Embryo Biopsy for Stem Cells?

The President's Council on Bioethics and others have suggested that embryo biopsy might be used to generate human embryonic stem cells without destroying embryos. Embryo biopsy is a procedure by which a single cell, called a blastomere, is removed from a human embryo, leaving the rest of the embryo intact. Embryo biopsy currently is used for preimplantation genetic diagnosis (PGD).

Two to four days after fertilization, the embryo usually consists of approximately eight cells. For PGD, one or two cells can be removed from this embryo and subjected to genetic tests. Once the results of the genetic tests are known, the embryos determined to contain the desired genetic characteristics – generally those not carrying particular mutations associated with disease – are transferred into a woman's uterus to start a pregnancy. Since it was first made available in the early 1990s, there have been more than 1000 births worldwide following PGD.

A fertilized egg will divide and form two cells; each of those cells will divide and so on. Each cell at this stage of development is called a blastomere. If one cell is destroyed in a two-cell embryo, the remaining cell can produce an entire embryo. Or, if the two cells become separated, each cell can give rise to an individual embryo, resulting in identical twins. In other words, blastomeres are totipotent -- they can give rise to all the cell types of the body.

Although blastomeres are totipotent, the impact of blastomere biopsy on the embryo and the subsequent fetus and child is less well known. There have been no definitive studies of whether the blastomere biopsy procedure hinders implantation of the embryo in the uterus to initiate pregnancy, nor have comprehensive follow up studies of the health of babies born from PGD been conducted. Any potential long-term effects on people born from embryos where a few cells were removed for PGD have not yet been researched.

At five to seven days after fertilization, the embryo's cells undergo physical changes to prepare it for implantation into the uterine wall. After implantation, the cells of the embryo start interacting with their neighbors to begin taking on different cell identities. However, if cells are isolated prior to embryo implantation and grown under laboratory conditions in a Petri dish, they can continue to divide and remain pluripotent – meaning they have the ability to develop into most cell types found in the adult – for long periods of time. These cells are called embryonic stem cells (ESCs).

The human ESCs currently available all were generated by isolating and culturing cells from week-old human embryos. This procedure destroys the embryo.

Embryo biopsy techniques used to isolate one or two blastomeres from an eight-cell embryo for PGD also might provide an alternative method for generating human ESC without harming the embryo. Instead of using the isolated blastomeres for genetic analysis, the blastomeres would be cultured in a Petri dish and allowed to grow and divide to give rise to more cells. Since cells at this developmental stage are pluripotent, this approach could give rise to more pluripotent ESCs. The embryo from which the blastomeres are removed could, in theory, be transferred to a woman's uterus to start a pregnancy, avoiding the destruction of embryos.

The embryo biopsy technique has been used to isolate mouse ESCs. The biopsied mouse embryos were transferred back into a mouse uterus and developed into apparently healthy mice.

While some in Congress have introduced legislation to provide federal funding for research to explore this approach in humans, substantial animal and human research is required to determine whether embryo biopsy causes harm to the embryo or the resulting child. These results will be critical in considering whether this approach could ever be a viable alternative human ESC source.

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