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Free radical, oxidative stress and diabetes mellitus: A mini review

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ABSTRACT

According to both experimental and clinical studies it is proposed that oxidative stress play a vital role in the development of type 1and type 2 Diabetes. Human body is affected with diabetic mellitus through destruction of beta cell that may be the outcome of oxidative stress. Oxidative stress a familiar term that may be coined as the imbalance between level of free radical and antioxidant. As free radicals are highly reactive, the pathologic phenomenon of reactive oxygen species (ROS) and reactive nitrogen species (RNS) is to interrupt the function of lipid, protein and DNA. Increased level of oxidative stress in our body tissue and blood is considered to play a critical role in diabetes mellitus. The goal of this review is to concise the how the free radicals propagate in our body and gradually causes diabetes mellitus.

Keywords: Oxidative stress, free radicals, hyperglycemia, reactive oxygen and nitrogen species.

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FREE RADICALS

Free radicals are molecules that contain an unpaired electron. Free radicals are highly reactive because they contain free electron.[1] Generally it is believed that approximately 10000-20000 free radicals invading most of the cell everyday out of them some are beneficial for health that helps our body to fight against acute and chronic inflammation, destroy bacteria and helps to control smooth muscle contraction and relaxation. On the contrary, free radicals are responsible for induction of several types of diseases such as Parkinson disease, cancer, heart diseases, arthritis, alzheimer diseases and diabetes mellitus when it is produced in excess amount.[2]

Route of free radical generation

The production of free radicals in human body is ongoing process and inevitable. The main reasons behind this include: genetic factor (such as aging, metabolism and stress),dietary factors (such as broiled fried,, grilled, additives, alcohol and coffee etc), immune system (continuously produced oxy-radicals and reactive oxygen species) , drug (for example Nitrofurantoin, Chlorpromazine Bleomycin, Mitomycin C) and toxins (Toluene, Parquet, Aniline dyes).[3]

Free radical features and oxidants

Non radical molecules are most stable than radical molecules but reactivity of radicals molecules are more than non radicals. Example of free radicals include superoxide ($O_2^{\bullet -}$), nitric oxide (NO•),hydroxyl (OH•),nitrogen dioxide($NO_2^{\bullet}$). In addition there some molecules such as singlet oxygen, ozone(O3), hydrogen peroxide (H_2O_2), nitrous acid (HNO_2), peroxynitrite , dinitrogen trioxide and lipid peroxide which not free radicals but can be easily converted to free radicals through reaction.[4]

Effect of free radical in homeostasis

Free radicals play a significant role in detoxification, apoptosis, and phagocytosis.It helps to maintain cellular homeostasis in human body by taking part in several signaling pathways. It is considered that free radicals are involved in different metabolic and cellular process such as gene expression, transcription, signal transduction, wound healing and oxygen sensing. Free radicals may also engaged in the production of prostaglandins, hydroxylation of several amino acids such as proline and lysine etc.[5,6]

Free radical concerns

Free radicals target the vital cellular components such as lipids, proteins and DNA. Lipid peroxidation is the common phenomenon of free radical reaction which may interfere with fluidity and permeability of the membrane as a result some toxic metabolites are generated. These toxic metabolites are coined as 2nd messenger which may show their harmful effect away from site of generation.[7] Protein, an important cellular components directly affected by free radical and introduce oxidation reaction therefore alter the

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protein structure and their enzymatic activity. Protein peroxidases, an unstable oxidized product interact with transition metal ions slowly deposit in the body and causes neurodegenerative diseases like Alzheimer disease.[8] Again free radical attack the C4-C5 double bond of both pyrimidine and purines. As a result poly (ADP-ribose) synthetase enzyme is activated that ultimately causes DNA fragmentation and break NAD+ to help the repair of DNA. Finally when the impairment is widespread NAD+ levels may reduce to a great extent and the cell death occur.[8]

DIABETES

Diabetes may be defined as a metabolic syndrome that is marked by elevated level of blood sugar level and inadequate production of insulin by the pancreas inside the body.[9] There are two types of diabetes named type 1 and type2 .Type1 diabetes are most commonly occur in juvenile age that may result from destruction of pancreatic beta cell.[10] Type two diabetes occur in the adult age and obese individuals are more susceptible to this.[11]

