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Research Article

ASSESMENT OF QUALITY OF LIFE AND OXIDATIVE STRESS IN TUBERCULOSIS PATIENTS VISITING DIRECTLY OBSERVED TREATMENT SHORT COURSE CENTRES OF WARANGAL

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ABSTRACT

Objectives: Tuberculosis (TB) is a disease associated with a wide range of respiratory symptoms. It remains a major public health problem worldwide. In TB, oxidative stress is a result of tissue inflammation, poor dietary intake of micronutrients due to illness, and free radical burst from activated macrophages. In recent years, efforts have been dedicated for assessing the health-related quality of life (HRQoL) in TB patients. The objectives of the study were to evaluate the impairment of HRQoL in TB patients using by DR-12 questionnaire and to estimate oxidative stress parameters such as malondialdehyde (MDA), glutathione (GSH), vitamins A, and C in TB patients.

Methods: A total of 142 patients meeting the study criteria were recruited in the study to evaluate HRQOL. The patients were administered with DR-12 questionnaire at 0 week, 4 weeks and at the end of intensive phase of the treatment. A paired t-test was applied and a $p<0.05$ was considered as significant. 40 patients meeting the study criteria were recruited for assessment of oxidative stress parameters. The blood samples were assessed for the concentration of MDA, GSH, vitamin A, and vitamin C using suitable methods.

Results: A significantly higher HRQOL scores were observed at the end of intensive phase of the treatment for both pulmonary and extrapulmonary TB patients. There was a significant improvement in their QOL ($p<0.05$). An increased oxidative stress was obtained in plasma of TB patients as compared to normal healthy controls. There was a significant increase in the MDA levels of TB patients (7 times greater than control) when compared to normal population. There was a double decrease in GSH and vitamin A concentrations in TB cases compared with controls. The plasma levels of vitamin C in TB cases obtained thrice lesser in TB cases than the control population.

Conclusion: The study showed that in TB patients free radical activity is quite high and antioxidant levels are low. A suitable antioxidant therapy may improve QoL and prove beneficial supplementation for fast recovery.

Keywords: Tuberculosis, Health-related quality of life, Directly observed treatment short course, DR-12 score, Antioxidants, Free radicals.

INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by the bacillus of *Mycobacterium* species. It typically affects the lungs (pulmonary TB [PTB]) but can affect other sites as well (extrapulmonary TB [EPTB]) [1]. TB is a one of the major global health problems ranking as the eighth leading cause of death in low- and middle-income countries (seventh for men and ninth for women); among adults aged 15-59, it ranks as the third cause of death, after HIV/AIDS and ischemic heart disease. There are 22 so-called high-burden countries (HBCs) that account for about 80% of the world's TB cases, and which have been given particular attention in TB control since around the year 2000. India is also one among the HBCs [2]. Studies have shown that the major risk factors especially in poor countries for infections and death due to TB are less health care access [2-4], higher exposure to unhealthy and crowded living, unhealthy working conditions, malnutrition, HIV-infection, diabetes mellitus, smoking [5-7], alcoholism, and drug abuse. *Mycobacterium* species causes TB in the lungs and other tissues of the human body. The other species causing TB includes hominis, bovis, avium, murine, and non-pathogenic smegmatis [8]. *Mycobacterium* TB is transmitted from a patient with infectious PTB to other persons by droplet nuclei, which are aerosolized by coughing, sneezing, or speaking. Other routes of transmission of tubercle bacilli, such as through the skin or the placenta, are uncommon and of no epidemiologic significance [8]. The organism also spread to other organs, such as the lymphatics, pleura, bones/joints, or meninges, and cause EPTB [9]. Tuberculin skin testing is the most common method used to screen for latent *M.* TB. Acid fast bacilli (AFB) microscopy is based on the finding of AFB on microscopic examination of smear of expectorated sputum or of tissue (a lymph node biopsy). TB is treated with the first line drugs. These drugs have high antitubercular efficacy as well as low toxicity and are used routinely. They are isoniazid (H) rifampicin (R) pyrazinamide (Z) ethambutol (E) streptomycin (S). The second line drugsse drugs have either low antitubercular efficacy or high toxicity or both, used in special circumstances only. They are thiacetazone, para amino salicylic acid, ethionamide, cycloserine, kanamycin, amikacin, and capreomycin. Newer drugs include ciprofloxacin, oflaxacin, clarithromycin, azithromycin and rifabutin.

