Original Article

DOI: http://dx.doi.org/10.21088/ijsn.2277.467X.8119.1

Correlation of Malondialdehyde Status with Wrist Sprain in Nurses: A Case-control Study

IJSN
Volume 8, Number 1

Mrinal Kanti Ray[1], Tapas Ghosh[2], Basabdatta Samanta[3]

Abstract

Context: Nurses handle heavy workloads and often sustain injuries, like wrist sprains. So, management of this requires a good understanding of the pathophysiology, which can be approached from many sides. It may be relevant to study the role of free radicals or their derivatives like malondialdehyde (MDA). *Aims:* Aim of the present study was to estimate the levels of MDA in healthy nurses and in nurses who sprained their wrists. *Settings and Design:* Sixty nurses from orthopedics ward were enlisted as subjects following predetermined inclusion and exclusion criteria and divided into two groups. Group I consisted of thirty subjects who had healthy wrists and they served as controls. Group II had thirty age and sex-matched nurses who had recent wrist sprains and they served as cases. *Methods and Materials:* Estimation of serum MDA levels were done in both groups. *Statistical analysis used:* The MDA levels of the two groups were compared. *Results:* In group II (cases with wrist sprains) levels of MDA were highly significantly increased in comparison to MDA levels in group I (control subjects). *Conclusion:* Oxidative stress in wrist sprains leads to decreased MDA levels.The findings of this research might be relevant in strengthening the association between oxidative stress (caused by free radicals and leading to lipid peroxidation) and sprains; further, the above mentioned data may be important for workers in this area of study.

Keywords: Serum; Malondialdehyde; Nurses; Wrist; Sprain.

Introduction

Nurses in different wards of hospitals handle heavy workloads and naturally, often sustain various kinds of problems. Wrist sprain is a common injury, which occurs more commonly in orthopedics wards. So, management of this requires a good understanding of the pathophysiology, which can be approached from many sides. A recent trend is to study the role of free radicals as they may cause various diseases.

In our body free radicals are produced in normal health. One- and two-electron reduction of O_2 generates superoxide and hydrogen peroxide, respectively, both of which are generated by numerous routes in vivo. In the presence of free transition metals, superoxide and hydrogen peroxide together generate the extremely reactive hydroxyl radical. Ultimately, hydroxyl radical is assumed to be the species responsible for initiating the oxidative destruction of biomolecules [1]. Though superoxide is much less reactive than hydroxyl radical, superoxide can attack various biological substances in our body. It is now well established that free radicals and other ROS are continuously being produced in vivo. In addition to the above mentioned species, singlet oxygen, hypochlorous acid, ozone, nitric oxide, etc are produced [2]. The most important reactants in free radical biochemistry in aerobic cells are oxygen and its radical derivatives. Reactive free radicals formed within cells can oxidise biomolecules and lead to cell death and tissue injury. But establishing the involvement of free radicals in the pathogenesis of a disease is extremely difficult due to the short lifetimes of these species [3]. In general, free radicals are reactive chemically, some being extremely reactive. Reactive free radicals are able to produce chemical modifications of, and damage to, proteins, lipids, carbohydrates and nucleotides. Therefore, if such reactive free radicals are produced in vivo in amounts sufficient to overcome

Author Affiliation: [1]Associate Professor, Dept of Orthopedics, [2]Associate Professor, Dept of Anatomy, [3]Assistant Professor, Dept of Biochemistry, Burdwan Medical College, Bardhaman, West Bengal 713104, India.

Corresponding Author: Tapas Ghosh, Associate Professor, Dept of Anatomy, Burdwan Medical College, Bardhaman, West Bengal 713104, India.

E-mail: gtapas17@yahoo.com

Received on 04.01.2019, **Accepted on** 02.02.2019

the normally efficient protective mechanisms, we can expect metabolic and cellular disturbances to occur in various major ways [4]. Reactive oxygen species generated by mitochondria, or from other sites within or outside the cell, cause damage to mitochondrial components and initiate degradative processes [5]. free radicals can cause tissue damage by reacting with polyunsaturated fatty acids in cellular membranes [6]. various derivatives are produced during oxidation of PUFA by free radicals [7].

