

for age and body mass index), assessed the differences in functional performance at 1- and 5-years between the ACLR group and the healthy control group.

**Results:** The contralateral limb had a significantly ( $p < 0.05$ ) greater decrease in functional performance between 1- and 5-years for the three hop-tests, compared to the ACLR limb. Worsening was more common in the contralateral limb than the ACLR limb; resulting in significant improvements in the LSI for the single-hop (mean 87% at 1-year to 95% at 5-years), side hop (77% to 86%) and one-leg rise (76% to 85%). The LSI on all four tests at 1-year post-ACLR was significantly lower than healthy controls, but did not generally differ between groups at 5-years.

**Discussion:** Although the LSI significantly improved between 1- and 5-years post-ACLR, this was mostly due to worsening function in the contralateral limb. The LSI should not be used in isolation to evaluate functional performance changes after ACLR, as it may overestimate functional improvement. Exercise-based interventions may need to continue beyond the typical rehabilitation period of 6-12 months to improve or maintain function in both limbs, considering the deficits at 1-year post-ACLR compared to healthy controls, and minimal improvement over the preceding 4-years.

**Conflict of Interest:** My co-authors and I acknowledge that we have no conflict of interest of relevance to the submission of this abstract

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## S0 (6)

### Does cam morphology size and location affect self-reported burden in football players with femoroacetabular impingement syndrome?

R. Agricola<sup>c</sup>, K. Crossley<sup>a</sup>, J. Heerey<sup>a</sup>, J. Kemp<sup>a</sup>, M. King<sup>a</sup>, P. Lawrensen<sup>b</sup>, B. Mentiplay<sup>a</sup>, M. Scholes<sup>a</sup>, A. Semciw<sup>a,b</sup>

<sup>a</sup>La Trobe Sport and Exercise Medicine Research Centre, School of Allied Health, Human Services and Sport, La Trobe University

<sup>b</sup>University of Queensland

<sup>c</sup>Department of Orthopaedics, Erasmus University Medical Center

**Introduction:** Diagnosis of femoroacetabular impingement (FAI) syndrome requires hip and/or groin (hip/groin) pain, positive clinical signs, and cam and/or pincer morphology. Cam morphology most often occurs in the anterosuperior region and is better visualised using a Dunn 45° radiograph than an anteroposterior pelvis (AP) radiograph. The relationship between anterosuperior (Dunn 45°) or superior (AP) cam morphology size and reported burden is unknown in people with FAI syndrome who do not seek surgery. Therefore, we aimed to investigate the relationships between cam morphology size and scores for the Copenhagen Hip and Groin Outcome Score (HAGOS) and International Hip Outcome Tool-33 (IHOT-33) in football players with FAI syndrome.

**Methods:** One hundred and eighteen sub-elite football players (12 women) with FAI syndrome (>6months of hip/groin pain, positive flexion-adduction-internal rotation test, and cam morphology) completed HAGOS and IHOT-33 questionnaires. All participants were aged 18 to 50-years-old and free from hip osteoarthritis and acetabular dysplasia. Participants underwent an anteroposterior (AP) pelvis and Dunn 45° radiograph. An alpha angle  $\geq 60^\circ$  determined anterosuperior (Dunn 45°) and superior (AP pelvis) cam morphology to be present. Linear regression models were used to investigate the relationships between alpha angle (independent variable – assessed separately using AP and Dunn 45° radiographs) and IHOT-33 and HAGOS scores (dependent variables – score of 0 to 100).

**Results:** In total, 110 (93%, 9 women) and 77 (65%, 8 women) participants had cam morphology when assessed using the Dunn 45° and AP radiographs, respectively. Larger anterosuperior alpha angles were associated with worse scores for the IHOT-Total, IHOT-Symptoms, IHOT-Job, and IHOT-Social subscales (unadjusted estimate range -0.555

to -0.321 (95% confidence interval -0.899 to -0.044),  $P=0.002$  to 0.024,  $R^2=0.049$  to 0.089). Superior alpha angles were not related to any scores.

**Discussion:** Football players with larger anterosuperior, but not superior, cam morphology reported worse burden on all IHOT-33 scores, except the IHOT-Sport. Larger cam morphology identified using the Dunn 45° radiograph might have greater clinical relevance in football players with FAI syndrome, than the AP radiograph; however, further prospective studies are needed to discern importance of these findings over time.  $R^2$  values suggest that other physical and non-physical factors also contribute to reported burden in football players with FAI syndrome.

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## S8

### Glenoid Labral Tears are associated with Increased Neurofilament Innervation

J. Beretov<sup>a,b,c</sup>, P. Lam<sup>a,b</sup>, S. Marvi<sup>c</sup>, G. Murphy<sup>a,b</sup>, G. Murrell<sup>a,b,c</sup>

<sup>a</sup>University of New South Wales, Australia

<sup>b</sup>Orthopaedic Research Institute, Australia

<sup>c</sup>St George Hospital, Australia

**Background:** Pain is a common presentation following glenohumeral labral injuries. However, the source of that pain is undetermined. We aimed to determine if there is a differential expression of nerve fibres around the glenoid labrum and if torn labra have increased neuronal expression compared to unorn labra.

