Stem cells and skin disorders

By

Heather Davies
Martha Stevens
Lauren Turley

Word count: Approx 2500

Grade awarded June 2006: PASS WITH MERIT

Research based on
Pathology lectures at
Vetsix 2005
Abstract

In this paper, my work is about ‘the idea of the use of stem cell technology in veterinary medicine’. It will explore the actual ideas behind stem cell use to treat diseases and conditions such as damaged nerve cells, leukaemia and skin conditions. Within this project, ethical issues surrounding the use of stem cells is also discussed, along with ethical issues the scientific community have to think deeply about to avoid controversy. Would stem cell use within veterinary medicine save time and lives or would it be too expensive and controversial even to take off?

Introduction

Currently, there are a number of areas of development regarding embryonic stem cell research. As an overview, stem cells have no function, but have the capacity to replicate themselves into cells from their surroundings with similar properties in order to maintain a pool of predecessor cells. My research is into the future stem cell developments within veterinary medicine, and the moral and ethical issues surrounding it.

Stem cells are valuable because they have the potential to form a number of different tissues. An idea that these cells could be used in animals to replicate faulty cells or to be used to treat various conditions, such as generating new nerve cells for spinal cord injuries, help skin conditions in animals and aid diseases and conditions such as diabetes, are all possible ideas in the future of veterinary medicine.

Stem cell technology was originally brought forward by James Thomson, a Professor at the Wisconsin Regional Primate Research Centre at the University of Wisconsin. In the November 6, 1998, issue of the Journal, Science, he reported the development of first line human embryonic stem cells. His report states, "These cell lines should be useful in human developmental biology, drug discovery, and transplantation medicine." The implications of this statement were momentous, but at the same time catastrophic because an exceptionally potent human cell was alive and well, living in James Thomson’s laboratory.

In animals, stem cells are most commonly found in the bone marrow. Embryonic stem cells are, in theory, considered more useful than adult stem cells, as they are pluripotent (they have the ability to change into a vast number of different cells), which opens up doors in science to potentially save thousands of lives.

Scientists are currently looking into the possibility of creating a vast bank of tens of thousands of embryonic cells by extracting stem cells from extensive numbers of human embryos, and could one day provide effective low-cost treatment for diabetes, skin conditions and many other health problems.

This idea can be applied to help animals in the same manner as humans, and also provide the vet with another possibility to save a life,

Stem cells are firstly cultured to become the required type of cell, and then implanted into the body. The main method for creating embryonic stem cells is known as ‘therapeutic cloning’. In this practice, a human egg has its nucleus removed, and an adult human cell is combined with it. This results in a rapidly dividing human embryo. If these embryos were implanted in the womb, they would have the potential to grow into human cloned babies. In theory, scientists should be able to remove the stem cells from the embryo, and use them to culture cells for use within the body. This should stop the body from rejecting the cells.
Discussion

Presently, stem cell research is a relatively new idea that has opened many doors for the scientific community to explore. Within the work surrounding stem cells there is a cloud of controversy, where moral and ethical issues are frequently raised. Today stem cells are being used to treat conditions such as cancer and leukaemia. Leukaemia is a cancer of white blood cells, or leukocytes. Leukocytes are made in the bone marrow that begins with adult stem cells. Mature leukocytes are released into the bloodstream to fight off infections. To cure leukaemia successfully, all abnormal leukocytes would have to be eliminated from the patient, so healthy ones can grow in their place. Chemotherapy, which uses potent drugs to target and kill abnormal cells, can be used but is not always 100% effective and a bone marrow transplant might have to be considered. This is where all cancerous cells are removed from the bone marrow and healthy stem cells are introduced into the patients blood. If the transplant is successful, the stem cells will migrate into the patient's bone marrow and begin producing new, healthy leukocytes to replace the abnormal cells.

In my opinion I think that by using stem cells in veterinary medicine, a very common ailment seen by vets could be treated easily e.g. skin conditions. Many dogs, cats, rabbits and birds are frequently diagnosed with skin conditions such as demodectic mange, dermatitis and pyodermas (bacterial skin infections).