Oxidative stress and diabetes

To lead a healthy life the balance between free radical radicals and antioxidant is must. But when there is a imbalance between these two, a phenomenon so called oxidative stress occur.[12] There has been a numerous study which suggests that oxidative stresses are existed in the diabetic patients.[13-15] Generally it is suspected that oxidative stress help in the development of type 2 diabetes.[16] Type 2 diabetes also known as non-insulin dependent diabetes is occurred when insulin secretion is impaired by pancreatic beta cell where insulin becomes resistant.[17] Free radicals are generated in diabetes patient due to the non-enzymatic glycation of proteins, increased lipid peroxidation that may proceed towards the increased risk of insulin resistance and it is the phenomenon of oxidative stress.[18] There remains a doubt about the exact source of oxidative stress. Further reactive oxygen species trigger pathogenesis of inflammatory response and ischemic reperfusion that promote diabetes. Latest research showed that both lipid and apolipoprotein components of LDL generate insoluble aggregate because of hydroxyl induced cross-linkage in apo-B monomer. Hyperglycemia, an important concern that may enhance the production of free radicals via several mechanism. Diabetes patients are more occupied with acute and chronic oxidative stress that increases the possibility of diabetes related macrovascular complications.[19] In diabetes mellitus mitochondria is main source of oxidative stress. Oxidative metabolisms occur in mitochondria where a molecule of oxygen is reduced to water and the other oxygen molecule is converted to oxygen free radicals that finally generate reactive species such as H 2 O 2 , ONOO-,OH.[20] Reactive oxygen species (ROS) and reactive nitrogen species (RNS) regulate insulin signaling through two ways, the first one is that ROS/RNS showed its effect when it is stimulated by insulin and the second one is that ROS and RNS showed negative control on insulin signaling ,illustrating them to reveal insulin resistance which may susceptible to type 2 diabetes.[21] Conclusion: The link between oxidative stress and diabetes mellitus is unambiguous. In this review it is undoubtedly clear that diabetes mellitus is the pathologic phenomenon of oxidative stress.

Finally, we conclude that free radical generation is not the initial cause of diabetes mellitus but it plays a critical role in pathogenesis of diabetes. More investigation will require elucidating its exact mechanism of action.

REFERENCES

1. Riley PA. Free radicals in biology: oxidative stress and the effects of ionizing radiation. International journal of radiation biology. 1994 Jan 1;65(1):27-33.
2. Pala FS, Gürkan H. The role of free radicals in ethio pathogenesis of diseases. Adv Mol Biol.2008 Apr 1;1:1-9
3. Mohammed MT, Kadhim SM, Jassimand AM, Abbas SI. Free radicals and human health. Int JInnov Sci Res. 2015;4(6):218-3.
4. Genestra M. Oxyl radicals, redox-sensitive signalling cascades and antioxidants. Cellular signaling. 2007 Sep 1;19(9):1807-19.
5. Noori S. An overview of oxidative stress and antioxidant defensive system. Open access scientific reports. 2012;1(8):1-9.
6. Alfadda AA, Sallam RM. Reactive oxygen species in health and disease. BioMed Research International. 2012 Aug 8;2012.
7. Sarma AD, Mallick AR, Ghosh AK. Free radicals and their role in different clinical conditions: an overview. International Journal of Pharma Sciences and Research. 2010;1(3):185-92.
8. Devasagayam TP, Tilak JC, Boloor KK, Sane KS, Ghaskadbi SS, Lele RD. Free radicals and antioxidants in human health: current status and future prospects. Japi. 2004 Oct;52(794804):4.
9. Maritim AC, Sanders A, Watkins Iii JB. Diabetes, oxidative stress, and antioxidants: a review.Journal of biochemical and molecular toxicology. 2003;17(1):24-38.
10. Vlassara H. Pathogenic effects of advanced glycosylation: biochemical, biologic, and clinical implications for diabetes and aging. Lab. Invest.. 1994;70:138-51.
11. Lebovitz HE. Type 2 diabetes: an overview. Clinical chemistry. 1999 Aug 1;45(8):1339-45.
12. Sies H. Oxidative stress: from basic research to clinical application. The American journal of medicine. 1991 Sep 30;91(3):S31-8.
13. Keaney Jr JF, Loscalzo J. Diabetes, oxidative stress, and platelet activation.
14. Haffner SM. Clinical relevance of the oxidative stress concept. Metabolism. 2000 Feb 1;49(2):30-4.

15. Bonnefont-Rousselot D, Bastard JP, Jaudon MC, Delattre J. Consequences of the diabetic status on the oxidant/antioxidant balance. Diabetes and metabolism. 2000 May 1;26(3):163-77.
16. Pham-Huy LA, He H, Pham-Huy C. Free radicals, antioxidants in disease and health. International journal of biomedical science: IJBS. 2008 Jun;4(2):89.
17. DeFronzo RA. The triumvirate: β-cell, muscle, liver: a collusion responsible for NIDDM. Diabetes. 1988 Jun 1;37(6):667-87.
18. Maritim AC, Sanders A, Watkins Iii JB. Diabetes, oxidative stress, and antioxidants: a review. Journal of biochemical and molecular toxicology. 2003;17(1):24-38.
19. Oberley LW. Free radicals and diabetes. Free radical biology and medicine. 1988 Jan 1;5(2):113-24.
20. Moussa SA. Oxidative stress in diabetes mellitus. Romanian J biophys. 2008 Jun;18(3):225-36.
21. Erejuwa OO. Oxidative stress in diabetes mellitus: is there a role for hypoglycemic drugs and/or antioxidants?. In Oxidative stress and diseases 2012. InTech.