MDA may be generated during hydrolysis by the oxidation of polyunsaturated fatty acids (PUFA) in the sample and by degradation of preexisting oxidation products [8]. MDA is a three-carbon dialdehyde. MDA chemistry has been of interest for a long time and has received attention recently because of suggestions that it may play a role in degenerative biological transformations [9]. The plasma concentration of MDA is often used as a marker of lipid peroxidation [10]. MDA is one of the final products of polyunsaturated fatty acids peroxidation in the cells. An increase in free radicals causes overproduction of MDA [11]. Therefore MDA is a frequently measured biomarker of oxidative stress. The vast majority of analytical approaches for the determination of MDA make use of some kind of derivatization. Most strategies are based on the "aldehydic-reactivity" of MDA, hence employing hydrazine-based derivatization reagents [12]. The reaction of MDA with TBA is often used to assay levels of MDA in plasma. It is dependent on the development of a red pigment resulting from the reaction of TBA with oxidized lipids. The TBA test continues to be helpful when used judiciously in studies of lipid peroxidation [13]. This method is widely used and is a standard for estimating free radical induced damage [14]. The most likely reason for this wide application might be its convenient utilization in particular to large sample numbers, needing only a plate reader instrument [12]. Urinary MDA is also used as an indicator of lipid peroxidation in the diet and in the tissues [15]. Elevated plasma MDA levels have been found in various conditions, including ageing and cancers, probably due to increased lipid peroxidation [16,17]. MDA has also been associated with pain levels [18], but it is thought that it is a marker of free radical damage rather than a causative factor for pain [19].

Wrist injury including sprains are common and may significantly impair the overall function of upper extremity unless properly managed [20]. Work-related musculoskeletal disorders of hand and wrist are associated with the longest absences from work and are, therefore, associated with greater lost productivity and wages than those of other anatomical regions [21]. There is now much evidence both direct and indirect implicating reactive oxygen species in pathogenesis of inflammatory synovitis. Cells present in inflamed joint, such as endothelial cells have the ability when isolated and stimulated to produce reactive oxygen species [22]. Since free radicals play an important role in inflammation, the pathophysiology of wrist sprain is likely to be influenced by their levels [23]. Increased levels of superoxide and other free radicals are found in inflammation [24]. But, to our knowledge, even after extensive search, measurements of MDA in patients with wrist sprain have never been recorded.

Since free radicals might be an important agent in the process of sprains and tears, in an attempt to ascertain the relevance of MDA, this study was designed to assay the serum levels of MDA in healthy nurses as well as in nurses who sprained their wrists.

Subjects and Methods:

This was a case control study. Sixty nurses from orthopedics ward were enrolled as subjects. These subjects were grouped in the following manner: Group I consisted of thirty nurses who had healthy wrists and these subjects were the controls; Group II had thirty age and sex-matched nurses who had recent wrist sprains and they were the cases.

All subjects were explained properly about the study matter and duly signed consent form was collected from each individual. The study duration was one year and four months. Ethical clearance from institutional review board was obtained. Detailed health histories of all patients were recorded and physical examinations were performed. Smokers, patients with history of trauma or surgery within the last month were excluded from the study. The patients were advised not to use topical or systemic corticosteroid or other immunosuppressive treatment in the preceding 3 months of the study. Also it was ensured that participants did not have upper respiratory tract or other infectious diseases in the preceding 3 weeks before the selection of subjects.

Blood was drawn from all subjects and serum MDA estimation was done [25].

Each result was expressed as mean±standard deviation. Statistical significance of the data was determined by student's t-test.

Results

There was increase in MDA levels (in micromole/ litre) in Group II (1.9+0.7) compared to those in Group I (1.3 + 0.6), as shown in Table 1.

