**An update on the use of stem cells for injuries in the equine athlete**

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## Introduction

Musculoskeletal injuries are a leading cause for decreased performance and early retirement in the equine athlete. In accordance with Murphy's Law, there is a common impression that the horses who incur these injuries are inevitably those with the most "heart" – or those who try hard enough to hurt themselves. For obvious reasons, promoting the most effective repair of injuries in these athletes is of tremendous concern to owners, trainers and veterinarians in the equine industry.

Following a musculoskeletal injury, the repaired tissue rarely returns to normal. Bone is the one exception - the body may heal and remodel a fractured bone to a strength equal to, or even greater than, it was pre-injury. In sharp contrast, most other injuries will heal with tissue that is either structurally or functionally inferior to the normal tissue. For example, a severely torn muscle may be replaced with scar tissue that reduces its capability to contract or lengthen. Similarly, a tendon/ligament injury often heals with poorly organized scar tissue. This scar tissue does not possess the important structural and functional characteristics of the normal tissue. As a consequence, the uniform elasticity of the tendinous/ligamentous unit is lost and the horse is predisposed to re-injury and/or decreased performance for the remainder of its career.

Because of their ability to transform into multiple cell types, stem cells have captivated the interest of scientists and medical professionals for their potential to replace injured or diseased tissues with a tissue of identical structure and function. This new branch of medicine and research is called "regenerative medicine" and is still in its infancy. In the future, successful regeneration of abnormal tissues could abolish the heightened risk of re-injury in athletes.

## The Science

The clinical use of stem cells in horses has preceded extensive published research, however there is a growing body of supportive literature. In the laboratory, equine stem cells have been induced to differentiate into multiple cell lines, including cells that produce cartilage and tendon fibers. In joints, injection of stem cells following experimental injury has been reported to help early cartilage repair and was also reported to improve athletic outcome in a multi-center clinical trial. In one of the most exciting publications, stem cell therapy for experimentally induced damage to the knees of goats decreased the degree of arthritis and actually potentiated regrowth of meniscal tissue. Stem cells have also been reported to improve outcome following tendon (superficial digital flexor) and ligament (suspensory) injuries. They markedly decreased re-injury rate in a large series of clinical tendon injuries. They have been shown to persist at the site of tendon injury for 8 weeks after implantation. Other studies have demonstrated improved tendon architecture, fiber organization, and biomechanical characteristics

following treatment with stem cells. While the majority of studies demonstrate the promising results of stem cells, it is worth noting that some studies have failed to demonstrate such significant effects. I am unaware of any equine study to suggest a detrimental effect on healing.

The Technique

Stem cells are most commonly harvested from bone marrow or fat in the clinical setting. I prefer to use stem cells harvested from bone marrow in the sternum. The harvest procedure is quick and is performed with minimal discomfort in the standing horse. I generally perform this procedure in a set of stocks with short acting sedation. An ultrasound is used to confirm that the sternum is anatomically normal and identify the appropriate sites for the procedure. The skin is clipped and cleaned thoroughly. A local block is applied so the horse feels little or none of the procedure. A special cutting needle is then advanced through the outer layer of the bone (into the marrow cavity) of the sternum, and a small volume of marrow is taken (Figure 1). The skin defect is sufficiently small that it need not be sutured and bleeding is minimal to absent. I generally administer an anti-inflammatory (such as bute) for the procedure, but most horses never show any evidence of discomfort related to this procedure. Antibiotics are unnecessary.

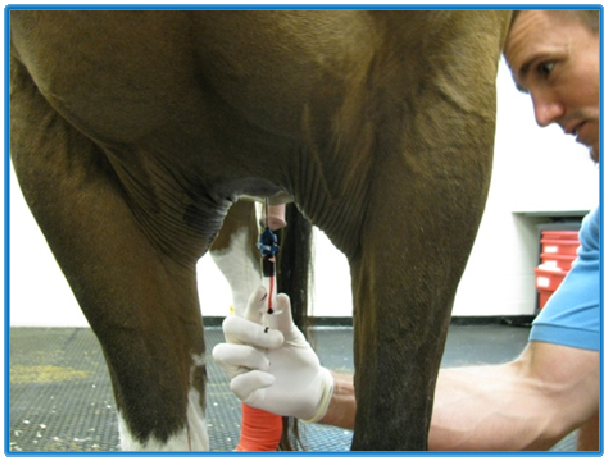

Figure 1: Aspiration of bone marrow from the sternum in a standing horse

The harvested marrow is then carefully packaged and shipped overnight to an outside laboratory. These cells are processed and expanded to contain a much higher number of stem cell (usually 10-20million). Once this expansion has been achieved (usually 3 weeks), the cells are shipped back to the hospital for implantation.

The implantation procedure varies with the specific injury to be treated. Most often this is also performed as a standing procedure under a short acting sedative. Ultrasound guidance is often used to visually confirm deposition of the cells directly at the site of injury (Figures 2&3).

Figure 2: An sterile ultrasound probe (left) is used to guide a needle (top) directly into a tendon injury in the leg of a horse (right).

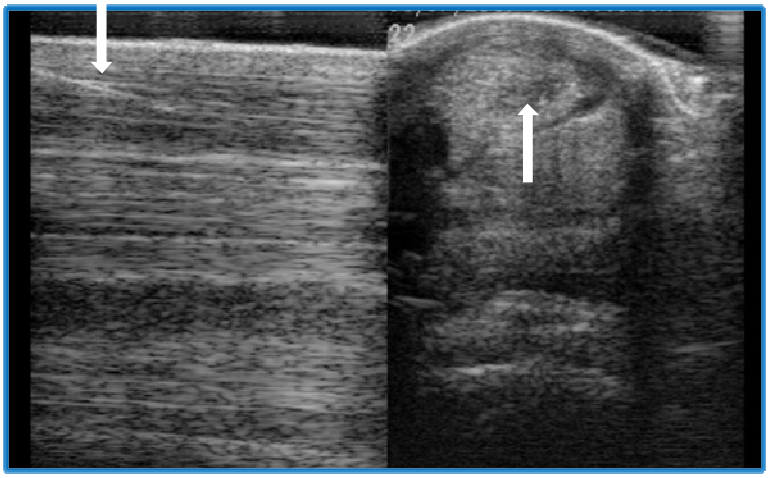

Figure 3: Ultrasound views (long on left, cross section on right) of a needle (marked by white arrows) inserted precisely into the damaged (darker) area of a tendon.

Complications

As with any medical procedure, side effects are of concern. Sterile technique is imperative to avoid the introduction of infection. An occasional reaction or “flare” following injection into a joint has been noted, however this is self limiting. Uncontrolled cell growth or tumor formation from the stem cells, to my knowledge, has not been reported in the horse. I consider stem cells to be one of the safest therapies available and I do not hesitate to use them in the clinical setting.

## The Cost

Probably the reason stem cells are not used more frequently is their cost. The average cost for the stem cell harvest, lab expansion to 10million cells, and implantation will be around $2500. If the injury requires a larger cell expansion, or if cells are frozen and stored for additional treatments, the price will increase accordingly.

## Conclusion

I think that stem cells are an exciting development for sports medicine in the horse. Although we are still early in the game, stem cell treatment in equine athletes seems to aid in a structurally and functionally superior repair following many injury types, but also appears to be a very safe treatment method. With cautious optimism, I have enjoyed many clinical successes with stem cells. I am eager for the expanded knowledge and application of this treatment that will be afforded by continued research and the test of time.

Please feel free to contact me with any questions

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