BEST: International Journal of Humanities, Arts, Medicine and Sciences (BEST: IJHAMS)
ISSN(P):2348-0521; ISSN(E):2454-4728
Vol. 3, Issue 9, Sep 2015, 63-72

OXIDATIVE STRESS DURING CARDIAC CATHETERIZATION

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ABSTRACT

Background

Cardiac catheterization (coronary angiogram) is an invasive imaging procedure to check heart function and to determine the need for treatment (like an interventional procedure or coronary artery bypass).Contrast material which contains usually iodine dye is injected through the catheter and fluoroscopy is performed as the contrast material moves through the heart's chambers, valves and major vessels. It was found that high amounts of free radicals (which pose a threats to our health & to DNA strands) are released from interaction of ionizing radiation and tissues and results in catastrophic numbers of different cancers. Iodine which is used in the contrast media also regarded as oxidizing agent.

Aim of the Study

To investigate whether the procedure of cardiac catheterization causes oxidative stress to the body or not through its effect on the level of GSH in the erythrocytes& on the activity of granulocytes by mean of chemiluminescence.

Methods

This study was carried out at the cardiac catheterization unit at Al- Sadar teaching hospital Basrah& involved 49 patients(who were known & controlled cases of hypertension & diabetes mellitus). They were selected randomly & were undergoing cardiac catheterization, their ages ranged from 35 -66 years with mean of (52.04±7.95). 34were males and 15 were females.

The patients were divided into 3 groups, the first group consisted of 26patients,the second group consisted of 13 patients &the third group consisted of 10 patients. .For all patients we measured the level of erythrocytes reduced glutathione (the natural antioxidant system)&W.B.Cs activity through chemiluminesencephenomena before catheterization. Then immediately after catheterization for the first group, after 2hrs for the 2nd group & after 4 hrs for the third group

Results

In the first group, the level of GSH significantly decreased from 74.18±39.23mg% before catheterization to 59.45±22.53mg% immediately after catheterization (P<0.01) & the peak of CL significantly increased from 10.93±4.83cm to 12.22±4.84cm (p=0.001) with significant decrease in the total WBCs count from 7.53±1.85x10 3 cells/µ to 6.43±1.22x103 cells/µ(<0.05).

In the 2nd group , the level of GSH significantly decreased from 66.09±20.99 mg% before catheterization to

55.55±25.91mg% after 2hrs after catheterization(<0.05) & the peak of CL insignificantly increased from 11.16±3.51 cm to 12.08±2.65cm (p>0.05) with insignificant decrease in the number of W.B.Cs from 8.74±2.62 x10 3 cells/µ to 7.31±2.69 x10 3cells/µ(>0.05) In the 3rd group , , the level of GSH significantly decreased from 111.89±33.86mg% before catheterization to 99.81±27.9mg% after 4hrs after catheterization(p<0.005)& the peak of CL significantly increased from 7.5±1.63cm to 9±1.97cm (p<0.05) with significant decrease in the number of WB.Cs from 10 .42±1.43x10 3cells/µ to 8.6±2.02x103cells/µ(p=0.05) .

Conclusions

Cardiac catheterization can cause significant oxidative stress to the patient tissues as a results of ionizing radiation and iodinated contrast media used during the procedure, this need further study to assess its short & long term clinical effects on the patients health.