The two-tailed p value equals 0.0007.

By conventional criteria, this difference is considered to be statistically extremely significant.

The difference of the means of the two groups was 1.6.

95% confidence interval of this difference: from -0.937 to -0.263

Table 1: MDA levels in serum in cases and controls (N = No. of subjects)

	Group I	Group II
N	30	30
Mean (+ SD)	1.3 (+ 0.6)	1.9 (+ 0.7)
SEM	0.110	0.128

Discussion

Free radical mechanisms have been associated with a large number of disease states including inflammation. The site of free radical generation, that is whether the generation of radical species is predominantly extracellular or intracellular, may determine to a degree, the types of macromolecular and cellular damage which result [26]. Nitric oxide, superoxide and reactive oxygen species exert multiple modulating effects on inflammation and play a key role in the regulation of immune responses. They affect virtually every step of the development of inflammation. Superoxide anion produced by NAD(P)H oxidases present in all cell types participating in inflammation (leukocytes, endothelial and other vascular cells, etc) may lead to toxic effects, when produced at high levels during oxidative burst. The effects of both nitric oxide and superoxide in immune regulation are exerted through multiple mechanisms [27]. Superoxide radical depolymerizes hyaluronic acid and bovine synovial fluid; McCord et al. suggested this as the mechanism of synovial fluid degradation in an inflamed joint [28]. Free radicals are largely released into surrounding tissues of RA patients, eventually leading to tissue damage [29]. A short course of nonsteroidal, anti-inflammatory medication and perhaps repeated applications of cold may also reduce free-radical-induced secondary tissue injury [30].

MDA is a frequently measured index of lipid peroxidation [31]. MDA is determined as the thiobarbiturate chromogen formed by reaction of the plasma with 2-thiobarbituric acid under acid and heating conditions [32]. Since MDA is a metabolite of free radicals, it is logical that MDA levels might be an indicator of oxidative stress. MDA has been labelled as a biomarker of oxidative stress in subjects with familial hypercholesterolemia [33]. Eisenberg et al. found elevated levels of MDA and anti-oxidants in serum and saliva of patients with complex regional pain syndrome, therewith establishing a possible involvement of oxidative stress in the disease mechanism of this condition [34].

In inflammation neutrophil-generated superoxide reacts with an extracellular precursor to generate a substance chemotactic for neutrophils [35]. Thus it is logical that the inflammatory process in wrist sprains is dependant on free radicals. In our study also we found that there was increase in MDA levels in cases with sprained wrists compared to those in controls having healthy wrists, as shown in Table I. This data supports the idea that sprains are linked with free radicals. But some aspects of this study may be considered. Further detailed studies involving other free radical derived products like 4-hydroxynonenal, hexanal, acrolein, etc [36] should be carried out to confirm our findings. We chose MDA as it is time tested, the most abundant, widely produced, frequently measured free radical derivative of lipid peroxidation [37,38,39]. The TBARS assay also is a convenient, simple and standard method to estimate free radical damage. Further evidence for the role of oxidative stress may be obtained by studying the activity of antioxidants. Since the present study was conducted in eastern India, a larger population with different demographic profiles may ascertain a better representation of the actual scenario and prove more beneficial. Oxidative stress could cause cell damage and in order to minimize the damages, antioxidants could help to protect the cells by enhancing the body's defence systems against oxidative stress [40]. Thus, our study may help in a better understanding of the interactions of free radicals with our system, and facilitate ways to keep our body healthy.

Conclusion

Oxidative stress in wrist sprains leads to decreased MDA levels. The findings of this research might be relevant in strengthening the association between oxidative stress (caused by free radicals and leading to lipid peroxidation) and

sprains; further, the above mentioned data may be important for workers in this area of study.

