New classification 3 columns theory of lumbar degenerative cascade (literature review)

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Lumbar degeneration is a pathologic condition in the aging spine that changes the bio-mechanic construct of the lumbar mobile segment either single or multi-levels, leading to low back pain syndrome and lead to a deformity/de novo scoliosis. The generally well accepted theory of lumbar degeneration was published by Kirkaldy-Willis, et al (1978), and clearly described the pathologic cascade of lumbar mobile segment, but only involve 2 columns: the anterior column (disc) and middle column (posterior joint/facet). The posterior column degenerative cascade was published by Christian Ingerslev Baastrup (1933). He described about the pathologic changes on spinous processes of lumbar vertebrae and the soft tissues in between them, which was then known as Baastrup’s disease or Kissing Spine. Lacking off to understand the etiology due to a limitation of studies in histologic and radiographic changes at that time, then this theory was forgotten in the clinical practice until the recent Bristol and Auckland study, which were published in European Spine Journal (2012). Their study describes clearly the pathologic cascade of the posterior column that contributing the lumbar degeneration. Based on this 3 columns theory of lumbar degenerative cascade, then a new classification is designed to describe detail of bio-mechanic change in the anterior, middle and posterior column leading to low back pain syndrome and deformity. The justification of surgical treatment to fix and reconstruct the bio-mechanic changes of the 3 columns of lumbar mobile segment could be based on this new classification. Key words: lumbar degeneration, spine, theory of cascade.

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The lumbar disc herniation theory by McNab and Mc Culloch (1990) describe only the pathology of anterior column (fig. 2). The pathologic grading grading for discopathy by Thompson (fig. 3) also describe the degenerative changes of anterior column, then the degenerative grading of the facet joint by Grogan (fig. 4) and the grading of the osteophyte by Fujiwara (fig. 5), all describe the degenerative changes of the middle column. All these theories have a relationship with the
Degenerative cascade of the three joint complex of Kirkaldy-Willis describing 3 cascades: dysfunction, unstable and stabilization (fig. 6), but only involve the two columns of Roy-Camille, the anterior and middle column.

Christian Ingerslev Baastrup a Danish Radiologist Copenhagen (1855–1950) described the pathologic changes on the spinous processes in the lumbar vertebrae including the soft tissues between them which was mentioned as Kissing spine. A breakdown of the inter-spinous ligament occurs and leading to a development of neo-arthrosis between adjacent spinous processes, characterized by abutment, enlargement, sclerosis and bursa.
But due to a limitation of studies on histologic and radiographic changes in his era, his theory was forgotten in relation with the application in clinical practice.

Later a study of the Kissing spine was done in 2010 by Auckland group and by Bristol group.

The Bristol study (2010) analyze 100 standing X-rays regarding: lumbar lordosis, inter-spinous gap, and lumbar disc height, while the Auckland study analyze 200 CTs with the age ranging between 20–90 years: the abdominal CTs being used for the asymptomatic group and CT myelogram for the symptomatic group.

The result of these observation show that by aging, the width of the spinous process increase 50% (fig. 7), the height increase 30% (fig. 8), thus when the width and height of the spinous process increase as a consequence the lordosis of the lumbar spine decrease (fig. 9), and as a conclusion this study support the Kissing spine theory as described by Baastrup.

The Bristol and Auckland studies also describe 4 types of kissing spine abutment: type 1 end to end, type 2 hypertrophic, type 3 ball and socket, and type 4 oblique (fig. 10). In type 4, the oblique abutment produces a torque across this level creating an inter-segmental rotation also a lateral listhesis and causing a deformity of de novo scoliosis (fig. 11, 12).

Combining the both theory of Kirkaldy-Willis and Baastrup will bring us to a new understanding about the loss of lumbar lordosis, that it is not merely related to disc degeneration but also due to enlargement of the spinous process related to spinous process degenerative cascade (fig. 13).

A new theory is built to give a clear understanding about Lumbar degenerative process: that it may start from either one of the three columns, alone or together, starting from inflammatory to a compressive reactions, change the bio-mechanic construct of the lumbar spine, single or multi-levels and leading to an adult deformity or de novo scoliosis (fig. 14).

A new classification should be designed to give a complete description about various individual cascade of Lumbar degeneration, and as a consequence in the clinical application of evidence based treatment related to this theory: the justification of treatment for various individual cases will be different.

