comparing each group separately does not reveal any significant relation-ship between the number of the columns involved and radiographic or neurologic findings either before or after surgery.

Revision of the English literature was not helpful in this regard. In Denis original paper,[2] he correlated the neurologic deficits to the mechanism of injury and the fracture pattern but not to the number of involved columns. Also, McA-fee,[13] did not mention any correlation between the number of

injured columns and radiologic or neurologic findings. Of course, there were no previous studies regarding spine tumors or infections dependent on the column theories in their evaluation.

The biomechanical studies[14-18] in this aspect have some limitations. Being *in vitro* studies, the effect of muscle and ligamentous forces are not accounted for. Second, the results of the experimental work could never be correlated to the clinical findings. Third, being an experiment, there is always an interobserver variations and controversies which may lead to decrease of the importance of the results of the biomechanical studies in the clinical practice.

REFERENCES

1. Holdsworth F. Fractures, dislocations and fracture-dislocations the spine. J Bone Joint Surg (Br) 1963;45(3):6-20.
2. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 1983;8: 817-831.
3. Denis F. Thoracolumbar spine injuries: classification. Current Orthop 1988;2(4):214-217.
4. Cobb J. Outline for study of scoliosis. Instructional course lectures (The American Academy of Orthopedic Surgery). Ann Arbor, Edwards 1948;5:261-275.
5. Bradford D, McBride G. Surgical management of thoracolumbar spine fractures with incomplete neurologic deficits. Clin Orthop 1987;218:201-216.
6. Abumi K, Panjabi M, Kramer K, Duranceau J, Oxland T, Grisco J. Biomechanical evaluation of lumbar spinal instability after graded facetectomies. Spine 1990;15:142-147.
7. Farfan H, Gracovetsky S. The nature of instability. Spine 1984; 714-719.
8. Frymoyer J, Selby D. Segmental instability: rationale for treatment. Spine 1985;10:280-286.
9. Nachemson A. Lumbar spine instability: a critical update and symposium summary. Spine 1985;10:290-291.
10. Willen J, Lindal S, Istram L, Nordwall A. Unstable thoracolumbar fractures. A study by CT and conventional roentgenology of the reduction effect of harrington instrumentation. Spine 1984;9: 214-219.
11. Gertzbein S, Seligman M, Holtby R, et al. Centrode patterns and segmental instability in degenerative disc disease. Spine 1985;10: 257-261.
12. White A, Panjabi M. Clinical biomechanics of the spine. Philadelphia: JB. Lippincott 1978.
13. McAfee P, Yuan H, Fredrickson B, Lubicky J. The value of computed tomography in thoracolumbar fractures. J Bone Joint Surg (Am) 1983;64:461-473.
14. Haher T, Felmy W, Baruch H, et al. The contribution of the columns theory of the spine to rotational stability. Spine 1989; 14:663-669.
15. Oxland T, Panjabi M, Southern E, Duranceau J. An anatomic basis for spinal instability: a pocrine trauma model. L Orthop Res 1991; 9:452-462.
16. Posner I, Edwards W, Hayes W. A biomechanical analysis of the clinical instability of the lumbar and lumbosacral instability spine. Spine 1982;7:374-389.
17. James K, Wenger K, Schlegel J, Dunn H. Biomechanical evaluation of the stability of thoracolumbar burst fractures. Spine 1994; 19:1731-1740.
18. Panjabi M, Oxland T, Kifune M, et al. Validity of the three column theory of thoracolumbar fractures. A biomechanical Investigations. Spine 1995;20:1122-1127.