Erasmus+

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.1. Which cervical biomechanical instrumented evaluation protocols exist?

Politechnika Śląska

IBV INSTITUTO DE BIOMECÁNICA DE VALENCIA

VNIVERSITAT DE VALÈNCIA

AMSE THE ASSOCIATION OF MEDICAL SCHOOLS IN EUROPE

D.1. Which cervical biomechanical instrumented evaluation protocols exist?

OBJECTIVES

- To recall the main features that make up a biomechanical evaluation test.
- To learn some of the protocols used for kinematic evaluation of the cervical spine.
- To learn some of the protocols used to evaluate strength and muscular activity in the cervical spine.
- To work on defining a protocol for evaluating cervical mobility.

D.1. Which cervical biomechanical instrumented evaluation protocols exist?

INDEX

- Remember: What is a biomechanical test? What does it involve?
- Protocols to evaluate motion
  - Electrogoniometry and inclinometry
  - Photogrammetry and inertial sensors
  - Others: Kinect, MCU system
- Protocols to evaluate strength:
  - Isometric dynamometry.
- Assessment of muscular activity: Surface EMG

What is a biomechanical test? What does it involve?

Complementary test done by means of biomechanical techniques

There are different biomechanical assessment tests. The aspects that define them are:

- What function is being assessed.
- What instrument and technique it is based on.
- What assessment protocol has been used (D.1).
- What results it provides, in what units and with what data analysis techniques they have been obtained.
- Standardised criteria for interpretation..

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  - Others: isokinetic.
- Assessment of muscular activity: Surface EMG

Protocols for evaluating the cervical spine

Evaluating motion: protocols?

We may decide to measure any other gesture provided that:

- We know how to choose the right instrument and technique;
- Suitable biomechanical model;
- Proper data processing;
- Valid, reliable results obtained;
- Standardised interpretation of the results.

Protocols for evaluating the cervical spine

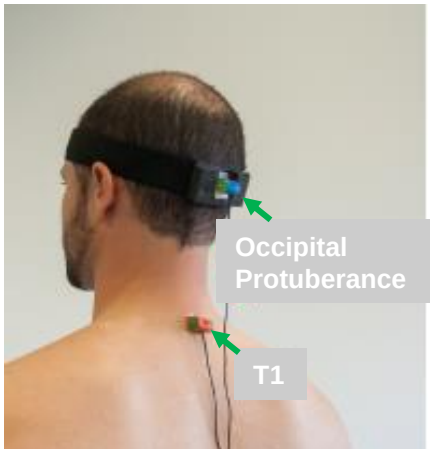
ELECTROGONIOMETRY

- Prior calibration
- Device placed by users with knowledge about locating anatomical points.
- Motion to be measured performed according to the established protocol:
  - T. Allahyari et al,. once for each arc. The maximum range is reached at the patient's chosen speed.

T. Allahyari et al. 2016

Protocols for evaluating the cervical spine

INCLINOMETRY



NedRangos/IBV

Electronic inclinometry system using two inclinometers:
The inclinometers are placed to assess the axes of motion for lateral flexion and flexion-extension of the neck.

Protocol based on the American Medical Association's guide (three measurements differing by less than 10% or 5º). The neutral position is measured, then the active or passive motion to be assessed (flexion, extension or lateral flexions) is performed.

Protocols for evaluating the cervical spine

INCLINOMETERY: cervical lateral flexion

1. Neutral position
2. Maximum left rotation motion.
3. Maximum right rotation motion.

A minimum of three valid measurements according to the AMA's repeatability criteria, differing by less than 10% or 5°.