Quality of life (QoL) [9]

The WHO defines QoL as individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. It is a broad ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, personal beliefs and their relationship to salient features of their environment. Health-related QoL (HRQoL) is a concept of multidimensions which connect the physical, emotional and social components of the individual with his medical conditions [10]. HRQoL is a complex type of Patient Related Outcomes that evaluates health status. Patients with chronic diseases place a high value on their mental and social well-being as well as pure physical health. Hence, HRQOL has become an area of increasing interest and evaluated in many diseases, including TB [11].

TB and QoL [11]

Though effective therapy has been available, TB remains a major public health threat worldwide. Many aspects of TB treatment could potentially compromise patients' HRQoL. Anti-TB therapy consists of usage of medications for at least 6-9 months to complete, with serious risks of adverse reactions. Furthermore, TB patients are perceived as a

source of infection and the resultant social rejection and isolation leads to long-term impairment on patients' psychosocial well-being. Many TB patients also report to experience negative emotions, such as anxiety and fear. Hence, it is important to measure HRQoL of TB patients and the current goal of TB management is to achieve microbiological "cure," and there has been little effort taken to consider patients' HRQoL which also promotes the impact of TB and associated treatment on patients' HRQoL. HRQoL involves assessing a person's perception of his or her physical and mental health. Both physical and mental distress is common in TB patients leading to poor disease outcome or poor treatment outcome because of decreased ability to take treatment. By knowing patient's TB HRQoL it enables clinicians to understand the functioning and well-being of patients so that specific needs are addressed to attain the best clinical or treatment outcome. HRQoL measures the impact of a disease on a patient's daily activities, behavior, perceived health, and functional state.

The DR 12 questionnaire has been extensively used in many health outcome studies involving TB patients [12,13]. This questionnaire has also been effectively utilized to measure the perceptions of TB patients regarding their physical, mental and social well-being and to determine the long-term effect of treatment of chronic diseases. These scores assume greater importance for TB patients treated under the directly observed treatment short course (DOTS) strategy in India, as treatment outcome is based only on sputum examination results and not on health status.

