Stem Cells Restore Some Function To Spinal Injured Rats

November 20, 2006 -- It seems like every week, or maybe even every day, the headlines are announcing some new breakthrough involving stem cells: Stem cells repair hearts! Stem cells repair spinal injury! And of course each and every major media piece on stem cells includes the obligatory phrase, "stem cells hold out the promise of curing diabetes, heart disease, Alzheimer's, Parkinson's, and spinal cord injury".

Discerning the reality through the hype can be difficult, especially given the inflamed rhetoric and ethical controversy swirling around the use of embryonic stem cells. While the short-term promise of stem cells may be exaggerated, and despite the hype, the reality is that scientists are advancing our understanding of stem cells every day. And with literally billions of research dollars ready to pour into the field, researchers around the world are turning their attention to turning the promise of stem cells into reality.

Why is this important to the Chiari community? Because stem cells, which are able to become different types of cells, may be one way to undo what is now permanent damage to the nervous system from syringomyelia. Neural cells, which make up the brain and spinal cord, naturally do not regenerate very much. This is why damage to the brain or nervous system, from an injury or disease, generally does not heal well.

The biggest problem for people with Chiari and syringomyelia after surgery is often the damage that occurred before there was a diagnosis. The nerve damage can lead to intractable pain, loss of function, and disability. Since nerve cells don't repair themselves, stem cells - which can become new nerve cells - theoretically could help repair the damage.

Given the focus which Christopher Reeve brought to the issue of spinal cord injuries (SCI), many scientists are researching how stem cells can be used to limit the damage from, or even repair, spinal injuries. An example of their progress can be found in a report in the November, 2006 issue of the Journal of Neurosurgery: Spine by a group from Chiba University in Japan.

The Japanese researchers used stem cells derived from umbilical cord blood to restore some functionality in spinal injured rats. The group chose umbilical cord blood as a source of stem cells (these are also known as homopoietic stem cells, or HSC) because of their wide availability, ease of use, and because they avoid the ethical issues of embryonic stem cells.

To study the effects of the stem cells, the scientists used a well established model of spinal cord injury in rats where a weight is dropped onto the exposed spine. Of interest to the Chiari community is the fact that a crushing, or bruising injury like this results in the formation of a cyst cavity at the site of the injury.

Nineteen rats were injured in this fashion and one week later 8 of them were given an injection of the cord blood stem cells directly into the center of the injury (the dura was opened for this). The other 11 rats were given an injection of a control substance also in the center of the injury.

Using a well established locomotion scale, the rats were then assessed at various points in time after the injury and treatment. On a motion scale ranging from 0-21, all rats scored a 21 prior to the injury and scored a 0 immediately following the SCI (see Table 1). However, at the five week point, the rats who were given the stem cells scored an average of 9.8 versus only 7.2 for the control group. To relate this to actual functionality, a score of 9.8 means the rats were able to put some weight on their back legs, while a score of 7.2 means the rats were not able to put any weight on their back legs.

To further examine the effects of the stem cells, certain rats were euthanized at the different time points and their spinal tissue examined microscopically. In this fashion, the researchers were able to determine that the stem cell injections had actually significantly reduced the size of the cystic cavity associated with the injury. In other words, the stem cell rats had smaller cavities than the control rats. Similarly, the rats who received the stem cells had more white matter - a type of neural tissue - around the injury than the ones who didn't get the treatment.

Interestingly, when the researchers looked for signs of the injected stem cells in the spinal tissue they found that while the cells were abundant one week after the treatment, they were largely gone by 3 weeks, and had completely disappeared by the 5 week mark. Also, and somewhat of a surprise to the team, they could find no evidence that the stem cells had actually become neural cells.

The Japanese study is a good example of the current state of stem cell research, especially as it applies to spinal cord injury. There are indications that stem cells can be of some benefit, but the gains are not miraculous and scientists do not completely understand how they work.

Key Points

1. The media is full of headlines talking about the promise of stem cells
2. It can be difficult to assess what stem cells can really do
3. Study used stem cells from umbilical cord blood to study restoration of function in rats after spinal cord injury
4. Weight was dropped on the exposed spines of rats to cause SCI
5. 1 week after injury, stem cells were injected into center of injury for some of the rats
6. Five weeks after injury, these rats had noticeably improved function in hindlimbs versus control group
7. Stem cells also reduced the size of the cystic cavity
8. Still a long way from stem cell type treatments for SCI and syringomyelia

Definitions

control group - in an experiment a group which does not receive the treatment being investigated, thus acting as a source of comparison for the experimental group

contusive - bruising type injury

cystic cavity - fluid filled cavity; contusive spinal cord injuries result in cystic cavities; similar to a syrinx

hemopoietic stem cells (HSC) - stem cells derived from blood

neural cells - cells of the nervous system; the brain and spine

stem cells - cells which have the ability to become other types of cells, such as muscle or neural

white matter - type of neural tissue

cerebellar tonsils - portion of the cerebellum located at the bottom, so named because of their shape

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation I - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

decompression surgery - general term used for any of several surgical techniques employed to create more space around a Chiari malformation and to relieve compression

Source

Source: Nishio et al. The use of hemopoietic stem cells derived from human umbilical cord blood to promote restoration of spinal cord tissue and recovery of hindlimb function in adult rats J Neurosurg. 2006 Nov;105(5 Suppl):424-33.

While it would seem the goal of completely repairing nerve damage to the spine is a long way off, it is intriguing that even at this early stage there are indications that stem cells reduced the size of the cystic cavity. And given the incredible amount of resources being applied to stem cell research, maybe the ability to repair damage due to a syrinx will be here sooner rather than later.

Table 1
Functional Restoration in Experimental Group vs Control Group (0-21)

	Experimental Group	Control Group
Before SCI	21	21
After SCI	0	0
5 wks After SCI	9.8	7.2

Note: Standard Locomotion Scale was used with a max score of 21; rats were scored by two trained observers

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