IOCBE 2024 Conference
The 1st International Online Conference on Bioengineering
16–18 October 2024 | Online
MDPI

Electrophysiological biomarkers to understand the compensatory mechanisms of hamstring tears: A narrative review

Gonzalo Daniel Gerez (gonzalo.gerez@facdef.unt.edu.ar), Manuel Parajón Víscido, Fernando Daniel Farfán, Leonardo Ariel Cano.

Universidad Nacional de Tucumán - Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina

INTRODUCTION & AIM

Hamstring muscle tears are among the most common sports injuries. They account for approximately 25% of all sports injuries, with high recurrence rates ranging from 15% to 60%, posing a significant challenge to the recovery of athletes. Muscle injuries can alter the movement control system and generate compensatory strategies that affect muscle synchronisation. A thorough study of how hamstring tears generate adaptive mechanisms that alter motor strategies is crucial to improve assessment and rehabilitation processes. In this context, electrophysiological biomarkers provide an excellent study tool due to their high temporal resolution. The aim of this work was to review and summarise the evidence on the analysis of electrophysiological biomarkers and provide insights into the compensatory and adaptive mechanisms generated by hamstring muscle tears.

METHOD

A literature review was conducted using the PubMed-MEDLINE and Google Scholar databases, focusing on studies relevant to applied research in athlete recovery. The search employed keywords such as "hamstring tear", "hamstring injuries", "electrophysiological biomarkers", "EMG analysis", "functional connectivity", "intermuscular coherence", "muscle synergies", "muscle networks", and "motor control". Articles were selected based on their relevance to the field of sports science and rehabilitation, particularly in the context of athlete recovery strategies.

RESULTS & DISCUSSION

The evidence reviewed shows a wide variety of electromyographic biomarkers used for the assessment of muscle activity in people with a history of hamstring injury. Surface EMG measures used are for example EMG amplitude, intermuscular ratio of EMG amplitude, ratio of EMG amplitude of a hamstring muscle compared to total hamstring EMG amplitude, mean EMG power frequency, onset and offset of EMG activation, among others (Fig. 1)

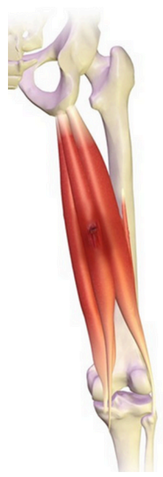
The results are variable, sometimes contradictory and conflicting. The main differences when comparing healthy and injured legs were observed during isokinetic tests of eccentric contractions at different speeds.

Other measures such as mean EMG power frequency were used without results to support their use as a biomarker capable of differentiating between groups of people with a history of hamstring tear and control groups.

Furthermore, great variability can be observed in the methods of normalisation of the EMG signal and in the evaluation methodology, which prevents the generation of conclusive recommendations.

Most studies based their analysis on aspects such as amplitude and frequency of the EMG signal, using univariate approaches. No evidence was found for studies using bivariate and multivariate analysis.

Bivariate and multivariate analyses using EMG data offer a comprehensive approach to understanding muscle synchronisation strategies, thereby addressing the shortcomings of traditional univariate analysis focused on parameters such as amplitude, latency, and spectral power density.



EMG biomarkers of muscle function in hamstring tear
EMG amplitude
Intermuscular ratio of EMG amplitude
Mean EMG power frequency
Onset and Offset of EMG activation

Fig. 1- Electromyographic biomarkers of muscle function in hamstring tear

CONCLUSION

The use of EMG biomarkers is useful to identify altered muscle activity in patients with a history of hamstring tear. This evidence suggests that hamstring injury results in compensatory mechanisms of altered muscle activity when comparing the injured limb to the uninjured limb.

Using an approach based on bivariate and multivariate analysis would allow a better study of the compensatory mechanisms induced by muscle injury on motor behaviour.

REFERENCES

Areia, C., Barreira, P., Montanha, T., Oliveira, J., & Ribeiro, F. (2019). Neuromuscular changes in football players with previous hamstring injury. Clinical Biomechanics, 69, 115–119. https://doi.org/10.1016/j.clinbiomech.2019.07.010

Avrillon, S., Hug, F., & Guilhem, G. (2020). Bilateral differences in hamstring coordination in previously injured elite athletes. Journal of Applied Physiology, 128(3), 688–697. https://doi.org/10.1152/japplphysiol.00411.2019

Badrinath, K., Crowther, R. G., & Lovell, G. A. (2022). Neuromuscular Inhibition, Hamstring Strain Injury, and Rehabilitation: A review. Journal of Postgraduate Medicine Education and Research, 56(4), 179–184. https://doi.org/10.5005/jp-journals-10028-1597

Higashihara, A., Ono, T., Tokutake, G., Kuramochi, R., Kunita, Y., Nagano, Y., & Hirose, N. (2019). Hamstring muscles' function deficit during overground sprinting in track and field athletes with a history of strain injury. Journal of Sports Sciences, 37(23), 2744–2750. https://doi.org/10.1080/02640414.2019.1664030

Ohtsubo, R., Saito, H., & Hirose, N. (2024). Characterizing Muscle Activity in Soccer Players with a History of Hamstring Strain Injuries during Accelerated Sprinting. Journal of Sports Science and Medicine, 656–662. https://doi.org/10.52082/jssm.2024.656

Presland, J. D., Timmins, R. G., Maniar, N., Tofari, P. J., Kidgell, D. J., Shield, A. J., Dickson, J., & Opar, D. A. (2021). Muscle Activity and Activation in Previously Strain-Injured Lower Limbs: A Systematic review. Sports Medicine, 51(11), 2311–2327. https://doi.org/10.1007/s40279-021-01487-w