KEYWORDS: Cardiac Catheterization, Oxidative Stress

INTRODUCTION

Cardiac catheterization (coronary angiogram) is an invasive imaging procedure, in whicha catheter is inserted through a plastic introducer sheath (which is a short, hollow tube inserted into a blood vessel in the arm or leg). Then the catheter is guided through the blood vessel to the coronary arteries with the aid of a special x-ray machine. Contrast material which contains usually iodine dye is injected through the catheter and fluoroscopy is performed when the contrast material flows through the heart's chambers, valves and major blood vessels. This procedure can be used to check the heart functions like:

- Blood flow in the coronary arteries and to confirm the presence of any disease in these arteries, in valves or in aorta including congenital abnormality.
- Heart muscle function
- Blood flow and pressure in chambers.
- And to determine the need for treatment like medicines or further interventional procedure or coronary artery bypass)

The patients may exposed to different risks during cardiac catheterization either as a result of the procedure, exposure to x-ray irradiation or contrast media (1), which include:

- Allergy to iodine or to other medicines used,sothe patient should be asked for history of asthma or anaphylaxis.
- Arrhythmias
- Infection
- Bleeding
- Signs of ischemic heart diseases
- Mild to moderate skin reactions because of allergy orX-ray exposure
- Renal failure

It was also found that high amounts of free radicals which are very threats to our health & to DNA strands are released from interaction of ionizing radiation and tissue, whichresults in catastrophic numbers of different cancers.(2). Iodine which is used in the contrast media also regarded as oxidizing agent (3).

But we can antagonize oxidant processes by certain nutritional supplements like polyphenols, antioxidant, soy components,(4)herb, spice & other plant extracts like curcuim.(5)

N-acetyl cysteine (NAC) is a sulfur-containing compound,so it can supports the natural antioxidant glutathione making it as a radio protective agent.(6)

So it can protect the liver from damage, reducing oxidantDNAdamage and hence protection of bone marrow cells from radiation in the mice (7-9) This protection is significantly increased if a multi-supplement mixture from vitamins C and E with NAC is used.(10)

S-adenosylmethionine (SAMe) is a powerful methyl group donor, so it is also essential for keeping up cellular levels of the natural antioxidant glutathione (.11) It is also important for proper function of enzymes vital to DNA repair.(12)

The "ACE" vitamins also has antioxidant protection effect as a result of their molecular structures. So their supplementation can protect airline pilots from radiation-induced chromosomal damage and lipid oxidation,(13) Animal studies also showed that vitamin A could reverse radiation-induced gene expression abnormalities which may causes cancer.(14)

Aim of the Study

The aim of this work is to investigate whether the process of cardiac catheterization causes oxidative stress to the body or not through its effect on the level of GSH in the erythrocytes& on the activity of granulocytes by mean of chemiluminescence.

Patient& Methods

This study was carried out at the cardiac catheterization unit in Al- Sadar teaching hospital in Basrah (southern of Iraq) during period January –july2014 & involved 49 patients (who were known to have coronary artery disease &refered for coronary angiography). They were selected randomly & were undergoing cardiac catheterization, their ages ranged from 35 -66 years with mean of (52.04±7.95). 34were males and 15 were females.

During cardiac catheterization contrast media was injected and the amount used differin different patients according to the time of the procedure and the amount used was ranged between (20-600ml) with an average of (87.03±138.03ml). Fluoroscopy also used during the procedure to visualize any blockage in the blood vessels and the flouro-time for each individual was measured, which represent the time of exposure to the X-ray, which ranged between (0.45-16.11) minutes with an average of (3.2±3.38 min).

The patients were divided into 3 groups, the first group consisted of 26patients, the second group consisted of 13 patients &the third group consisted of 10 patients. .For all patients we measured the level of erythrocytes reduced glutathione (GSH) the natural antioxidant system & W.B.Cs activity through chemiluminesencephenomena (CL) before catheterization. Then immediately after catheterization for the first group, after 2hrs for the 2nd group & after 4 hrs for the third group. These parameters were measured in physiology department / college of medicine /university of Basrah.

The level of reduced glutathione was determined by the method described by(Beutler&Baluda,1963)(15)by using(Optma,SR 300 spectrophotometer model

Packed cell volume was determined by the method described by Daice 1995(16) ,using (CHIO Hematocrit centrifuge.