Oxidative stress

Oxidative stress is a cellular condition implying elevated amounts of reactive oxygen species (ROS). It occurs when the available supply of the body's antioxidants is insufficient to handle and neutralize free radicals of different types. The result is massive cell damage that can result in cellular mutations, tissue breakdown, and even immune compromise [14]. ROS are highly reactive toward internal cellular biomolecules. Lipid peroxidation, oxidative damage to DNA and protein, inflammation, lowered activity of antioxidant mechanisms and oxidative stress are often interpreted as the same thing [15]. ROS are believed to be involved in various pathologic conditions such as Alzheimer's disease, macular degeneration, autoimmune disease, multiple sclerosis, cancer, muscular dystrophy, cardiovascular disease, pancreatitis, cataracts, parkinson's disease, diabetes, rheumatoid arthritis, iron overload, segmental progeria disorders, and ischemic-reperfusion injury. Free radicals can be defined as molecules or molecular fragments containing one or more unpaired electrons in atomic or molecular orbitals. This unpaired electron(s) usually gives a considerable degree of reactivity to the free radical. In the process of using oxygen during normal metabolism within the cell to create energy (called oxidation), free oxygen radicals are created. If these free radicals are not neutralized rapidly, they cause damage to the vessel wall, cell wall, lipids, proteins, and even the nucleus (DNA) of the cell. Radicals derived from oxygen represent the most important class of radical species generated in living systems. Superoxide anion radical is an important oxygen free radical. The primary source of ROS is leakage of electrons from the respiratory chain during the reduction of molecular oxygen to water to generate the superoxide anion, $O_2^{\bullet -}$. The antioxidative network acts as a defense mechanism against stress; the human body has antioxidative enzymes such as superoxide dismutase (SOD), glutathione (GSH), and catalase (Cat), which scavenge free radicals. These enzymes make up a preventive type of antioxidative network. The antioxidants eliminating free radicals and are called radical-scavenging antioxidants. These are divided into water-soluble substances, such as vitamin C, and fat-soluble substances, such as vitamins A and E as well as coenzyme Q. The water- and fat-soluble antioxidants mutually react with each other and individually form sophisticated networks that protect the body against oxidative damage. The pathogenesis of TB is multifactorial and includes the effects of oxidative stress. ROS and reactive nitrogen intermediates are induced by mycobacteria through the activation of phagocytes by respiratory burst mechanism which is crucial to host defense and also promote tissue injury, inflammation and may further contribute to immune suppression. Several studies have reported that decreased antioxidant concentrations and disturbed GSH metabolism leads to enhanced ROS in TB patients. The malnutrition in patients with TB contributes to the impaired antioxidant capacity in these patients. Lipid peroxidation, a general mechanism of tissue damage by free radicals is known to be responsible for cell damage and may induce many pathological events. The examination of antioxidants in patients with TB may identify deficiencies that predispose to severe oxidant injury and immunodeficiency [16]. Activated macrophages are capable of releasing a variety of chemicals including oxygen free radicals. An increased circulating level of free radical activity has been found in patients with active PTB [17]. TB patients have been reported to have decreased concentrations of antioxidants, enhanced generation of ROS and increased levels of lipid peroxidation product as a consequence of impaired activity of scavenging enzymes. Superoxide, a free radical is produced during cellular metabolic reactions. SOD, an antioxidant enzyme, changes superoxide anion into hydrogen peroxide and oxygen. SOD is expressed at high levels in mammalian lungs but not expressed in TB patients [18]. In TB, plasma concentrations of vitamin E, vitamin C and beta-carotene are low and have increased levels of circulating lipid peroxides. Studies have shown that GSH levels are decreased in individuals with active PTB and this decrease correlates with increased proinflammatory cytokine production and enhanced growth of *M.* TB. Since liver plays a major role in GSH synthesis, liver dysfunction can possibly result in impaired GSH synthesis. Enhanced reactive oxygen intermediates and tumor necrosis factor-α are responsible for low GSH levels in TB patients. GSH plays a vital role in maintenance of cell viability, DNA replication and thiolation of proteins. Estimation of antioxidant status in TB patients comprises measurement of different compounds of antioxidant system and lipid peroxides in plasma and cells (malondialdehyde [MDA], GSH, vitamin A and vitamin C).

METHODS

The study was performed in various phases. PHASE-I study was conducted in District TB Control Office (DTCO), Warangal. DTCO is the main coordinating center for rural TB DOT centers in and around Warangal. DTCO is under the control of State TB Office (STO) which in turn regulated by Central TB Division Office (CTD), New Delhi. DTCO regulates and randomly check and conducts supervisory visits to all medical office treatment units (TU). In Warangal, there are about 7 TU, namely Geesukonda, Raghunathpally, Govindaraopet, Thorrur, Khanapur and Regonda. For every TU, there are 1 Senior Treatment Lab Supervisor and 1 Senior Treatment Supervisors coordinating designation microscopy centers (DMC), primary health centers (PHC), community health centers, subcenters, and DOTS. There about 36 DMCs each having 1 lab technician (LT) and 70 PHCs under DTCO control. In DTCO, about 300-400 patients visit every month suspecting TB. After the sputum analysis, the confirmed cases will be provided with DOTS therapy. The patients will be directed to the nearest accessible DOTS centers. Their treatment will be carried out under the supervision of senior treatment supervisors at the respective DOTS centers. If the patient is residing very close to DTCO, treatment charts will be provided and asked to further follow-up and receive the DOTS therapy. Study designs were a prospective observational study. The research was done on the convenient sample. The study was conducted over a period of 9-month from December 2014 to August 2015. Inclusion criteria include all TB patients of either sex of the age group 18 and above years treated at DOTS centre. Patients of either sex detected as TB and referred to DOTS centre for anti-tubercular therapy. Patients willing to provide contact details and inform consent form. The patients willing to provide 5 ml of blood forthis study. TB patients of either sex able to communicate in either Hindi, Telugu, or English. Exclusion criteria is patients <18 years of age. Patients unable to respond to verbal questions. Pregnant/Lactating mothers, patients with concomitant immunecompromised conditions, cancer or AIDS. Patients not willing to provide informed consent and blood. A source of data is Patients' case notes, treatment charts, laboratory and diagnostic reports, interviewing patients/patients caretakers, interviewing healthcare professionals, any other relevant sources. Protocol of the study including

