Effects of a Tailored Exercise Program in Knee Osteoarthritis Patients with Chronic Pain: An fNIRS Study

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INTRODUCTION

Exercise has clear benefits for pain relief and improvement of functional outcomes for knee OA, but the effects of exercise on functional brain hemodynamic has not been investigated. DLPFC has a role in pain modulation.

OBJECTIVES

Our aim was to investigate the role of exercise therapy on brain hemodynamics of DLPFC via functional near-infrared spectroscopy (fNIRS). Our second aim was to discover the possible correlation between pain decrease and DLPFC activation changes.

METHODS

Eleven right-handed knee osteoarthritis (8 females) subjects who have chronic pain were recruited. All subjects attended a tailored exercise program for 18 sessions. The fNIRS experiment had a block design shown in Figure 1. The protocol consisted of 15 cycles, separated by 30 seconds of rest intervals. Before starting the experiment, the patients' pressure pain threshold level was detected via digital algometer and this value was regarded as painful stimulation. Pain level was assessed using the Visual Analog Scale (VAS) during activity.

fNIRS Data Acquisition

Continuous-wave multi-channel NIRSCout device was used before and after the exercise therapy (NIRX Medical Technologies LLC, Berlin, Germany). The signal sampling rate was 4.17 Hz. Our probe design consisted of 15 detectors and 15 sources, which form a 47 channel setup with an inter-probe distance of maximum 3 cm (Figure 2). Painful and non-painful stimuli were exerted from 3 cm medial to the medial edge of the patella and ii) 3 cm inferior to the inferior edge of the patella by digital algometer.

Figure 1. Experimental design

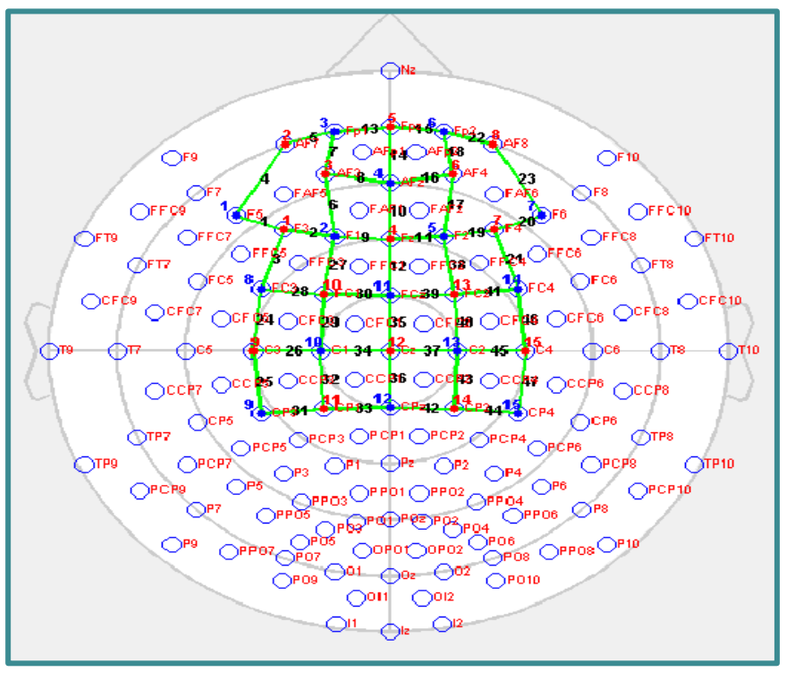

Figure 2. Probe design

Descriptives	Mean±SD (n=11)	Min-Max
Age (years)	59,1±6,95	49 – 70
BMI (kg/m^2)	31,9±3,47	26,2 – 34,9
MMSE score	24,9±1,04	24 - 27
Symptom duration (months)	10,00±9,03	4,00 – 24,00
HADS anxiety	3,73±3,38	0,00-10,00
HADS depression	3,55±3,42	0,00-10,00

Table 1. Patient demographics.

RESULTS

After exercise therapy, painful stimulation related statistically significant oxyHB signal increase was obtained in the DLPFC (Ch=19, 20, 21, 23, 38) ($p<0,05$) (Figure 3). Our results also revealed that there was a moderate positive correlation between the individual pain decrease level and longitudinal changes of painful-related cortical oxyHb signal in DLPFC ($r=0,51$) (Figure 4).