The GSH concentration can be obtained by using the following equation:

GSH mg/dl of erythrocytes= (GSH concentration from the standard curve / hematocrit χ100)

The GSH standard curve can be obtained from preparation of different concentration of GSH standard, as in figure (1)

And the chemiluminescence phenomena which is related to respiratory burst as a result of granulocytes activity that is described by Allen et al(17). and confirmed by many groups like (Cleas) (18) was measured by multipurpose photon counting system which is designed & built up in the department of physiology/College of medicine /University of Basrah(19)Iraq(Al-Thaher)

The number of W.B.Cs were also measured for all patients before and after cardiac catheterization.(16)The results were analyzed using SPSS version 19 software and independent t test were used to compare the differences in the values of the measured parameters obtained before & after cardiac catheterization & were reported as mean ± S.D. The P value < 0.05 was regarded as statistically significant

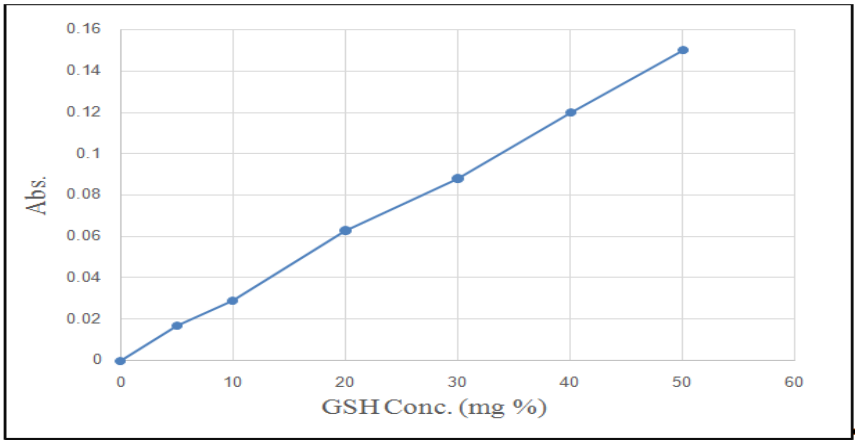

Figure1: GSH Standard Curve

RESULTS

In the first group in whom the amount of iodinated contrast media used was 42.5ml±17.53ml& the fluoro time was 2.45±1.84min, the level of GSH significantly decreasedfrom 74.18±39.23mg% before catheterization to 59.45±22.53mg%immediatelyafter catheterization(P<0.01)& the peak of CL significantly increased from 10.93±4.83cm to 12.22±4.84cm(p=0.001) as shown in figure(2), with significant decrease in the total WBCs count from 7.53±1.85x10 3 cells/µ to6.43±1.22x103cells/µ(<0.05) as shown in table (1).

In the 2nd group ,in whom the amount of iodinated contrast media used was 48.93±21.59ml& the fluoro time was 2.76± 1.58min.,the level of GSH significantly decreased from 66.09±20.99 mg% before catheterization to 55.55±25.91mg% after 2hrs after catheterization(<0.05) & the peak of CL insignificantly increased from 11.16±3.51 cm

to 12.08±2.65cm (p>0.05) as shown in figure (3)with insignificant decrease in the number of W.B.Cs from 8.74±2.62 x10 3 cells/µto 7.31±2.69x10 3cells/µ(>0.05) as shown in table (2).

In the 3rdgroup,the amount of contrast media used was 176± 227.8ml & the fluoro time was5.03± 5.93min, the level of GSH significantly decreased from 111.89±33.86mg% before catheterization to 99.81±27.9mg% after 4hrs after catheterization(p<0.005)& the peak of CL significantly increased from 7.5±1.63cm to 9±1.97cm(p<=0.01) as shown in figure (4) with significant decrease in the number of WB.Cs from 10 .42±1.43x10 3cells/µ to 8.6±2.02x103cells/µ(p=0.05) as shown in table (3).

