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Reprogramming the Neurosciences

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With the concept of reprogramming somatic cells into pluripotent stem cells (iPSCs) [1,2] and cells belong to other lineages [3-6], some progresses were made this year.

In order to approach the way of the clinical use of induced neural stem cells derived from human somatic cells, we used Sendai viruses (SeV) carrying four Yamanaka factors to generate induced neural progenitors (iNPs) from human fibroblasts [7,8]. SeV is a RNA virus. To date, there is no report of pathogenicity associated with SeV in primates, and its safety could be further enhanced by the F-deficiency [9]. SeV-based vector has been used in clinical gene therapy for cystic fibrosis [10,11] and vaccine delivery [12]. Additionally, the temperature-sensitive nature of the RNA virus [13] offers another safeguard step to ensure the removal of viral genomes. The SeV derived-iNPs were generated and cultured in laminin-coated plates with a chemically defined medium. They exhibit characteristic morphology, gene expression patterns, growth rate, as well as predictable in vitro and in vivo differentiation potentials. Furthermore, the regional information of these iNPs was carefully examined. The stable expandable iNP lines carry a hindbrain identity and can differentiate into hindbrain neurons and, when caudalized, an enriched population of spinal cord motor neurons. Regional specific human iNPs are another effort towards clinical application. The ideal way to generate clinical-grade human iNPs may be using some non-virus, non-integration ways, such as artificial RNAs, in an animal-free and chemically defined environment. And the iNPs should be well characterized, especially the regional identities, because as for neurodegenerative diseases, usually they needed accurate region-targeted treatment. Furthermore, how to maintain the stability of the human iNPs is another important issue for the future industry production and clinical application.

One potential clinical application for the iPSC derived cells is for autologous transplantation. We differentiated Rhesus monkey iPSC into neural stem cells and then transplanted into the same Rhesus monkeys, whose skin fibroblasts were used for generating iPSCs [14]. Data show that these autologous cells could survive and become mature in the nonhuman primate brain. This is the first but important step towards autologous transplantation using iPSC-derived cells. More importantly, as expected, behavioral improvement after transplantation need to be investigated under some diseases situation, such as Parkinson's disease (PD).

Another possible application for reprogrammed cells is the in vitro disease modeling [15], which may help people understand neural degenerative and developmental diseases at the level of human beings. Potentially, based on the phenotypes in the dishes, high-through drug screening could be applied on the human cells, especially on the patients' reprogrammed cell derived neural cells. If the phenotypes observed in vitro could truly reflex what happened in vivo, the screened drugs may probably be effective on human beings. Of course, systematic animal trials and clinical experiments are still needed; however, we could expect that more animals may be saved and the efficiency for drug development also could be improved a lot.

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