	Pre-exercise (n=11)	Post-exercise (n=11)	Mean difference (CI%95)	P value
VAS (activity)	6,11±1,54	3,15±2,11	-2,96 (-1,78 to -4,15)	<0,001

Table 2. VAS change score

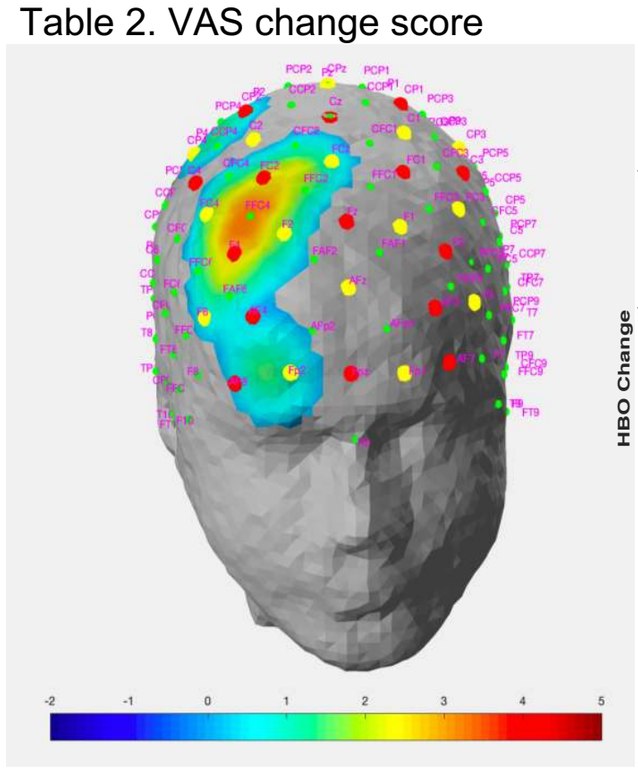

Figure 3. T Statistics for Changes in Cortical Activation during Painful Stimuli (Post Exercise-Pre Exercise Difference)

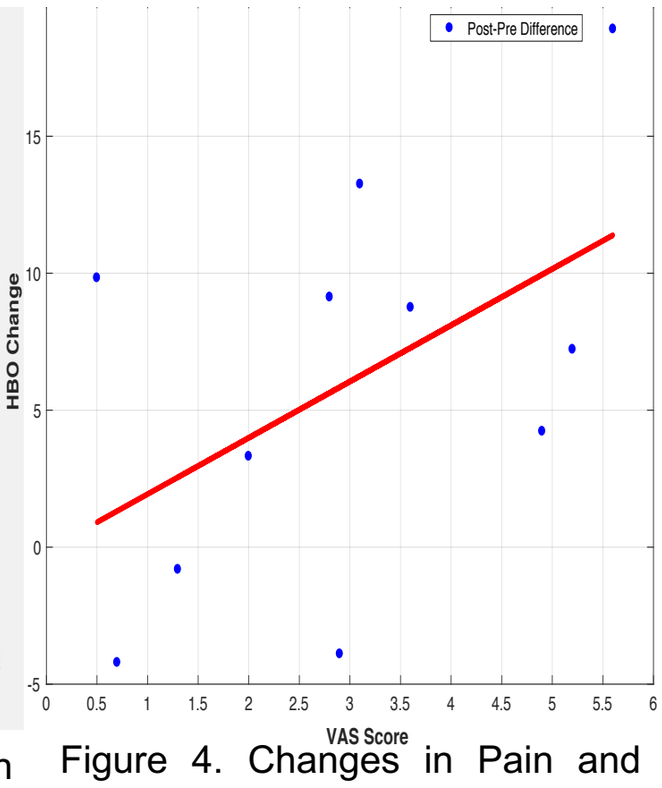

Figure 4. Changes in Pain and Brain Hemodynamic Parameters for significant DLPFC channels.

CONCLUSION

Exercise therapy in patients with chronic pain due to knee osteoarthritis was associated with increased activity of the DLPFC during painful stimulation, a brain region implicated in pain modulation. Our data show that cortical control mechanism plays a role in response to exercise in patients with chronic pain. We suggest that the role of DLPFC in top-down pain modulation should be assessed with various exercise and other physiotherapy approaches.

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References
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