Dopamine: an old target in a new therapy

Sushanta K. Banerjee

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Abstract Dopamine, a molecule of joy and emotions, plays vital role in regulation cancer growth and tumor angiogenesis. Dopamine secretes from neural cells in brain and peripheral cells as well. Peripheral dopamine is associated with tumorigenic events. Recent publication [Sarkar *et al. Int. J. Cancer*: doi:10.1002/ijc.29414, 2014] suggests that dopamine can be an ideal substitute as an anti-vascular endothelial growth factor A (VEGF-A) agent for the treatment tumor angiogenesis as dopamine is less expensive, minimum side-effect and more sensitive than other drugs. The studies also found that dopamine prevent the 5FU-induced neutropenia in tumor-bearing mice. Collectively, these pre-clinical studies claim that dopamine could be a novel therapy for managing cancer growth and chemotherapy related disorder.

Keywords Cancer · Tumor angiogenesis · Dopamine

Dopamine is a safe antiangiogenic drug which can also prevent 5-fluorouracil induced neutropenia (Sarkar *et al.* 2014). Dopamine was discovered 57 years ago (Carlsson *et al.* 1958; Rubi and Maechler 2010). For Dopamine discovery, Dr. A Carlsson received the 2000 Nobel Prize in Physiology and Medicine. Dopamine, which is a neurotransmitter (Carlsson *et al.* 1958), plays a vital role in controlling our brain's functions associated with movement,

emotion, pleasure and pain as well as drug addiction through specific receptors of G protein-coupled receptor family (Leknes and Tracey 2008; Rubi and Maechler 2010; Schultz 2007). The dopamine producing neurons are located as clustered in the mid brain called substantia nigra (Rubi and Maechler 2010). These neurons are absent in the brains of patients with Parkinson's disease (PPD), thus the brains of PPD produces no or little dopamine. In contrast, the schizophrenic patients' brains contain over-active dopamine. Therefore, PPD are treated with dopamine or dopamine agonist while schizophrenic patients are given antagonist of dopamine.

Multiple studies have shown that Dopamine level is increased in plasma and it could be originated from sympathetic nerves. Peripheral dopamine found to regulate multiple physiological and pathophysiological functions (Rubi and Maechler 2010). A biphasic role of dopamine in cell proliferation, survival and cancer growth has been documented. Dopamine promotes normal cell growth and survival while in tumor cells dopamine exhibits anti-proliferative effect in vitro and in vivo (Asada *et al.* 1999; Ishibashi *et al.* 1994; Rubi and Maechler 2010; Schrell *et al.* 1990). Moreover, Chakraborty *et al.* (Chakraborty *et al.* 2004) demonstrated that Dopamine therapy significantly delays the xenotransplanted human gastric cancer tissue in nude mice through the inhibition of angiogenesis. Subsequent studies they found that Dopamine therapy stabilizes blood vessels through the regulation of angiopoietin 1 expression in pericytes and Kruppel-like factor-2 expression in tumor endothelial cells (Chakraborty *et al.* 2011). Recent studies have postulated that Dopamine is not only a safe antiangiogenic drug but it also prevents 5-fluoracil mediated neutropenia (a condition of low level of neutrophils, a type of white blood cells) (Sarkar *et al.* 2014). This exciting study opens a new venue of research on cancer therapy. Now

S. K. Banerjee (✉)
Cancer Research Unit, VA Medical Center, Kansas City, MO, USA
e-mail: Sbanerjee2@kumc.edu

S. K. Banerjee
Division of Hematology and Oncology, Department of Anatomy and Cell Biology and Department of Pathology, University of Kansas Medical Center, Kansas City, KS, USA

the question is that when the pendulum will begin to swing in favor of Dopamine for bench to bed side as an inexpensive cancer therapy or it will stuck in the laboratory notebook.

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