**Methods:** Labral tissue was collected at 3, 5, 9 and 12 o'clock during total shoulder arthroplasty. Samples were also collected at 3, 5 and 12 o'clock during rotator cuff repair, anterior labral repair, type II superior labral anterior to posterior (SLAP) repair and capsular release for idiopathic capsulitis. Sections were immunostained with antibodies to neurofilament, a specific neuronal marker which is used to identify central and peripheral nerve fibres, and the concentration and intensity of immunostained-positive cells assessed.

**Results:** The concentration of neurofilament staining was similar in the superior, anterior, posterior and inferior glenoid labrum in unorn labra (8 neurofilament expressing cells/mm<sup>2</sup>,  $p > 0.05$ ). Torn labra exhibited a 3-4-fold increase in neuronal expression which was isolated to the location of the tear in SLAP ( $p = 0.09$ ) and anterior labral tears ( $p = 0.02$ ). The concentration of neurofilament expressing cells in torn glenoid labrum samples were comparable to the glenoid labrum of adhesive capsulitis samples ( $p > 0.05$ ).

**Conclusions:** This study supports the hypothesis that following a traumatic tear of the anterior or superior labrum, the labrum in that region becomes populated with new nerves fibres and that these fibres are likely to be responsible for many of the symptoms noted by patients with superior (SLAP) and/or anterior labral (Bankart) tears.

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## S11

### Long-Term Durability of Restorative Neurostimulation for Chronic Mechanical Low Back Pain – Two-Year Pivotal Trial Results

B. Mitchell<sup>a</sup>

<sup>a</sup>Metro Pain Group, Australia

**Introduction:** Chronic mechanical low back pain (CMLBP) can be caused by impaired neuromuscular control and degeneration of the multifidus muscles resulting in functional instability of the lumbar spine. Available treatment options often lack long-term effectiveness and prognosis is unfavourable. An implantable Restorative Neurostimulation system (ReActiv8® by Mainstay Medical), that stimulates the L2 medial branches of the dorsal rami to reactivate neuromuscular control, received FDA Premarket Approval based on evidence from the ReActiv8-B pivotal trial (clinicaltrials.gov/show/NCT02577354). Here we report the two-year results of the open-label phase of this trial.

**Methods:** Participants had refractory, activity limiting CMLBP with average low back pain VAS $\geq$ 6cm, Oswestry Disability Index ODI $\geq$ 21 points, evidence of multifidus inhibition (prone-instability-test) and no indication for spine surgery. Participants self-administered up to 60-minutes of stimulation per day and were followed-up through two years.

**Results:** At baseline (N=204), participants were 47 $\pm$ 9 years of age, had backpain for 14 $\pm$ 11 years, average LBP-VAS of 7.3 $\pm$ 0.7cm, ODI of 39.1 $\pm$ 10.3 points, EQ-5D (quality-of-life) of 0.585 $\pm$ 0.174 and had LBP on 97 $\pm$ 8% of days during the year before enrolment.

At two-years (N=159), all prespecified outcome measures showed statistically significant (P<0.0001) and clinically substantial improvements compared to baseline. Average LBP-VAS improved by -4.8 $\pm$ 2.4cm (-65.9 $\pm$ 32.6%), ODI by -21.7 $\pm$ 16.8points

(-54.7 $\pm$ 39.2%) and EQ-5D by 0.215 $\pm$ 0.215; 71% of participants had  $\geq$ 50% LBP-VAS improvement; 66% had VAS $\leq$ 2.5cm (LBP-resolution); 62% had  $\geq$ 20points ODI improvement; 77% had  $\geq$ 50% improvement in LBP-VAS and/or ODI; 80% were "Definitely satisfied" with the treatment and 59% voluntarily eliminated or reduced opioid consumption. The overall safety profile is favourable, and no lead migrations were observed.

**Discussion:** Long-term restorative neurostimulation is an effective and durable treatment option with an encouraging safety profile for patients with refractory, activity limiting CMLBP, impaired multifidus motor control and no indications for spine surgery. Clinically substantial improvements, which progressively accrue through two years, are consistent with the restorative mechanism of action.

**Conflicts of Interest Statement:** The ReActiv8-B study was sponsored by Mainstay Medical, who paid the study sites to perform study-related activities, including Assoc Prof Bruce Mitchell's site.

