

**OXIDATIVE ASSAULT DURING MAGNETIC
RESONANCE IMAGING EXAMINATION****Saad S Hammadi***, **Salman K Ajlan[@]**, **Asal B. Shindi[#]** & **Abdul-Sattar J Yousof[%]**

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Abstract

This study aimed to evaluate the degree of oxidative stress associated with magnetic resonance imaging (MRI) examination.

Serum malondialdehyde (MDA) levels were estimated in 70 patients, 44 males and 26 females, 16-70 years of age underwent MRI examination for various reasons.

There was an overall increase in serum MDA level following MRI examination with overall mean difference between pre- and post- MRI examination MDA level of 0.066 ± 0.110 Mmole / l ($P < 0.001$).

Variables causes significant elevation of serum MDA level included, age older than 25 years (P -values for 25-44 years, 45-64 years and ≥ 65 were < 0.001 , < 0.05 and 0.001 respectively), MRI examination of durations shorter than 20 minutes ($P < 0.05$) and MRI examinations of the brain ($P < 0.01$) and the abdomen ($P < 0.05$). On the other hand, parameters of no significant effect on MDA levels included younger ages, MRI examinations of durations longer than 20 minutes, systemic diseases and MRI examination of the spine ($P > 0.05$).

It is concluded that MRI examination is associated with significant free radical activity reflected by marked elevation of serum MDA levels. This implies that MRI examination may impose an oxidative assault which in turn, may be of clinical significance in elderly patients in particular.

Introduction

Magnetic resonance imaging (MRI) is non-invasive method of mapping the internal structures of the body which completely avoid the use of ionizing radiation and appears to be without hazard. It employs radio frequency (rf) radiation in the presence of carefully controlled magnetic fields in order to produce high quality cross-sectional images of the body in any plane. It portrays the distribution of hydrogen nuclei and parameters relating to their motion in water and lipid¹.

MRI has now rapidly progressed from being a technique with great potential to one which has become the primary and often the only diagnostic method of many clinical problems¹.

The safety of MRI is an important consideration, and yet no basic hazard has been identified, provided that the machine is used sensibly¹. However, the possible adverse effects that have been considered include, static magnetic field, current induction due to changing magnetic field, heating effects on vulnerable tissues such as the lens of the eye, and acoustic noise².

The adverse effects that may be encountered in some patients after injection of contrast agent include acute anaphylactoid and cardiovascular reactions, delayed reactions and renal effects³. Skin burns have also been reported⁴⁻⁶.

Auto-oxidation of lipid exposed to oxygen (lipid peroxidation) is responsible

for tissue damage in vivo, where it may cause cancer, inflammatory diseases, atherosclerosis and aging. The deleterious effects are initiated by free radicals (ROO° , RO° & OH°) generated during peroxide formation from fatty acids containing methylene interrupted: double bonds⁷. A wide variety of diseases are associated with an increased oxidative stress including coronary artery disease (CAD)⁸, hypertension⁹, haemoglobinopathies^{10,11}, breast cancer¹², major depressive disorders¹³, Alzheimer's and vascular dementia¹⁴, active pulmonary tuberculosis¹⁵, uraemia¹⁶, hypothyroidism¹⁷ and other conditions^{18,19}. One of end products of arachidonic acid metabolism, malondialdehyde (MDA), a secondary product of lipid peroxidation, is widely used as a marker of free radical activity^{7,20,21}. Plasma fluorescent oxidation products are also used as markers of oxidative stress²². In addition, measurement of paraoxonase and aryl-esterase activities may also, reflect the oxidative/anti-oxidative status^{8,9,15,18,19,23}. The aim of this study was to evaluate the oxidative stress and consequently lipid peroxidation in association with MRI examination.

Patients and Methods

The study included 70 patients, 44 males and 26 females, 16-70 years of age, underwent MRI examination at Al- Sadr Teaching Hospital in Basrah. Those patients were referred from different hospitals and clinics in Basrah and nearby cities. There several types of MRI examination including brain, thoracic, abdominal, spinal and joint MRI. Detailed medical history undertaken from patients including the chief complaint and the presence of systemic illnesses. There were 8 patients with diabetes mellitus, 5 with hypertension, 2 with coronary artery disease (CAD), while the remaining patients have no significant medical illnesses.

Venous blood samples were collected from all patients prior to and immediately after MRI examination. Serum MDA level were determined using thio-barbituric acid method²⁴.

Statistical analysis was carried out using paired t-test. P-value <0.05 was considered statistically significant.

Results

Table I presents the characteristics of the studied patients. Table II summarizes the results. MRI examination was associated with a significant increase in serum MDA levels with overall mean difference between pre- and post- MRI examination MDA levels of 0.066 Mmole/L ($P < 0.001$). There was significant differences in MDA levels in ages older than 25 years. MRI examinations of duration of 10-20 minutes accompanied with an increment in serum MDA levels ($P < 0.05$), while longer durations have no significant effects ($P > 0.05$). Systemic diseases (diabetes mellitus, hypertension, or CAD) have no particular effect on serum MDA level during MRI examination ($P > 0.05$). Brain and abdominal MRI examinations showed significant rise in serum MDA levels ($P < 0.01$ and $P < 0.05$ respectively) unlike lumbosacral or dorsolumbar examinations ($P > 0.05$).