the introduction, objectives, data collection form and methodology was submitted to the Human Ethical Committee, Talla Padmavathi College of Pharmacy. After the agreement of ethical committee members, the study was approved (Annexure 1). The graduate pharmacist visited the TB DOTS centers every day on regular basis. Patients meeting the inclusion and exclusion criteria were selected for the study. The patient was explained in detail about the study and asked to provide the informed consent form. The entire relevant patient data were collected from the patient and documented in the suitably designed data collection form 5 ml of blood will be collected from the patient and it was suitably processed and stored for further assessments. The patient was given HRQOL questionnaire and the patient's health condition, physical and mental status was assessed. The same questionnaire was applied to the study patient at the end of 4th week (Window period of ± 5-day). The patient's health condition, physical and mental status was assessed by DR-12 questionnaire at the end of intensive phase therapy or at the end of 8th week (Window period of ± 5-day). All collected data were analyzed using relevant statistical methods. Disposable syringes and needles were used for blood collection. Blood samples were taken from the TB patients and control groups by vein puncture. Samples were taken into EDTA tubes allowed to stand at 37°C, and then centrifuged at 3000 rpm for 15 min. Plasma was removed and stored at −30°C until analysis in disposable eppendrof tubes. DR-12 is a disease specific questionnaire. It has been developed and validated by Dhingra and Rajpal. DR-12 was developed for TB as an additional evaluative tool for DOTS. It mainly consists of 12 parameters which were divided into 2 scores. The 12 items in the questionnaire evaluate two different dimensions of health. Score I includes about 7 parameters which are related to the symptoms of TB. Score II includes 5 parameters which are related to Socio-psychological and exercise adaptation. The items for each dimension were coded and aggregated, then transformed on a scale ranging from 1 (reflecting the poorest state of health) to 3 (reflecting the best state of health). Total score includes combination of both Score I and Score II. Phase-II involves determination of oxidative parameters like. MDA, reduced GSH, ascorbic acid (vitamin C) and retinol (vitamin A). All the results were expressed as mean ± standard deviation (SD) Paired t-test was used for analysis of HRQOL scores in TB patients according to data distribution pattern to assess differences with in groups of subjects on follow up that is, in the first day of treatment, at the end of 1st month and at the end of 2nd month. Statistical significance level used was 0.05 the results of oxidative stress were expressed as unpaired *t*-test which was used to verify the association of oxidative stress parameters in TB patients.

RESULTS

Quality of life

Table 1: Gender and age

Gender	Distribution	Mean age
Males	106	42
Females	36	34

Table 2: Categories and sputum status

Patients	Pulmonary TB (135)	Extrapulmonary TB (7)
Category		
I	101	7
II	34	0
Sputum status		
Negative	45	7
Positive	90	0

Table 3: HRQoL scores in TB patients according to the site of involvement in those patients who completed intensive phase

