

## **Cerebral Activation Related to Shoulder Apprehension in Patients with Glenohumeral Instability; A Ten Years Follow Up**

Alexandre Ladermann<sup>1</sup>, Blaise Cochard<sup>2</sup>, Sven Haller, Hugo Bothorel, Gregory Cunningham

<sup>1</sup>La Tour Hospital, <sup>2</sup>Orthopaedics and Traumatology, Geneva University Hospital

**INTRODUCTION:** Fear, anxiety, and anticipation of situations that could lead to a dislocation are essential cognitive processes in shoulder apprehension. In 2012, using functional magnetic resonance imaging (fMRI), we demonstrated correlation between shoulder apprehension and cerebral area's activation before glenohumeral stabilization. Coherently, results showed, one-year postoperatively, a decreased activation in the left pre-motor cortex postoperatively, demonstrating that stabilization surgery induced improvements both at the physical and at the cerebral levels. The purpose of the present study is to reassess and describe the fMRI findings and clinical outcomes of the same cohort of patients operated for shoulder instability 10 years ago. The hypothesis of the study is that time and progressive muscle reconditioning would finally allow complete brain healing.

### **METHODS:**

Long-term clinical and radiological follow-up analysis of a previously reported monocentric cohort of patients who underwent a shoulder stabilization and pre- and postoperative fMRI 10 years ago and control group was performed in this prospective cross-sectional study. Primary outcomes were 1) task-correlated functional connectivity assessed with tensorial independent component analysis, 2) behavioral responses to apprehension videos showing typical apprehension movements versus control videos, 3) structural changes in white matter using tract-based spatial statistics analysis with multimodal MR imaging.

Task-related and functional connectivity functional magnetic resonance imaging activation patterns occurring during apprehension video cue stimulation were correlated with six clinical tests and scores corresponding to secondary outcomes: pain Visual Analog Scale (VAS), Rowe score for instability, Simple Shoulder Test (SST), Subjective Shoulder Value (SSV), Single Assessment Numeric Evaluation (SANE) instability, and Western Ontario Shoulder Instability (WOSI).

**RESULTS:** Of the 15 patients and 10 controls enrolled in the initial study, and after application of the exclusion criteria, 10 patients and 9 controls were included in the present study. The mean age for the APPREHENSION group was  $28.5 \pm 9.1$  years old and  $30.6 \pm 2.6$  for the CONTROL group. All participants were male. Ten years after shoulder stabilization, fMRI allowed to highlight a normalization of the hyperactivations in the primary sensory-motor areas, dorsolateral prefrontal cortex, and the dorsal anterior cingulate cortex/dorsomedial prefrontal cortex and anterior insula in the patient group. At final follow up, the apprehension group had a mean VAS pain score of  $1.0 \pm 2.3$ , an SSV of  $88.3 \pm 13.5$ , a Rowe of  $87.8 \pm 16.2$ , an SST of  $11.0 \pm 2.0$ , a WOSI of  $82.4 \pm 14.8$ , and a SANE of  $86.7 \pm 14.1$ . There was no significant difference between the functional scores at 1 and 10 years postoperatively. The level of apprehension was nevertheless significantly different ( $p=0.001$ ) between the apprehension group and the control group at the final follow up.

**DISCUSSION AND CONCLUSION:** Time and muscle reconditioning allow the brain to normalize the neurocognitive aspect of apprehension.