Discussion

MRI is a way of obtaining detailed images of organs and tissues throughout the body without the need for X-rays¹. It seems to be without hazards apart from some unwanted effects on vulnerable tissues such the eye lens, in addition to adverse reactions to contrast agent²⁻⁶. To our knowledge, No previous study reported any other major adverse effects due to MRI examination provided that the absolute contra indications to MRI examination are strictly followed.

Free radical generation is a steady state cellular event in respiratory cells, but their production can be greatly accelerated and amplified in response to a variety of pathophysiological circumstances including inflammatory diseases, immunological disorders, hypoxia, drug or alcohol metabolism, exposure to ultraviolet or therapeutic radiation and antioxidants depletion²⁵.

We found significant elevation of serum MDA level following MRI examination, indicating that, it associated with significant free radical activity resulting in considerable degree of lipid peroxidation. This result seems to be of clinical importance in several diseases with proven oxidative assault and consequently an increment in free radical activity such as diabetes mellitus²⁶⁻²⁹, cancer^{12,30-32}.

Haemoglobinopathies^{10,11,33,34}, CAD^{35,36}, hypertension with renovascular disease³⁷, osteoarthritis³⁸, chronic hepatitis³⁹ and chronic renal failure undergoing haemodialysis⁴⁰. Such patients or others with diseases associated with an increase in free radical activity may be at more risk of potentially severe oxidative stress due to additive effect of disease process and the MRI examination. However, other study suggested that MRI examination produced the positive effect of decreasing oxidative stress in men following short-term exposure⁴¹.

The study revealed that an increase in age is associated with significant increase in MDA levels compared to younger age, implying that elderly patients would be, probably, at risk of high oxidative stress, and its consequences, than younger patients.

MRI examinations of short durations showed significant increment in serum MDA levels unlike longer durations. This

result does not indicate that MRI examinations of longer durations causes little free radical activity compared to short duration, but the non-significant results may be due to small number of patients underwent MRI examination of longer duration.

The effect of systemic diseases on serum MDA concentrations during MRI examination was not significant, and can be explained by low number of patients with these diseases (15 patients only) underwent MRI examination.

Regarding the effect of type of MRI examination, those underwent brain MRI showed marked rise in MDA levels following MRI examination. This is due to the fact that nearly half patients included (48.6%) underwent brain MRI.

Patients with abdominal MRI showed similar result which can be partly explained by the fact that abdominal MRI examination covers wide surface area of the body.

In conclusion, MRI examination is associated with considerable free radical activity resulting in a remarkable oxidative assault. Elderly patients are more susceptible to oxidative stress during MRI examination. In addition, it appears that, MRI examination body areas like brain and abdomen are particularly accompanied by high free radical activity than other regions of the body.

A wide scale study including large number of patients undergoing MRI examination is recommended, not only to confirm the oxidative assault following MRI examination, but also to evaluate the effect(s) of the examination on the homeostatic processes in the body. This necessitates the evaluation of a wide variety of physiological and biochemical parameters.

Table I: Characteristics of patients

Age (years)	Males		Females		Total	
	No.	%	No.	%	No.	%
<25	9	20.5	3	11.5	12	17.1
25-44	14	31.8	14	53.8	28	40.0
45-64	18	40.9	8	30.8	26	37.1
>=65	3	6.8	1	3.8	4	5.7
Total	44	100.0	26	100.0	70	100.0

Table II: Serum MDA levels [X (SD)] in relation to different variables

Variable	No.	MDA level (Mmole/L)*	P-value	
Overall serum MDA level	70	0.066(0.110)	< 0.001	
Age (years)	<25	12	0.055 (0.097)	>0.05
	25-44	28	0.083 (0.085)	< 0.001
	45-64	26	0.066(0.149)	<0.05
	>=65	4	0.680 (0.078)	< 0.001
Duration of MRI Examination(minutes)	10-20	46	0.050(0.110)	<0.05
	21-30	19	0.060(0.146)	>0.05
	31-40	5	0.104(0.108)	>0.05
Systemic Diseases	Diabetes mellitus	8	0.048(0.158)	>0.05
	Hypertension	5	0.116(0.123)	>0.05
	CAD	2	0.160(0.042)	>0.05
Type of MRI Examination**	Brain	34	0.056(0.103)	<0.01
	Lumbosacral	10	0.048(0.135)	>0.05
	Abdominal	9	0.101 (0.129)	<0.05
	Dorsolumbar	7	0.101 (0.105)	>0.05

* MDA level represent the mean difference between pre- and post- MRI examination MDA levels.

** Patients underwent MRI examination of the chest, cervical spine and joints were excluded here for their small no. (total no.=10).

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