Table 1: The Level of GSH, CL Peak and W.B.Cs Counts before and Immediately after Cardiac Catheterization

Gsh1 M±S.D	Gsh2m±s.d	Mean Difference M ±s.d	T Value	Sig.
74.18±39.23	59.45±22.53	14.73±24.96	3.009	0.006
Ch.peak1 M±S.D	Ch.peak2M±S.D	Mean difference M±S.D	T value	Sig.
10.93±4.83	12.22±4.84	1.29±1.76	-3.74	0.001
W.B.C.1 M±S.D	W.B.C.2M±S.D	Mean difference M±S.D	T value	Sig.
7.53±1.85	6.43±1.22	1.100±1.002	2.69	0.043

Table 2: The Level of GSH, CL Peak and W.B.Cs Counts before and 2hrs after Cardiac Catheterization

GSH1 M±S.D	GSH2M±S.D	Mean Difference M ±S.D	T Value	Sig.
66.09±20.99	55.55±25.91	10.59±16.75	2.27	0.043
Ch.peak1 M±S.D	Ch.peak2M±S.D	Mean difference M±S.D	T value	Sig.
11.16±3.51	12.08±2.65	0.92±2.07	-1.61	0.134
W.B.C.1 M±S.D	W.B.C.2M±S.D	Mean difference M±S.D	T value	Sig.
8.74±2.62	7.31±2.69	1.43±3.31	1.43	0.183

Table 3: The Level of GSH, CL Peak and W.B.Cs Counts before and 4hrs after Cardiac Catheterization

GSH1 M±S.D	GSH2M±S.D	Mean Difference M ±s.d	T Value	Sig.
111.89±33.86	99.81±27.90	12.08±9.73	3.93	0.003
Ch.peak1 M±S.D	Ch.peak2M±S.D	Mean difference M±S.D	T value	Sig.
7.50±1.63	9±1.97	1.5±1.59	-2.96	0.016
W.B.C.1 M±S.D	W.B.C.2M±S.D	Mean difference M±S.D	T value	Sig.
10.42±1.43	8.6±2.02	1.8 ±2.52	2.26	0.05

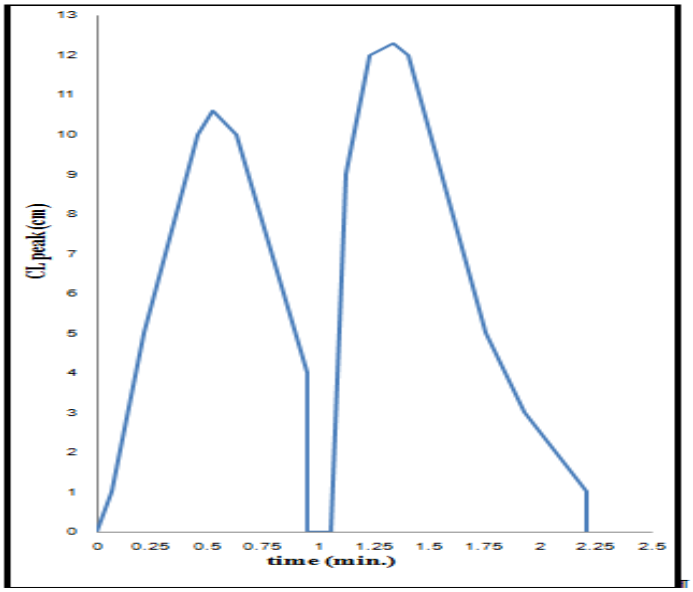

Figure 2: Effect of Cardiac Catheterization on the CL Response of the Blood (Response Immediately after Cardiac Catheterization)

