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How to Use Functional Electrical Stimulation (FES) for Rehabilitation after Stem Cell Therapy

Stem cell therapy continues to show promise for use in tendon, ligament, joint and bone problems of horses. However, rehabilitation protocols after stem cell therapy have not been extensively explored.

Functional Electrical Stimulation (FES) is utilized in rehabilitation to obtain early controlled movement by replicating the motor neuron response. FES has been used to reduce atrophy, decrease muscle spasticity, reduce inflammation and scar tissue, re-educate muscle function, and strengthen muscles and tendons.[1-3]

Research has shown FES to be safe even for denervated muscle,[4] and it could prove to be a useful tool for early mobilization after stem cell therapy. Electrical stimulation of stem cells has been found to encourage appropriate cardiac stem cell differentation[5], neural stem cell proliferation and differentation[6] and the differentiation of myoblasts into myotubes.[7]

Reducing inflammation after stem cell therapy could be an important factor in quality healing. Researchers from the University of Pittsburg have found that inflammation has a negative effect on the differentiation of tendon stem cells (TSCs) into quality tendon tissue. When inflammation occurs in the presence of TSCs, there is an associated reduction in the number of tenocytes available for repair. In addition, inflammation produces an increase in the transformation of TSCs into fatty and calcified tissues, which is the type of tissue seen in the later stages of tendinopathy.[8]

Early mobilization during rehabilitation after injury or surgery is a well-established protocol and has been used extensively to improve the quality of healing.[9] FES can provide controlled movement of muscles, tendons and the associated ligaments, which is necessary in the early rehabilitation process. Researchers have found that exercise can have a positive effect on stem cell therapy. Findings on mice have suggested that exercise increases the proliferation of TSCs, and also increases the TSC-related cellular production of collagen.[8] In addition, physical exercise is known to increase ependymal cell proliferation, while improving functional recovery.[10,11]

Mild mechanical stretching and its effect on stem cell proliferation and differentation of TSCs into tenocytes has also been documented. However, excessive mechanical loading may be detrimental because it promotes differentiation of TSCs into non-tenocytes, including lipid and calcium accumulation.[12,13] FES can be used to obtain a full range of stimulation sensations, from mild, sensory-level stimulation up to strong, motor-level stimulation, while obtaining a high compliance by the horse. Therefore, the use of FES can be tailored to meet the level of mobilization required to produce the best possible results.

Researchers at Stanford University have found that electrical activity acts directly on neural stem/progenitor cells (NPCs) to promote production of neurons. These results suggest that electrical stimulation may promote the replacement of neurons in the

damaged nervous system.[14]

In 2008, researchers at Johns Hopkins University implanted a functional electrical stimulation device into the motor cortex. Electrical stimulation produced an increase in cell birth and differentiation of the endogenous neural stem cells in the spinal cord. In addition, FES was found to promote remyelination and neural repair.[6] In another study, these researchers found that FES induced an 82-86% increase in cell birth in the lumbar spinal cord. The authors reported that FES activation of the central nervous system may enhance spontaneous regeneration after neurological injuries.[15]

Stem cell therapy has the potential to improve the outcome of equine injuries and with the addition of an appropriate rehabilitation program the results could be even more encouraging.

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Acknowledgements

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