Type of Patients	Scores (mean±SD)							
	0 week	4 weeks	Average gain	Paired t-test	0 week	8 weeks	Average gain	Paired t-test
Pulmonary TB (n=135)								
Score I	12.785±2.046	16.038±2.002	3.242±1.597	p<0.05	12.785±2.046	17.985±1.725	5.189±1.765	p<0.05
Score II	10.459±2.058	12.023±1.714	1.523±1.108	p<0.05	10.459±2.058	13.182±1.517	2.682±1.338	p<0.05
Total score	23.2±3.753	28.061±3.365	4.811±2.328	p<0.05	23.20±3.753	31.167±2.922	7.917±2.610	p<0.05
Extra pulmonary (7) or sputum negative								
Score I	15.571±2.44	17.286±1.799	1.714±0.951	p=0.003	15.571±2.44	19.00±0.816	3.429±1.988	p=0.003
Score II	11.571±1.512	12.857±0.690	1.286±1.113	p=0.022	11.571±1.512	13.857±0.690	2.286±1.380	p=0.004
Total score	27.143±3.185	30.143±2.035	3.00±1.826	p=0.004	27.143±3.185	32.857±1.345	5.714±2.870	p=0.001

TB: Tuberculosis, SD: Standard deviation, HRQoL: Health-related quality of life

Table 4: HRQoL scores in TB patients according to their categories

Category	Scores (mean±SD)							
	0 week	4 weeks	Average gain	Paired t-test	0 week	8 weeks	Average gain	Paired t-test
Cat I (108)								
Score I	13.324±2.10	16.383±1.861	3.065±1.556	p<0.05	13.324±2.10	18.280±1.589	4.963±1.888	p<0.05
Score II	10.972±1.867	12.393±1.503	1.383±0.977	p<0.05	10.972±1.867	13.495±1.299	2.486±1.208	p<0.05
Total score	24.296±3.500	28.756±3.054	4.449±2.142	p<0.05	24.296±3.500	31.776±2.578	7.449±2.541	p<0.05

HRQoL: Health-related quality of life, TB: Tuberculosis, SD: Standard deviation

Table 5: HRQoL scores in TB patients according to their sex

Gender	Scores (mean±SD)							
	0 week	4 weeks	Average gain	Paired t-test	0 week	8 weeks	Average gain	Paired t-test
Males (106)								
Score I	12.726±2.054	16.010±1.963	3.272±1.529	p<0.05	12.726±2.054	17.951±1.795	5.214±1.747	p<0.05
Score II	10.481±2.076	12.019±1.749	1.485±1.092	p<0.05	10.481±2.076	13.136±1.615	2.602±1.301	p<0.05
Total score	23.208±3.715	28.029±3.414	4.757±2.229	p<0.05	23.208±3.715	31.087±3.087	7.816±2.516	p<0.05
Females (36)								
Score I	13.500±2.324	16.361±2.127	2.861±1.791	p<0.05	13.500±2.324	18.278±1.406	4.778±1.973	p<0.05
Score II	10.611±1.975	12.194±1.508	1.583±1.156	p<0.05	10.611±1.975	13.444±1.054	2.833±1.444	p<0.05
Total score	23.944±4.098	28.556±3.121	4.611±2.643	p<0.05	23.944±4.098	31.722±2.173	7.778±3.062	p<0.05

HRQoL: Health-related quality of life, TB: Tuberculosis, SD: Standard deviation

Table 6: HRQoL scores in TB patients related to sputum status at the end of IP

Gender	Scores (mean±SD)							
	0 week	4 weeks	Average gain	Paired t-test	0 week	8 weeks	Average gain	Paired t-test
Males (106)								
Score I	12.726±2.054	16.010±1.963	3.272±1.529	p<0.05	12.726±2.054	17.951±1.795	5.214±1.747	p<0.05
Score II	10.481±2.076	12.019±1.749	1.485±1.092	p<0.05	10.481±2.076	13.136±1.615	2.602±1.301	p<0.05
Total score	23.208±3.715	28.029±3.414	4.757±2.229	p<0.05	23.208±3.715	31.087±3.087	7.816±2.516	p<0.05
Females (36)								
Score I	13.500±2.324	16.361±2.127	2.861±1.791	p<0.05	13.500±2.324	18.278±1.406	4.778±1.973	p<0.05
Score II	10.611±1.975	12.194±1.508	1.583±1.156	p<0.05	10.611±1.975	13.444±1.054	2.833±1.444	p<0.05
Total score	23.944±4.098	28.556±3.121	4.611±2.643	p<0.05	23.944±4.098	31.722±2.173	7.778±3.062	p<0.05