References

1. Beckman KB, Ames BN. The free radical theory of aging matures. Physiol Rev. 1998;78(2):547-81.
2. Halliwell B. The chemistry of free radicals. Toxicol Ind Health. 1993;9(1-2):1-21.
3. Cheeseman KH, Slater TF. An introduction to free radical biochemistry. Br Med Bull. 1993;49(3):481–93.
4. Slater TF. Free Radical Mechanisms in Tissue Injury. In: Cañedo LE, Todd LE, Packer L, Jaz J, editors. Cell Function and Disease. Boston: Springer; 1988.
5. Cadenas E, Davies KJ. Mitochondrial free radical generation, oxidative stress, and aging. Free Radic Biol Med. 2000;29(3-4):222-30.
6. Machlin LJ, Bendich A. Free radical tissue damage: protective role of antioxidant nutrients. FASEB J. 1987;1(6):441-5.
7. Botsoglou NA, Fletouris DJ, Papageorgiou GE, Vassilopoulos VN, Mantis AJ, and Trakatellis AG. Rapid, Sensitive, and Specific Thiobarbituric Acid Method for Measuring Lipid Peroxidation in Animal Tissue, Food, and Feedstuff Samples. Jr Agri Food Chem. 1994;42(9):1931-7.
8. Draper HH, Hadley M. Malondialdehyde determination as index of lipid Peroxidation. Methods Enzymol. 1990;186:421-31.
9. Nair V, Vietti DE, Cooper CS. Degenerative chemistry of malondialdehyde. Structure, stereochemistry, and kinetics of formation of enaminals from reaction with amino acids. Jr Am Chem Soc. 1981;103(11):3030-6.
10. Child RB, Wilkinson DM, Fallowfield JL, Donnelly AE. Elevated serum antioxidant capacity and plasma malondialdehyde concentration in response to a simulated half-marathon run. Med Sci Sports Exerc. 1998;30(11):1603-7.
11. Gaweł S, Wardas M, Niedworok E, Wardas P. Malondialdehyde (MDA) as a lipid peroxidation marker. WiadLek. 2004;57(9-10):453-5.
12. Giera M, Lingeman H, Niessen WMA. Recent Advancements in the LC- and GC-Based Analysis of Malondialdehyde (MDA): A Brief Overview. Chromatographia. 2012;75:433.
13. Nair V, Turner GA. The thiobarbituric acid test for lipid peroxidation: Structure of the adduct with malondialdehyde. Lipids. 1984;19:804.
14. Liedtke AJ, Mahar CQ, Ytrehus K, Mjøs OD. Estimates of free-radical production in rat and swine hearts: method and application of measuring malondialdehyde levels in fresh and frozen myocardium. Basic Res Cardiol. 1984;79(5):513-8.
15. Piché LA, Draper HH, Cole PD. Malondialdehyde excretion by subjects consuming cod liver oil vs a concentrate of n-3 fatty acids. Lipids. 1988;23(4):370-1.
16. Gönenç A , Özkan Y, Torun M, Şimşek B. Plasma malondialdehyde (MDA) levels in breast and lung cancer patients. J Clin Pharm Ther. 2001;26(2):141-4.
17. Inal ME, Kanbak G, Sunal E. Antioxidant enzyme activities and malondialdehyde levels related to aging. Clin Chim Acta. 2001;305(1-2):75-80.
18. Chi CH, Shiesh SC, Lin XZ. Total antioxidant capacity and malondialdehyde in acute abdominal pain. Am J Emerg Med. 2002;20:79–82.
19. Pappagallo M, Leslie JB, Raffa RB, Kash P, Fleischer C, Sinclair N, et al. Evaluation of a novel topical essential oxygen oil for the treatment of pain in acute tendinopathy and sprains. Muscles Ligaments Tendons J. 2011;1(1):25–30.
20. Garcia-Elias M, Folgar MA. The management of wrist injuries: an international perspective. Injury. 2006;37(11):1049-56.
21. Barr AE, Barbe MF, Clark BD. Work-related musculoskeletal disorders of the hand and wrist: epidemiology, pathophysiology, and sensorimotor changes. J Orthop Sports Phys Ther. 2004;34(10):610-27.
22. Zweier JL, Kuppusamy P, Lutty GA. Measurement of endothelial cell free radical generation. Evidence for a central mechanism of free radical injury in postischaemic tissues. Proc Natl Acad Sci 1988;85:4046-50.
23. Winrow VR, Winyard PG, Morris CJ, Blake DR. Free radicals in inflammation: second messengers and mediators of tissue destruction. Br Med Bull. 1993;49(3):506-22.
24. SalinML, McCord JM. Protection of phagocytosine leukocytes by superoxide dismutase. Free radic inflamm. J Clin Invest. 1975;56(5):1319– 23.
25. Satoh K. Serum lipid peroxide in cerebrovascular disorders determined by a new colorimetric method. Clinica Chemica Acta. 1978;90(1):37-43.
26. Del Maestro RF. An approach to free radicals in medicine and biology. Acta Physiol Scand Suppl. 1980;492:153-68.
27. Guzik TJ, Korbut R, Adamek-Guzik T. Nitric oxide and superoxide in inflammation and immune regulation. J Physiol Pharmacol. 2003;54(4):469-87.
28. McCord JM. Free radicals and inflammation: protection of synovial fluid by superoxide dismutase. Science. 1974;185(4150):529-31.
29. Bauerova K, Bezek A. Role of reactive oxygen and nitrogen species in ethiopathogenesis of rheumatoid arthritis. Gen Physiol Biophys. 1999;18:15–20.
30. Denegar C R, Miller S J. Can Chronic Ankle Instability Be Prevented? Rethinking Management of Lateral Ankle Sprains. J Athl Train. 2002;37(4):430–5.