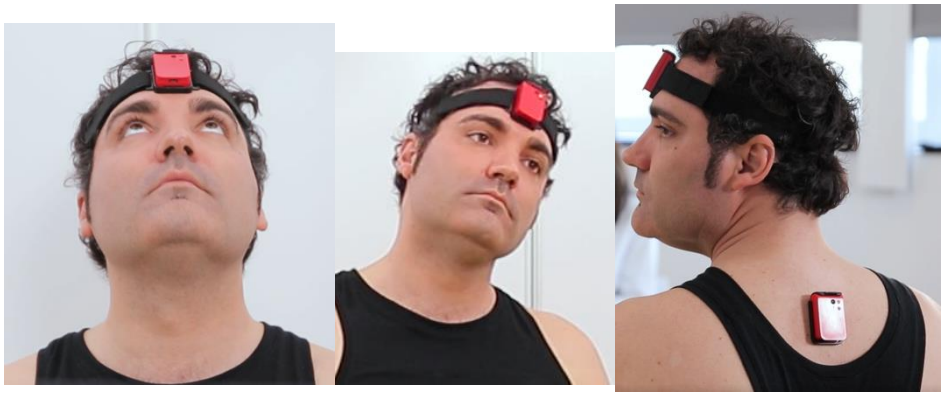
Protocols for evaluating the cervical spine

PHOTOGRAMMETRY

Protocols for evaluating the cervical spine

INERTIAL SENSORS

Evaluation protocols the same as for photogrammetry.
Some technical limitations compared to photogrammetry, but a faster, simpler instrumentation process.



Protocols for evaluating the cervical spine

Multi Cervical Unit (MCU; BTE®)

Combined system to measure cervical MOTION AND ISOMETRIC STRENGTH.
Based on a computerised goniometry system.

In order to see how to carry out a motion evaluation protocol with this instrument, it is advisable to see some videos online such as this one (see the first part): https://www.youtube.com/watch?v=WJpOEvj0NXg

The material that the hyperlinks lead to is public and available for viewing online. It has been selected for its suitability to the subject covered in this unit after a search using the terms "Multi Cervical Unit" in the website indicated above. You can find and view other interesting public educational videos like these using the same search terms.

Information and images from: https://www.btetechnologies.com/rehabilitation/mcu/

Protocols for evaluating the cervical spine

Microsoft Kinect System

- Sitting position with Kinect sensor 2 m in front of the subject and 1 m above the ground. No instruments required.
- The subject being evaluated must perform maximum motions in each of the cervical spine's arcs of motion, including flexion-extension, lateral extensions and rotations.
- Before beginning, the process is explained in detail to the subject, with the evaluator performing the gestures to explain them. A preliminary test is carried out to ensure they have understood the instructions.

Information and images from: T. Allahyari et al. 2016

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  - **Isometric dynamometry.**
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Protocols for evaluating the cervical spine

ISOMETRIC DYNAMOMETRY

- These devices are to measure resistance force without changing the length of the muscle fibres and with no movement of the joints.
- They are the most commonly used (isokinetic ones are not widely used in the cervical region).
- Different protocols.

MicroFET2 manual dynamometer for musculoskeletal evaluation

Evaluation of isometric force in each arc. Maxim force peak determined and force curves and gra generated.

Information and images from:
https://tienda.fisaude.com/dinamometro-evaluacion-musculo-esqueletica-microfet2-p-39680.html

Protocols for evaluating the cervical spine

Multi Cervical Unit (MCU; BTE®)

Combined system to measure **cervical** MOTION and **ISOMETRIC STRENGTH**.

In order to see how to carry out an isometric force evaluation protocol with this instrument, it is advisable to see some videos online such as this one (second part of the video):

https://www.youtube.com/watch?v=WJpOEvj0NXg

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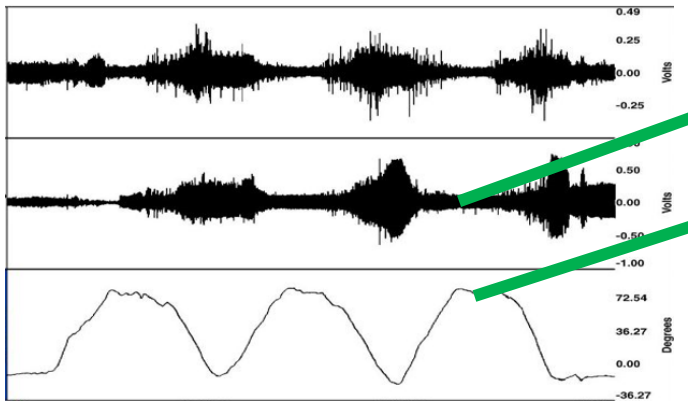
- **Assessment of muscular activity: Surface EMG**

Protocols for evaluating the cervical spine

SURFACE EMG

There are many evaluation protocols that use surface EMG:

- **Measurement of the flexion-relaxation phenomenon in the cervical spine:**
  - ✓ More well-known at the lumbar region: relaxation in the musculature at maximum flexion (healthy subjects).
  - ✓ It is not so evident at the cervical region and it is more complex to measure it, but it can also be evaluated.



