

Development of innovative training solutions in the field of functional evaluation aimed at updating of the curricula of health sciences schools



MODULE BIOMECHANICS OF SPINE

Didactic Unit D: INSTRUMENTED ANALYSIS OF THE SPINE

D.6 In which cases and how can a biomechanical instrumented analysis of spine be useful?



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1. Objectives

The objectives of this unit are:

- To show different uses of biomechanical assessment techniques within the clinical setting to assess spinal pathologies.
- To analyse through scientific studies the usefulness of the biomechanical assessment of the spine.
- To highlight some aspects of interest in the broad area of assessing using biomechanical analysis tests.

2. Clinical applications of biomechanical tests. General information

Within the clinical setting, a biomechanical test is understood as a test that assesses mechanical or physiological aspects of human motor functions such as muscle strength and movement, considering coordination, balance, and muscle activation patterns.

The analysis of movement and its characteristics plays a fundamental role within the functional analysis of the spine since it makes it possible to study the movements within different activities in a pathological patient. From a broad point of view, and as previously seen, the most important systems for the instrumented assessment of the postural function of the spine are kinematic analysis (photogrammetry and inertial systems), kinetic analysis (dynamometric platforms), electromyographic studies (surface electromyography) and muscle strength analysis (dynamometers). All these systems allow us to measure function, that is, to know what the neuromusculoskeletal system can do, as opposed to the measuring systems most commonly used in clinical practice: functional scales.

This technology for movement analysis objectifies and quantifies the movements and forces exerted by people when they perform physical activities, such as going up and down stairs, lifting loads, etc. These techniques require very controlled set-ups (calibration) together with well-defined measurement protocols, which ensures reliable results. Similarly, the professionals who use them or who interpret the results must be highly qualified in biomechanics.

The use of these tests for assessment and medico-legal purposes has increased in the last years. Their reliability is a fundamental aspect that should be taken into account¹. It should be possible to apply a biomechanical test by several evaluators at different times. Therefore, there may be factors that affect its reproducibility, which should be controlled. These aspects include those associated with the measurement equipment (calibration), those aspects related to the application of the measuring procedure (instrumentation, protocol, patient positioning, repetition of tests, instructions given to the patient, etc.), those involving the observer (explanation to the patient, interpretation of the results, etc.) and, above all, those related to the patient (collaboration, understanding, motivation, etc.). Still, although all these factors may affect the reliability of the biomechanical tests, different publications support it.²⁻⁵

Biomechanical analysis techniques, together with the measuring protocols applied to assess patients with impaired movement due to spine disorders or pain, become particularly interesting in clinical assessment. The application of the tests focuses on recording deficits, monitoring processes, controlling the functional effects of specific treatments, and determining sequelae.

3. Usefulness of the functional biomechanical assessment of the spine

The evolution of biomechanics within clinical assessment has proven to be an effective instrument that makes it possible to:

- Monitor the progress or improvement of the musculoskeletal system pathology that caused the temporary disability and establish the moment in which this recovery is compatible with the performance of the patient's work.
- Quantify the functional improvement or worsening of the patient's clinical process.
- Determine the functional stabilisation of the injury and therefore the possibility of starting a permanent disability process.
- Focus the treatment on the functional deficit detected.
- Quantify the result of a specific therapy.
- Analyse whether the patient is malingering or exaggerating the pathology to extend the temporary disability, or to obtain a higher degree of permanent disability.

This evaluation is essential, for example, when assessing in the work environment, because the fundamental medical purpose of the assessment of an injured person is not only the recovery of the patient, but also to recover that person's previous life by, for example, regaining autonomy to perform the activities of daily life, sports or work. In this sense, diagnostic tests do not go beyond a physiological and structural level, whereas biomechanical tests do reach the function and activity level.

The references below include some scientific work from which the benefits of biomechanical tests in a real context of use can be deduced.

The teacher has these articles in a complementary folder as class material. They can be used not only to understand the usefulness of these tests in the context of spine assessment, but also as a basis for doing some search and include other types of biomechanical tests.

The works cited are summarised and discussed below.

They allow you to analyse whether the patient is malingering or not

- [Baydal-Bertomeu, J. M., Page, Á. F., Belda-Lois, J. M., Garrido-Jaén, D., & Prat, J. M. \(2011\). Neck motion patterns in whiplash-associated disorders: quantifying variability and spontaneity of movement. *Clinical biomechanics*, 26\(1\), 29-34.](#)

This study⁶ focuses on patients who suffer whiplash syndrome. It addresses the difficulty that some medical professionals have in differentiating patients who malingering from those who do not. This study evidences the fact that healthcare professionals cannot identify the patients who are malingering or exaggerating pain just by observing them. By mechanically assessing the behaviour of these patients, three large groups can be distinguished: the group of healthy patients (without cervical pain), the control group, the group of patients who have limited neck mobility due to pain, and the group of subjects who malingered limited mobility due to pain. This fourth group was made up of people who had suffered a whiplash from a traffic accident and were asked to try to deceive the clinical professional by malingering. Why is it possible to

mechanically differentiate mobility behaviours? Because people with real cervical pain have a natural biofeedback, which is the functional limitation caused by pain; consequently, when they reach that functional limitation because pain occurs, their movement pattern changes. People who try to simulate a limitation do not have this biofeedback that determines the behaviour to avoid problems, that is why the movement strategy adopted will be different from the movement strategy of a person who really suffers this injury.

