Mid term report

Can Inertial Movement Sensors (IMUs) provide a valid and reliable way of measuring Spinal Mobility in Axial Spondyloarthritis (axSpa): a Clinimetric Evaluation	
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Country	UK, Ireland, Spain, Portugal

An Evaluation of Electronic Movement Sensors in Assessing Mobility in Ankylosing Spondylitis (AS)

1. Objective of the project

The main objective of this project is to test the reliability of electronic sensors in measuring spinal movement in AS. Current methods rely on tape measures and are not reliable enough to evaluate new treatments for AS. We also want to test if we can reliably measure spinal movement when the patient is unsupervised. We are also planning to develop a mobile 'app' so that patients with AS will be able to get feedback and advice about their spinal mobility at home or at work.

2. Background

With recent advances in the accuracy of 'wearable sensors' they are now widely used in mobile phones, watches and other wearable devices. This technology has been tried in patients with low back pain but has not yet been used in patients with AS. The standard method of measuring spinal mobility using a tape measure is known as the Bath AS Metrology Index (BASMI). Unfortunately, it is not accurate enough to evaluate new treatments for AS and it cannot be used in the home setting. A more accurate 'motion-tracking' method uses a set of cameras to measure movement in a 'gait laboratory'. Tests with one of these setups (UCOTrack) showed that it was more accurate and reliable than BASMI, and it was also better able to show changes with treatment. MRI scans of the spine can detect changes in inflammation before and after treatment but

Image: IMU sensors use electronic signals to detect movement in 3-Dimensions

again this is too expensive to be widely used. Previous studies showed that changes in the BASMI didn't match the changes seen on MRI, so part of our study will be to compare the MRI changes with changes in the 'sensor mobility index' (we're calling it IMU-ASMI for now).

3. Methods and approach

One of our first studies (**Londonderry**, UK) tested if the sensor measurements are reliable – that is, if the measurements remain the same no matter which therapist is doing the test or when it is repeated on another day. Another study (**Cordoba**, Spain) tested the sensor measurements against an accurate electronic motion detection system called UCOTrack to see which is the most reliable. This Spanish gait lab developed the UCOTrack specifically to measure spinal mobility in AS. The third study (**Dublin**, Ireland) tests whether or not sensor tests of movement and function can be carried out accurately at home without supervision. In this study patients will take the sensors home and wear them for up to 24 hours alongside completing some questionnaires and a symptom/activity diary.

Our preliminary results (Dublin, Londonderry) have confirmed the accuracy and reliability of these sensors in the clinic setting. We are still testing the best way to carry out tests accurately at home.

The **second section of our project** is to test how useful the sensors will prove in evaluating treatments in the real world – when our patients are starting on biologic drugs, will the sensors be able to detect any changes in mobility? This section will have three parts – the first will focus on testing against the UCOTrack, the second on comparing supervised/unsupervised sensor measurements against the BASMI and the final one (involving teams in **London**, UK and **Coimbra**, Portugal) will investigate how changes in sensor measurements relate to MRI changes.

4. Primary and Secondary Outcome Measures

Different statistical analysis will be done to analyze variability between measures.

5. Recruitment of participants

About 180 patients with AS will be recruited across the six studies planned in this three year project.

6. Inclusion and Exclusion criteria

We will recruit a broad cross-section of adult patients with AS or 'axial spondyloarthropathy (axSpA)'. In the second part of the study we will study patients who are commencing biologic therapy for their condition, and in the MRI sub-study we will include patients who can safely have an MRI scan (some people with metal implants or pacemakers are unable to do so).

7. Expected benefits for patients

If this technology proves accurate, it will give both therapists and patients a new way of accurately measuring and monitoring their spinal mobility.

8. Expected benefits for society

When patients are able to see the benefits of exercise we hope that they will be able to preserve their flexibility better and be able to maintain their ability to participate fully both at home and at work.

9. Burden for patients participating.

Those participating will have to spend (at most) a couple of hours being tested in clinic, and in some studies they will have to wear the sensors for 24 hours. In one study patients will have two MRI studies of the spine.
10. Risks of the project.
Apart from the usual screening of patients before MRI scans we are not aware of any risks to patients.

We have formed the **'iMaxSpA Study Group'** which is made up of Rheumatologists, Physiotherapists, Biomechanical Scientists and IT specialists. We will plan to share our expertise with other physiotherapists and rheumatologists so that these technologies can become widely used in clinics.

Our smartphone app is to be called **'iMaxSpondylitis'** to get across the hope that the use of sensor instruments (i) will maximize spinal mobility (Max) and improve quality of life in patients with axSpA.

The Principle Investigator ensures this report has been developed in agreement with and approved by all collaborators in the consortium.

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Date and signature Principle Investigator

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