HRQoL: Health-related quality of life, TB: Tuberculosis, SD: Standard deviation

Table 7: Age and sex distribution

Age group in years	No. of patients		
	Male	Female	Total
18-30	15	11	26
31-50	7	4	11
51-70	3	0	3

Oxidative parameters

Table 8: Age and sex distribution TB patients

Age group in years	No. of patients		
	Male	Female	Total
18-30	4	3	7
31-50	14	6	20
51-70	12	1	13

TB: Tuberculosis

Table 9: Mean values of plasma MDA in TB patients compared to control population

Serial number	Test group (n=40)	Plasma MDA (mean±SD) (µmol/l)	p value
1	Control population	1.525±1.038	-
2	TB patients	7.309±2.422	≤0.05

MDA: Malondialdehyden, TB: Tuberculosis, SD: Standard deviation

Table 10: Mean values of reduced GSH in TB patients compared to control population

Serial number	Test group (n=40)	Plasma reduced GSH (mean±SD) (mg/dl)	p value
1	Control population	50.275±5.252	-
2	TB patients	26.951±7.886	≤0.05

SD: Standard deviation, TB: Tuberculosis, GSH: Glutathione

Table 11: Mean values of plasma vitamin A in TB patients compared to control population

Serial number	Test group (n=40)	Plasma vitamin A (µg/dl) (mean±SD)	p value
1	Normal/control population	35.844±8.563	-
2	TB patients	15.310±4.32	≤0.05

SD: Standard deviation, TB: Tuberculosis

Table 12: Mean values of plasma vitamin C in TB patients compared to control population

Serial number	Test group (n=40)	Plasma vitamin C (mg/dl) (mean±SD)	p value
1	Control population	1.469±0.3584	-
2	TB patients	0.5002±0.3025	≤0.05

SD: Standard deviation, TB: Tuberculosis

Table 13: Oxidative markers and antioxidants in TB patients compared to normal population

Oxidative stress marker	Controls	TB patients
MDA (µmol/l)	1.525±1.038	7.309±2.422
Reduced GSH (mg/dl)	50.275±5.252	26.951±7.886
Vitamin A (µg/dl)	35.844±8.563	15.310±4.32
Vitamin C (mg/dl)	1.469±0.3584	0.5002±0.3025

MDA: Malondialdehyden, GSH: Glutathione, TB: Tuberculosis

DISCUSSION

QoL

The impact of chronic diseases such as TB of an individual affects not only his physical health but also his economic, social and psychological well-being. An objective assessment of patient's HRQoL represents the functional effects of his illness and its consequent therapy on the patient as perceived by the patient. HRQoL measures are, however, not a substitute for disease outcomes but are adjunct to them. HRQoL has

been appreciated as an important health outcome measure in clinical research. HRQoL assessment in TB research is still a new area, and a valid and reliable TB-specific instrument is much needed. Currently, a wide range of HRQoL instruments were utilized in the literature. The SF-36 was the most frequently used instrument and it appeared to be a valid and reliable tool to be used in TB. The results showed that the SF-36 score of TB patients were low before treatment indicating a decline in HRQoL especially in the physical domain. The 12 items in the questionnaire evaluate two different dimensions of health which includes questions related to symptoms that are associated with TB (score 1) and score 2 relating to their interest in work, household activities, mental status, exercise and social adaptability. These scores in the combine are usually expressed as total HRQoL score or DR-12 score. The items for each dimension of DR-12 were transformed on a scale ranging from 1 to 3, where 1 reflects the poorest state of health and 3 reflects the best state of health.