31. Guichardant M, Valette-Talbi L, Cavadini C, Crozier G, Berger M. Malondialdehyde measurement in urine. J Chromatogr B Biomed Sci Appl. 1994;655(1):112-6.

32. Wade CR, Jackson PG, Van Rij AM. Quantitation of malondialdehyde (MDA) in plasma, by ion-pairing reverse phase high performance liquid chromatography. Biochem Med. 1985;33(3):291-6.

33. Pirinccioglu AG, Gökalp D, Pirinccioglu M, Kizil G, Kizil M. Malondialdehyde (MDA) and protein carbonyl (PCO) levels as biomarkers of oxidative stress in subjects with familial hypercholesterolemia. Clin Biochem. 2010;43(15):1220-4.

34. Eisenberg E, Shtahl S, Geller R, Reznick AZ, Sharf O, Ravbinovich M, et al. Serum and salivary oxidative analysis in complex regional pain syndrome. Pain. 2008;138:226–32.

35. Petrone WF, English DK, Wong K, McCord JM. Free radicals and inflammation: superoxide-dependent activation of a neutrophil chemotactic factor in plasma. PNAS. 1980;77(2):1159-63.

36. Barrer G. Oxidative Stress and Lipid Peroxidation Products in Cancer Progression and Therapy. ISRN Oncology. 2012;2012: [about 21 p.]. Available from: http://dx.doi.org/10.5402/2012/137289.

37. Marnett L J. Oxy radicals, lipid peroxidation and DNA damage. Toxicology. 2002 Dec 27;181-182:219-22.

38. Giera M, Lingeman H, Niessen WMA. Recent Advancements in the LC- and GC-Based Analysis of Malondialdehyde (MDA): A Brief Overview Chromatographia. 2012;75(9–10):433–40.

39. Basu AK, Marnett LJ. Unequivocal demonstration that malondialdehyde is a mutagen. Carcinogenesis. 1983;4(3):331–3.

40. Hajrezaie M, Salehen N, Karimian H, Zahedifard M, Shams K, Batran R A, et al. Biochanin A gastroprotective effects in ethanol-induced gastric mucosal ulceration in rats. PLoSOne. 2015;10: [about 24p.]. Available from: https://doi.org/10.1371/journal.pone.0121529.