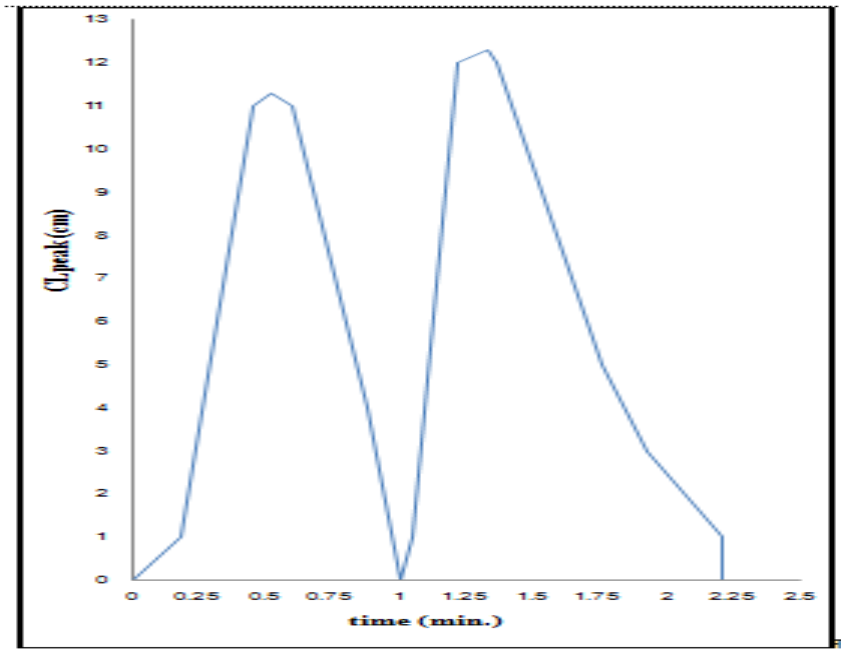

Figure 3: Effect of Cardiac Catheterization on the CL Response of the Blood (Response two Hours after Cardiac Catheterization)

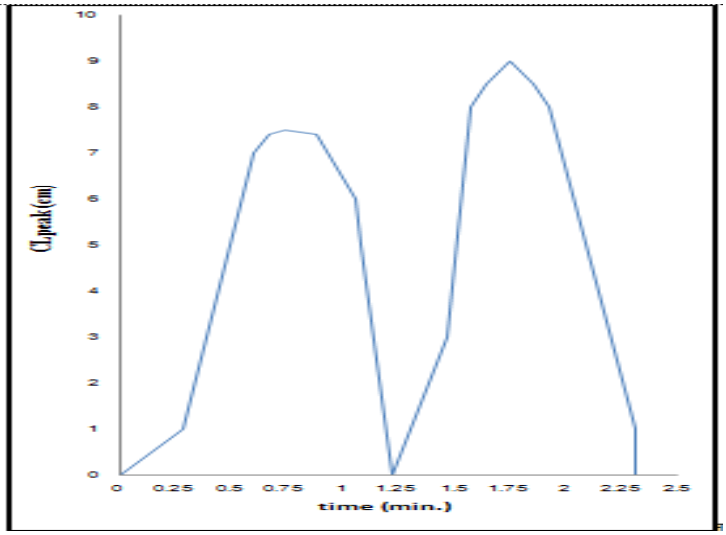

Figure 4: Effect of Cardiac Catheterization on the CL Response of the Blood (Response Four Hours after Cardiac Catheterization)

DISCUSSIONS

The results showed significant decrease in the level of GSH immediately after cardiac catheterization ,2hrs & 4 hrs after cardiac catheterization .The CL peak was increased after cardiac catheterization which was significant immediately and 4 hours after cardiac catheterization, , but not significantly increased after 2hrs from cardiac catheterization in spite of decrease in the number of W.B.Cs after cardiac catheterization which may be as a result of X-ray used& it is in agreement with the study of sultan et al(20) .This indicate that cardiac catheterization causes oxidative stress which may occur as a result of Iodine in the contrast media used(3) or as a result of radiation used during angiogram(21). The results also shows that the oxidative stress can continue even 4hrs after cardiac catheterization ,especially if the dose of contrast media was high as shown in this work that oxidative stress after 4hrs was higher than after 2hrs .Oxidative stress may become clinically important when combined with suitable comorbidity like G6PD deficiency, renal problems , diabetes mellitus, smoking or hyperlipidemia, patients can be protected by using antioxidant supplement before cardiac catheterization to avoid complications, like NAC.(22&23), NAC also has vasodilator effects (24) ,so exert its nephroprotective role by Increasing medullary blood flow(25)