In this study, both at the beginning of therapy and at the end of intensive phase of the treatment, PTB patients had lower HRQoL scores than the EPTB patients. After the onset of treatment, HRQoL scores of both PTB and EPTB patients were increased. This implies that there was a significant improvement in HRQoL of both PTB and EPTB patients after 1 month of drug therapy having clear marks of improvements in HRQoL domains. Several studies have shown that on completion of IP itself, the symptom of TB disappear. Hence, we found a significant improvement in Score I (symptom score) at the end of IP. The study showed that there were higher HRQoL scores in both the domains during the therapy among the patients who had shown their sputum status negative at the end of IP when compared to patients of sputum positive at the end of IP. This suggests that HRQoL of sputum negative patients were significantly better than sputum positive patients at the end of IP. Similarly, newly diagonised patients (Cat I) had higher HRQoL scores during therapy than relapsed or reinfections or drug defaulters (Cat II) proving that HRQoL of Cat I patients had more significantly better improvement in HRQoL than Cat II patients. HRQoL should be considered as in important factor along with pharmacological treatment by the physicians.

Antioxidant study

In our study, total of 40 TB patients were selected and the extent of oxidative stress were assessed and compared with that of normal healthy volunteers. We found that oxidative product like MDA was dramatically high in case of TB patient when compared to that of the normal population. On other side, antioxidants like GSH, vitamin A and vitamin C are comparatively lesser in the case of TB patients than normal ones. Our results show lower antioxidant potential and enhanced lipid peroxidation products (MDA) in TB patients. Our findings further support a role for oxidative stress in the pathogenesis of TB and suggest lower antioxidant capacity and higher oxidative stress in the TB patient than in healthy human volunteers.

Lipid peroxidation is a complex process whereby polyunsaturated fatty acids in the phospholipids of cellular membranes undergo reaction with oxygen to yield lipid hydro peroxides. Among the compounds with terminal carbonyl groups that result from lipid peroxidation, MDA is widely used as an index of oxidative damage for its ability to interact with lipoproteins. Several defense mechanism exists which can reduce the damages brought about by the ROS. Due to increased production of ROS and increased oxidative stress, lipid peroxidation products are found to be elevated in TB patients MDA, a marker of oxidative stress due to increase peroxidation of lipid [20]. There was a significant increase in the MDA levels of TB patients (7 times greater than control) when compared to normal population.

It has been shown that GSH levels are decreased in TB patients [21]. In our study, there was a significant decrease in the Reduced GSH levels of TB patients (2 times lesser than control) when compared to normal population. There was a significant decrease in the vitamin C levels of TB patients (around 3 times lesser than control) when compared to normal population. Low vitamin A levels are common in patients with active TB. Circulating and hepatic concentrations of retinol have been observed to fall in TB patients [22,23]. TB patients are unable to produce sufficient amount of anti-oxidants to neutralize increased oxidative stress in them. Furthermore, several published studies suggest that low concentrations of vitamins A, C, and E and high concentrations of MDA is associated with increased severity of TB [24]. There was a significant decrease in the Vitamin A levels of TB patients (around 2 times lesser than control) when compared to normal population.

CONCLUSION

We are in the conclusion that if the patient adheres to his TB drug regimen, his HRQoL increases significantly. Also just that they felt better after the IP, he/she should not stop the CP, as there are chances of bacteria gaining resistance. Furthermore, the HRQoL tools can also be used by the physicians as an additional evaluative tool for the monitoring of the patient. Even after the treatment, if the patient is not doing better, it implies either he is suffering from a drug resistance TB or he is not adhering to his medication properly. Particular attention should be given to some methodological issues on assessing HRQoL among people with active TB disease. In this regard, further multicentred studies have to be conducted and published. In conclusion, we are in the opinion that TB patients are in need of antioxidant therapy. Because of the disease impact, already the patient will be in a malnourished state. Hence, antioxidants and vitamin supplementation were not only beneficial for the patient, it also helps in reducing oxidative stress burden.

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