Some dogs develop atopic dermatitis because of an allergic reaction and the sensitivity of their skin. It is caused by immunological hypersensitivity to common substances in the environment such as house dust mites or pollen. The immune system makes antibodies to substances that are foreign to body. Antibodies are of several types, IgE being involved in atopic dermatitis, particularly with the protection against parasites. IgE cover mast cells in the skin and wait until the parasites proteins are detected. The mast cell will then release chemicals which try to destroy the invader. In allergic animals this system is oversensitive and the chemicals from mast cells are released inappropriately to substances such as pollens, moulds and dust mites.

The most frequent cause of atopic dermatitis is from the common dust mite (Dermatophagoides pteronyssinus) which lives in all of our homes. The dust mite is about 0.3 mm in size and it lives by absorbing moisture and oxygen from the environment.

At the present there is no definitive test for atopic dermatitis, but after the veterinary surgeon has eliminated all other causes for the itching, skin testing
can be used as a pointer to any allergies involved. Flea infestation must first be completely ruled out, and rigorous measures must be taken to kill all fleas before atopic dermatitis is diagnosed as it is likely that the dog is also allergic to fleas, lice and mites.

My idea is that in the future we could use stem cells to help cure these animals and offer another alternative for veterinary surgeons to use. Because the animal is suffering from over-sensitive cells in their skin, allergies or immune deficiencies wouldn’t it help if healthy new cells were put in their place? My idea is that less-sensitive, normal stem cells could be used for these animals. At the present, stem cells are used, to make skin grafts, and help treat joints and tendons in animals, especially racehorses. At the present-day, it would be impossible to completely cure an animal of all sensitive skin cells as a whole new skin for the animal would have to be made, and monitored carefully, then put on the animal, much like the recent face transplant that has taken place on a human.

My idea would involve future research into stem cells and a way to overcome this problem. I think that careful research could potentially offer a new way forward in stem cells… to let the stem cells grow over the animals existing skin rather than in a laboratory. This would mean that the whole skin would not have to be grown and cultured in a laboratory then transplanted into the patient. But for this to work, a lot more study into stem cells would have to be made as this is currently impossible. The stem cells would have to firstly be given the instructions to turn into skin cells, and would also have to be grown on the animal, regardless of the external conditions.

To cure skin problems such atopic dermatitis, after all fleas, ticks and mites have been eliminated this future idea could stop recurrence forever, as these less-sensitive stem cells would be re-introduced to the animal and would continue to multiply until no unhealthy, sensitive cells remained on the animal. To cure immunity problems such as demodectic mange, my idea is that healthy stem cells could be placed in the bone marrow, similar to the treatment needed for leukaemia, so that healthy stem cells could become normal white blood cells which would cure the immunity problem that that animal.

In the future, it is possible that research will move away from actual embryonic stem cells, and move towards using adult stem cells. This is because there are a number of problems with embryonic stem cells. Firstly, embryonic stem cells are hard to control, and grow in a reliable way. They have "minds" of their own, and embryonic stem cells are often unstable, producing unexpected results as they divide, or producing even cancerous growths. Human embryonic stem cells usually cause an immune reaction when transplanted into people. This means cells used in treatment may be rapidly destroyed unless they are protected, perhaps by giving medication to suppress the immune system, carrying its own risks.

As with all research and ideas, we must consider the advantages and disadvantages, ethical and moral issues surrounding this idea which I believe is the real weakness of embryonic stem cells. As an over view the stem cell research is already attracted negative attention as a stereotypical view of cloning mills, cloned people and animals is portrayed. Many people think that it is unethical to use embryonic stem cells as it is like playing God, and refusing that embryo a right to life. Others disagree with this and think that with this new technology, thousands of lives could be saved.
There are many ethical disadvantages surrounding the use of embryonic stem cells. When the stem cells are removed from an embryo, the embryo effectively dies, and can no longer become a human or animal life. This has caused a huge commotion world wide, leading to embryonic stem cell research being banned in many countries. Scientists are unlikely to be allowed to continue with research into the use of embryonic stem cells as a viable treatment for the general public and for their household companions, for the simple reason that so many people are pro-life, and do not agree with the treatment.

To find cures for pets, animals would have to be tested on, which throws another controversial issue on top of the original embryonic stem cell use. Animal rights activists protest strongly against the use of animals in medical research, but for many, it is seen as a necessity for medical development. However, the use of animals for research into stem cells can be highly beneficial for the veterinary world, providing new treatments for animals with genetic disorders and cancer.