For this reason, biomechanical analysis tests allow us to objectivise and make it is easier to analyse this pattern of behaviour using objective data, which helps to detect malingering or exaggerating behaviours.

They quantify the improvement or worsening of the patient's clinical process

With regard to the use of these techniques in the context of long absences from work, what is the usefulness of biomechanical tests?

- López-Pascual, J., Peydro-de-Moya, M. F., Garrido-Jaén, J. D., Bausá-Peris, R., & Villadeamigo-Panchón, M. J. (2009). Análisis del uso de herramientas de valoración funcional de las dolencias lumbares en el ámbito laboral. *Rehabilitación*, 43(1), 16-23.

This study⁷ focuses on evaluating the days that a person cannot work because they are being clinically monitored due to an injury or damage. The study sample involves people with chronic low back pain. They exceeded an average of 250 days without going to work and the centre that monitors these patients decided to incorporate biomechanical assessment techniques to evaluate their function.

After performing the biomechanical tests and analysing the results, the days of sick leave decreased. This was due to the fact that these tests can objectively determine when these patients have reached functional stability, either because they have recovered normality or because they are left with sequelae or limitations. Ultimately, biomechanical assessment tests help medical professionals to objectivise the improvements or worsening of the patient's condition, and therefore help them to decide when to end a treatment.

They monitor progress and determine functional stabilisation

- Broseta, M. J. V., Bosch, I. B., de Moya, F. P., & Corresa, S. P. (2017). Is kinematic analysis useful as a clinical test during whiplash associated disorders recovery? A clinical study. *Gait & Posture*, 57, 358.

This work⁸ also focuses on whiplash syndrome, specifically on the treatment process. Approximately 100 patients who had suffered a traffic accident and were diagnosed with whiplash were monitored. Throughout the clinical process, biomechanical tests were performed to determine the patient's functional status.

The results obtained with these tests indicated that, at the beginning of the physical treatment, 30% of the patients actually had a normal function, that is, they may experience some minor discomfort, but they did not require treatment. Then, during the whole treatment process, it became evident that the treatments were longer than actually necessary, which increases the cost of the therapy and makes healthcare processes longer.

The clinical treatment processes lasted longer because health professionals did not have an objective test to assess with greater accuracy those cases where there was disagreement with the patient or where the professional was not sure. In these cases, the professionals tried to prolong the treatment because they were not sure when to discharge the patient, since no objective test determined if such patient had reached a normal function or had functionally stabilised with some kind of sequelae.

These objective tools help reduce the duration of the treatments, because this information will allow healthcare professionals to make a much quicker decision. In fact, this study evidences a savings of 35 percent of the treatments. Similarly, it also showed that there was a group of patients who, without biomechanical assessment tests, were discharged before they had recovered their function; however, the biomechanical tests showed that they were actually improving day-to-day.

If health professionals had had these techniques, they could have prolonged the treatment of the patients who were actually improving little by little.

They determine the degree of damage

This study focuses on the assessment of bodily harm in traffic accident victims who had whiplash syndrome, but who suffered mild cervical trauma.

- [Broseta, M. J. V., Tendero, C. P., de Francisco Enciso, E., Roselló, R. M., García, A. M. E., & Mendoza, M. V. \(2017\). Utilidad de la valoración biomecánica en la determinación de secuelas por cervicalgia postraumática. *Revista Española de Medicina Legal*, 43\(3\), 106-114.](#)

This study⁹ was carried out by doctors who help judges interpret medical information in order to make judicial decisions. They evaluated 260 cases of traffic accidents. As they were not sure about 70 of those 260 cases, they were asked to make a proposal for a final decision about the assessment of bodily harm in these 70 cases. Once this proposal was made, the patients were sent to a biomechanics laboratory to assess their cervical spine. Subsequently, the results of the biomechanical test were submitted, and the doctors made a proposal for a final decision based on these results. Therefore, there was an evaluation of each subject before having the biomechanical assessment report, and another one after having the biomechanical assessment report. In some of the cases, the doctors changed their final decision about the sequelae since the biomechanical tests showed that there were no such sequelae. In other words, these professionals changed their evaluation proposal after obtaining and reviewing the biomechanical assessment reports. In short, there was an average reduction of about 37 percent of the sequelae proposed.

4. Key ideas

The biomechanical assessment of the spine makes it possible to:

- Objectivise the existence of an alteration by comparing with normalised databases of healthy population.
- Plan a treatment based on the condition objectivised and assess its benefits.
- Monitor the progress of the patient.
- Establish the normalisation or stabilisation of the pathological process.
- Assess the functional limitations resulting from an injury (support in the assessment of sequelae).
- Help detect malingering behaviours.

It should be noted that:

- They involve significant technological resources, as well as trained staff and time commitment.
- A strict protocol must be followed to maintain the reliability and reproducibility of the test and then compare with databases.
- There are various types of tests that provide different information.
- A biomechanical assessment test is not a diagnostic test.
- A biomechanical assessment test completes the information about the functional status of an injury.
- It is not a substitute for clinical examination.
- It provides objective information in patients with subjective pain symptoms.
- It makes it possible to monitor the patient's progress and to determine when the treatment should end.

5. References

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