Eccentric Knee Flexor Strength and Between Limb Strength Asymmetries in Cricket

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Abstract

Cricket was once regarded as a “moderate injury risk” sport. However, more recent research suggests that the injury rate in elite cricket is rising, with hamstring strain injuries (HSIs) one of the most common and severe injuries (Frost and Chalmers, 2014). Multiple cricket playing nations have documented the occurrence of cricket injuries over several seasons and all have demonstrated an increase in injuries over recent times with the introduction of Twenty20 cricket and the increase in matches played per year (Frost and Chalmers, 2014, Orchard et al., 2011). International cricket injury reports suggest that elite pace bowlers are the most at risk of incurring an injury throughout each season, with a high affiliation to HSIs (Frost and Chalmers, 2014, Mansingh et al., 2006, Orchard et al., 2002, Orchard et al., 2011, Orchard et al., 2006, Stretch, 2003).

Preventative measures can be further deduced from the causation of hamstring strains in order to reduce the risk of sustaining a HSI. Addressing strength imbalances and improving eccentric knee flexor strength have been proposed as a key component of HSI prevention for a variety of high intensity sports. The addition of the Nordic hamstring exercise (NHE) to training programs for elite sports has resulted in significant reductions in HSI rates (Arnason et al., 2008, Askling et al., 2003, Brooks et al., 2006). However, as a HSI may result in chronic inhibition of the injured (weaker) hamstring (Fyfe et al., 2013, Sole et al., 2012), further research needs to be conducted to determine how best to improve recruitment patterns in the injured hamstring. One such approach may be the use of psychological strategies such as augmented feedback (AF). AF has demonstrated improvements in overall quality of training and increases in acute and chronic strength gains, power and skill based tasks when associated with complex movements related to sport (Argus et al., 2011, Jung and Hallbeck, 2007, Kim and Kramer, 1997, McNair et al., 1996, Tod et al., 2005). Considering the importance of increased eccentric knee flexor strength and reduce bilateral limb asymmetries in helping lower the risk of sustaining a HSI, the use of AF during training may provide acute increases in performance during the NHE that result in increased chronic adaptations.

The objective of research study one of this thesis was to compare eccentric knee flexor strength and bilateral asymmetries in elite, sub-elite and school level cricket players; and to determine if playing position and limb role influenced these eccentric knee flexor strength indices. Seventy four male cricket players of three distinct skill levels (elite, sub-elite and school level) performed three repetitions of the NHE on the experimental device. Strength was assessed as the absolute and relative mean peak force output for both limbs, with bilateral asymmetries defined as the percent difference in force between limbs. There were no significant differences between elite, sub-elite and school level athletes for mean peak force (elite 313 ± 67N and 3.65 ± 0.89N.kg⁻¹; sub-elite 308 ± 77N and 3.74 ± 0.96N.kg⁻¹;
school $285 \pm 68N$ and $4.11 \pm 0.77N.kg^{-1}$ for absolute and relative mean peak force respectively; $P>0.05$) and bilateral asymmetries (elite $11.5 \pm 8.6\%$; sub-elite $15.1 \pm 12.2\%;$ school $12.6 \pm 11.6\%; P>0.05$) of the knee flexors. There were no significant differences observed between bowlers’ and batters’ mean peak force ($297 \pm 77N$ and $3.74 \pm 0.97 N.kg^{-1}$; $305 \pm 65N$ and $3.99 \pm 0.76 N.kg^{-1}$ for bowlers and batters respectively; $P>0.05$) and bilateral asymmetries ($13.7 \pm 10.3\%$ and $13.2 \pm 12.5\%$ for bowlers and batters, respectively; $P>0.05$). There were no significant differences between front and back limb mean peak force outputs ($299 \pm 79N$ and $3.83 \pm 1.03N.kg^{-1}$; $303 \pm 71N$ and $3.84 \pm 0.84N.kg^{-1}$ for absolute and relative mean peak force, respectively; $P>0.05$). Skill level, playing position and limb role appeared to have no significant effect on eccentric knee flexor strength and bilateral asymmetries. Further, bowlers and elite players had the lowest relative eccentric knee flexor mean peak force outputs which may present cause for the increased number of HSIs in these demographics. Future research should seek to determine whether eccentric knee flexor strength thresholds are predictive of HSIs in cricket and if specific eccentric knee flexor strengthening can reduce these injuries.