Another issue surrounding stem cell research is one that is overlooked by many people, because it has already come about from the rapid progression in medicine in the 20th century. This is the effect of prolonged life. With some genetic diseases being cured and human infections treated with antibiotic therapy, there is no longer the “survival of the fittest” philosophy.

There are also many benefits to using stem cells in the medical world. Embryonic stem cells are thought by most scientists and researchers to hold potential cures for spinal cord injuries, multiple sclerosis, diabetes, Parkinson's disease, cancer, Alzheimer's disease, heart disease, skin conditions such as atopic dermatitis and hundreds of rare immune system and genetic disorders. Embryonic stem cells can also be obtained through cord blood, which is the blood from the umbilical cord and is rich in embryonic stem cells; therefore, no life would be wasted or destroyed using this technique. Many unused embryos produced through in-vitro fertilization will be discarded whether or not the stem cells are taken from them, so isn’t it right it use these cells to cure other people and animals than just letting the whole embryo go to waste?

Due to the huge ethical issues, scientists in the future are likely to look into ways round the problem. One that is in practice now and is a benefit, is using this idea of preserving the umbilical chord between mother and baby when the child is born. This is because it is filled with large numbers of pluripotent stem cells, and so if the child needs stem cell treatment in the future, cells can be removed from its chord to use within its body. This is a good form of treatment for two reasons. Firstly, at no point is a potential life destroyed during the process, yet the cells are still highly pluripotent. Secondly, as the tissue is a match for the child, the body will not reject the stem cells. The major drawback in this method is that the chord must be frozen almost immediately after birth, and will only be used for the specific person to whom it belongs. This means it is not likely to become a very widespread method.

Currently the use of stem cell therapy in veterinary medicine does not, in the majority, involve the use of embryonic stem cells. This technology is still in early stages in human medicine and so use in veterinary medicine is limited. The treatment of animals using such methods is most common in the equine field. Tendon injuries, degenerative joint disease and fractures are treated using adult stem cells taken from the animal itself, so no destruction of embryos or such ethical issues are applicable.
In conclusion, I think that using embryonic stem cells in veterinary medicine could potentially save thousands of lives, and open up a door in the scientific community that is groundbreaking. As for any new idea there are many problems and implications attached. Firstly I must consider that stem cell therapy in the future could cost a lot of money, be time consuming, so would be an in-effective option for the owner. But the more prominent problem with this idea is the moral issues that it faces. The use of embryonic stem cells could not only save lives, but also refuse the rights of an embryo even to have a life, and natural selection would be forgotten. There is however a glimmer of hope for the future of stem cells, as a development being worked on by a scientist named Scholer could, in theory eliminate the ethical problems.

Scholer has identified a receptor, the germ cell nuclear factor or GCNF, which could lead to new ways of creating embryonic stem cells. Scholer has undertaken a number of experiments on mice, during which he discovered that as stem cells grow, GCNF acts upon them, restricting their ability to change into different cells. The result is the adult stem cell, having a smaller chance at becoming any other type of cell. He believes that if he can discover how GCNF works, there is a possibility that he will be able to reverse its effects. If he and his research team succeed, he intends to be able to remove cells from a human or animal body and put them back into their embryonic state. It is clear that this would quiet ethical debates, because Scholer would only be producing embryonic stem cells, not the embryos themselves, therefore there would be no potential for human or animal life.
References

Web sources

Article from informit.com by Christopher Thomas Scott.  
http://www.informit.com/articles/article.asp?p=424446&rl=1

Vet on the web, an introduction to skin problems by Tim Mainland MRCVS  
http://www.petz.co.uk/vetontheweb/new/article19.html

Vet-stem, regenerative veterinary medicine, Stem cell information.  
www.vet-stem.com,

Stem cell research foundation  
www.stemcellresearchfoundation.org.

Atopic Dermatitis in the dog, GStephen Shaw, BVetMed, CertSAD, MRCVS  
http://www.priory.com/vet/vetatop1.htm

Genetic science learning centre, the University of Utah, stem cell therapies in the future  
http://gslc.genetics.utah.edu/units/stemcells/scefuture/

Journal

Science 6 November 1998: Vol. 282. no. 5391, pp. 1014 - 1015