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## S13

### The effect of a neuromuscular neck exercise program on head impact magnitude during heading: A pilot randomised controlled trial

J. Anderson<sup>a</sup>, A. Gardner<sup>e</sup>, I. Gilchrist<sup>c</sup>, M. McKay<sup>a</sup>, T. Meyer<sup>d</sup>, K. Peek<sup>a</sup>, T. Versteegh<sup>b</sup>

<sup>a</sup>University Of Sydney, Australia

<sup>b</sup>School of Physical Therapy, Western University, Canada

<sup>c</sup>School of Kinesiology and Health Studies, Queen's University, Canada

<sup>d</sup>Institute of Sports and Preventive Medicine, Medical Faculty, Germany

<sup>e</sup>Priority Research Centre for Stroke and Brain Injury, School of Medicine and Public Health, The University of Newcastle, Australia

**Introduction:** Football is the only sport where the head is deliberately used to strike a ball. While heading has always been an integral part of football, there is growing research and public concern that retired footballers have an increased risk for neurodegenerative disease due to changes to brain tissue from repeated ball-head impacts. Any impact to the head has the potential to cause a transmission of force to the brain. Whether this results in detrimental stress and strain to brain tissue is likely related to head impact magnitude. Head impact magnitude (including peak linear acceleration and angular velocity of the head) may be attenuated by player neck strength.

**Objectives:** The primary objectives were to explore the effect of a neuromuscular neck exercise program on a) isometric neck flexor, extensor and side flexor strength, and b) head impact magnitude during purposeful heading in male and female adolescent football players. A secondary objective was to explore the acceptability of the exercise program.

**Design:** Pilot randomised controlled trial.

**Methods:** Male and female players (aged 12-17 years) were randomised by team to the intervention (five-week supervised neuromuscular neck exercises integrated into Part 2 of the FIFA 11+) or control (Part 2 of the FIFA 11+ but no neck exercises). Outcomes included isometric neck strength and head impact magnitude (linear head acceleration and angular velocity) during standardised heading (baseline and six-weeks) plus an anonymous evaluation survey.

**Results:** From a total of 88 eligible players, 52 players (n=31 intervention; n=21 control) completed the study. Repeated MANOVAs revealed significant differences in neck strength variables (p<0.001) and peak linear acceleration (p<0.01) between the intervention and control groups over time. A trend towards significance was reported for peak angular velocity (p=0.05). Intervention players demonstrated significant increases in mean composite neck strength (53.8% intervention versus 15.6% control) as well as significant decreases in mean linear head acceleration during heading (-11.8% v -5.0%) from baseline to follow-up. Reduction in angular velocity was more pronounced in female (-27.7%) than male players (-11.5%) in the intervention arm. Players who completed neck exercises reported this as a positive experience which was beneficial to them and their team.

**Conclusion:** Players who completed neuromuscular neck exercises demonstrated an increase in isometric neck strength and decrease in head impact magnitude during heading. The addition of neuromuscular neck exercises into Part 2 of the FIFA 11+ was feasible and accepted by players.

**Conflict of Interest:** My co-authors and I acknowledge that we have no conflict of interest of relevance to the submission of this abstract.

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## S29

### Time-efficient physical activity intervention for older adolescents: the Burn 2 Learn cluster randomised controlled trial

S. Costigan<sup>a,g</sup>, N. Eather<sup>a</sup>, P. Gyawali<sup>i</sup>, C. Hillman<sup>e,f</sup>, E. Holliday<sup>h</sup>, S. Kennedy<sup>a</sup>, A. Leahy<sup>a</sup>, C. Lonsdale<sup>b</sup>, D. Lubans<sup>a</sup>, M. Mavilidi<sup>a</sup>, P. Morgan<sup>a</sup>, M. Nilsson<sup>c</sup>, M. Noetel<sup>b,d</sup>, R. Plotnikoff<sup>a</sup>, T. Shigeta<sup>e,f</sup>, J. Smith<sup>a</sup>, S. Valkenborghs<sup>a</sup>, N. Weaver<sup>h</sup>

<sup>a</sup>Priority Research Centre in Physical Activity and Nutrition, University of Newcastle, Australia

<sup>b</sup>Institute for Positive Psychology and Education, Australian Catholic University, Australia

<sup>c</sup>Faculty of Health and Medicine, University of Newcastle, Australia

<sup>d</sup>School of Behavioural and Health Sciences, Faculty of Health Sciences, Australian Catholic University, Australia

<sup>e</sup>Department of Psychology, Northeastern University, United States of America

<sup>f</sup>Department of Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, United States of America

<sup>g</sup>School of Exercise and Nutrition Sciences, Deakin University, Australia

<sup>h</sup>School of Medicine and Public Health, University of Newcastle, Australia

<sup>i</sup>School of Biomedical Sciences and Pharmacy, University of Newcastle, Australia

**Introduction:** Time-efficient physical activity interventions are needed for older adolescents ( $\geq$ 16 years) in the senior school years (i.e., Grades 11 and 12) where there is a heavy focus on academic performance and physical education is not mandatory. The aim of our study was to evaluate the impact of a time-efficient school-based intervention designed to improve older adolescents' cardiorespiratory fitness (CRF) by integrating high-intensity activity breaks into curriculum time.