The objective of research study two was to determine the acute effects of real-time visual AF provided during the NHE in reducing bilateral knee flexor strength asymmetries and increasing bilateral knee flexor strength outputs. Forty four male cricket players of two distinct skill levels (sub-elite and school level) performed two testing sessions of the NHE with and without the aid of visual feedback of force production using a cross over study design. Strength was assessed as the peak force output for both limbs, with bilateral asymmetries defined as the percent difference in force between limbs. Differences in mean peak force outputs and bilateral asymmetry were compared between the two conditions. There was a significant increase in mean peak force production when feedback was provided compared to no feedback (NFB) ($d=0.61; P<0.05$), but no significant difference in bilateral limb asymmetry for feedback ($12.7 \pm 12\%$) or NFB ($15.5 \pm 13.2\%$) ($d=0.41; P>0.05$). Increases in force production for the feedback condition were a result of increased force contribution for the weaker limb ($284 \pm 65N$ vs $299 \pm 72N; d=0.22$) compared to the strong limb ($327 \pm 77N$ vs $331 \pm 78N; d=0.05$). In conclusion, the use of real-time visual feedback during the NHE resulted in significantly increased eccentric knee flexor force. As the significant improvement in the knee flexor force was observed primarily in the weaker limb, the chronic performance of NHE with feedback may reduce HSI risk by increasing eccentric knee flexor strength, especially of the weaker limb.

In summary, the present thesis provides insight into the eccentric knee flexor strength performance characteristics associated with cricket at multiple skill levels and has provided additional training recommendations to a sport that has limited literature encompassing all playing positions. Elite level athlete’s absolute eccentric knee flexor strength was found to be
similar to sub-elite and school level cricket players, even though it should be greater considering the elite players' greater body mass, absolute running workloads and higher number of HSIs. Real-time visual feedback during the NHE may be a valuable tool for increasing the acute force outputs which may accelerate strength gains and reductions of between limb strength asymmetries over the course of a typical training cycle. Future research might determine what eccentric knee flexor strength threshold best predicts HSIs in cricket. Once this is known, strength and conditioning staff may focus on their weaker players reaching this threshold, and once that is achieved, direct more focus to reducing between limb strength asymmetries.
Declaration

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Masters by Research. This thesis represents my own original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

Wade Chalker

Sign: __________________
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List of Conference Proceedings

**Chalker, W. J.,** Shield, A. J., Opar, D. A., Keogh, J. W.L. Eccentric Knee Flexor Strength Asymmetries and the Effect of Augmented Feedback in Elite Cricket Players: A Pilot Study. 5th World Congress of Science and Medicine in Cricket, March 2015, Sydney (Oral Presentation and Abstract) (Appendix E)

**Chalker, W. J.,** Shield, A. J., Opar, D. A., Keogh, J. W.L. A Review of Hamstring Strain Injuries in Cricket and Potential Methods to Reduce the High Occurrence of Strains. 5th World Congress of Science and Medicine in Cricket, March 2015, Sydney (Oral Presentation and Abstract) (Appendix F)
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### Abbreviations

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<th>Description</th>
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<tr>
<td>AEs</td>
<td>Athlete exposures</td>
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<tr>
<td>AF</td>
<td>Augmented feedback</td>
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<td>ARF</td>
<td>Australian Rule Football</td>
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<tr>
<td>BF</td>
<td>Bicep femoris</td>
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<td>FB1</td>
<td>Received feedback in the first testing session</td>
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<td>FB2</td>
<td>Received feedback in the second testing session</td>
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<tr>
<td>H : Q</td>
<td>Hamstring to quadriceps strength imbalance ratio</td>
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<tr>
<td>H : Q_convol</td>
<td>Concentric strength imbalance ratio of hamstrings and quadriceps</td>
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<tr>
<td>H : Q_func</td>
<td>Concentric strength of the quadriceps to eccentric strength of the hamstrings ratio</td>
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<tr>
<td>HSI</td>
<td>Hamstring strain injury</td>
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<td>IPL</td>
<td>Indian Premier League</td>
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<td>NFB</td>
<td>No feedback</td>
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<td>NHE</td>
<td>Nordic hamstring exercise</td>
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<td>sEMG</td>
<td>Surface electromyography</td>
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<tr>
<td>SM</td>
<td>Semimembranosus</td>
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<td>ST</td>
<td>Semitendinosus</td>
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<td>T20</td>
<td>Twenty20</td>
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### Units of Measurement

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<td>N.kg^{-1}</td>
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