ACEvitamin supplementation also reduces tissue oxidation and raise the level of natural antioxidant(26)Trace minerals especially zinc and manganese act as cofactor for the function of our endogenous antioxidant systems such as super oxide dismutase ,catalase and glutathione peroxidase, it was also found that zinc supplements protected rats from oxidant damage to their red blood cells induced by radioactive iodine(27). These two minerals also provide powerful mitochondria- specific radioprotection in animal study (28)

CONCLUSIONS

Cardiac catheterization can cause oxidative stress as a result of iodinated contrast media & x-ray used. Further studies need to assesss the clinical side effects of these phenomenon &wether certain supplement can be used to decrease these adverse effect like NAC or ACE vitamins or trace minerals especially zinc& manganese.

ACKNOWLEDGMENTS

We would like to express our deep thanks to the MakyaTaharHumood (a nurse in the cardiac catheterization unit In Al-Sader Teaching Hospital Basrah - Iraq) for her help in the collection of blood samples from the patients.

REFERENCES

1. Morton JK. Cardiac catheterization. The cardiac catheterization,Handbook.Saunders Elsevier,5th edition,2011:1-5
2. Fang YZ, Yang S and Wu G. Free radicals, antioxidants, and nutrition. Nutrition. 2002 Oct;18(10):872-9
3. Lindinger MI, Franklin TW, Lands LC, Pedersen PK, Welsh DG and Heigenhauser GJF, "NaHCO3 and KHCO3 ingestion rapidly increases renal electrolyte excretion in humans," Journal of Applied Physiology, 2000 ; 88, (2): 540550
4. Bickenbach KA, Veerapong J, Shao MY,Mauceri HJ, Posner MC, Kron SJ and Weichselbaum RR. Resveratrol is an effective inducer of CArG-driven TNF-alpha gene therapy. Cancer Gene Ther. 2008 Mar; 15(3):133-9.
5. Srinivasan M, Rajendra Prasad N and Menon VP. Protective effect of curcumin on gamma-radiation induced DNA damage and lipid peroxidation in cultured human lymphocytes. Mutat Res. 2006 Dec 10;611(1-2):96-103.
6. Selig C, Nothdurft W and Fliedner TM. Radioprotective effect of N-acetylcysteine on granulocyte/macrophage colony-forming cells of human bone marrow. J Cancer Res ClinOncol. 1993;119(6):346-9.
7. Liu Y, Zhang H, Zhang L, Zhou Q, Wang X, Long J, Dong T and Zhao W. Antioxidant N-acetylcysteine attenuates the acute liver injury caused by X-ray in mice.Eur J Pharmacol. 2007 Dec 1;575(1-3):142-8.
8. Kilciksiz S,Demirel C,Erdal N,Gürgül S,Tamer L,Ayaz Land Ors Y. The effect of N-acetylcysteine on biomarkers for radiation-induced oxidative damage in a rat model. Acta Med Okayama. 2008 Dec;62(6):403-9.
9. Baier JE, Neumann HA, Moeller T, Kissler M, Borchardt D and Ricken D. Radiation protection through cytokine release by N-acetylcysteine. StrahlentherOnkol. 1996 Feb;172(2):91-8.
10. Wambi C1, Sanzari J, Wan XS, Nuth M, Davis J, Ko YH, Sayers CM, Baran M, Ware JH and Kennedy AR.Dietary antioxidants protect hematopoietic cells and improve animal survival after total-body irradiation. Radiat Res. 2008Apr;169(4):384-96.
11. Fontecave M, Atta M andMulliez E. S-adenosylmethionine: nothing goes to waste. Trends Biochem Sci. 2004 May;29(5):243-9..
12. Batra V, Sridhar S and Devasagayam TP. Enhanced one-carbon flux towards DNA methylation: Effect of dietary methyl supplements against gamma-radiation-induced epigenetic modifications. ChemBiol Interact. 2010 Feb 12;183(3):425-33.
13. Yong LC, Petersen MR, Sigurdson AJ, Sampson LA and Ward EM. High dietary antioxidant intakes are associated with decreased chromosome translocation frequency in airline pilots. Am J ClinNutr. 2009 Nov;90(5):1402-10.
14. Zhang R, Burns FJ, Chen H, Chen S and Wu F. Alterations in gene expression in rat skin exposed to 56Fe ions and dietary vitamin A acetate. Radiat Res. 2006 May;165(5):570-81.

