PARKINSON'S TREATMENTS

ADULT STEM CELLS VS. EMBRYONIC STEM CELLS

Adult Stem Cells Treat Parkinson's in Humans and Animals:

2006 Scientists used adult stem cells from the solid umbilical cord to treat rats with Parkinson's, and found significant recovery in motion and behavior. Weiss ML, et al., Human umbilical cord matrix stem cells: preliminary characterization and effect of transplantation in a rodent model of parkinson's disease, *Stem Cells* 24, 781-792, March 2006.

2005 British researchers performed the first ever pathology follow-up (see original study below) of one patient treated for Parkinson's disease. The study showed that the protein stimulated sprouting of new neurons in the brain. Love S. et al., "Glial cell line-derived neurotrophic factor induces neuronal sprouting in human brain." *Nature Medicine* 11, 703-704, July 2005.

2005 Scientists at the University of Kentucky treated ten Parkinson's patients with a protein to stimulate the patients' own brain stem cells and showed significant improvement in symptoms. Slevin JT, et al., Improvement of bilateral motor functions in patients with Parkinson disease through the unilateral intraputaminal infusion of glial cell line-derived neurotrophic factor, *Journal of Neurosurgery* 102, 216-222, February 2005.

2004 A Japanese research team from Kyoto University reported success in treating mice with Parkinson's disease by transplanting nerve cells developed from their own bone marrow stromal cells. Mari Dezawa et al. "Specific induction of neuronal cells from bone marrow stromal cells and application for autologous transplantation" *Journal of Clinical Investigation* 113:1701-1710, 2004.

2003 British researchers injected a natural protein into the brains of 5 Parkinson's patients and found that it stimulated the patients' own adult neural stem cells. This treatment provided an average 61% improvement in motor function. Gill SS et al.; "Direct brain infusion of glial cell line-derived neurotrophic factor in Parkinson disease"; *Nature Medicine* 9, 589-595; May 2003.

2002 Dr. Michel Levesque at Cedars-Sinai Medical Center and Dr. Toomas Neuman with Celmed BioSciences treated a patient with his own neural stem cells. They isolated the patient's adult neural stem cells, induced them to differentiate into the desired nervous system cells, and implanted them back into the patient's brain. One year after the procedure, the patient's symptoms were reduced by more than 80%. Dr. Levesque has been authorized by the FDA to conduct a Phase II clinical trial for Parkinson's disease. Lévesque M and Neuman T, "Autologous transplantation of adult human neural stem cells and differentiated dopaminergic neurons for Parkinson disease: 1-year postoperative clinical and functional metabolic result", *American Association of Neurological Surgeons annual meeting*, Abstract #702; April 8, 2002.

2002 Scientists in Sweden showed that neural stem cells expressing a specific gene could form all neuronal cell types, migrate throughout the brain, and prevent loss of dopamine neurons and behavioral problems in Parkinson's mice. Åkerud P et al.; "Persephin-overexpressing neural stem cells regulate the function of nigral dopaminergic neurons and prevent their degeneration in a model of Parkinson's disease"; *Molecular and Cellular Neuroscience* 21, 205-222; November 2002.

Touted ESCR Parkinson's Studies—Mixed Results in Animals:

2006 Scientists in Sweden and Japan found no improvement of Parkinson's rats treated with embryonic stem cells, and many animals developed severe tumors. Brederlau A, et al., Transplantation of human embryonic stem cell-derived cells to a rat model of parkinson's disease: effect of in vitro differentiation on graft survival and teratoma formation, *Stem Cells* express online publication doi:10.1634/stemcells.2005-0393, March 23, 2006.

2005 A Japanese team turned monkey embryonic stem cells into neural stem cells. They transplanted these into monkeys with artificially induced Parkinsons's, and some cells turned into dopamine producing cells. There was mild alleviation of symptoms. Yasushi Takagi et al. "Dopaminergic neurons generated from monkey embryonic stem cells function in a Parkinson primate model" *The Journal of Clinical Investigation* 115 (1): January 2005.

2004 An Israeli team turned human embryonic stem cells into neural progenitors and transplanted these into rats. Some cells made dopamine, but the cells stopped growing at 12 weeks. Rats exhibited a partial improvement in behavioral tests, but it was too early to see if tumors formed. Ben-Hur T, et al. "Transplantation of human embryonic stem cell-derived neural progenitors improves behavioral deficit in Parkinsons rats." *Stem Cells* 22 (7): 1246-55, 2004.

2003 Dopaminergic neurons made from mouse embryonic stem cells were transplanted into Parkinson's mice and provided some decrease in symptoms, but 20% of mice receiving the embryonic stem cells died due to teratoma formation. F Nishimura et al.; "Potential use of embryonic stem cells for the treatment of mouse Parkinsonian models: improved behavior by transplantation of in vitro differentiated dopaminergic neurons from embryonic stem cells"; *Stem Cells* 21, 171-180; March 2003.

2002 NIH and South Korean researchers used gene engineering to enrich mouse embryonic stem cells for dopamine neurons. The Parkinson's rats received some benefit up to 8 weeks after injection. J-H Kim et al.; "Dopamine neurons derived from embryonic stem cells function in an animal model of Parkinson's disease"; *Nature* 418, 50-56; July 4, 2002.

2002 Researchers injected Parkinson's rats with mouse embryonic stem cells. The rats showed a modest benefit for just over 50% of the rats, but one-fifth (20%) of the rats died of brain tumors caused by the embryonic stem cells. Bjorklund LM et al.; "Embryonic stem cells develop into functional dopaminergic neurons after transplantation in a Parkinson rat model"; *Proc. Natl. Acad. Sci.* 99, 2344-2349, February 19, 2002.