

Relationships between Oxidative Stress, Cancer Development and Therapeutic Interventions

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Editorial

Oxidative stress is defined as an imbalance between the generation and elimination of reactive oxygen species (ROS) [1]. Low or moderate amounts of ROS have beneficial effects on several physiological processes including wound healing, killing of invading pathogens and tissue repair processes [2]. However, excessive production of ROS can lead to damage of deoxyribonucleic acid (DNA), lipids and proteins that in turn may result in oxidative tissue damage and cancer [3].

Recent studies have reported the important roles of oxidative stress in development of cancer [4] at its various steps including initiation, promotion and progression [5]. Initiation results when a normal cell sustains a DNA mutation that, when preceded by one or more rounds of cell division, results in fixation of the mutation, producing an initiated cell [4]. Thus, initiation is irreversible despite the initiated cell may eventually die during the development of the neoplasm. On the other hand, promotion is an epigenetic event which exhibits a change in gene expression without change in DNA thereby it is reversible [6]. Progression like initiation is an irreversible process that requires further mutations from genetic instability [7].

Oxidative damage to cellular DNA can lead to mutations and may, therefore, play an important role in the initiation [7]. Moreover, oxidative stress may also participate in the progression stage of the cancer process by adding further DNA alterations to the initiated cell population [7]. Following additional oxidative stress, multiple cell divisions and acquisitions of further mutations in the preneoplastic focal lesions, the formation of benign and/or malignant neoplasms can occur during the progression stage [4]. ROS-induced DNA damage can result in single- or double-strand breakage, base modifications, DNA cross-linking and deoxyribose modification [8,9]. If the oxidative DNA damage is not repaired prior to DNA replication, DNA mutation, replication errors, and genomic instability can occur [8,9].

The majority of mutations induced by ROS appear to involve modification of guanine, causing G→T transversions [10]. 8-Hydroxydeoxy guanosine (8-OHdG) and 8-oxoguanine (8-oxoG) are considered by many publications as the most common lesions produced by ROS during carcinogenesis; hydroxydeoxy guanosine (8-OHdG) is more common than 8-oxoguanine (8-oxoG) [4,11]. 8-OHdG in its stable syn conformation can pair with both cytosine and adenine [4]. If the A:G mismatch is not repaired, a G:C to T:A transversion will occur, commonly found in mutated oncogenes and tumor suppressor gene which are important regulatory genes for cell proliferation and apoptosis [4,10,12].

As the excessive production of ROS is involved in and associated with the process of carcinogenesis, the use of antioxidants during the cancer development may have protective and preventive potentials against DNA alterations during initiation and further DNA mutation

during progression. Thus, scavenging of reactive oxygen species by antioxidants may be beneficial for prevention of carcinogenesis. Based on this elucidation, many natural antioxidants were tested by previous publications which reported their efficiencies in protection against and prevention of cancer development [13,14]. In another way, a number of natural compounds have also been demonstrated by different publications to provide promising cancer treatment as they selectively kills cancer cells by induction of ROS generation while it is less toxic to normal cells [15-17]. This is due to the fact that cancer cells are sensitive to oxidative stress. Thus, the mechanism of action for many cancer chemotherapeutic drugs involves ROS-mediated apoptosis of cancer cells [4].

In conclusion, [1] the exacerbated production of ROS plays a crucial role in the development of cancer [2] the supplementation of antioxidants may mitigate carcinogenesis by scavenging ROS that cause mutations in oncogenes and tumor suppressor genes and [3] finally the developed cancer cells that are more sensitive to ROS can be combated by chemotherapeutic agents via induction of oxidative stress.

References

1. Reuter S, Gupta SC, Chaturvedi MM, Aggarwal BB (2010) Oxidative stress, inflammation, and cancer: how are they linked? *Free Radic Biol Med* 49: 1603-1616.
2. Bhattacharyya A, Chattopadhyay R, Mitra S, Crowe SE (2014) Oxidative stress: an essential factor in the pathogenesis of gastrointestinal mucosal diseases. *Physiol Rev* 94: 329-354.
3. Waris G, Ahsan H (2006) Reactive oxygen species: role in the development of cancer and various chronic conditions. *Journal of Carcinogenesis* 5: 1-8.
4. Klaunig JE, Kamendulis LM, Hocevar BA (2010) Oxidative Stress and Oxidative Damage in Carcinogenesis. *Toxicologic Pathology* 38: 96-109.
5. Sødring M, Gunnes G, Paulsen JE (2016) Spontaneous initiation, promotion and progression of colorectal cancer in the novel A/J Min/1 mouse. *Int J Cancer* 138: 1936-1946.
6. Klaunig JE, Kamendulis LM (2007) Chemical carcinogenesis. In Casarett & Doull's *Toxicology: The Basic Science of Poisons*, 7th edition 329-380.
7. Klaunig JE, Xu Y, Isenberg JS, Bachowski S, Kolaja KL, et al. (1998) The role of oxidative stress in chemical carcinogenesis. *Environ Health Perspect* 106:289-295.
8. Klaunig JE, Kamendulis LM (2004) The role of oxidative stress in carcinogenesis. *Annu Rev Pharmacol Toxicol* 44: 239-267.
9. Valko M, Rhodes CJ, Moncol J, Izakovic M, Mazur M (2006) Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chem Biol Interact* 160: 1-40.
10. Lunec J, Holloway KA, Cooke MS, Faux S, Griffiths HR, et al. (2002) Urinary 8-oxo-2'-deoxyguanosine: redox regulation of DNA repair in vivo? *Free Rad Biol Med* 33: 875-885.
11. Yoshihara M, Jiang L, Akatsuka S, Suyama M, Toyokuni S (2014) Genome-wide profiling of 8-oxoguanine reveals its association with spatial positioning in nucleus. *DNA Research* 21: 603-612.

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12. Grollman AP, Moriya M (1993) Mutagenesis by 8-oxoguanine: an enemy within. *Trends Genet* 9: 246-249.
 13. Kim MJ, Kim KH (2015) Anticancer Effect of Lycopene in Gastric Carcinogenesis. *J Cancer Prev* 20: 92-96.
 14. Liu Y, Wu YM, Zhang PY (2015) Protective effects of curcumin and quercetin during benzo(a)pyrene induced lung carcinogenesis in mice. *Eur Rev Med Pharmacol Sci* 19: 1736-1743.
 15. Kang YH, Lee E, Choi MK, Ku JL, Kim SH, et al. (2004) Role of reactive oxygen species in the induction of apoptosis by alpha-tocopheryl succinate. *Int J Cancer* 112: 385-392.
 16. Pardhasaradhi BV, Ali AM, Kumari AL, Reddanna P, Khar A (2003) Phycocyanin-mediated apoptosis in AK-5 tumor cells involves down-regulation of Bcl-2 and generation of ROS. *Mol Cancer Ther* 2: 1165-1170.
 17. Trachootham D, Zhou Y, Zhang H, Demizu Y, Chen Z, et al. (2006) Selective killing of oncogenically transformed cells through a ROS-mediated mechanism by beta-phenylethyl isothiocyanate. *Cancer Cell* 10: 241-252.