15. Buetler E ,and Baluda MC. Blood 1963;22:323-333.
16. Dacie JV and Lewis SM. Practical Haematology.8thed.churchil living stone.Hong Kong,1995;57-60..
17. AllenRC,Stjernholm R L and Steele RH. Biochem.Biophys.Res.Commun.1972;47:679.
18. Cleas Dand Tommy S.J. Biolumin. Chemilumin1991;.6:81-86.
19. Al- Thaher GH..A study of the activity of human granulocytes by mean of chemiluminescence.M.Scthesis.University of Basrah ,1994.
20. Sultan AM. Hematological findings in male X-ray technicians. Saudi Medical Journal 2004; (7): 852-856
21. Deger Y1, Dede S, Belge A, Mert N, Kahraman T and Alkan M . Effects of X-ray radiation on lipid peroxidation and antioxidant systems in rabbits treated with antioxidant compounds.Biol Trace Elem Res. 2003 Aug;94(2):149-56.
22. Skrzydlewska E. and Farbiszewski R. “Protective effect of N-acetylcysteine on reduced glutathione, reduced glutathione-related enzymes and lipid peroxidation in methanol intoxication,” Drug and Alcohol Dependence 1999; 57(1): 61–67,.
23. Nitescu N, Ricksten S-E, Marcussen N, Haraldsson B, Nilsson U, Basu S and Guron G . 'N-acetylcysteine attenuates kidney injury in rats subjected to renal ischaemia-reperfusion' *Nephrology, Dialysis, Transplantation*2006; 21(5): 1240-1247
24. Girouard H, Chulak C, Wu L, Lejossec M, and De Champlain J. “N-acetylcysteine improves nitric oxide and α-adrenergic pathways in mesenteric beds of spontaneously hypertensive rats,” American Journal of Hypertension 2003; 16(7): 577–584.
25. Efrati S, Berman S, Ilgiyeav I, Siman-Tov Y, Averbukh Z and Weissgarten J. “Differential effects of N-acetylcysteine, theophylline or bicarbonate on contrast-induced rat renal vasoconstriction,” American Journal of Nephrology 2009; 29(3): 181–191.
26. Kayan M,Naziroglu M, Celik O, Yalman K and Koylu H. Vitamin C and E combination modulates oxidative stress induced by X-ray in blood of smoker and nonsmoker radiology technicians. Cell BiochemFunct. 2009 Oct;27(7):424-9.
27. Dani V and Dhawan DK. Radioprotective role of zinc following single dose radioiodine (131I) exposure to red blood cells of rats. Indian J Med Res. 2005 Oct;122(4):338-42.
28. Epperly MW, Gretton JE, Sikora CA, Jefferson M, Bernarding M, Nie S and Greenberger JS: Mitochondrial localization of superoxide dismutase is required for decreasing radiation-induced cellular damage. Radiat Res; 2003 Nov;160(5):568-78