

# Detection of Spinal Microinstability: A Real Clinical and Forensic Problem

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## Abstract

The concept of vertebral instability has evolved in the last years, given the last scientific evidences on the degenerative cascade. Another concept has been developed in a parallel way to the one of the vertebral instability: it is the concept of microinstability, intended as biomechanical dysfunction of the motor spinal unit, responsible of symptoms but not showed by dynamic X-Rays. The introduction of the concept of microinstability has increased the diagnostic capacities towards low back pain and, subsequently, the therapeutic choices, but has increased the number of medico-legal issues related to the diagnostic and therapeutic pathway of this condition.

Many issues related to microinstability have to be explained, to guarantee to the patients the best treatment available and, at the same time, to uphold the surgeon to perform the treatment in a safe condition.

Our group has proposed a test, developed with the aim to furnish quantitative data on the basis of radiological examinations that can diagnose microinstability, giving indications on diagnosis and therapy of the dysfunctional phase of the degenerative cascade.

The retrospective analysis seems to validate the test, with a good predictive value, mainly towards Adjacent Segment Syndrome (ASD). The few cases analysed in a perspective manner, even if in preliminary phase and with a short follow-up, seem to confirm the data.

## Introduction

The concept of vertebral instability has evolved in the last years, given the last scientific evidences on the degenerative cascade. Another concept has been developed in a parallel way to the one of the vertebral instability: it is the concept of microinstability, intended as biomechanical dysfunction of the motor spinal unit, responsible for clinical symptoms but not showed by dynamic X-Rays.

The introduction of the concept of microinstability has increased the diagnostic capacities towards low back pain and, subsequently, the therapeutic choices, but has increased the number of medico-legal issues related to the diagnostic and therapeutic pathway of this condition [1-3].

If it is true that microinstability is often the cause of low back pain, is true also that a surgical treatment with pedicle screw placement and fusion without an evident spondylolisthesis showed by dynamic X-Rays can rise some medico-legal issues [4].

It is important to highlight the key characteristics of this clinical condition with the aim of protecting the patient by furnishing the best treatment available and, at the same time, to uphold the surgeon to perform the treatment in a safe condition.

## The Concept of Microinstability

The first phase of the degenerative cascade, defined as the phase of unstable dysfunction, includes many pathological alterations affecting the constitutive elements of the motor spinal unit. Those alterations will be unavoidably leading, during the years, to spondyloarthrosys [5-8]. The alterations are related to a dynamic overload of the articulation in the motor spinal unit, especially to the intervertebral disc (responsible for the characteristics of load and torsion resistance) and to the articular processes (the true responsible for the movement). The alterations are generated by an anomalous hypermovement, an overstress of an articulation that is not capable of bearing the applied load. In the phase of unstable dysfunction there are ongoing anatomopathological alterations in absence of vertebral slippage. In the first phase of the degenerative cascade the alterations are evident both in clinical condition and in radiological examinations, but the combination of the two allows making a predictive diagnosis of the situation. In this

phase, the symptoms are aspecific and the I and II level radiological examinations (X-Rays, CT, MRI, dynamic X-Rays) do not show a frank instability [5-10]. At the moment, no exam available allows to detect an active segmental hypermobility, in conditions where a microinstability is suspected.

## Clinical and Radiological Aspects

The main symptom complained by a patient within the unstable dysfunction phase of the degenerative cascade is Low Back Pain, often varying with position (positional lumbalgia), without radicular symptoms or neurogenic claudication.

The radiological examination of choice is MRI; this technique allows to identify and quantify degenerative changes of the intervertebral disc (with the Pfirmann classification), degeneration of the articular masses (individuation and measuring of facet fluid and Fujiwara grading), alterations of vertebral endplates and adjacent vertebral marrow changes (Modic changes), and fat degeneration of paravertebral muscles [5-8].

The execution of static and dynamic X-Rays allows identifying direct or indirect signs of instability (Ullmann's line, Van Akkerveken measurements, Hadley's S curve).

Only in a few cases those examinations need a diagnostic integration with a CT scan, providing further information about the degeneration of the facet joints and their grade of tropism.

The only examination that can provide a diagnosis of instability

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is, at the moment, dynamic X-Rays. The identification of instability is characteristic of the second phase of the degenerative cascade: the phase of spondylolisthesis [4].

### Critical Aspects in Imaging and Clinical Consequences

From literature data has emerged that the lack of comparative analysis of radiological examinations is the main reason of misdiagnosis in lumbosacral degenerative pathology. MRI scan, in particular, performed with the patient in supine position, is not able to detect the variations in balance and the alterations of facet joints during load bearing or during the execution of a movement. In order to overtake this problem, MRI machines, capable of performing orthostatic and dynamic scans, have been developed [11-14]; those machines are not widespread among the hospitals, so their use cannot be recommended as standard of care. It has been evidenced that the execution of dynamic X-Rays in orthostatic position only, can hide a spondylolisthesis with the antalgic contraction of the paravertebral and psoas muscles [4,15-18]. This issue has been overtaken by performing the X-Rays in recumbent position. The recumbent position allows reducing the antalgic hypertonus of the musculature, revealing a latent slippage and showing a hidden spondylolisthesis [4].