Decrease in EMG activity.

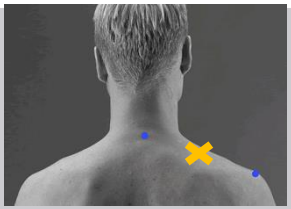
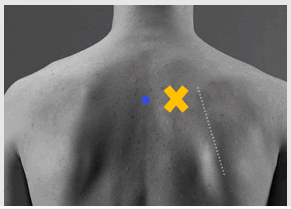
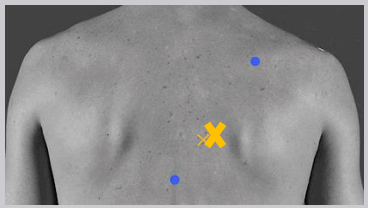
Maximum flexion.

Protocols for evaluating the cervical spine

SURFACE EMGs: other protocols

SENIAM (Surface Electromyography for the non-invasive assessment of muscles) includes a series of proposals to evaluate muscle activity in the superficial cervical muscles, including recommendations for action or movement to be carried out during the measurement. These include:

http://www.seniam.org/

Muscle	EMG sensors (X)	Activity/Test
Trapezius descendens (upper)		Elevate the acromial end of the claviculae and scapula; extend and rotate the head and neck towards the elevated shoulder with face rotated in the opposite direction. Apply pressure against the shoulder in the direction of depression and against the head in the direction of flexion anterolaterally.
Trapezius transversus (middle)		Adduction of the scapula from a position of rotation in which the inferior angle is rotated laterally. The elbow needs to be extended and the shoulder at 90 degrees abduction and lateral rotation. This rotation of the shoulder is denoted by the position of the hand with the palm facing cranially (without elevating the shoulder girdle).
Trapezius ascendens (lower)		Depression, lateral rotation of the inferior angle, and adduction of the scapula. To obtain this position of the scapula in order to place emphasis on the action of the ascending fibres and to obtain leverage for the test, the arm is placed diagonally overhead with the shoulder laterally rotated. Apply pressure against the forearm in the downward direction.

IMPORTANT ASPECTS OF CERVICAL EVALUATION USING TECHINQUES WITH INSTRUMENTS

- There are many protocols to evaluate the cervical spine with techniques using instruments, whether it is to measure strength, motion, muscular activity or something else.
- In theory, any gesture can be evaluated with instrumental techniques provided we choose the correct one, a suitable protocol, proper data-processing and we have standardised criteria to interpret the results.
- The protocol for measuring in any case must include: the instruments (if required), the gesture we are measuring, the number of repetitions, the prior instructions and the orders given to the patient during the test, the subject's posture before and after the measurement, the timing (rests, trials), and the greatest amount of detail possible to enable anybody to follow the same protocol.
- The definition of a measuring protocol must take into account all possible factors that may alter the validity (we measure what we intend to measure) and reliability (if the protocol is repeated by the same or different evaluator under the same conditions, the results will be similar) of the results.

Class activity (30')

You are going to work in groups:

1. Draw up a list of factors that can have an effect on the measurement of spinal strength (force) and mobility, and on the results.
2. Put these factors into groups according to:
   - Those related to the **gesture** to be measured (posture, type of movement, etc.)
   - Those related to the **protocol**: prior warm-up, amount of repetitions, etc.
   - Those related to the **orders and instructions** given to the subject.
   - Those related to the **subjects themselves or to factors unrelated** to the test.
   - Others.
3. Create a **protocol for measuring cervical mobility by kinematic analysis.** You must define gesture, times, number of repetitions, posture, orders and instructions, and any information you can.
4. Share your impressions and your protocol with your colleagues.

There are articles that may help you by Strimpakos et al. about the factors that can have an influence on an evaluation of mobility, proprioception (part I), and strength (part II) of the cervical spine. You can also include other factors that you think might have an influence on the measurement but which do not appear in those articles.

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