Novel Luciferase-Fluorescent Nanodiamond Assay for Cytotoxic Evaluation of Chemotherapy Drugs in Cancer and Mesenchymal Stem Cells

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Previous studies have shown that chemotherapy drugs have detrimental side effects of inhibiting immune pathways that healthy human mesenchymal stem cells (MSCs) regulate. However, current cytotoxic evaluations of chemotherapy focus primarily on cancer cells while neglecting cytotoxicity testing in MSCs due to the unavailability of suitable cytotoxicity assays for MSCs. The absence of such an assay reduces the quality and safety of chemotherapy. Therefore, this study proposes a novel cytotoxicity assay that carries out sensitive testing in both cancer cells and MSCs. The assay is the conjugation of fluorescent nanodiamonds (FNDs) with bioluminescent luciferase (Luc) protein coating. The traditional transfection rate of Luc is only 1% while the conjugation with FNDs improves the Luc uptake rate to about 70%. This study includes property analysis and the validation of Luc-FND as a viable cytotoxicity assay after comparing with conventional assays in the market. Finally, Luc-FND assay is applied in the preclinical testing of chemotherapy drug treatment in both cancer cells and MSCs which show that Luc-FND assay has high sensitivity to discern the IC50 between drug-treated cancer cells and MSCs. This allows the selection of certain drugs with high efficacy in killing cancer while not presenting great damage to MSCs. Moreover, results demonstrate that Luc-FND has over 1000 times more sensitivity in MSCs and 10~100 times more sensitivity in cancer cells when compared to conventional assays in market. In conclusion, my study verifies that my novel Luc-FND assay is a sensitive, accurate, and efficient cytotoxicity assay for both cancer and MSCs.

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