It is clear that all the signs that can be identified in X-Rays, MRI and CT scans, with negative dynamic X-Rays, can only provide hypothetical data over the presence of a dysfunction in metameric stability. This condition puts the surgeon in a difficult position: starting a therapeutic route without quantitative data to support his choice.

### Clinical Consequences

At this point there are three case scenarios that a spinal surgeon might face:

#### Microinstable level

A patient might have an apparently stable level (by a radiological point of view) and can be treated with a standalone decompression. This patient can have a clinical worsening due to a nondiagnosed microinstability, revealing itself after the decompression.

#### Dysfunctional level

A patient might have a level, in the initial phase of dysfunction that is treated with stabilization even if it has good chances of improvement with conservative care.

Adjacent segment syndrome: a stabilized patient can have a microinstable adjacent level, with a major risk of developing an adjacent segment disease (ASD).

At the moment, the treatment of patients with a level in the unstable dysfunction phase is improvised, implying the possibility of overtreatment as much as undertreatment, with consequences on the patient, on medicolegal issues and on the sanitary expenses [15].

Is there a way to find a solution to this problem? Is there a way to surely identify microinstability, to quantify it and to link it to clinical symptoms? Is it possible to plan and apply a correct surgical strategy without running into medicolegal issues? Is it possible to furnish quantitative data to prevent ASD?

### Solution Hypothesis

Our group has elaborated a score that analyses all the possible anatomopathologic alterations related to microinstability that are evidenced by X-Rays, MRI and CT scans in a vertebral segment whose dynamic X-Rays do not show instability.

Aim of the score is to classify the grade of alterations of the segment in 3 groups on the basis of the progression of the alterations. The final score is given by the sum of every single score, and it may vary from 0 to 13. It allows also the formulation of a treatment algorithm that can be used by the surgeon on the basis of quantitative data. The score considers the analysis of the following radiological examinations, in a patient with negative dynamic X-Rays, and a score for single analysis that varies with the gravity of the anatomical alterations.

**Lumbosacral X-rays:** Van Akkerveekens measurement, Hadley's "S" curve, Ullmann's line

**MRI scan:** Pfirrmann classification, Modic changes, muscular fat degeneration, facet liquid measurement

**CT scan:** Fujiwara grading of facet degeneration, facet tropism

### Classes of Microinstability

The final score gives a stratification of the patient with suspect microinstability in three classes:

#### Score 0-3: stable patient

The patient might be treated conservatively or with decompression alone, without fusion. This kind of patient does not show alterations related to overload solicitations.

#### Score 4-8: dysfunctional patient

This patient might be treated conservatively but with an inferior rate of success. If decompression has to be performed, the need for fusion is related to the entity of the decompression. This patient has dysfunctional alterations in initial phase that might have benefit from physical therapy, osteopathic manipulations and rehabilitative treatments.

#### Score 9-13: Microinstable patient

This patient needs fusion. In this patient the low back pain is attributable to metameric microinstability; the pathologic movement has to be neutralized, being responsible for pain.

The test has been validated using it in a retrospective manner on patients that underwent surgery at our institution for lumbar degenerative disease, analysing their radiological examinations and applying the test "a posteriori".

The analysis of the results has showed a good sensibility both for diagnosis and for predictive value in the individuation of a microinstable level and in the prevision of ADS.

The stratification into three groups of the patients with suspect microinstability, gives to the surgeon qualitative and quantitative data, so that he can plan the therapeutic pathway in an unequivocal way.

### Clinical and Therapeutic Implications

The use of the test and the identification of microinstability have some clinical and therapeutic implications, most of all in two situations:

#### Treatment of low back pain

A correct diagnosis allows evidencing the cause of low back pain in patients apparently without surgical indication, decreasing the possibilities of undertreatment. This aspect is very important not only because it permits to reduce the sanitary expense, but it also allows the patient to be definitely cured for a symptom that would have been treated by many specialists without results.

## Individuation and prevention of ASD

The identification of microinstability and of the dysfunction of the motor spinal unit allows highlighting, in a patient needing arthrodesis, if the segment adjacent to the arthrodesis is yet dysfunctional (with a major risk of ASD development). A more complete surgical intervention can be performed in this way, also with the possibility to realize hybrid stabilizations. The treatment can be considered as “definitive”, with a reduction of the medical expenses.

## Conclusions

The accurate analysis of the radiological examinations allows, at the moment, to make a diagnosis of microinstability with a good, but not absolute, predictive value. Many clinical and medicolegal situations put the surgeon in a difficult position: to treat pathology without guidelines.

The test proposed by our group, has been created in the effort to provide quantitative data on the basis of the available radiological techniques in order to furnish criteria for the diagnosis and treatment of microinstability.

The retrospectively analysed patients seem to validate the test, with a good predictive value, especially with the ASD. The few cases analysed in a prospective manner, even if in a preliminary phase and with a short follow-up, seem to confirm the data. The study, at the moment, needs more patients, longer follow-ups and multicentric studies.

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