**New Classification of Lumbar Degeneration**

The new classification is based on the three columns theory of lumbar degeneration, using the radiologic parameters of dynamic lumbosacral X-rays and MRI studies, should describe a complete
assessment of bio-mechanic construct changes involving the three columns, and each column or level might be in different cascade.

Grade 1: involve either one of the three column of SMS, each level or column in different cascade.

Grade 2: involve either 2 columns of SMS, each column or level in different cascade.

Grade 3: involve 3 columns of SMS, each column or level in different cascade.

Case 1: Grade 1
1 column (anterior): 2 levels disc herniation $L_4^\text{IV} - L_5^\text{IV}$, $L_5^\text{V} - S_1$, no instability, no abutment, no facet hypertrophy nor central stenosis (fig. 15).

Case 2: Grade 1
1 column (posterior): 3 levels abutment $L_1^\text{II} - L_3^\text{III}$, $L_3^\text{III} - L_4^\text{IV}$, $L_4^\text{IV} - L_5^\text{V}$, no instability, no facet hypertrophy nor central stenosis (fig. 16).

Case 3: Grade 2
2 Columns (anterior, middle): 2 levels disc herniation $L_4^\text{IV} - L_5^\text{V}$, $L_5^\text{V} - S_1$, 1 level Instability $L_3^\text{III} - L_4^\text{IV}$, 1 level facet hypertrophy and central stenosis $L_4^\text{IV} - L_5^\text{V}$, no abutment (fig. 17).

Case 4: Grade 2
2 Columns (anterior, middle): 1 level disc herniation $L_4^\text{IV} - L_5^\text{V}$, 1 level facet hypertrophy and stenosis $L_4^\text{IV} - L_5^\text{V}$, 2 levels instability $L_3^\text{III} - L_4^\text{IV}$, $L_4^\text{IV} - L_5^\text{V}$, no abutment (fig. 18).

Case 5: Grade 2
2 Columns (anterior, middle): 1 level disc herniation $L_4^\text{IV} - L_5^\text{V}$, 1 level facet hypertrophy and stenosis $L_4^\text{IV} - L_5^\text{V}$, 3 levels instability $L_3^\text{III} - L_4^\text{IV}$, $L_4^\text{IV} - L_5^\text{V}$, $L_5^\text{V} - S_1$, no abutment (fig. 19).
Fig. 18. Justification of treatment: discectomy and decompression $L_{IV} - L_{V}$, stabilization $L_{III} - L_{IV}$, $L_{IV} - L_{V}$

Fig. 19. Justification of treatment: discectomy $L_{IV} - L_{V}$, decompression and stabilization $L_{III} - L_{IV}$, $L_{IV} - L_{V}$, $L_{V} - S_{I}$

Fig. 20. Justification of treatment: discectomy and decompression $L_{II} - L_{III}$, $L_{III} - L_{IV}$, $L_{IV} - L_{V}$, $L_{V} - S_{I}$, decompression of kissing spine abutments $L_{II} - L_{III}$, $L_{III} - L_{IV}$, $L_{IV} - L_{V}$, Stabilization $L_{II} - L_{III}$, $L_{III} - L_{IV}$, $L_{IV} - L_{V}$, $L_{V} - S_{I}$
Case 6: Grade 3

3 Columns (anterior, middle, posterior): 4 levels disc herniation LII–LIII, LIII–LIV, LIV–LV, LV–SI,
4 levels facet hypertrophy LII–LIII, LIII–LIV, LIV–LV, LV–SI, 3 levels abutments LII–LIII, LIII–LIV, LIV–LV,
4 levels instability LII–LIII, LIII–LIV, LIV–LV, LV–SI (fig. 20).

Case 7: Grade 3

3 Columns: 4 levels disc herniation LII–LIII, LIII–LIV, LIV–LV, LV–SI, 4 levels facet hypertrophy LII–LIII, LIII–LIV, LIV–LV, LV–SI, 3 levels abutments LII–LIII, LIII–LIV, LIV–LV, LV–SI, 4 levels instability LII–LIII, LIII–LIV, LIV–LV, LV–SI, 2 levels abutments LIII–LIV, LIV–LV (fig. 21).

Conclusions

The new classification could describe a complete assessment of all the bio-mechanic construct changes involving the three columns of mobile segment and each column in different cascade and different levels.

The new classification can be used as a Guideline to fix and reconstruct all the bio-mechanic construct changes of the mobile segment in lumbar degeneration.

It also can be used as an evidence based consideration to justify the different methods of treatment for various cases of lumbar degeneration.

Conflict of interest. The authors declare the absence of conflict of interest.

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