The long-term effects of sports concussion on motor cortex plasticity in retired Australian football players

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Sports concussion is continuing to provoke the sporting community and the wider Australian public, particularly on measuring acute changes following a head injury, and the manifestation of long-term effects on the corticomotor system.

In two separate studies, using transcranial magnetic stimulation (TMS), 100 Australian football athletes participated in one of two studies. Study one investigated the long term effects of repeated serious concussions in retired Australian football players at both elite (n = 20; mean age 49.7 years) and amateur levels (n = 20; mean age 48.5 years), compared to healthy age-matched controls (n = 20; mean age 47.5 years). All participants completed measures of fine dexterity, visuomotor reaction time, and neurocognitive assessments. TMS was used to measure corticospinal excitability (stimulus-respons curves and motor evoked potential 125% of active motor threshold), and intracortical inhibition (cortical silent period, short-interval intracortical inhibition and long-interval intracortical inhibition). Study two involved 40 players (mean age 25.7 years) who completed the same variables as study 1. However, the methodology of this study was to quantify time-course changes before and after players had experienced, and were diagnosed with, concussion injury at 24 hours, 96 hours, and 10 days. Players (n = 8) concussed were compared to players (n = 32) who did not experience a concussion injury.

In study 1, ANOVA and post-hoc planned comparisons revealed retired football players at both elite and sub-elite demonstrated reduced performance in fine dexterity ($F_{2,57}$ = 3.941; P = 0.025) and visuomotor reaction ($F_{2,57}$ = 5.878; P = 0.005) and movement time ($F_{2,57}$ = 3.478; P = 0.038) compared to the age-matched healthy participants. TMS measures revealed a reduction in cortical silent period duration ($F_{2,57}$ = 17.375; P > 0.001), and increased short-interval intracortical inhibition ($F_{2,57}$ = 3.286; P = 0.045) and long-interval intracortical inhibition ($F_{2,57}$ = 3.317; P = 0.040) between football groups and healthy comparisons. In study 2 concussed players showed an increased cortical silent period at 24 and 96 hours post concussion ($F_{2.5,21}$ = 9.804; P = 0.001).

This is the first study to measure the neurophysiological responses in the motor cortex of Australian football players from both an acute and chronic perspectives. In summary, the data demonstrate that following a concussion injury (Study 2), intracortical inhibition is increased in the acute phase; however, for older retired Australian football players (Study 1) multiple concussions manifest as reduced intracortical inhibition that may account for motor changes observed.